

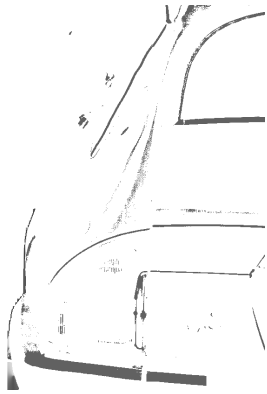
**EXPERIENCE
IN A
BOOK**

Help For The Jaguar XJ-S Owner

by

Kirby Palm

Updated: May 21, 2009



EXPERIENCE IN A BOOK

Help for the Jaguar XJ-S owner

by Kirby Palm

Compiled by an XJ-S owner, *Experience in a Book* is a unique type of automotive resource providing the sort of how-to information not found in either owner's handbooks or repair manuals. The information provided includes maintenance tips, common problems, suggested modifications, and some sources for parts. The book is not intended to replace a repair manual, but rather to complement it.

This is not a small pamphlet; the book is 739 pages when printed with a 10-point proportionally-spaced font, and includes quite a few illustrations and schematics. It grows as more information becomes available.

Experience in a Book may be downloaded, free of charge, from the World Wide Web at:

<http://www.jag-lovers.org/xj-s/book/>

Yes, you read right: This whole thing is *free*. If you have a computer, internet access, and a printer, all it costs you is the effort to log on and download plus the paper and ink to print. There are no catches; this is a hobby, not a profit-making enterprise.

This book -- along with a great deal of other Jaguar-related stuff -- is also available on the *Nine Lives* CD-ROM. There are links to online ordering from the URL provided above, or you can order it directly from:

Coltrane Productions
PO Box 932
Morgantown, WV 26507

The cost is \$2 plus shipping, and shipping is \$0.97 in the US, \$1.20 to Canada, \$1.66 to Mexico, or \$3.40 to the rest of the world.

Experience in a Book is a work in progress and is revised when new information becomes available. If you have learned something about your XJ-S that the rest of us should know, please visit:

<http://www.jag-lovers.org>

and log on to the xj-s@jag-lovers.org or v12-engine@jag-lovers.org e-mail discussion lists and post your discoveries there. Most of the contents of this book came from these discussions.

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The door locks are electric, so they are discussed under Electrical. However, the handles themselves are discussed under Body.

I live in the US. This book has been distributed worldwide, and upon rereading and editing I constantly notice comments I have made that have a distinctly US bias, like how such-and-such part can be found at the local Walmart. I have made the decision that I will leave the book this way, rather than trying to qualify each of these instances for all the people in various parts of the globe. Those in other countries will know better than I how the advice given will apply in their area.

The XJ-S is sold in countries where they drive on the wrong side of the road, so there are left hand drive (LHD) and right hand drive (RHD) models. To minimize confusion, in this book the location of an item will nearly always be described as being on the left side or right side of the car -- meaning left or right as viewed sitting in the car facing forward. The terms "driver's side" or "passenger's side" will *only* be used to describe the location of items that *switch* sides between LHD and RHD models, such as steering column, pedals, glovebox, fuseboxes, etc.

Please note that I have made the decision *not* to cover the six-cylinder AJ6/AJ16 engines in this book in any detail (there are a few minor exceptions). Since it is the same engine that is in the XJ40/X300, it shouldn't be too much trouble to find information on this engine elsewhere. The parts of this book covering non-engine items should still be of some value to owners of AJ6/AJ16-powered XJ-S's.

I also make no effort to cover features unique to the XJ12. Owners of such cars would probably be well advised to acquire both this book and Jim Isbell's book on the XJ6 (see <http://www.jag-lovers.org>) and use the parts of each that apply. There will still be some shortcomings -- neither will properly cover the carburetor setup on the early XJ12, for example -- but the owner is still likely to benefit greatly from both books.

DISCLAIMER

My own car is a 1983 XJ-S H.E.. Understandably, this book is likely to be more complete and accurate for similar vintage cars than for the early (B-W tranny, non-H.E.) cars or the newer (ABS, revised bodywork, 6.0 liter) cars. It also cannot be expected to accurately cover the differences of cars sold in countries other than the US.

While most of the information (both from my own experience and that sent in from others) has been verified on my car, obviously I cannot be responsible for the applicability to other XJ-S's. I am not associated with Jaguar, and have no means for verifying configurations of other cars. Therefore, the XJ-S owner should take advice accordingly and determine for himself if it applies to his car and will serve his purposes.

It should also be understood that an owner performing even minor work on his own car can affect his warranty. If there is any doubt whether or not the item in question is covered under warranty, the owner is advised to take it to his dealer prior to doing any work himself. If the owner is told by the dealer that the item is not covered, then the owner can make his own informed decision how to proceed.

Finally, an owner making changes to his car is responsible for making sure he is not violating emissions laws or safety or other regulations applicable where he lives and drives. There have been a few comments made in this book about regulations in various areas, but they are to be taken as general info, not legal advice.

IS THIS A REFERENCE BOOK?

Many XJ-S owners may consider this book reference material, and don't bother to look at it until they need to work on something or spend some money on the car. Unfortunately, sometimes the money spent could have been saved if they had read about how to avoid problems in the first place! And, yes, sometimes the money saved can amount to thousands of dollars; both the Lucas and later Marelli ignition systems have faults that can cost you an engine or even the entire car in *very* short order.

Hey, it's up to you; it's your car, your time, and your money. However, I highly recommend you *read* this book! Jaguars are not drive-it-and-forget-it cars; they demand a certain amount of awareness on the part of the owner, and reading this book cover-to-cover will go a long way toward making the owner aware of his car -- and possibly save him loads of \$\$\$ in the future, as well as making Jaguar ownership a more pleasant experience.

If you cannot be convinced, at a minimum *please* read about the following topics:

- Ordering manuals and catalogs starting on page 16.
- Hot shutdowns on page 34.
- Centrifugal advance mechanism seizure (pre-Marelli ignition) beginning on page 137.
- Reread the discussion of centrifugal advance mechanism seizure beginning on page 137.
- If you still haven't overhauled the distributor by this point, reread the discussion of centrifugal advance mechanism seizure again. In fact, keep rereading it until that distributor has been overhauled. Am I getting through yet?
- Relocation of ignition amp (pre-1983 models), page 148.
- Catalytic convertor meltdowns on page 161 (Marelli ignition cars; if you have a car with Marelli ignition, *do not fail* to read this section!).
- Shortcomings of the cooling system, recommendations, and "How hot is too hot?", starting on page 173.
- Advice on using cooling system sealers on page 189.
- Fan cracking on page 214.
- Engine fires on page 232.
- Fuel sump pickup problems on page 251.
- Fuel pump power supply concerns on page 255.
- Soft shifts on page 337.
- Replacing the steering rack bushings on page 375.
- ABS brake testing (on cars so equipped) on page 454.
- Radius arm mount rust problems on page 464.
- Brake fluid level switch problems on page 596.
- Saving the stereo from water damage on page 665.

THE JAGUAR XJ-S

WHAT'S IN A NAME?: First and foremost, it's high time to quit abusing the name "Jaguar". It does not rhyme with "quagmire"! According to Jim Isbell: "At a recent Jag Club meeting they showed a video of the history of Jaguar from the Swallow to the present. I was most interested to see how the owners and perpetrators of the Jaguar company pronounced it. There were several old voice interviews and I listened very carefully every time one of them spoke. The pronunciation I got from those interviews was: Jag-u-wer. I think the people who invented it must know how to pronounce it."

The name of the car that this book addresses is the "XJ-S" -- or, at least that *was* the name. Up until 1982 the dash actually had its own part number, since the four characters on the back end of the car were four separate pieces; through the rest of the 80's, the four characters on the back of the car were a single badge, but the hyphen was still apparent. Since the badge on the car itself has to be considered the ultimate authority, up until 1991 anyone referring to the car as an "XJS" was in error. This was a very common error, since XJ6 and XJ12 do not have dashes in the names and it was commonly assumed that this was normal Jaguar naming convention. Unfortunately for anyone trying to keep such things straight, even the folks at Jaguar were guilty of this error, as evidenced in several of their brochures and manuals.

According to Paul Skilleter's book "Jaguar XJS: A Collector's Guide", when the bodywork was revised for the 1991 model year the name of the car was officially changed to "XJS" to emphasize the change.

I will also mention what a "Daimler" is. Daimler was a British automobile company that was bought out by Jaguar in 1960. However, Gottlieb Daimler also founded a German automobile company that merged with Benz & Cie. in 1926 forming Daimler-Benz AG (later DaimlerChrysler, still later Daimler AG). The Mercedes manufacturer registered the name Daimler in the US, so Jaguar cannot use the name in the US even though the former British company by that name belongs to them. Daimler-Benz always called its cars Mercedes (after somebody's girlfriend many decades ago), so there are no cars known as Daimlers sold in the US.

While the British Daimlers were originally a distinct line of automobiles, eventually they became variations on Jaguars. Regarding the cars covered by this book, the Jaguar XJ12 was also sold as the Daimler Double Six in some countries, with detail differences including a distinctive fluted grille.

S TYPE: From "Great Marques - Jaguar" by Chris Harvey:

The S type saloon

There was a considerable demand for a more luxurious version of the compact saloon, and Lyons decided to combine the major improvements of the Mark X with the established features of the Mark 2, once the Daimler had been launched. The result was the Jaguar S type saloon introduced in 3.4-litre and 3.8 litre forms in September 1963. These cars were similar to the Mark 2 in most dimensions and running gear, except that they had the new independent rear suspension.

The S type (no hyphen) and most other lines of Jaguar saloon were discontinued when the XJ6 was introduced in 1968.

In a shameless attempt to capitalize on William Lyons' glory of years past, Ford/Jaguar introduced a new S-type (with hyphen) in 1998. David Berman says, "The S-TYPE is related to the Lincoln LS6/8. This is known as the DEW98 platform."

So why is all this discussion in a book on the XJ-S? Because some people insist on referring to the XJ-S as an "S-type". Makes sense; the rolling phallic symbol known as the E-type in Europe and elsewhere was marketed as the XKE or XK-E in the US, so it naturally follows that Jaguar's marketing department must be similarly misguided regarding the XJ-S. Connoisseurs of the E-type sometimes get huffy if you are so base as to refer to their cars as XKE's, so people may actually think they are using the more proper term for the XJ-S when they call it an S-type.

So, how common is this error? Believe it or not, it spread to the marketing department at Jaguar again! The 1981 XJ-S sales brochure said:

Jaguars have always been distinguished by a special grace of form and a rare poise in motion. Yet even among the legendary Jaguars of the past, this new S-type stands out. The XJ-S does what Jaguars have always done -- only better. It is quick and responsive, stable at speed, silent in motion and notably luxurious.

Despite the disinformation tactics of those goobers, it's really not proper to refer to an XJ-S as an S-type; the mid-60's car was an upscale compact saloon, and even the 1998 knockoff appears to follow along that same theme. The XJ-S is clearly in an entirely different class.

VIN NUMBER DECODING: There are two different VIN numbering schemes for the Jaguar XJ-S. All cars have a VIN number stamped into the sheet metal dead center in front of the hood seal, and this VIN corresponds to the scheme described below, based on input from Richard Mansell, William Noorloos, and Paul Skilleter's book.

Position 1-3 denotes manufacturer
SAJ = Jaguar

Position 4 denotes marque
J=Jaguar
D=Daimler

5th is model
N=XJ-S
S=XJR-S
T=Special edition

6th is class
A=baseline
J=Japan
K=Japan with airbag
L=Canada
M=Canada with airbag
V=USA spec with manual belts
W=USA spec with driver airbag
Y=USA spec with passive belts.

7th is body type
C=Cabriolet
D=Convertible
E=Coupe
F=2+2 Convertible

8th is engine type

B=3.6 4VB
C=3.6 4VC or 3.6 4Y
D=3.6 4VD or 4.0 4Y
E=3.6 4VE
K=5.3 F
S=6.0
V=5.3 A
W=5.3 B
X=5.3 C
Y=5.3 D
Z=5.3 E

9th is Transmission and steering

3=Auto RHD
4=Auto LHD
7>manual RHD
8>manual LHD

10th is model or year change

A=XJ-S original spec
B=HE coupe
C=AJ6 coupe and convertible
D=V12 convertible
E=facelift (1992-)

except for USA, Canada and Korea where from 1981 the 10th letter indicates year of build starting with B=1981. Skip the letter I, so J=1988.

11th is emission control equipment

(up to 1987: manufacturing plant, C=Browns Lane)

12th-17th are the vehicle's unique number.

Andrew Stott says, "My car is UK spec, pre-HE, made in 1979, D-Jetronic. The VIN is JNAEW1AC101185. One confusing thing is that the character in the VIN that denotes the transmission and steering is a '1' and according to the books it should be a '7' as it is a manual RHD car. In Skilleter's XJ-S Collectors Guide, he gives details of the last production XJ-S manual. It was made in 1979 and had a VIN of JNAEW1AC1018xx; this would suggest that the '1' in the transmission character position is valid for a RHD manual car."

Now, if you have a US-spec car, there is a tag within the left edge of the windshield that carries a totally different VIN number. This VIN corresponds to the following scheme, from the "MOTOR import car crash estimating guide" for the US:

1st-3rd Position - Manufacturers Code
SAJ=Jaguar, United Kingdom

4th Position - Model Line

A=XJ6
A=Vanden Plas
C=Sovereign
F=XJ6
H=XJ6, Sovereign
K=Vanden Plas
M=Majestic
M=XJ12
N=XJ-S/XJSC
P=XJR/Sport
S=Jagsport
T=Rouge/Classic

5th Position - Class/Restraint

A=Passive Seat Belt (87-89)
T=Driver Air Bag w/Passive belt
V=Active Seat Belt
W=Driver Air Bag (90-95)
X=Driver & Pass Airbag
Y=N. American Spec (83-87)
Y=Passive Seat Belt (89-93)

6th Position - Body Style

1=4 door sedan
2=2+2 Convertible
3=2 door Cabriolet
4=Convertible
5=2 door coupe

7th Position - Engine Code

0=5.3l 12 cyl, Calif.
1=4.0l 6 cyl, Supercharged
2=4.2l 6 cyl, Calif.
3=4.2l 6 cyl
3=6.0l
5=3.6l 6 cyl low compression
6=3.6l 6 cyl high compression
7=4.0l 6 cyl
8=5.3l 12 cyl
9=4.0l 6 cyl

8th Position - Transmission & Steering

4=Automatic (LHS)
8=Manual (LHS)

9th Position - Check Digit

10th Position - MODEL YEAR

D=1983
E=1984
F=1985
G=1986
H=1987
J=1988
K=1989
L=1990
M=1991
N=1992
P=1993
R=1994
S=1995

11th Position - Assembly Plant

C=Browns Lane, England

12th-17th Position - Production Sequence Number

Alex Dorne had a US-spec car shipped to Sweden, and reports that the process included removing the VIN tag at the left side of the windshield -- possibly to avoid confusion between this VIN and the one under the hood. He was allowed to keep the windshield tag. Also, the VIN under the hood also appears on the aluminum panel inside the trunk, just to the right of the latch. He postulates that this may have been stamped as part of the Swedish import procedures as well.

ACTIVE SEAT BELTS? They don't *look* very active. Peter Cohen clarifies: "It means that if you are not "active" and "actively" fasten your seat belt, it ain't gonna be fastened. As opposed to "Passive" seat belts that are motor mouse driven."

WHAT'S IN A YEAR?: Now that you have deciphered your VIN and know for sure what year your XJ-S is, do you really know what year your XJ-S is? If you live in the US, perhaps you've noticed that each model year seems to appear several months before the year itself, which certainly makes it doubtful that the car was actually *built* in the year it's purported to be. Apparently, the "model year" is a term that varies from country to country, and -- of course -- the US has the least rational definition. Peter Cohen says, "For those interested in trivia, here's how it works: In the US a given model year can only be manufactured to be offered for sale on a single January 1st. That's the only rule. This can result in the following (more or less true) example: A certain 1996 model of vehicle began manufacture in December 1994, was put on sale 2 January 1995 and continued to be sold as a 1996 model until September 1996 (although legally they could have been sold until 31 December 1996). This is not to say that one that remained unsold on 1 January 1997 would have become a 1997. It is the date that it is intended to be sold as a "current" model that the regulation applies to. So, that's what happens when marketing types run amok.

"I find it particularly galling when you go to buy a used car. You will be asked the same price for a 4 year old car as for a 5 year old car. You don't know what you are buying unless and until you remember to check the manufacture date, and even then it probably won't help your bargaining position.

"On US spec vehicles, the certification label should say something like "This vehicle meets all US specifications...in effect for model year 19xx." IMHO, that is what year a US spec car is, regardless of the manufacture date or what's on the title.

"When you get outside of the US, "year" becomes too simplified of a question. I don't think that non-North American spec cars come labelled with month/year of manufacture. In England, cars are referred to by their registration letter, which changes on 1 August each year. So a leftover model becomes next years' car by virtue of having the newer

registration letter.”

John Littler adds, “In Oz, date of manufacture is required on the ADR compliance plate. We have a nice simple system where a car made in ’88 is an ’88 model.”

Unfortunately, this MY hogwash can’t help but cause some inconsistencies in this book. For example, one person’s quote might describe a fix on his ’88 when somewhere else it’s made clear that the problem shouldn’t even exist past 1987. There is simply no way to correct such things in everyone’s direct quotes, although wherever possible attempts are made to clarify which configuration a quote is intended to reflect. In general, if this book states that something applied to a particular range of model years, please allow about one year of leeway before deciding whether or not it applies to your car.

XJ12 STYLES: For the benefit of those XJ12 owners who read this book, I am including some info on the various different cars that have all been called an XJ12. The following is courtesy of B.J. Kroppe: “XJ12s were made in Series III body style until 1992 (yes, alongside XJ40 6-cylinder models). XJ12s in XJ40 body style were made for one year. Whether it was only one-half of a year or a full year, it was 1994. XJ12s in X300 body style were made from 1995 - 1997, when the V12 engine was retired from production.

Series I XJ12 5.3l	1972 - 1974
Series II XJ12 5.3l	1974 - 1979
Series III XJ12 5.3l	1979 - 1992
XJ40 XJ12 6.0l	1993.25 - 1995
X300 XJ12 6.0l	1995 - 1997
XJ-S 6.0l	1993.5 - 1997

“Note there were no XJ40 5.3l cars produced.”

Steve Lipscombe explains why the Series III XJ12 continued long after the XJ40 was introduced: “The first XJ40 was certainly designed with a narrow engine bay to prevent the British Leyland management forcing the Rover V8 unit on them. Later, when privately owned, they redesigned the bay to take the V12. This was before the Ford takeover and the X300.”

CABRIOLET: David L. French, a US owner, describes the Cabriolet: “It has the body profile of the convertible that was made later but has a 3-piece removable hardtop. T-tops up front and a fully removable hardtop on the rear. Totally factory made.”

Since the Cabriolet lacks the buttresses of the coupe, it stands to reason that the body isn’t as stiff in that area. Jaguar apparently addressed that problem by adding “ladders” underneath the rear suspension. Julian Mullaney reports: “The ladder brace was fitted to Cabrios from the factory. Quite crude looking. You can easily spot it on a cabrio just looking from the side. I think it connects the chassis with steel bars fore and aft of the diff. It passes under the diff. The ladder frame does not connect to the subframe, it is definitely a chassis stiffener.”

The Cabriolet was apparently offered in 1986-87-88 model years. David King says, “There were at least 1900 Cabriolets shipped to the US and all were V12s even though it looks as if in the rest of the world the AJ6 was the more common engine for the Cabrio. There were a total of 5014 Cabriolets built during their production run: 5013 Jaguars and a one-off Daimler.”

HESS & EISENHARDT CONVERTIBLE: The XJ-S was designed in an era that never expected to see a convertible again; they were expected to be outlawed for safety reasons. For many years, the only way to get an XJ-S convertible was to hire one of many aftermarket customizing outfits to cut the roof off your coupe. By the mid-80’s the expected ban on convertibles had failed to materialize and convertibles were making a comeback, so Jaguar responded by contracting with Hess & Eisenhardt in Cincinnati, Ohio to make convertibles from coupes to be sold as new cars at the Jaguar dealerships. After two years, the response had been so good that Jaguar began making its own convertibles at

the factory, and continued until the end of XJ-S production.

Mike Cogswell elaborates: “The H&E's were built in '87 and '88 (my '88 is one of the last, possibly *the* last). The H&E is easily spotted by:

1. The small oval Hess & Eisenhardt badge on each side behind the front wheel well.
2. The top folds down flat, the later factory convertible tops are pretty high when folded.
3. The H&E has four window rocker switches. Early ones are separate, later ones in a single gang of four.
4. The factory convertible has a small, ugly <grin> hump in the sheet metal on the side right behind the doors. This covers the tops of the rear quarter windows, which don't fully retract.

“There are many other differences, but those are some of the most obvious.”

David Johnson adds, “The top also looks better than the regular convertible because it is fabric, not a plastic.” This may be true for only *some* of the H&E tops, though. Another owner says, “I figure they had the tops made in California by Robbins.”

Supposedly the building the H&E's were made in burned down, but H&E is still in business making limousines and other things.

Of course, the nickname H&E is only too likely to cause confusion with the H.E. used to describe the V12 engine with the Michael May-designed heads.

If you own an H&E or would like to know more about them, Johnson is the guy to talk to. He operates an e-mail discussion list dedicated to the H&E and serves as a clearinghouse for available information. His phone number is +1 303-708-1850, you can send him e-mail at david@davemjohnson.com, or you can visit his web site at

<http://www.davemjohnson.com/>.

LISTER: Lister is the name of an outfit that became famous for building racing “specials” powered by Jaguar XK engines in the late 50's. Brian Lister withdrew from the racing scene in 1959 when one of his drivers was killed in a Formula 2 race, but the Lister name reappeared in the mid 80's in a modified form of the XJ-S. Peter Cohen describes a 1988 Lister XJ-S he looked at: “The car had a V12 with a 5 speed manual gearbox, as well as all trim in body color (no chrome, no stainless, no black rubber or vinyl), as well as suspension modifications. The car also has some "ground effects" type body cladding.”

Brian Schreurs refers to a Road & Track article on the Lister: “It states that US versions got no engine upgrades, but outside-US versions were tweaked considerably. It received a 5-speed from Getrag, the same used in BMW's 7-series at that time, and also significant improvements to handling at no cost in ride.”

Of course, when Jaguar started offering its own JaguarSport models, the market for such aftermarket modifications dropped. For the 90's, Lister was building a fire-breathing monster called the Storm powered by a highly souped up 7+ litre Jaguar V12, and was competing in the major endurance races against Vipers and the like.

TWR: Stands for Tom Walkinshaw Racing, an organization with considerable success racing Jaguars in Europe. Walkinshaw's team won the James Hardie 1000 in Australia (better known as the Bathurst 1000) in 1985 in an XJ-S, after an ignominious effort in 1984 in which the engine stalled on the starting grid and the car was creamed by a Camaro coming from behind.

TWR modified customers' XJ-S's for street use until the formation of JaguarSport -- see below.

1988 LE MANS: Jaguar won the 24 hours of Le Mans! Brian Schreurs says, “The original XJR-S of 1988 was considered the 'Le Mans Celebration' model. The first 100 were grey in color, had special badging, and a build number plate. Otherwise they were built to the same specs as any other XJR-S.”

John Goodman elaborates: "Early '88, all tungsten grey, 15" speedline "bottle-top" alloys and body spoiler kit, slight suspension upgrade. A limited edition to commemorate Le Mans races."

JAGUARSport: John Goodman: "It was set up in the late eighties, a joint venture between Jaguar and TWR Group, sadly disbanded in '93-'94, all the tech people now work for Aston Martin. Remember, in the late eighties Jaguar was on a high, winning race cars and everyone hyped up over the XJ220 (till they found out it had a poxy V6!). Obviously Jaguar wanted to promote their racing pedigree... Enter Tom Walkinshaw who had been modifying Jaguars to special order.

"Standard XJ-S's and XJ40's were taken from the Coventry production line and modified at the new JaguarSport plant in Bloxham (near Banbury in the Cotswold hills England). This is the same plant that assembled the XJ220 and race cars. This plant now makes the Aston Martin DB7.

"The very low volume production run of JaguarSport 6.0L engines were expensive to produce. Jaguar upped the cc of the last of the standard Jaguar XJ-S's and XJ12's with a different updated 6.0L engine and 4 speed autos, this is reportedly *not* the same 6.0L as the JaguarSport unit; I do not know the difference, output is similar at 335 bhp, but retains Marelli ign.

"The JaguarSport XJ40's '88-'92 (both 3.6 and 4.0L models were made, no US versions) were more heavily modified, special cams and cyl heads."

Richard Mansell adds: "The first JaguarSport cars were modified at Kidlington, the home of the TWR Jaguar racing team. JaguarSport moved to Bloxham a year or two later. Cars to be modified were delivered there minus bumpers but trimmed to JaguarSport spec.

"Owners with standard cars could have them modified to JaguarSport spec under the FAB scheme (Fitted At Bloxham)."

Nathaniel Musselman says, "I tried to call JagSport in UK, but the number is answered as Aston Martin."

XJR-S: Richard Mansell: "Some of the many mods included on the original XJR-S's were: 11% stiffer front springs, 20% less compliant rear radius arm bushes, specially valved Bilstein shocks. They were shod with 15" x 7.5" Speedline wheels. Later on the wheels were widened by 0.5" and different tyres specified. Various suspension mods were made along the way too. The original paint colours available were - Signal Red, Regency Red, Black, Solent Blue, Silver Frost and Brooklands Green. The only other colour mentioned for the early cars is Tungsten Grey which was used on the first 100 XJR-S's sold as Le Mans specials.

"In theory a real XJR-S will have the letter S as the 6th character of the VIN."

John Goodman: "The Le Mans model changed or rebadged to the XJR-S in '88 until October '89 when the XJR-S was more heavily modified with updated engine (6.0L), autobox, all new updated suspension, and similar "bottle-top" wheels but 8" wide and 16" diameter. Except for the spare which is still 15" with a temporary speed limited tyre!! Could be because the 245/55 tyres don't fit the wheel well in the trunk; more likely it is because the wheels have different offsets and different size tyres (225/50 front), so you would need *two* spares! Or risk mismatched wheels; at least with this it has a bright orange label on it clearly showing the speed restriction and a warning to change as soon as possible.

"Surprisingly there is no rear anti-roll bar fitted, do not know about the '92's. I do know that TWR spent a lot of time perfecting the setup for its intended market, i.e. it must retain its Jaguar qualities and handle better, it was never meant to be a track car. The Lister modified cars were more for the race track feel. Similarly the Sportspack equipped 3.6 manual was designed for another market, it had to *feel* like it was sporty even if the ride was uncharacteristic for a Jag.

"The XJR-S continued in the new body shape with even more revisions until the introduction of the last of the "standard" XJS's with the 6.0L/4 speed auto. A dark blue was introduced for the '92 cars and a nice metallic silver/pink, but you could probably have any Jaguar colour off the production line.

"The genuine JaguarSport XJR-S 6.0 may be identified by the red "JaguarSport V12" badge on the inlet manifolds at a

quick glance. Officially these came out in Sept '89. I think all 6.0L engine numbers must start with 8W01***** (mine does anyway)

“The '88 XJR-S and Sept '88 limited edition Celebration model XJR-S were all standard 5.3. However, TWR converted a few cars to special order before it changed over to JaguarSport. Some were just cosmetic with standard engines and some had various engine mods up to 7.2L but the most common was 6.1L and apparently more V12 saloons were converted than XJ-S's.

“As TWR rebuilt customers' own cars/engines (not necessarily new ones either) then I would guess that the engine no. relates to the original 5.3 that the car started with. But, I believe there should be a bronze identification plate somewhere on the engine indicating a genuine TWR engine.

“Should you be lucky enough to actually have an early pre production XJR-S 6.0 it could be some sort of hybrid, may not have all the mods.

“First look in the boot, the ECU is very obviously different, for a start it's mounted on the left of the fuel tank. There are two injector power resistors on the L/H inner front wing instead of the usual one of the standard V12 and the air boxes are also totally different from the standard car, everything else looks the same.

“On the road they are magic! Not harsh, but very good handling. The GM 400 auto box has modified shift speeds and are quicker in changing, and less reluctant to kick-down into 1st. The steering racks have reduced assistance and appear to turn faster. The suspension/spring set up is unique to the 6.0L, not the same as the sport spec. option.

“The '92 cars had more power than the pre-facelifted version, went from 318 to 338 BHP with cat exhausts. The BHP increase is quite small but the engine has a lot more torque.

“US spec: Only 50 coupes and 50 convertibles imported '93 -'94, all were red or black... So are very rare. Easily identified by special steering wheel and JaguarSport logo on the seat headrests. Special 6.0L engine (338 bhp) with Zytex ignition/injection and sequential injection, special reprogrammed GM400 shift speeds, special springs/ bilsteins (not the same as the sport spec option on the standard cars), 8" wide special alloys with different offsets for front and rear and an odd mix of rubber, 245/55 rear 225/50, front revalved power steering rack 30% stiffer, twin in tank fuel pumps. Also, revised more efficient electric cooling fan, revised ducted cold air intakes for the manifolds and a few other bits! It's not just plastic body mouldings and badges as you thought!!!

“You can order the XJR-S product support manual publication no S-80, unfortunately only available in the USA. Around \$25, but it looks like a dealer service manual.

“The only downside to these cars are the special ECU and distributor. Very expensive and the average Jag dealer knows little about them! They can be repaired however if sent to the Zytex factory here in the UK. All the other engine sensors are std. XJS. JaguarSport parts are easily available, I have had no difficulty.”

“Any Jag dealer should be able to give you a print out of all the JaguarSport parts (a few hundred). Apart from the engines, revised GM400 shift settings, injection/ignition, suspension, bodykit and minor interior changes the rest of the parts are the same.

“JaguarSport has been disbanded, I have horrendous trouble trying to get technical information for my F.I. problem (minor problem). However, I have had no trouble in the availability of "JaguarSport" parts.

“US dealers did have, may still have, a technical help hotline to Jaguar UK for all XJR-S queries.”

Goodman adds that “There are full parts lists for all JaguarSport bits on the XJR-S web pages.”

<http://www.jag-lovers.org/xj-s/xjrs/index.htm>

SPORTSPACK: John Goodman: “The SportsPack has nothing to do with JaguarSport. In fact I believe it is standard on most of the 3.6L coupe XJ-S's (not sure on US cars) and an option on the V12 and 3.6 convertible. Jaguar assumed the 3.6 5 speed would appeal to the sporty driver! Basically it is harsher springs and dampers, rack bushes and a sporty steering wheel; I think the cross spoke alloys with 235/60 tyres were part of the package at first but were later offered

separately. Ride is quite knobby; it does not include the re-valved steering rack of the XJR-S 6.0L, which has yet again different springs/ bilsteins (which also appears lower) and has a far smoother ride than a V12 with the SportsPack option.”

Richard Mansell: “It was introduced by Jaguar as standard on the 3.6 in Sep 1987 and comprised of 43% uprated front springs, 3% uprated rear springs, uprated Boge shocks all round, increased diameter front anti-roll bar, rear anti-roll bar re-introduced, reduced assistance power steering, stiffer rack bushes and Pirelli P600 235/60 VR tyres on the lattice wheels.

“The SportsPack, a variation of the one on the 3.6, was introduced on the V12 in Dec 1989. Judging by the parts manual the front suspension is different, I guess because of the extra weight of the V12. The rear springs and shocks are the same as the 3.6. The rear radius arm and anti roll bar is from the 3.6.

“The sports suspension became available in the US in Feb 1993.

“The later 5 volume workshop manual has a table of shift points for the standard gearbox and one for the SportsPack gearbox.”

“The twin coachlines along the side of the car were two tone as part of the SportsPack although from VIN 144700 (3.6) and VIN 148782 (V12) this became standard.

“The sports seats were originally only available as part of the SportsPack.”

1990 LE MANS: Jaguar won again! Mansell: “The second Le Mans Special Edition was introduced at the Birmingham (UK) Motor show in September 1990 to celebrate the TWR XJR-12 win. Based on a standard car, the 280 models built had quad headlights, 16" lattice wheels, sports suspension, full Autolux leather interior, high-contrast walnut veneer, a four spoke leather steering wheel and Wilton carpets. The stainless steel sill plates had a 'Le Mans V12' motif along with the limited edition serial number.

North America did not receive the Le Mans but had their own Classic Collection instead. Along with unique paint colours, magnolia leather with contrasting piping, leather gearshift knob, charcoal toned leather steering wheel they also had gold boot and bonnet badges.”

Goodman: “Just a standard XJ-S with SportsPack and spoilers.”

Brian Schreurs says, “There were 280 built for the world. No breakdown on Federal vs. ROW.”

1990 ROUGE EDITION: Brian Schreurs says, “It is a special trim package; no structural changes.”

CALIFORNIA, 1991: Peter Cohen says, “Here in California, there were no 1991 XJ-S's. The dealers sold 1990 models all through 1991, until the 1992 model came out. I thought that was just the way it was until 1994 when I came across an actual 1991 Federal model. Now I realize that there are 1991 XJ-S's all over, just not in California.”

1993, US MARKET: Enrico Campelli says, “For 1993 the standard XJ-S V12 was dropped for USA market and was only available as XJR-S version, coupè or convertible. 50 coupè and 50 convertible were produced, finished only either in Signal Red or Jet Black.”

Charlie Randle disagrees. “The US 1993 year XJR-S series were manufactured in a limited edition of 50 Convertibles and 50 Coupes featuring a serialized plaque on the Dash. The 6.0 engine had the ZyteK Engine Management system and the old 3 speed slushomatic transmission. However, the colors were not limited to black and red. I have seen a Silver coupe and a Silver convertible here in North Florida, both of which seemed to cycle through the dealer's used car lot fairly often as the ZyteK system was hard to maintain and a frequent problem according to the dealer.”

Steve Gallant cleared up the discrepancy by reporting that, in addition to the 100 red and black cars, there were 4 silver

“press” cars (three coupes and one convertible). “Believed to be *not* part of the 100 since they do not have the silver ID plate on the console.” He adds: “Red cars have a cream leather interior, black and silver have a black leather (charcoal) interior. The '94 and later Jaguar 6.0L XJS' have nothing to do with these cars”

Jaguar offered the 4.0 XJ-S in the US in 1993 while the V12 engine was being reworked.

INSIGNIA EDITION: Brian Schreurs says, “Insignia was a limited edition special order. The differences were:

- The wood veneer in any colour.
- The leather colour any which you wanted.
- Piping on the seats.
- Insignia Alloy wheels.
- Boot fabric was different, thick flannel.”

John Goodman adds, “Not sure about the numbers produced but certainly not more than 100-200, documented information is very scarce. Mechanically a standard XJS, but with the option at the time to choose a wide range of wild pearlescent non-standard body colours and customised interior colours/fabrics, including I believe the option of different wood veneers or grey stained (like the XJ sports sedans). UK market had the quad headlights as well.

“Basically, whatever the customer wanted Jaguar would try to do it! Some colours were quite tame, some wild! All the mechanical bits are standard so no maintenance worries. May have the option of the sports suspension kit as well; depends, I think, on country.”

Richard Mansell: “The Insignia options were available by special order from October 1992 and it basically allowed you to personalise your car with a range of different finishes. The Jaguar sales catalogue from around that period says:

“Like all Jaguars, the latest XJ-S models provide a comprehensive wealth of equipment and appointments as part of their standard specification; there is no question of providing just a basic car and then charging extra for virtually every desirable refinement. As a result, the list of items shown here as being optional at extra cost is quite small. Nevertheless, there is one important development which must be mentioned. This is 'Insignia', a service carried out by the craftsman of Jaguar Special Vehicle Operations. Under this service they offer:

- Stunning, exclusive paint colours
- Soft, semi-aniline all-leather interiors, uniquely styled and trimmed in a range of special colours
- A choice of natural or tinted wood veneers to compliment and enhance the chosen paint and trim colours”

Mansell mentions that Jaguar Special Vehicle Operations “built the Daimler DS420 Limousine and other specials.”

WEIRD CONVERSIONS: Lots of Jaguars end up converted or modified, especially in the early years when convertibles weren't available from the factory. If you have something you can't identify, Peter Cohen suggests: “The answer should lie on your doorpost. US federal law requires that a company that modifies a vehicle (such as a motorhome or convertible conversion) affix a label to the vehicle that says something to the effect of:

“Modified by: _____ Date: _____

This vehicle conforms to all applicable motor vehicle safety standards in effect on date of manufacture shown above”

or something like that.

“This should tell you who did the conversion, and, if you are lucky, it will tell you where they are located.”

PRODUCTION NUMBERS: John Ratcliff provided these numbers from “a 60-page supplement to the June 95 edition of Classic and Sports Car, called ‘60 Years of Jaguar - A Celebration’.”

XJ12	1972-73	3228	
XJ12 SII	1973-79	16,010	
XJ Coupe (5.3)	1975-77	1855	
XJ-S	1975-81	14,890	
XJ12 SIII	1979-92	15,918	
XJ-S H.E.	1981-91	46,895	
XJ-S Cabriolet	1983-88	1143	(3.6)
		3864	(5.3)
XJ-S 3.6 coupe	1983-91	9979	
XJ-S V12 convertible	1987-91	12,771	
XJR-S	1988-93	n/a	
XJS (4.0, 5.3, 6.0)	1991-	n/a	
V12 saloon (XJ40)	1993-94	n/a	
XJ6/XJ12 (facelift)	1994-	n/a	

HORSEPOWER: Brian Schreurs: “According to my library, these are the various horsepower/torque ratings:

British-spec pre-HE 5.3L V12: 285@5500/294@3500
 Federal-spec pre-HE 5.3L V12: 244@5250/269@4500

British-spec 5.3L V12 HE: 299@5500/318@3000
 Federal-spec 5.3L V12 HE: 262@5000/290@3000

British-spec 3.6L 6-cyl: 225@5300/240@4000

British-spec AJ6 4.0L 6-cl: 223@4750/277@3650 (to summer 1994)
 Federal-spec AJ6 4.0L 6-cyl: 219@4750/273@3650 (to summer 1994)

British-spec AJ16 4.0L 6-cyl: 241@4700/282@4000 (to present)
 Federal-spec AJ16 4.0L 6-cyl: 237@4700/282@4000 (to present)

(no difference in market noted) 6.0L V12: 308@5350/355@2850

SHOPPING FOR A USED XJ-S

If you are considering the purchase of a used XJ-S, there is one very important thing to do: Insist upon having a compression check performed -- by an independent mechanic, if possible. On a V12, one or two bad cylinders can easily go unnoticed on a test drive if you aren't familiar with how the Jaguar should drive.

If any cylinders read lower than the rest by more than 10% or so, be aware that an engine overhaul will cost thousands. You will probably decide to pass on the car unless it is really cheap and you plan on engine work anyway.

Note that it is unusually difficult to pull the spark plugs on this car, so a compression check will involve a couple hours labor on the part of your mechanic. Money well spent.

Mike McGaw suggests that, if the car has ABS brakes, special attention be paid to their condition. Apparently some owners, upon learning how much it will cost them to repair their ABS brakes, decide that the solution is to disconnect the warning indicators and sell the car. This is liable to lead to a very expensive and a very dangerous situation indeed. There is a diagnostic process described under "Accumulator Testing" on page 457 that is easily performed and will go a long way toward instilling confidence in the condition in the system.

One other noteworthy comment regards mileage. If properly maintained, the Jaguar can easily pass 200,000 miles before any major renovation is needed. So, the prospective Jaguar buyer would be well advised to pay a little less attention to what the odometer says and a little more attention to the completeness of the maintenance records.

As far as everything else on the car is concerned, it's pretty much the same as buying any other car. Bodywork and repainting are always expensive, and are more so on a Jaguar. Rust is always a call for concern. Apparent bodes or slipshod repairs are signs of trouble.

If you're really a careful shopper, read this entire book first. It will give you a really good idea what pitfalls to look for in a used car.

Don Marlin notes that you can check out the Kelley Blue Book WWW page at:

<http://www.kbb.com/>

Or, of course, you could actually buy a Kelley Blue Book. There is another similar product by the National Automobile Dealers Association (NADA). Both come in both a consumer and a dealer version.

Mike Wilson adds another source of value estimation:

CPI Value Guide
P.O. Box 3190
Laurel, MD. 20709
1-800-972-5312

RELIABILITY CONCERNS: Is the Jaguar XJ-S a reliable automobile? I think that, based on a review of any of the available statistics, the short answer would have to be no. However, the real reasons for the poor reliability record are probably not those commonly offered. It's not really the fact that the engine has 12 cylinders, although this does affect the cost of repairs.

There are really two basic reasons for the poor reliability record. The first is that there were a few minor glitches in the design of particular components, which is not all that unusual in automobile design, but while most automakers try to correct such problems in a timely manner Jaguar apparently allowed many of these problems go unaddressed for *decades*. This is arguably because Jaguar was suffering management problems as well as financial problems for a considerable portion of the production life of this car.

The second reason is a long and shameful history of consistently incompetent service from Jaguar dealers, specialists,

and everyone else offering to work on these cars. Obviously, when a common problem becomes apparent in the design of a car, competent service providers would determine the corrective action necessary and offer such repairs to owners. But, as noted in many places in this book, service providers have not helped and have even exacerbated many problems, and apparently continue to do so to this day!

Fortunately, the problems of the design of the XJ-S are all minor and easily corrected, which can render the car very reliable indeed. When looking for a used car, make sure to select one that hasn't already been seriously damaged by poor maintenance (notably overheating), and then promptly read the page titled "IS THIS A REFERENCE BOOK?" at the front and check through all the items listed. Be sure to actually take the corrective actions recommended; don't just read about them!

Some prospective owners are reportedly even scared off by the size of this book! As the author I'm clearly biased, but I'd suggest that anyone who spent more than ten years compiling information on a Chevrolet Camaro or Ford Mustang or any other model that's been offered for more than 20 years would end up with a book at least as hefty as this one!

DURABILITY: Durability is really a different concept than reliability. Reliability is all about a car's tendency to quit and leave you stranded or cost you money, while durability is about how long you can drive the car before it's worn slap out and needs to be completely renovated or replaced. The two concepts are often confused, and in fact are somewhat related; as individual components wear out and break down, they render the car unreliable. But when talking about true durability, the Jaguar XJ-S is a standout among automobiles. One being worn to the point of requiring renovation is almost unheard of. If the car has the problems noted in this book addressed and the owner replaces items such as rubber seals, belts and hoses, and normal wear items on a timely basis, the Jaguar XJ-S could easily be considered a car to last a lifetime. There may be a few other cars with comparable durability, but one that's this much fun to drive is truly rare!

The one notable exception to the car's durability is probably the original paint. The paint used up until at least the mid-80's was lousy, usually fading, crazing, and otherwise looking really terrible. If such a car hasn't been repainted already, purchasers should probably budget about \$3000 for a complete strip and repaint as part of bringing such a car up to acceptable condition. The 90's cars supposedly used better paint.

GENERAL

GETTING SERVICE: Keeping your Jaguar in good working order is like anything else: If you want it done right, do it yourself. Doing as much of your own maintenance as possible is *highly* recommended, based on experiences shared on the online discussion lists (many of which are related in this book). You might be thinking, “Yeah, but wouldn’t I be better off hiring somebody with a lot of experience working on these cars?” The answer: You’re holding all the experience you’re ever likely to need. That’s why the book was so named.

Nevertheless, there will be owners who don’t want to get dirty, or don’t have the time, or don’t have the tools, or don’t have a garage, or for whatever other reason would simply prefer to pay someone else to work on their car than do it themselves. There’s nothing wrong with such a strategy; it simply must be made clear that such a decision should *not* be made with the expectation that the car will get *better* service. More convenient, maybe; quicker, quite possibly. But a long history of experiences with Jaguar dealers, specialists, mechanics, and the like indicate that the XJ-S owner should expect *more* problems if he takes his car somewhere for service than if he maintains it himself using this book as a guide.

That said, some guidelines on finding a good mechanic: First, note that the XJ-S has been out of production for some time now, and Jaguar dealerships are not likely to be all that enthused about working on it. Some dealers might be lucky to even have a mechanic on staff that was there when these cars were built, and all the newer mechanics will have been trained on the current models rather than the older models. When you pull into a dealer for service, don’t be surprised if the only enthusiasm displayed towards you and your car comes from a salesman anxious to talk you into trading in that old pile of junk on a brand new whatever.

With a car such as the Jaguar XJ-S, you will invariably be far better off finding an “enthusiast” -- a guy who loves these cars and loves to work on them. Even if he works in a dilapidated shack, you’re likely to be much happier with his work than you would taking the car to a shiny dealership that doesn’t care about your car.

Of course, enthusiasts can be hard to find. One excellent idea would be to ask other Jaguar owners who they take their cars to. If there is a Jaguar club in the area, ask them. Finally, if there simply are no enthusiasts in your area, consider finding out where the nearest one is anyway; even if you don’t take your car that far away for oil changes and the like, there may come a day when you need someone to call who can really help.

Striking out totally in the enthusiast search, your next best option would be to simply find a good independent mechanic. If he’s willing to tackle a Jaguar, he will probably be capable of fixing most of the problems likely to crop up; it’s not *that* different from other cars. If you do a little reading in this book before you go, quite likely the two of you can get started in the right direction towards getting your problems sorted.

I’d like to suggest that you simply make a copy of this book and give it to your mechanic to help him work on your car, but experience shows that this doesn’t work very well. Many mechanics seem to consider it an insult that you would suggest that he needs help from a book. Others apparently can’t read. And almost none of them are inclined to put that kind of time into learning about Jaguars, especially since they have never seen a book like this one and are unaware anything of the sort exists. So, perhaps you might offer a copy, or perhaps just discuss your car with him and if he asks how come you know so much you can tell him about it. If you happen to find a mechanic who expresses an interest in the book, I’d suggest you have a keeper; if he actually reads a significant portion of it, he *will* be the best mechanic you’re likely to find.

Meanwhile, if *you* will read this book, you will find yourself far better able to judge whether or not a mechanic is up to snuff on the Jaguar XJ-S. You will become an informed consumer.

PARTS REPLACEMENT STRATEGIES: For those obsessed with keeping their cars in original condition, obviously only original parts will do. The suggestions throughout this book are for those who simply want their cars to run and to minimize cost and grief in the process.

Experienced British car enthusiasts will agree that most of their reliability problems come from two sources: Non-

metallic parts and Lucas electrics. This is especially true for Jaguars, where the rest of the car is generally excellent.

Rumors abound as to why the rubber and plastic parts on British cars tend to crap out so soon. One rumor says there is a law in Britain requiring the use of natural rubber rather than the far superior synthetic elastomers. Whatever the cause, the Jaguar owner is well advised to replace the original Jaguar seals, hoses, belts, etc., with non-British substitutes whenever feasible.

It has been suggested that the various vinyl and rubber protectants on the market, such as STP Son Of A Gun, can be used to help many rubber components last longer. Sandy Gibbs: "When I owned a TR8 I had many of the same problems regarding engine heat and rubber components. I found Armor All and Son of a Gun were useless unless applied every three or four days (if you drive the car much). What did work was brake fluid, of all things. You have to soak the part in question pretty well then rub the fluid in. Let the part dry before running the car. This procedure may have to be repeated two or three days in a row but then the rubber is revitalized, after that one need only repeat the procedure every two or three months. The key here is keeping the brake fluid off anything but the rubber part. This process works on nearly any rubber part except, for some reason, tires."

Lucas has been called the "Father of Darkness". Contrary to popular opinion, Lucas did not invent darkness -- they merely perfected it to a fine art! The owner is well advised to replace Lucas electrical components with alternative products when feasible. It should be noted that many of the electrical parts on a Jag are not really Lucas; the "Jaguar" stereo is probably made in Japan, and many of the EFI components are Bosch relabelled as Lucas.

Other than electrical and non-metallic parts, Jaguar components are typically excellent, and most are reasonably priced. Whether it is better to replace a broken item with the Jaguar original or a substitute must be decided on an individual basis. A good general rule is: If the original failed of its own accord, it might be better to try another source. But if the failure was secondary (due to something else failing first), the Jaguar parts may very well be the best there are; substitutions are in order only where the prices of the originals are unreasonable.

Regarding rebuilt parts, Randy Wilson says, "There are many companies out there that rebuild to a price, replacing only the "common" failure part. Their attitude is it's cheaper to only replace the one part and let the consumer figure out which units need more work than it is to full rebuild and test every unit. This is true with electrical, a/c, steering gear, and other things. The real sad part is these unscrupulous clowns often drive the reputable rebuilders out of the market by the price difference. Rebuilds are a pain. The cheap ones are no bargain. And just buying an expensive one is no guarantee. It may be a thorough rebuild, or it may be a cheap one that your vendor is making a killing on."

REPAIR MANUALS: For a listing of sources for manuals, see "PUBLICATIONS AND PERIODICALS" starting on page 722.

As mentioned on the flyer page, this book is *not* intended to substitute for a proper repair manual; you will need to buy one if you intend to do any work on the car. In general, there appear to be three to choose from: an *XJ-S Repair Operation Manual* from Jaguar intended for owners, a set of *XJ-S Service Manuals* from Jaguar intended for dealers and authorized mechanics, and a Haynes manual. The Jaguar publications come in several varieties for different model years, while the Haynes has been published in only one version.

The *XJ-S Repair Operation Manual* (commonly referred to as "the ROM"), is expensive (around \$100) and mediocre; not only is it somewhat difficult to follow, it is also fraught with errors. Nevertheless, it's still probably the best choice here.

From the introduction of the XJ-S until 1982, Jaguar offered a basic ROM, part no. AKM 3455, ©1975. This edition does not cover the GM400 automatic transmission.

With the introduction of the H.E. in 1982, Jaguar issued an addendum titled *Jaguar XJ-S H.E. - Supplement to the Repair Operation Manual*, part no. AKM 3455/S1, ©1982, commonly known as "the H.E. Supplement". They also issued an updated edition of the ROM, AKM 3455 Ed 3 "incorporating H.E. Supplement", ©1982. Understandably, the H.E. Supplement included in Ed 3 is identical to the Supplement available as a separately bound volume. Ed 3 does cover the GM400 automatic transmission, though.

In 1984 part no. AKM 3455 Ed 4 was issued; this apparently represents the last correction and update to the ROM itself, even though rather than incorporate the H.E. data into the main part of the manual it continued to feature an H.E. supplement. From 1984 on, the ROM was updated solely by the addition of supplements; "Ed 4" comes with Supplement A only, "Ed 4/2" (©1989) comes with Supplements A & B, and "Ed 4/3" (©1995) comes with Supplements A, B, and C:

A	1979 - 1984	H.E.
B	1984 - 1988 1/2	Lucas 'P', cabriolet from VIN 112586, 30 pages
C	1988 1/2 - on	6.0 litre, 4-speed A/T, ABS, new body, convertible, 168 pages

Physically, the ©1975 ROM and ©1982 Supplement came as separate softcover books with off-white covers, while in the Ed 3 and Ed 4 versions Jaguar incorporated the manual and supplements into a single binding. John M. Smith has the Ed 4 printing, and somehow got a hardbound copy: "Pre-H.E. sections in white pages. H.E. supplement at rear in green pages." Steve Draper reports on his Ed 4/2: "It is a single softbound volume." Chris Carley got the Ed 4/3, "One book soft bound in Jag green. Each supplement has black edge at the beginning page with heading so you can flick through & see it."

Supplement A in the Ed 4 books is apparently quite similar to the ©1982 separately-bound H.E. Supplement, even though the ©1982 Supplement is 63 pages while Supplement A is 74 pages. The pages must be counted by hand since neither of these supplements have sequentially numbered pages. This book contains many references to the ©1982 Supplement, since the author owns a copy; readers should generally presume that the references apply equally well to Supplement A.

Unfortunately, when you actually try to buy a repair manual, you not only may have trouble telling which version you're getting -- you may have trouble telling if it's a ROM! For some reason, many booksellers have an aversion to actually listing the title as clearly printed on the front of the book. Rather than offering an *XJ-S Repair Operation Manual*, they will call it an "Official Shop Manual", "Official Jaguar Repair Manual", or whatever other name they can dream up to confuse the customer. In general, if the price is in the \$80-\$120 range, you can assume it's the *XJ-S Repair Operation Manual*, but it never hurts to ask to make sure before shelling out the cash.

Also note: With some bookstores, if you tell them what year car you have, you may get only what they think you need; this author has an '83, and ended up with the ©1975 edition ROM and the ©1982 Supplement. While this may be considered acceptable, a later ROM is always better since they still contain the earlier info; the Ed 4 is clearly an improvement over the ©1975 ROM even if you own a mid-70's XJ-S simply due to the corrections incorporated. And there is always the possibility that you may decide to upgrade some part of your car with the parts from a later car. Just about the only reason to accept an earlier ROM is if you find a clearance price.

Note that if you have the GM400 transmission, you will want to insist upon the Ed 3 or Ed 4 edition; the ©1975 ROM covers only the Borg-Warner, and the ©1982 Supplement doesn't help. The Ed 4 edition covers the GM400 quite thoroughly, as described by Patrick MacNamara: "My ROM AKM 3455 Ed 4 has an extensive chapter on removal, fault finding and overhaul for the GM 400. It also contains everything on the BW except removal. Interestingly, the table of contents lists both transmissions and all related chapters as the same for both (ie 44.00.00 is data and description for the GM, while 44.00.00 is hydraulic flow charts for the BW). You just have to make sure you are looking at the correct chapter 44 in the text as there are two."

If you happen to get stuck with the ©1975 ROM and wish to work on your GM400 automatic transmission, your best bet would be to get a separate repair manual for the tranny. Andrew Kalman suggests *How To Work With And Modify The Turbo Hydra-matic 400 Transmission* by Ron Sessions, Motorbooks International, 1987, 224 pages, 300 illustrations; ISBN 0-89738-267-8. Kalman says: "It seems quite complete, with a historical overview, basic maintenance, operation, overhaul, modifications and speed tuning." This book is highly recommended by many; for example, Mark Johnson says, "If Kirby had compiled a book on transmissions, this would be it." How's that for an endorsement!

Of course, you will still lack instructions on how to remove and reinstall the GM400 in an XJ-S, but you can pretty much make that up as you go along (with help from the transmission mount info starting on page 342 in this book) -- or you could just buy a Haynes manual, described below. The Sessions book *plus* the Haynes manual will still be cheaper

than buying another ROM to get the GM400 info.

Your second repair manual option is to purchase the *XJ-S Service Manuals*, which come as sets of several volumes each. If you thought the *Repair Operation Manual* was expensive, the series of *XJ-S Service Manuals* ought to be good for a major coronary: Several hundred bucks a set. On top of that, you may end up having to buy more sets than you anticipated; while the later edition ROM's contain all the info on earlier cars, the multi-volume Service Manuals do not. Richard Mansell: "Now that I have the manuals in my hot little hands it appears to be more complicated than I thought. The pre-H.E. to 87-88 manuals (JJM 10 04 06) appear to be based around the pre-H.E. with extra sections to cover the differences between these and the H.E. (pretty logical so far). The new manuals, up to 91, (JJM 10 04 06-20) come in 5 volumes rather than the earlier 4 but only appear to cover the additions since the earlier manuals for the 5.3 plus a random selection of the original information. Oh, and it covers the 4.0 engine too. In other words, if you have an '89 to '91 5.3 and you want to know about the new ignition, etc., you will need both sets as the later volume set refers to many sections that only exist in the earlier set; e.g. under the heading "Cylinder heads overhaul" it says:

Remove left and right hand cylinder heads, see 12.29.01.

Where is 12.29.01? Only in the earlier set! Since the five-volume set costs more than the earlier one, I assumed it would be a complete guide to the later cars. Wrong!

"The only thing of great value in the five-volume set that is not in the four is the Marelli ignition.

"Each set comprise of hardback green ring bound folders with a white growler and the words Service Manual on the front. The copyright of the first manual is 1988. JJM 10 04 06-20 has the copyright date of 1991.

"I understand that there are add-ons, JJM 10 04 06-201 and 202 that cover models '92 to '96. 6.0L engine plus other changes." The H. D. Rogers web site (page 712) confirms this, and reiterates that these later manuals are not stand-alone either -- if you have a '92-on car you will need *all* of these sets to cover it.

Robert Woodling says, "I have purchased both the factory four-volume set and the *Repair Operation Manual*. The four-volume set in some instances provides better detail while the ROM provides a better step-by-step approach."

Before buying the multi-volume Service Manuals, you might want to consider the CD-ROM mentioned below. In fact, you might have to; Keith Lumsdaine says, "As of December 2000, the official Jaguar Workshop Manual part number JJM 100406 20 for the 1991-on cars is no longer available, as Jaguar have now [Feb 2001] issued it with the Supplements JJM100406 201 & JJM 100406 202 in CD-ROM form."

The only XJ-S repair manual made by anyone other than Jaguar is a Haynes manual, *Jaguar XJ12 & XJS*. This was manual #478 in Haynes' old numbering scheme, and is #49015 in their new numbering scheme -- but it's the same book either way. It's a *lot* cheaper than the Jaguar publications (under \$20), cheap enough you might as well pick one up even if you plan on buying the Jaguar books anyway. It's based on portions of the factory manuals with some photos of a teardown of a Daimler Double Six added. This repair manual is referred to simply as "the Haynes manual" throughout this book.

Classic Motorbooks catalogs list a Haynes manual titled *Jaguar 12-Cylinder 1972-85*, but this is actually the same book -- Classic Motorbooks simply cannot bring themselves to list the correct title.

The Haynes manual benefits from some recall and technical bulletin info that does *not* appear in the Jaguar manuals. It includes some basic procedures for the GM400 automatic, including a removal/reinstallation procedure, but no overhaul info. It only covers up to 1985, so owners of later cars will not get any info on the ABS brakes, Marelli ignition, etc., and would therefore be better advised to get the *Repair Operation Manual* with suitable supplements.

Gross errors in the ROM as well as the Haynes are addressed in this book, since the author owns both books; it is suggested that owners mark all corrections in their manuals as they read about them.

REPAIR MANUALS -- 6-CYLINDER XJ-S'S: The *Jaguar XJ-S Repair Operation Manual*, AKM 3455, does not cover the 6-cylinder engines at all, nor their respective transmissions. Gerda Kennedy of Bookspeed (page 722) says, "There is a separate manual for the XJS 6-cylinder 3.6 and 4.0" and that Bookspeed can provide it. The part number is AKM 9063. Unfortunately, Walter Petermann counters: "I picked up the AKM 9063. It only covers the 3.6.

Copyright date is 83.” That explains that; 1983 is when the AJ6 engine was *introduced*, so obviously the book won’t contain the 4.0 AJ16 engine or even the EFI system that was introduced in 1988 with the XJ40.

Petermann goes on to describe the publication: “There’s 9 'booklets', about 30-45 pages each. The complete manual is AKM 9063, but each book has its own number e.g. AKM 9063/1../2 etc.

Book 1: intro, general specs, engine tuning data, jacking, lubricants, maintenance, service tools.

Book 2: Engine

Book 3: emission control, fuel system, cooling system, manifold & exhaust

Book 4: Clutch, manual gearbox

Book 5: Propellor (?), final drive

Book 6: Steering, front suspension, rear suspension, brakes, wheels & tires

Book 7: Body

Book 8: Air conditioning

Book 9: windscreen wipers & washers, electrical, instruments

“The AKM 9063 is now discontinued.”

Note that AKM 9063 *does* cover the 8CU electronic fuel injection system used on the early AJ6, which never appeared in any other Jaguar and therefore may be a bit difficult to get info on elsewhere.

Even if you have a later 6-cylinder car, buying AKM 9063 might still make more sense than buying a V12 ROM. Perhaps you might choose to buy AKM 9063 along with another book -- such as an XJ40 (1988-94 XJ6) manual -- that covers the later engine configurations (the XJ40 and the ‘88-on 6-cyl XJ-S have the same engine and transmission). XK’s Unlimited (page 697) offers a book called the *Jaguar XJ6 Workshop Manual -- Owners Edition*: “Covers 1988 to 1994, 180 pages. This is an "Owners Edition" manual, meaning it is a boiled-down version of the full factory manuals and covers the maintenance and repair projects most likely to be tackled by an owner.” The good news is that it’s only about forty bucks. A Haynes manual might also be a consideration; see below.

There apparently is a later Jaguar publication that covers the 6-cylinder XJ-S. XK’s Unlimited offers a book titled *XJ-S 3.6/XJ-SC 3.6/XJ-S 4.0 Service Manual*, number 11-0252D (which may be an XK’s number rather than a Jaguar number). It’s priced at a little over \$100, indicating it may be the equivalent of a ROM.

If you’re interested in the multi-volume *XJ-S Service Manuals* described above, Richard Mansell indicates that they *do* cover the 6-cylinder engines.

If you have a 6-cylinder XJ-S, the Haynes manual #478/49015 will be no help with the engine or transmission at all. However, you could opt to buy the Haynes #478/49015 to cover the rest of the car *and* Haynes manual #49011, *Jaguar XJ6 1988 thru 1994: Automotive Repair Manual*, ©1997 (thanks to Loudon Seth for this info) for information on the engine and transmission, as well as the later IRS with outboard brakes. Or, you could supplement the Haynes #478/49015 with the *Jaguar XJ6 Workshop Manual -- Owners Edition* described above. Either combination of two books should cover most of what you need to know, with the notable exception of the 8CU EFI system used on the 1983-87 3.6 cars.

REPAIR OPERATION MANUALS -- XJ12, DAIMLER DOUBLE SIX: This book is on the XJ-S, but I’ll be a nice guy and list what little I know about *Repair Operation Manuals* for saloons as well. John Littler reports that for Series I/II cars, Jaguar issued one manual for the XJ12 and another for the XJ6, but starting with the Series III they issued a single manual to cover both.

Regarding the S I/II manual, Littler says, “*Jaguar XJ12, Daimler Double Six, Repair Operations Manual*. Publication Part No. E190/4. Copyright 1979. Covers Series 1 and 2 (of which the only significant difference are carbs vs. EFI and the swap to GM400 halfway through the S2 model run - not the start contrary to common belief.)”

“*Series 3 Service Manual* - 3 items listed on first page:

Service Manual complete, AKM 9006 Edition 2

Service Manual Book 14, AKM 9006/15 Ed. 2

“Copyright 1985. Covers both XJ6 and XJ12 series 3; the XJ12 has both H.E. and Pre-H.E. sections although they aren't particularly differentiated. The S3 manual I have doesn't seem to cover the late XJ12 S3's (1987-92). It covers P and D Jetronic but there's no mention made about the later ECUs.”

ADDING YOUR OWN BINDER: If you get a softbound ROM -- or any other manual from Jaguar or the UK in general -- and decide to tear it apart, holepunch it, and put it in a 3-ring binder, you will find that it is a metric sized book and won't fit in a US-standard 8½” x 11” binder. If you're in Europe that's no problem, but here in the US you may find it a bit of a challenge. Better office supply stores sell metric “A” size binders, but you'll also need to get the proper 4-hole punch.

Another option is to drop into a Wal-Mart and buy a photo album intended for the Kodak Advanced Photo System; these albums are quite a bit larger than standard notebooks yet retain the standard 3-hole pattern. Having a 3-hole punch with an adjustable paper stop is a plus, so you can adjust the stop to center the holes on the longer pages. Just throw the photo sleeves out, although the section dividers are nice, you'll wanna keep them to separate the manual from the supplements and the like. These photo albums have the added benefit that they are really nice quality; this author even found one with a dark green, gold, and black cover that looks like it could have come from Jaguar.

PRIMERS: If you are new to automotive tinkering, you should buy one of the many books on the market explaining general procedures for car repair. While this book is written to be as clear as possible, it is not intended as a primer and no efforts are made to explain standard auto repair procedures. For example, this book may describe in great detail how a particular electrical component has a history of shorting out at a particular spot, but it will not provide any instructions on how to use a VOM to track down a short. Quite the contrary, the reader is expected to know how to do things like track down a short, so problems that are easily isolated and corrected may not even be mentioned.

PARTS BOOKS: Jaguar also makes parts books. Many owners suggest these books are *more* helpful to the mechanic than the repair manual; they contain exploded views of just about everything which are often easier to understand than the step-by-step text in the ROM or Service Manual. And it helps to know the part number of what you need when placing a parts order by phone, since the names of Jaguar parts are often confusing and mercurial.

Stephen Wood describes the parts book for the early XJ-S: “*Jaguar Parts Manual*, RTC-9109-B, for the XJ-S, 1976 to 1982, pre-H.E. cars.”

This author owns the one for the next generation: “*Jaguar Parts Catalogue, XJ-S H.E. and XJ-S V12*”, RTC9888CE, August 1987. Note that the title might be misleading; this parts book does *not* cover the pre-H.E. cars. The title probably reflects the fact that the H.E. badge on the car was replaced with a V12 badge starting with VIN 125020 even though otherwise it's still the same car with the same engine. This book covers models from the introduction of the H.E. engine through the mid-1980's -- which should be kept in mind when using it, remembering that “up to” really means “from the introduction of the H.E. up to” and “from” really means “from this point until 1987.”

Richard Mansell reports on the next edition after that: “...the Jan '87 to late-'89 parts book (RTC9900CA). IMHO¹ this is laid out a lot better than the earlier parts manuals as it has a description for each item on the same page as the pretty picture. If you have an '87 to '89 3.6 or 5.3 XJ-S this guide is well worth getting, especially to aid reassembly.” He has a point about the layout since RTC9888CE has no descriptions at all on the page with the illustration but rather has the descriptions listed in the back under the part number.

JAGUAR BOOKS ON CD: The Jaguar Daimler Heritage Trust (page 691) offers several of the repair manuals and parts catalogues described above on CD-ROM. Compared to the paper publications, these CD's are dirt cheap: £12.77

¹ IMHO is an Internet abbreviation for “in my humble opinion”.

+ 17.5% VAT (£15 even) each plus £2.50 shipping, which adds up to about \$25 each or so. If you're outside Europe you're not supposed to have to pay VAT but they charge it anyway and so far nobody has called them on it. Tony Bailey says, "e-mail Julia Simpson at the JDHT on <jsimps16@jaguar.com> with credit card number and other details. If you are worried about the security of using plaintext e-mail, Julia's telephone number is +44 (0)24 76 202141, and her fax number is +44 (0)24 76 405581." Of course, you could always write a letter.

There are several CD-ROM's of interest to the Jaguar XJ-S owner. The first is titled *XJ-S to 1987 - Original edition Service & Parts catalogues*, part number JHM 1114. This disc contains:

JJM 10 04 06	Service Manual (4-volume)	1988
AKM 3455	Repair Operation Manual (Ed 3 with H.E. Supplement)	1982
RTC 9109B	XJ-S Parts Catalogue	January 1977
RTC 9889CA	XJ-S 3.6 Parts Catalogue	November 1985
RTC 9888CE	XJ-S H.E. Parts Catalogue	August 1987

Plus some photos, a JDHT brochure, etc. The Ed 3 ROM included doesn't cover 83-on cars, but hopefully the Service Manual will cover most anything in the pre-88 cars that isn't in the Ed 3 ROM.

The second CD-ROM is *XJS post 1987 - Workshop Service Manual*, part number JHM 1127. This disc contains:

JJM 10 04 06/20	Service Manual (5-volume)	March 1991
Amendment No. 1		August 1993
Appendix 1		August 1993
Appendix 2		January 1995

Amendment No. 1 was originally issued as four packages of pages; you're supposed to whip out your Volumes 1 through 4, pull out old pages and replace them with new pages. Of course, you can't do that when all the pages are on a CD-ROM. Good luck keeping this straight when looking things up. Printing out the tables of contents might help.

Apparently if you want a parts book for a 90's car, you're SOL.

George Balthrop says, "JHM-1146 is the current offering from JDHT."

There is another CD-ROM that might interest some readers: JHM 1122 covers the SIII XJ12.

Early versions of JHM-1114 and JHM-1127 were formatted using a software package called ScanFile, which is unsearchable. Really, it's only presenting scans of the paper; it doesn't recognize the data on it and therefore cannot sort or search it. The only way to find anything is basically the same way you'd find it in the paper version: you have to display the table of contents pages, find a listing that looks like it might contain the info you're looking for, display that page, read it, get frustrated, return to the table of contents, try to figure out where the Brits hide information, etc., etc. Note that JHM 1127 has a later release of ScanFile than JHM 1114. If you buy both, install the later release and use it to view both discs.

Nope, these CD's reportedly won't run on a Mac. The savings over buying the printed versions would probably pay for a real computer, though.

It doesn't help that whoever put these packages together didn't do the best job. Some collections start with the table of contents, completely omitting the title page and the copyright date. Sometimes they make up names; the four packages in Amendment No. 1 are called "Supplements" for some reason.

Reportedly there are later releases of these CD-ROM's that use better formatting.

There is also a JHM 1123. According to George Balthrop it's called a "Supplementary Information CD" and "contains Model Information as well as Electrical Technical Guides for the various models, with component location information."

Besides ordering directly from JDHT, Craig Sawyers says you can get them "...from a small number of appointed UK dealers and specialists - JDHT have only appointed 10 of these. The best one to go for IMHO is Martin Robey Ltd on (+44) 2476 386903. They export too, so no problem there (One of their quoted phone numbers is (+44) 7000 ROBEY SALES so it could be worth trying that from the US). Don't bother looking at their website at <http://www.martinroby.co.uk> - it is pretty useless and also doesn't mention JDHT parts."

JHDT says, "Please note that these CDs are generated by Jaguar Classic Parts at Unipart House and that we simply retail them. In principle therefore, the same CDs should be available at the same price from all the Jaguar Classic Parts outlets, whether Jaguar dealers or independent approved specialists."

Apparently the US dealers think you need to pay more -- *much* more -- than \$25 for this info. Don Lundquist says, "I tried to order from local Jag dealer (JHM1127)... Price quoted was \$123.37." JDHT responds: "Originally these CDs were being retailed in the USA by Jaguar dealers at far too high prices. However, it has now been agreed that they will be available through all Jaguar dealers in the USA at the cost of \$25.00. We have accordingly been asked by Jaguar Classic Parts to cease accepting orders from the USA, since we want to give the US dealers a fair chance. Any US customer who either has difficulty ordering a CD from a local dealer or is still being quoted the old price should contact Jaguar Classic Parts on +44 (0)1865 383358, or e-mail Brian_North@unipart.co.uk." There are already reports that the US dealers insist on adding fees to that \$25.

Even if you'd prefer the paper versions, it will undoubtedly prove cheaper to buy these CD-ROM's and print the books in entirety on your trusty inkjet. They print just fine -- although they want to print to metric-size paper and will try to make one page into two when printing on 8½ x 11. The part on the second page is usually just a blank half inch.

TECHNICAL GUIDES: Richard Mansell reports that there is a CD produced by Jaguar (not JDHT) called Jaguar Services Technical Guides & Focus Series 1998-1999, Issue 1, December 2000. The part number is

S TECH CD1

He lists the contents:

FOCUS SERIES

- S 58 XJ-S Engine Performance (1981-88 MY w/ Lucas Ignition)
- S 64 1989-91 MY XJS Coupe & Convertible Body Enhancement
- S 70 Electrical System Batteries and Charging Second Edition
- S 73 Sedan Power Hydraulic System
- S 91 1993-94 AJ6 4.0L Engine Management System OBD I Diagnostic Guide

TECHNICAL GUIDES

JTP 425/1 Air Conditioning System HFC Refrigerant Retrofit

XJ6/VDP/XJ12 SEDAN RANGE 1988-94 MY

- 1988 MY Sedan Range Introduction
- S 63 1989 MY XJ6 3.6 Model Year Update
- S 66 1990 MY Sedan Range Model Year Update
- S 69 1991 MY Sedan Range Model Year Update
- S 78 1993 MY XJ6 Sedan Range Model Year Update
- S 81 1994 MY XJ12 Sedan Technical Introduction

XJ6/VDP/XJR/XJ12 SEDAN RANGE 1995-97 MY

JJM 101512/50 1995 MY Technical Guide XJ6 & XJ12 Range Introduction JJM

181512/55 1995 MY Technical Guide XJ6 & XJ12 Range Supplement 1 JJM
181512/57 1996 MY Technical Guide XJ6 & XJ12 Range (Long Wheel Base
Sedan) JJM 181599/60 1996 MY Technical Guide XJ Sedan & XJS Ranges 1996
MY Update

XJS RANGE

-- 1986-88 MY Hess & Eisenhardt Convertible Repair Operation Manual
-- 1988 MY XJS Model Year Update S 60 1989 MY XJS Model Year
Update S 60/SUPP 1989 MY XJS Model Year Update Supplement (Marelli
Ignition) S 61 XJ-S Convertible Technical Introduction S 67 1990
MY XJS Model Year Update JJM 101506/01 1990 XJS Convertible Technical
Guide S 71 1992 MY XJS Technical Introduction S 79 1993 MY XJS
Model Year Update S 80 XJR-S Product Support S 83 1994 MY XJS
Model Year Update S 92 1995 MY XJS Model Year Update JJM 101506/52
1995 MY XJS Update from VIN 198335 JJM 181599/60 1996 Technical Guide
Sedan & XJS 1996 MY Update

XJ8/VDP/XJR

JJM 181512/80 1998 MY Technical Guide V8 XJ Series Sedan 1998 MY
Introduction JJM 181518/90 1999 MY Technical Guide XJ and XK Series 1999
MY Update

XK8

JJM 181514/70 1997 MY Technical Guide XK8 Sports Coupe and Convertible
Introduction JJM 181515/70 1997 MY Technical Guide AJ-V8 Engine and
5HP24 Transmission Introduction JJM 181518/90 1999 MY Technical Guide XJ
and XK Series 1999 MY Update

OWNER'S HANDBOOK: Owners who don't have an owner's handbook might want to get one. However, note that insisting on the proper one for your model year XJ-S might not work; apparently Jaguar published a single edition of the handbook intended to suffice for multiple model years without change. For example, the owner's handbook for the 1983 model year is titled "XJ-S H.E. HANDBOOK" and is publication part no. AKM 9045, 2nd Edition -- no model year evident. The copyright date is 1981. Ask for the one with the most recent copyright date *before* your model year.

If you have trouble finding a handbook from a bookseller, ask at junkyards and similar places that might be parting out a car of the same year as yours.

SCHEMATICS: See page 551 for info on available wiring diagrams and "electrical guides" -- invaluable on this car.

MAIL ORDER CATALOGS: To those just getting started with the XJ-S, take this bit of advice: Order at least two mail-order catalogs immediately. Turn to page 692, look through the list of new parts suppliers, and start calling until you have a couple of catalogs coming in the mail. You will want to have such catalogs on hand even if you never order any parts just so you can tell when some unscrupulous repair shop is trying to rape you on parts costs.

OTHER BOOKS: Richard Mansell suggests: "For XJ-S fans there is a book by Paul Skilleter called *Jaguar XJS: A Collectors Guide* (ISBN 0-947981-99-3). It is full of pretty pictures (nearly 200) of XJ-S's and variants. There is a fair bit of history detailing specification changes, etc., covering a total of 144 pages.

"Appendix A lists the technical specifications model by model.

"Appendix B lists the location of the chassis/VIN numbers and explains what each bit of the VIN means.

"Appendix C lists launch dates and prices.

"Appendix D is a fairly detailed list of production changes by date chassis and/or engine number.

"Appendix E lists annual production numbers.

"Appendix F lists performance figures.

"If you are into XJ-S's it is well worth a look." Skilleter's book is published by Motor Racing Publications Ltd., Unit 6, The Pilton Estate, 46 Pitlake, Croydon CRO 3YR, UK, ©1996.

Victor Naumann recommends Publication #S-58, *XJ-S Engine Performance*. "It has photos and diagrams of ignition and fuel systems, all the controls and switches and a good section on maintenance procedures, setting throttle plates and linkage and checking the potentiometer etc."

Jaguar XJS Gold Portfolio 1975-1988, compiled by R. M. Clarke, is a collection of road tests, specifications, comparisons, and reports on racing and other modifications. It is published by Brooklands Book Distribution Ltd., "Holmerise", Seven Hills Road, Cobham, Surrey, UK.

John T. Horner suggests "There is a brochure type booklet written by Jaguar when the V12 was introduced and which is sometimes still available: *Genesis of the Jaguar V12*. It has a good official summary of the history and specifications as well as beautiful color overlay drawings of an engine cutaway. I think Bookspeed in the UK may still offer it." This author has acquired a copy of this book; it isn't much from a maintenance standpoint, but it cannot be beat for instilling an appreciation of one of the finest automotive engines ever designed, providing a concise history and background of the engine's development. From an XJ-S owner's standpoint, the worst thing about the book is that it truly applies to the original Jaguar V12 introduced in the Series III E-type; many of the details changed by the time most XJ-S's were built. The engine shown in the book has carburetors, a canister-type oil filter mounted under the front end of the sump, an oil-to-coolant oil cooler, an oil pan that is no wider than the bottom of the block, an alternator mounted backwards so it sticks out the front of the engine, etc.

Bookspeed's address is on page 722. *Genesis of the Jaguar V12* is also available from Classic Motorbooks, page 723.

Lawrence Buja recommends *Jaguar Driver Technical Tips* by Bob Bate, ©1990, R.G. Bate Publishing, 501 Cleveland St., Birkenhead, Merseyside, England. "Technical Tips is a huge collection of tech articles published in the Jaguar Driver Club magazine by a professional Jaguar mechanic. It is about 500 pages long and covers an immense range of topics all related to the real-world operation, diagnosis and repair of Jaguar automobiles." Makoto Honjo adds, "Bob does advertise on the JDC, whose flier I sought for a lead. Well, turns out that *Jaguar Driver Technical Tips* is his private and is available through him at GBP40 (hey, you've got to pay for quality). You can call him at phone +44-151-653-6765 for a copy."

TECHNICAL PAPERS: In the US the Society of Automotive Engineers (SAE) maintains a collection of technical papers. Paper #720163, by Walter T. F. Hassan of Jaguar Cars Ltd., Div., British Leyland Motor Corp., is a quite

detailed engineering study of the development of the Jaguar V12. Of course, the paper predates such later developments as the H.E. Bob Weisickle points out that SAE papers can be ordered from:

<http://www.sae.org/>

but note that they only offer recent papers online; older papers don't even show up in a search! You'll have to call SAE at +1 (724) 776-4970 Monday through Friday, 8:00 a.m. to 5:00 p.m. Eastern time to get older publications.

In the UK there is a similar paper titled "Jaguar V12 Engine - Its Design and Background", also by Hassan, from the Technical, Administrative and Supervisory Section of the Amalgamated Union of Engineering Workers (AUEW-TASS), Onslow Hall, Little Green, Richmond, Surrey.

Roger Bywater says "there is also a similar Institute of Mechanical Engineers paper by Harry Mundy from about the same time (1972)."

SERVICE RECORDS: Chad Bolles: "...just go to any dealer's service dept., give them the serial no. of your car; they can pull it up on the computer and give you the available history."

FUEL ECONOMY: Keeping an eye on fuel consumption is an excellent way to monitor your car's condition. Since EPA ratings are generally unreliable in the real world, it is helpful to know what kind of fuel consumption the XJ-S *should* have:

	<u>miles/US gal</u>	<u>miles/Imp. gal.</u>	<u>litres/100km</u>
XJ-S H.E.:			
everyday:	16-18	19-22	13-15
highway:	18-20	21-24	12-13
Pre-H.E.:			
everyday:	9-12	11-14	20-26
6.0:			
everyday:	12	14	20
highway:	16-18	19-22	13-15

For those who like to do their own converting, there are 0.83267 Imperial gallons in a US gallon, 3.7854 litres in a US gallon, and 1.609344 kilometers in a mile.

The values for the pre-H.E. are based on fewer reports, but those reports were fairly consistent; apparently the H.E. really was a *huge* improvement in fuel efficiency over the previous design! Note that reportedly the difference only occurs under light (street) use; with harder running or racing the economy difference diminishes.

The values for the 6.0 are likewise based on fewer reports but the reports were consistent; since the cars are of more recent vintage and have electronic controls less subject to variation or misadjustment, you'd expect them to be consistent. It's perhaps surprising that these cars don't get better economy than they do, especially considering the improved transmission and the longer stroke engine. Perhaps the 6.0 drivers have their foot in it more than the 5.3 drivers!

Of course, the standard disclaimer: "Your mileage may vary." But you know if you are driving harder or under worse conditions than the average driver, and if you think your fuel mileage is worse than it should be you should immediately investigate the causes. Many of the common causes also result in major engine damage if left uncorrected.

Jim Isbell was doubtful, but now is a believer: "The O₂ sensors were changed. The results were fantastic. The around town mileage has increased from 12 MPG (US gallon) to 17 MPG on the first tank after the change."

Unfortunately, there is one other reported reason for bad city mileage. "B emission" (UK and Europe spec) H.E.'s have a timer that disables the vacuum advance for 15 minutes after startup if the coolant was below 45°C when started. If

you drive 15 minutes to work, park there 8 hours, and drive 15 minutes home, you are *always* operating on retarded timing and will get something around 12 mpg. See page 135.

Note also that some areas require the use of “oxygenated fuels”, sometimes just during particular seasons. Oxygenated fuels result in *far* worse fuel consumption in *any* car.

THREADS: The British invented the inch/foot system of measurement, so most of the fasteners on the pre-1984 XJ-S are English fine thread (UNF or National Fine), available in any hardware store in the US. Jaguar and other British cars extensively use fine threads, as opposed to the coarse threads (SAE or National Coarse) normally used on American cars. Coarse threads are sometimes used in aluminum parts, because aluminum is too soft for effective use of fine threads.

In 1984, many of the fasteners within the engine itself changed to metric sizes. Notably, just about every 5/16” stud appears to have changed to M8, according to David Johnson. Many of the 1/4” threads changed to M6.

Thanks to a continuing effort towards metric standards, there are metric fasteners in other parts of the car as well -- even in the pre-1984. Many of the subcomponents, such as the alternator, air conditioner compressor, and stereo are made with metric threads. Later cars seem to have more and more metric threads. Mike Morrin says, “The nuts holding the wiper blades are the only metric fasteners I have found on my 1975 car.”

WHITWORTH/BSF: There are, unfortunately, a couple of places where obsolete British standards such as BSF or Whitworth are found on the XJ-S. See the discussions on the crank damper retaining bolt on page 89, the surge tank vent connection on page 254, the main power terminals on the firewall on page 558, and the battery terminals and hold-down nuts on page 586. Also note that page 12 of the Haynes manual lists wrench sizes for such oddities. Most of the BSF/Whitworth wrench sizes don’t correspond to anything in SAE or metric sizes; supposedly, Mr. Whitworth decided to size his bolt heads so that the length of a flat on one side of the hex was some nice even number.

Keep in mind that BSF and Whitworth wrench sizes are the diameter of the bolt, not the dimension across the flats on the head. And, for some reason, the wrench that fits a BSF bolt seems to fit the next smaller size bolt in Whitworth.

To learn more about British non-standard standards, David Littlefield suggests visiting this WWW site:

<http://www.team.net/sol/tech/whitworth-hist.html>

Craig Sawyers: “At least here in the UK you can get spanners and sockets from the local tool store that are correct.” Actually, you can obtain Whitworth tools in the US and presumably other countries; it just takes more looking. Jeb Boyd says Snap-On has Whitworth tools. David Littlefield suggests British Tools and Fasteners; see page 710. A search of the WWW should turn up an assortment of mail-order sources.

Note: with the exception of the crank bolt (for which wrench options are discussed on page 89), all of the Whitworth/BSF wrench sizes used in the XJ-S seem to be the same size: 1/4” Whitworth/5/16” BSF. Hence, it might be good advice for the XJ-S owner/mechanic to obtain *one* wrench. The entire Whitworth set is not needed.

TORQUE UNITS: Torque, or twisting force, is specified as an amount of force applied at a radius. In the English system of measurement force is typically given in pounds or ounces, and radius (distance) in either feet or inches. The first point of confusion arises because units of mass are also called pounds. As a result, it is increasingly preferred to speak of pounds force or pounds mass instead of simply pounds. The abbreviation for pounds force is “lbf.” The f does *not* stand for feet, and lbf. does *not* stand for foot-pounds. Readers are encouraged to beat this into their hard skulls until it sinks in; reading “lbf.” and thinking “foot-pounds” is a good recipe for disaster with this car and this ROM.

The torque value is the amount of force applied *times* the radius. Twenty pounds applied at a radius of 18 inches is 360 inch-pounds or thirty foot-pounds. Hence, the terms for force and the terms for distance are written sequentially (doesn’t matter which order, really). Sometimes a hyphen is used, which in this author’s opinion makes things clearer, but as expected that means that Jaguar chooses not to use a hyphen. In the XJ-S ROM, foot-pounds are written as “lbf.

ft” and inch-pounds are written as “lbf. in” That last one, if you’re not paying attention, looks like foot-pounds followed by the word “in” -- especially if it’s word-wrapped and the “in” is at the beginning of the next line. If you make a mistake here, you will overtighten something by a factor of 12.

Lacking a hyphen may be confusing, but at least it’s technically correct. Putting a slash between the terms, such as lbf./ft or lbf./in indicates pounds force *divided by* feet or inches, and this is most definitely incorrect when used to indicate units of torque; lbf./ft or lbf./in are units of spring rate, not torque. Unfortunately, Jaguar is reportedly guilty of this error -- not just once or twice, but throughout entire manuals. The XJ-S ROM uses correct terms, but Peter Cohen reports “I don’t have the ROM. I have the 4 volume service manual. They use the term "lbf/in"." Loudon Seth says, “The SIII ROM uses (incorrectly) the form lbf/in or lbf/ft throughout.”

STUDS: Jaguar studs sometimes have fine threads on both ends, and are therefore difficult to find locally. Most studs in the US have coarse threads on one end and fine on the other. You can, of course, order studs from a Jag mail order outfit -- sometimes they’re even reasonably priced. If you want to get on with the job and not wait on the mail, however, you can find a very long stud or bolt at your local auto parts store on which the fine threaded end by itself is longer than the entire Jaguar stud (many Jaguar studs are rather short). Simply cut the end off and dress up the threads. Thread the sawn end into the part, leaving the factory-made threads for assembly.

SPIRAL GROOVE WASHERS: The V12 engine is covered with an unusual type of 5/16” washer, C30075/2, that has a spiral serration pattern on it and is slightly dished. This washer serves the purposes of both a flat washer and a lock washer. While the serrations may help prevent nuts and bolts from unscrewing, the real locking feature is the dishing; it makes the washer springy, keeping tension on the fastener.

David Johnson found an acceptable substitute for the spiral groove washers: “I found at Pep Boys an 8MM spring washer. It’s part number is 153-0800. They are in the racks of boxed hardware.” Note these washers don’t look much like the spiral groove washers; they have no serrations and are sprung the other way -- they’re not dished, they’re wavy. They are dirt cheap, though. If you find an auto parts store with a Dorman hardware case, Dorman sells essentially the same type wavy 8mm washer as part number 436-008. They are also available at Lowe’s as Pik-A-Nut part number 792694. Nobody seems to sell wavy spring washers in SAE sizes, but 8mm will fit perfectly on 5/16” bolts.

The V12 also uses a few 1/4” spiral groove washers. A 6mm wavy spring washer (153-0600 at Pep Boys, 436-006 in a Dorman case) will fit a 1/4” bolt perfectly and serve well.

Note that it is *always* recommended to use some sort of flat washer whenever a bolt head or nut tightens down onto aluminum. If you find any places on your engine where a fastener is tightened onto aluminum without a flat washer, it is recommended that you provide a flat washer.

Conversely, lock washers are only required in certain places. For example, the head studs require no locking feature because the tension on the stud is carefully applied with a torque wrench and the designers have ensured that the assembly will never allow the stud to become untensioned in operation. As a general rule, lock washers are required on short bolts or studs but not required on longer ones because the longer fasteners provide enough stretch to absorb vibrations and thermal transients without ever going completely slack.

PHILLIPS? THINK AGAIN!: Greg Meboe says, “*All* Phillips-looking screws on English cars are Pozidriv screws. (The Japanese radios do use real Phillips screws.) The two standards are different, and once I bought a set of Pozidriv screwdrivers I found life *much* easier. The practical difference is quite noticeable. The impressed angle, impression depth and drive spline widths are different between a Pozidriv and Phillips head design. Using the correct Pozidriv screwdrivers, I’ve even had consistent luck removing Pozidriv screws which appeared nearly rounded due to years of Phillips-buggering by misinformed mechanics.

“A Pozidriv screwdriver will not fit in or drive a Phillips screw. The drive lugs are generally too wide.

“Snap-On, Mac and others sell Pozidriv screwdrivers, but most Americans don’t know they exist (I didn’t for many

years). I've found Pozidriv #2 bits for the cordless screwdriver at Home Depot for a few bucks. Most Pozidriv screws on our cars are #2, while door striker mounts and seat mounts are #3." The big flush-head screws at the back end of the diagonal struts in the engine compartment are Pozidriv #4.

Peter Cohen adds, "From the look of several Pozidriv screws on my car (removed only by Jaguar dealer personnel, while under warranty), the dealer tool is a chisel."

You can learn all about Pozidriv at <http://www.phillips-screw.com/>.

Sometimes Phillips screwdriver bits are marked "No.2" or "P2" while Pozidriv bits are marked "PZ.2" (using size 2 as the example). Other companies mark their Phillips as "#2" and their Pozidriv as "P2". The marking on the packaging can be similarly confusing; the popular idea is to indicate tip types with a little symbol within a circle, but some companies show the Phillips with a + within a circle and the Pozidriv as an 8-point symbol within a circle while others show the Phillips as the + within a circle and the Pozidriv as an × within a circle -- basically the same as the Phillips symbol only rotated 45°. Forget about the markings and simply look for the telltale ridges down the center of each flute, which may be difficult to make out through the bubble packaging.

Apparently, Phillips Screw has the name "Pozidriv" trademarked, so some other toolmakers make tools to fit Pozidriv screws while carefully avoiding the illegal use of the name. Easypower Corporation of Chicago makes screwdriver bits described as "Positive Drive Phillips", and in fine print says "will fit Pozidriv screws". Easypower also makes screwdriver bits called "Octo Driv", apparently their own trademark, but indiscernible from Pozidriv. All of Easypower's bits that fit Pozidriv screws are marked "EZP.1", "EZP.2", or "EZP.3".

Oddly enough, one place to look for Pozidriv screwdriver bits is in a Dollar Tree store. Occasionally they offer a little plastic container with about 20 gold-tinted screwdriver bits, all for \$1, and the bits include Pozidriv bits in sizes 0, 1, 2, and 3. They may be cheap, but I haven't broken one yet.

You'll still need to find a #4, considerably more difficult because it's too big to be made as a standard screwdriver bit. Craig Sawyers says, "If you're going mail order, try Farnell 267-030 (200mm blade length, No 4 Posidriv), or 108-494 (203mm blade length, No 4 Posidriv/Supadriv)." Another suggestion is to check Snap-On, not for their 3/8" square drive #4 Pozidriv bit, but rather for the replacement tip for that Pozidriv bit. Evidently when the tip gets boogered up you're supposed to drive a roll pin out and replace the tip itself, but the tip itself is actually all you need! You can just drive it with a box end or a socket that fits the hex body of the tip itself.

Note that Posidriv is *not* the same thing as "anti-slip". Phillips screwdrivers described as anti-slip are regular Phillips screwdrivers with tiny ridges on the tip to supposedly keep the bit from slipping.

Meboe is quite right about *all* of the Phillips-looking screws being Pozidriv; the little screws on the taillight lenses, the big screws holding the mirrors on, the small screws holding the ignition pickup in the distributor, *everything* is Pozidriv. However, if your car has had any work done that may have involved replacing screws, chances are (in the US, anyway) that the replacement screws are Phillips. So, you may need both types of screwdriver to work on the car. You could closely inspect each screw before choosing a screwdriver, but that's a pain and strains the eyes. Instead, proceed as follows: Assume *all* screws are Pozidriv until you find a screw that the Pozidriv screwdriver won't even fit into, then pick up the Phillips.

Charlie Randle reports that the facelift cars replace many of the Pozidriv screws with Torx screws. One example is the large bolt on the diagonal braces under the hood: "I checked the fender struts in the '94's engine bay and they are Torx #50." With any luck, perhaps owners of facelift cars don't need a set of Pozidriv drivers at all -- but owners of earlier British cars certainly do, and shouldn't hesitate to acquire a set.

LOCKING WIRE AND TOOLS: Several places on the XJ-S call for locking wire, safety wire, siezing wire, whatever you call it -- notably on the braking system and IRS. You can buy suitable plain steel wire anywhere, even at Wal-Mart. Of course, you want it to look nice, so you want stainless steel wire. Many places sell one size of SS wire, 19 gauge, which is actually about right for most purposes. Note that you need a soft alloy for this job; many types of SS wire, such as fishing leader wire, are too hard for lockwiring.

If you want to get fancier, specialty stores sell stainless steel, inconel, or monel wire in various gauges along with “lockwire pliers”. Lockwire pliers are a specialized tool with a latch that holds the jaws clamped down on the wire and a spiral slider that spins the pliers with a simple pull. Lockwire pliers are popular with aircraft mechanics who may be applying lockwire from sunup to sundown, but for XJ-S purposes they are not really justified; you can do the few lockwiring jobs found on this car in a couple of minutes with regular pliers.

The theory of lockwire is simple enough, but aircraft mechanics and FAA inspectors will tell you that its use requires a specific technique and careful application to ensure the intention is achieved: Safety. Applying lockwire requires a bolt head with a hole drilled crossways through it; sometimes two holes are provided just to allow the choice of whichever one lines up the best. Often it’s the fact that the bolt heads *have* such holes that tells you that lockwire might be a good idea in this location. Insert the wire through the head of the bolt, wrap one end around one side of the bolt head and *underneath* the other end, and twist them together in the direction that is likely to *keep* the wire around the side of the bolt head instead of flipping off the top. On a right-hand-threaded bolt, the end wrapped around the head should wrap to the right, and the two leads should be twisted to the right. Twist enough wire to reach a second bolt head and insert one of the wires through that one, wrap the other wire around the head (this wrap will actually be to the left, since you are going the other direction), and twist the ends together on the other side (a left twist this time). The twisted section between the bolt heads doesn’t need to be in tension, but there shouldn’t be much slack in it. The twisted section should come to a hole on the right side of each head (looking at each from the other), so the two bolt heads and the twisted strand form a Z pattern. If done correctly, the wire between the bolt heads as well as the wraps around the bolt heads themselves are arranged so that neither bolt can turn in the loosening direction without stretching the wire. Finally, clip off the excess wire and bend the tip of the last twisted section back on itself to keep from snagging yourself on it when working in the area.

If you happen to be lockwiring a single bolt, you will need to tie the other end of the lockwire down to something nearby to effectively prevent the bolt from loosening. If you happen to be lockwiring three bolts, you can tie all three together by simply continuing on past the second to the third. If you happen to be lockwiring bolts that are pretty far apart, you may choose to tie each to something nearby rather than to each other, or to wrap the wire onto something in between rather than leaving a long span unsupported; vibrations may cause a long section of wire to wiggle, eventually breaking off.

If any of this is unclear, you can probably drop in on any aircraft maintenance shop and pick up a few pointers. It is rather important that you get it right, obviously.

If you decide you’d like more safety than was originally provided for, you can drill lockwire holes in bolt heads that don’t come with them. This is popular in racing, and some racing venues actually have specific requirements for things that must either be lockwired or provided with tabwashers or self-locking nuts.

ANTI-SEIZE COMPOUND: Since the XJ-S has many bolts and studs threaded into aluminum, be sure to keep a supply of anti-seize compound on hand. The stuff is a goop with tiny particles of soft metal in it -- usually copper, nickel, or silver. As threaded items are screwed together, these soft metal particles get crushed between the threads; later, after time, heat, and electrolysis have caused all the metals involved to fuse together, this layer of soft metal can easily be sheared by unscrewing without damaging the parent parts. Use it anytime steel is threaded into aluminum, to prevent galvanic corrosion from seizing it up. It also works great on exhaust manifold studs. The fact is, many experienced mechanics (including the author of this book) swear by the stuff, buy it in one-pound cans at better hardware stores (auto parts shops usually carry it only in small tubes) and use it on *everything* with threads.

An old toothbrush works great to apply anti-seize compound to threads. You only need to apply enough to give the parts the color of the anti-seize compound; no need to pile it on, it’ll just come off as the parts are screwed together anyway.

Anti-seize compound seems to work well on post-and-nut electrical connections, too. This is probably because the metal particles help make a more secure connection. Be careful not to cause shorts with it, though.

Note that anti-seize compound is not a lubricant, and should never be used on moving parts.

SO YOU FORGOT TO USE ANTI-SEIZE COMPOUND LAST TIME: Steve Hammatt describes a product to get stuck bolts loose: “The division is called National Chemsearch and the product is called “YIELD” and is quite unbelievable in loosening rusted nuts, bolts, etc. Their number is 1-800-527-9919. Their salesmen are everywhere including (believe) even in Russia!

“The key is to use a true penetrating product that has a lubricant, plus *time*. Leave it on for at least an hour, then return and proceed.”

Other folks swear by Liquid Wrench, and even WD-40 has its admirers. Whatever is used, allowing adequate time to soak in is always required.

Heating a bolt with a torch is also suggested as a method for loosening, but obviously it’s a good idea to wipe the penetrating oil away first. It also is a good idea to replace the bolt/nut, since the heating may destroy the temper.

SILICONE SEALANTS: Apparently, some silicone sealants can corrode metal parts. Jan Wikström says: “To quote the famous Castrol ad, silicones ain’t silicones. Some leave a residue of acetic acid as they cure, which is a very weak acid but could conceivably harm bare metal. The trick is to buy “neutral-cure” silicon.”

Ed Mellinger says: “Silicone sealant isn’t permitted in most aircraft applications for this reason (among others). Two neutral-cure silicones I know of are Dow Corning 3140 and 3145; one’s an adhesive and one’s a thinner “coating”, but I’m not sure either is designed to be an engine gasket so buyer beware. Warning... they are priced like aircraft parts too!

“In the “among others” category is the tendency of silicone to squeeze out in a bead and then peel off in strings... possibly into your engine oil on its way to a bearing! This definite no-no is the most cited reason I’ve heard against use of silicone in, er, sensitive areas.”

SEALS: If you’re shopping for parts and find you have a choice of seals, Richard Griffiths suggests “use a seal with an outward facing second lip to prevent dirt getting under the sealing lip.”

If you put a new shaft seal in and there is a bad shaft surface for it to ride on, the new seal won’t last long -- but replacing the shaft, or removing it for machining, is likely to greatly increase the cost and effort involved. Griffiths and others point out that there is an easier fix: Thin sleeves that can be slid over the original shaft and held in place with adhesives. Mike Morrin mentions “the “CR SPEEDI-SLEEVE” which is just this device. Their US number is 1-800-882-0008. Their range suits shafts from 0.472” to 8.00”.” Brian Schultetus: “These sleeves are almost as old as dirt and available at any good bearing supply. Since these are basically universal listed by shaft size and width, no application will be listed as a rule. There are two types of these made; stainless steel are best, the other versions I’ve seen were chrome plated and had a tendency to disturb or break the chrome loose when installed. The plated ones I’ve seen came from Silver Seal.”

DRIVE-ON RAMPS: The need to get under a car is inevitable, and for those of us who don’t have access to a garage with a lift, drive-on ramps appear to be a good solution -- cheap, easy to use, and sturdy enough to hold a 4000-lb Jaguar without dropping it on its owner. However, most ramps appear to have been designed for cars from another era, and the spoiler pushes them away long before the front tires get near them. Patrick Krejcik provides a solution: “I got the \$17.95 specials, and all I had to do was to put a 2x6, about 18-24 inches long on each ramp to lengthen the slope. I used a nail in the end of the 2x6, bent it and stuck it in a hole about half way down the original slope, and made the slope longer and more shallow.”

If you wanna get fancier, Mike Wilson says that Griot’s Garage (page 711) offers a “ramp extension kit”.

CHECKING FOR CRACKS: Jan Wikström provided this “backyard Magnaflux test” for checking for cracks in steel

parts: First, the area needs to be clean and smooth, so polishing may be required first. Allow a large, powerful horseshoe magnet to latch on to the part across the area to be checked. Now dribble kerosene with iron powder (collected from grinder) over the area; any crack will show up clearly.

ENGINE

H.E. VS. NON-H.E.: The H.E. (High Efficiency) engine, with 11.5:1 compression (12.5:1 outside the US) and a swirl combustion head designed by Porsche expert Michael May, was introduced in July 1981 and indicated by the letters "H.E." on the back of the car in place of the former "V12" emblem. In 1986, the H.E. emblem was unceremoniously dropped and a V12 emblem was used once again, but the H.E. combustion chamber design continued to be used in all Jaguar V12 engines until it ceased production.

If you have an engine laying around and need to know which it is, the trick is to look at the spark plugs. The plugs on the pre-H.E. tilt forward or rearward and are relatively easy to replace. The plugs on the H.E. tilt toward the centerline of the engine just enough to make them a real pain to get a socket on.

ENGINE NUMBERS: The engine number is stamped on the top rear center of the block just forward of the joint with the GM400 transmission bellhousing, but it is typically hard to find because it is covered with grime. Paul Hackbart sends this tip: "Take your oil dipstick out and get on the passenger side of car. You can stick it through near the oil pressure sender and scratch away until you see it. Just make certain you clean it off afterwards."

The XK's Unlimited catalog includes a guide of engine numbers for the XK 6-cylinder and the V12. It provides the following info on the V12:

7S1001>	E-type Series III	3/1971-2/1975
7P1001>	XJ12 Series I	1972-73
7P4000>	XJ12 Series II	1973 (Carbs)
7P25001>	XJ12 Series II	1974-79 (EFI)
7P?>	XJ12 Series III	1979-8?
8S1001>	XJ-S	up to 1980
8S18001>	XJ-S H.E.	1981-87

For more detail on XJ-S engines, Richard Mansell sends this helpful data from "The XJ-S Collectors Guide":

8S4551	Feb 76	Canister type oil filter introduced
8S5203	Oct 76	Revised EFI
8S6454		Modified fuel pump
8S7017	Apr 77	GM400 introduced
8S8632	Nov 77	Stronger manual trans selector shafts
8S10195	May 78	Modified air filter box to stop blowing off!!
8S11262	Oct 78	Ignition amplifier re-located
8S13094	Oct 78	Twin V groove water pump pulley introduced
8S16401	Nov 80	Digital P injection introduced*
8S17194	Nov 80	Sump plug relocated
8S18001	Jul 81	HE Introduced

Most changes after this are listed by VIN number but the following are listed too:

8S24175	Metric threaded cylinder heads
8S26992	Piston spec modified
8S27297	Inlet manifold modified to remove holes for cold start injectors
8S31737	Modified drive plate
8S41339	Spark plugs changed from B6EFS to BR7EFS
8S41344	Sump oil baffle plate changed
8S44227	Water pump bearing size increased
8S44317	Full flow oil cooling replaces relief flow
8S45527	GM400 revalved, modified sump pan

* Apparently the November 1980 introduction of Digital P is incorrect, as Ron Kelnhofer owns a Digital P car built in June 1980. His engine number is 8S17116SB, which does not conflict with the data in the listing, so perhaps only the date is incorrect.

5.3 vs. 6.0 LITER: The Jaguar V12, from its introduction in the E-type MkIII up to 1993, has been a 5.3 liter engine (326 c.i.), with a bore of 90 mm and a stroke of 70 mm.

Engines are often described by the relationship of bore to stroke. When the bore equals the stroke, the engine is described as “square”. Early gasoline engines tended to have long strokes and small bores, described as “under-square”. Racing engines have evolved to having the bore larger than the stroke, or “over-square”. The Jaguar V12 was designed to reestablish Jaguar’s eminence as a world-beater in the racing community (and prior to the fuel crisis of the early 70’s), hence the considerably over-square design. It was quite successful in this regard, still winning LeMans races in the late 80’s.

The popularity of over-square engines in racing is actually somewhat artificial. Most racing programs divide competition into classes based on engine displacement. An over-square design provides the most power for a given displacement, since it permits higher RPM and provides room for large valves. However, these priorities do not translate well to street use. Over-square engines tend to be heavy for their displacement; a larger displacement engine of comparable size and weight can be constructed with a nearly square configuration. The over-square layout also results in larger surface areas in the combustion chamber, which absorb combustion heat and reduce fuel efficiency. And while the design provides excellent power at high RPM, it tends to lack torque at lower RPM; since people like their engines to be turning slowly when cruising on the freeway, an over-square engine can seem anemic under these operating conditions.

Ford suspended production of the V12 for 1993, and reintroduced it in 1994 as a 6.0 liter (366 c.i.). More than merely an engine enlargement, the change made the V12 much less over-square, since the change was entirely an increase in stroke; the new engine has a 90 mm bore and a 78.5 mm stroke. This would tend to make the engine much more suitable for street use. It remains more over-square than most engines, and hence can provide excellent performance at high RPM, but is more tolerant of stop-and-go driving conditions and tall final drive ratios. The Michael May-designed H.E. combustion chambers remain in use in the larger engine, while the compression ratio has been reduced to 11.0:1.

Tom Walkinshaw Racing (TWR) was offering 6.0 litre engines much earlier. According to Richard Mansell, “TWR started making ‘sporty’ XJ-S’s in 1984. One of the options then was a 6.0 litre engine.” John Goodman reports that TWR also made 6.2 and 6.4 litre versions, and maybe even a 6.7.

Later on the JaguarSport XJR-S also had a 6.0. Mansell: “When JaguarSport officially started producing the XJR-S in 1988 only a 5.3 litre engine was available. It was not until mid-89 that the 6.0 litre was introduced as standard. This was then discontinued in 1993 as by then the standard XJ-S now had a 6.0 litre engine.”

Note, however, that the 1993-on updated engine has a lot of other features these earlier engines lacked, such as a revised bolt pattern for connecting the GM400 transmission.

WHAT’S IN A REDLINE?: Some people, probably accustomed to American pushrod V8’s, feel that the 6500 RPM redline marked on the tach is really aggressive and far too high for an engine this big for everyday use. Nothing could be farther from the truth; this is *not* an American pushrod V8, it’s an OHC V12 with an unusually short stroke. Roger

Bywater, who worked in the engine development department at Jaguar when this engine was designed, provides a more realistic understanding of just what that 6500 RPM redline is all about: “6500 r.p.m. is certainly safe and 7000 would not be a cause for concern. In fact I know of basically standard 5.3 V12s cobbled together with second hand bits being taken to near 8000 in race cars without suffering any problems at all. On the other hand an elderly engine does deserve a certain amount of respect. I expect the one thing that would result is that the timing chain and tensioner would start to show signs of distress a bit sooner if subjected to continual high r.p.m. In reality, there is not much point in revving a standard V12 beyond 6000 because it will be running out of breath anyway and therefore won't be making much power.

“The real problem taking these engines to 6000 and above is that the GM 400 torque converter distorts under centrifugal loads so that the blading can make contact creating fine metallic particles which then cause accelerated wear of the transmission. A way around this is to use a furnace braised converter which is more rigid and able to tolerate the higher r.p.m. without distorting so much.”

END OF AN ERA: The final Jaguar V12 engine was built April 17, 1997.

HOT SHUTDOWNS: It is never a good idea to shut down an engine immediately after running it hard; it is always better to run it at reduced power for a few minutes first to let it “cool down”. This has nothing to do with the temperature reading of the coolant; the problem lies with parts within the engine that get much hotter at full load than at low load, and can be subjected to high thermal stresses if the transition from high load to off is too sudden.

This problem is especially serious in the case of the Jaguar XJ-S. Several problems the car seems to have, including vapor locks, distributor seizures, and ignition amplifier failures, may be exacerbated by hot shutdowns. The underhood temperatures may skyrocket after a hot shutdown, and Jaguar is known to have had underhood temperature problems during development of this car.

Whenever you are driving the car hard, always drive the car leisurely for a few minutes before shutting it off. If you are forced to shut the engine off after running hard -- having a mechanical problem, for example -- at least open the bonnet to allow the heat to rise out of the engine compartment, providing some convective cooling.

See page 228 for tips on improving post-shutdown cooling.

KNOCKING/PINGING/PINKING/DETONATION/WHATEVER: Regardless of what you call that sound, it ain't good for an engine. A brief description of what's going on: When an engine is running properly, the fuel/air mixture within the cylinder is ignited by the spark plug and the flame front grows continuously and spreads throughout the combustion chamber until the entire charge has been burned. However, while this is going on, the piston is moving upwards towards the head, compressing the charge and thereby heating it. In the most severe cases of knocking, the compression causes the charge to self-ignite before the spark plug even fires. The result is that the entire charge ignites at once, rather than the gradual ignition of the flame front moving through the charge. This “explosion” has been likened to hitting the piston with a hammer. It can damage the piston, connecting rods, and the bearings in both ends of the con rods.

What usually happens is less severe, however. The spark plug fires well before the piston reaches the top of its stroke, so the flame front has begun its travel while the compression is still in progress. Since the burning charge is expanding, it is compressing the unburned charge into the far corners of the combustion chamber. The combined effects of the piston rising and the flame-induced pressure causes the remaining portions of the charge to self-ignite. The actual amount of charge exploded in this fashion can vary anywhere from a tiny portion to the entire charge, so knocking can be either severe or barely detectable.

There are many factors that contribute to knocking. The most notorious is compression ratio; the higher the compression ratio, the more likely it is for the charge to be detonated. Another key issue is the octane of the fuel, which is a measure of how hot it must be before it self-ignites; the higher the octane, the hotter the mixture must get before it will burn. And ignition timing is a factor, since lighting the mixture earlier will cause more of the charge to be burned

before the piston gets to TDC and therefore increase the peak pressure.

Other factors include the intake air temperature, the fuel temperature, and cylinder wall and head temperatures. EGR, which puts some inert gases into the mixture, makes it harder to ignite and therefore reduces the tendency to knock. Also, there are some minor details that can complicate the issue; sharp edges in the combustion chamber can act as “glow plugs” and ignite the charge prematurely. Carbon deposits can increase the compression ratio, as well as provide glowing embers to preignite the charge.

Knocking can be difficult to detect on the Jaguar V12. All those little cylinders mean that each knock is small, and all that sound deadening built into the car keeps the driver from hearing much of anything in the engine compartment. Basically, if you can hear it at all, you might need to be concerned. On the other hand, Mike Wilson reports: “I asked the local Jaguar rep and he had the audacity to say that “All Marelli cars ping”. He said it was even in the owners manual! So, I came home and read mine and sure enough, there it was in black and white! It said that a small amount of pinging was normal and if it happens on flat roads under no load, to see your dealer for further assistance.”

If something needs to be done about pinging, the usual reactions include changing to better octane fuel or retarding the timing. On the later XJ-S with Marelli ignition, you can’t adjust the timing by just rotating the distributor, so a jumper was provided that can be pulled to put the system onto a more retarded map when needed. Even if we try to buy good fuel, occasionally we always seem to get a tankful of real crap, and this jumper is a handy fix to get us to the next fillup.

Joe Ziehl shares some experience: “My mechanic told me to first try a higher octane fuel because while retarding the timing may help, the preignition might be caused by something other than spark plugs, such as carbon in cylinders or on pistons. He also recommended that I treat the gasoline and run the car hard for a few days. This made a significant improvement in the pinging.”

Jeff Elmore reports: “I had been getting some slight pinging under medium acceleration after the car had warmed up. I had tried many things, including checking the timing, high octane gas, etc. Then I tried the temperature at the thermostats. It was 213°F on one side and 203°F on the other. I just changed the thermostats and topped off the coolant (almost half a gallon low), and the pinging is gone. The car now runs better as a result, with my guess being that a lower CWT sensor means more fuel and power.”

Andrew Stott reports: “Autocar magazine had an XJ12 HE on long term test and in their 12,000 mile report (May 8 1982) they had quite a bit about the knocking noise and clouds of smoke at around 4,000rpm in 1st following a couple of weeks of gentle, town driving. Apparently, the Jaguar engineers discovered this quite early on in the development of the May heads and ran special endurance tests to highlight any problems, none were found.

“In their 36,000 mile report (April 9 1983) Autocar actually had one of the heads removed and found nothing at all amiss, not the slightest suggestion of pinking damage, and no measurable ovality or wear in the bores. There are pictures in the report. They also ran performance tests and found the car to be just as it was at 12,000 miles.

“Both these reports are in the Brooklands book on the XJ6 & XJ12 Series III (1979-1985), ISBN 0 946489 98X.”

The experience on the internet discussion lists indicate there is one sure-fire cure for knocking: the Italian Tune-Up. Get the car fully warmed up, then while cruising along at about 60 mph, move the shifter into 2 and punch it. Hold the pedal to the metal until somewhere close to redline, then let off and coast back to 60 -- and repeat. The first time or two, the car will show its displeasure by stumbling and blowing great clouds of black smoke out the rear. After a few such accelerations, the car will react *much* better to being punched, even feeling as though it is anxious to do it again, and there will be no trace of smoke. Owners consistently report there is no longer any trace of engine knock either, and the car runs better all around.

Obviously, an Italian Tune-Up wouldn’t be a good idea if the engine has serious mechanical faults such as fuel supply problems, overheating problems, etc. It also wouldn’t be good to run it through a speed trap.

People think I’m makin’ this stuff up about the Italian Tune-Up. Bill de Creeft provides a quote from a British car magazine after the HE engine came out: “...if one runs the car for not less than a working week of relatively gentle driving, typically commuting with no longer journeys between, then, once properly warm, accelerates flat out, the engine goes through a period between 4500 and 5000 rpm of loud detonation accompanied by pale but noticeable exhaust smoke. You learn, after the first rather frightening occasion, to keep your foot down regardless, to accelerate through

the knocking which, together with the smoke, stops and doesn't return until after the next period of town running. Jaguar, and Michael May, say that in gentle driving or with a lot of cold starts and short journeys combustion deposits build up in the head and on the valves. On hard acceleration these deposits heat up and burn, causing detonation but clearing, as they burn off into smoke. Jaguar says that in tests they conducted before the engine's launch (in July '81) in which such deposit-induced detonation was sustained artificially for long periods of hard running, showed no sign of piston or head damage."

OCTANE: ...ain't octane. If only things were simple. John Littler picked the following explanation up from an internet discussion; I presume that ULP stands for UnLeaded Petrol and PULP stands for Premium: "The US does things differently to the rest of the world (I bet you've heard that before!). In Australia the octane reported at the pump is the RON (research octane number). There is also another octane that you never hear about called MON (motor octane number). The MON is determined in a similar way, but under more severe conditions (so it yields a lower number). In the US they report AKI (anti knock index) which is an average of MON and RON.

"The ratings for ULP and PULP are typically:

	<u>MON</u>	<u>RON</u>	<u>AKI</u>
ULP	82.5	91	87 approx
PULP	86	95.5	91 approx

You can see that the US 91 is actually our PULP. This is the US mid-grade (also the main grade in Europe). They also have a premium grade which has an AKI of 93 or a RON of about 98."

Littler adds his own editing to this snippet: "I wish it were true that the US had a mid-grade rated at 91 AKI/95 RON. Then it would be suitable for my Jag which requires 95 RON. Unfortunately the US mid-grade is only 89 AKI/94 RON, so I have to pay for the 93 AKI/98 RON Super-Unleaded. If the Jag had a knock sensor I would risk trying the 94 octane stuff, but it doesn't, and the dealer has warned me to always use 98.

"BTW, prior to 1973 the US reported octane as RON like the rest of the world."

UNLEADED FUEL: XJ-S owners in the US have been using unleaded fuel for decades, but many owners in other countries are only recently facing the prospect of leaded fuel being no longer available. Since some of their owner's handbooks specify the use of "Four Star" leaded fuel only, they are understandably concerned.

Addressing this concern, Roger Bywater of AJ6 Engineering (and formerly with Jaguar Engine Development) wrote an excellent article for *Jaguar World* magazine (see page 723), Vol 10 No 3, January/February 1998, page 42. Some of the high points are summarized here.

There are two reasons for concern regarding the use of unleaded fuel: Octane and valve seat lubrication. Valve seat lubrication is simply not an issue in the Jaguar XJ-S; every engine the car has ever been built with has an aluminum head with hardened valve seat inserts, and the part numbers for these parts are the same for US-spec models always intended to run on unleaded fuel. If you have shoehorned in a Chevy engine old enough to have a cast iron head with no inserts and designed to require leaded fuel, well, shame on you.

Octane is another story. The US-spec engines have lower compression ratios to run on lower octane fuel. To be able to run the high compression engines on lower octane fuel, either the compression ratio will need to be lowered or the timing will need to be retarded. If the engine is being rebuilt anyway, lowering the compression ratio (different pistons, thicker head gaskets, machining the combustion chamber, whatever) may be workable, but most people will prefer to simply retard the timing. Bywater suggests that there's very little difference between a high compression engine with retarded timing and a low compression engine with advanced timing anyway.

With the Lucas ignition systems, retarding the timing is simply a matter of turning the distributor to a new setting. Bywater says that for the 95 octane unleaded that will be available in the UK and Europe, about three degrees should do it, although as many as five may be necessary for older cars with a lot of carbon buildup. On Marelli ignition cars, retarding the timing only requires pulling a jumper to switch the ignition ECU to a more retarded timing map.

UNLEADED FUEL -- AJ6 ENGINE: If you own an early ('83-87) AJ6-engined car with the Lucas 8CU EFI, you can retard your timing by simply turning the distributor. However, if you have a later ('87-on) 3.6 with the 9CU engine control system, the ignition timing is controlled electronically and not so easy to change. According to Bywater's article, there are two options: You can remount the crankshaft position sensor using the mount from the later 4.0 AJ6 engine, or you can remove the crank pulley and reposition the toothed rotor by drilling new mounting holes.

John Littler says, "Well, for around \$50US you can get a little gizmo from a number of vendors which then gives you a dial to advance or retard the stock timing by up to about 5 degrees either way (does it on the fly so it just takes 1 degree off whatever the ECU says etc). Definitely available from Summit (MSD and Crane), also available in Oz from two other suppliers as well. Lastly, seeing as I believe the AJ6 use Delco ECU's (is that right?), then a copy of the Kalmaker software will let you change anything you want on the EPROM."

THE DANGERS OF RUNNING LEAN: Most people tend to think of their car's fuel system as an on/off proposition: either you've got fuel, or you don't -- and if you don't, it won't run, so you've gotta fix it. There is, however, a third possibility that bites the Jaguar V12 owner only too often, and that is running lean.

Running lean is no big deal if you're driving gently; in fact, there are modern automobiles designed for "lean burn" operation, which means that at light throttle they can operate quite a ways leaner than stoichiometric in order to optimize fuel economy. But running hard -- in any gasoline engine, Jaguar, lean burn, whatever -- with an air/fuel ratio leaner than stoichiometric is just asking for engine damage. A Jaguar V12 that has been running lean for a year but has never seen full throttle is probably as good as new, but hold that pedal to the metal for 30 seconds and a couple of new pistons will probably be needed.

Why am I making a big deal out of this? After all, the XJ-S has EFI, which should provide reliable fuelling at all throttle conditions. The later models even have oxygen sensors that will correct for either lean or rich conditions on the fly. Why worry? Well, there's plenty to worry about. If the fuel pump or other parts of the fuel system aren't up to par, the EFI system may provide correct fuelling under normal driving conditions, but when floored the fuel supply can't keep up -- and the engine runs lean just when it is most dangerous! And, horror of horrors, there are absolutely no warnings that you're in trouble; everything on the dash looks just great, the engine sounds just dandy, and the car has plenty of pep -- right up until it starts missing on a couple of cylinders because the pistons are toast.

If you ever intend to explore the lower half of the pedal travel on the Jaguar V12 (and who doesn't? Why else would you own the car?), it is recommended that you install air/fuel ratio indicators, which are commonly available; they are very popular with performance enthusiasts for exactly the same reason: they provide a warning before it's too late. These indicators operate off the signal of a regular oxygen sensor. If your car doesn't have oxygen sensors, you can purchase generic sensors (the heated type are recommended), and it's a simple matter to have bosses welded into the exhaust downpipes to install them. If your car already has oxygen sensors, there's no need to install more; the indicators will read the signal from the existing sensors without interfering with EFI operation.

Both Jeg's (page 717) and Summit (page 720) offer LED air/fuel indicators, and they're even reasonably priced. You'll probably want two indicators, since you have two oxygen sensors -- or perhaps you can rig a switch to read one sensor and then the other with a single indicator. The indicators usually feature three colors of LED. If the engine is running near stoichiometric mixture, LED's near the center of the display are lit, and they are usually green. The rich and lean sides of stoichiometric are usually red and yellow LED's, but some indicators have red as rich and some have red as lean; make sure you understand that it is lean that means trouble, whichever color the LED's are.

When the engine is running in closed-loop mode (warmed up, light throttle), the indicators should be reading green. When floored, the ECU goes into open-loop mode, which means it should run richer than stoichiometric. A rich indication when floored is OK. If the gauge ever starts to read on the lean side of stoichiometric while you have your foot in it, lift your foot *now* and investigate problems in the fuel system before you romp on it again.

Air/fuel indicators can help you spot a *lot* of ills, including totally unheard-of problems not covered in this book. You'll be able to monitor how your fuel system is working at all times and notice when something goes wrong.

The May 1996 issue of Skinned Knuckles has an article, "Oxygen Sensors & Air/Fuel Ratio" by Hugh Poling, in which the author points out the limitations of air/fuel indicators that use a conventional oxygen sensor for input. Some A/F indicators have three LED's, indicating lean, stoichiometric or rich. Others have more than three, apparently indicating different degrees of lean or rich; according to Poling, these indicators are wired so that particular voltages from the oxygen sensor light up particular LED's. The indicators Poling objects to are the ones that are actually marked with different Lambda values; "From the SAE Transaction pertaining to oxygen sensors, this relationship of voltage to LED markings is bogus...Since the standard oxygen sensor covers a very narrow range of only a few percent around stoichiometric, this labeling is fraudulent." In other words, an LED indicator connected to a conventional oxygen sensor is quite reliable at indicating whether you are running lean or rich, but do not rely on it to tell you *how* lean or rich.

Note that there are instruments on the market that *can* provide accurate indications of mixture within the lean or rich ranges, but you'll know if you buy one -- they are very expensive, and they do not use a conventional oxygen sensor for a signal.

OIL CHANGING: If you buy an oil drain pan from the local auto parts store, slide it under the Jag, and open the plug in the sump, you may be in for a messy surprise. The Jag V12 will drain around 11 US quarts of oil, and this is more than the capacity of many conventional oil drain pans. Either be sure to get a really big pan, or figure out how to drain the sump into two pans.

Here's an idea: Get one of those plastic oil drain tubs that features a spigot to pour the oil into bottles without a funnel. When the tub is sitting on the floor, the spigot acts as a spillover; if too much oil is drained into the tub, it'll come out the spigot rather than spilling over an edge. With the tub sitting under the engine, set *another* container under the spigot. Your total drain capacity hence becomes the total of both tubs.

A disposable aluminum turkey broiling pan works great for that second pan. If it doesn't fit neatly under the spigot as is, it's not difficult to mangle the edge a bit to allow it to sit right.

OIL FILTER REPLACEMENT: The oil filter on the Jaguar XJ-S mounts nearly vertically, the way they all should; the dirt stays in the filter as it's being removed. Considering the position, you can do your engine a favor by filling the new filter with oil prior to installing it. When you start up, you will get pressure that much sooner. There are also reports that prefilling may help protect the element itself from rupture when the engine is started. You will find it helpful to use a small screwdriver or some such to poke through the smaller holes in the base of the filter and push open the flap a little to provide a vent while trying to pour oil in the center hole. And be patient; it takes a minute or two for oil poured into the center hole to soak through the element and fill the outer chamber.

It has been noticed that some filters for the XJ-S are different from others. Some are very large, extending almost level with the bottom of the pan. Others are of conventional size. Some have a series of flats around the bottom edge to fit the socket-type filter wrench that goes on the end, and some don't. Since you can't get to this filter from the side, it is recommended you get a filter wrench that can be used from the end, and make sure the filters you purchase can be removed with your wrench. The socket-type filter wrench works well and is cheap, but requires the series of flats on the filter. There are also coil type and strap type filter wrenches that will work on most any filter; note that the coil type cannot be used to tighten the filter.

Peter Cohen says, "I have found that if I hand tighten them as much as I can with one hand with the little bit of leverage available down there, I am able to hand remove them as well." Peyton Gill adds, "I got a box of disposable latex rubber gloves (used in the medical industry). They provide additional grip and make hand removal and installation much easier plus keep your hand clean when the oil runs down the filter. These things are cheap and can be bought at drugstores. It really makes a big difference applying torque."

Cohen provides some part numbers listed for earlier XJ-S's: "Fram PH2931 is correct, and I have used them for years on my 1989 XJS. Purolator L30255 is the new numbering scheme that replaces L3255. (They just stuck in a zero for some reason.)"

Dave Hernt reports that later spec filters fit better: "Both the PH2995 and L30381 are the filters specified for the 6.0L

V12. Same threads and gasket, just shorter. I have installed a Purolator L30381. Similar to the L30255, but a tad shorter. Goes in easy. It seemed to me that the L30255 was not going to go in without a hammer. Also tried a Fram PH2995, it fits."

OIL FILTER REPLACEMENT -- EARLY CANISTER TYPE: Until sometime in 1976, the XJ-S came with a canister filter assembly. Not only does this make it more difficult to change, but more care must be taken to make sure everything is working properly. Mike Morrin had a problem with a non-replaceable bypass valve that sits in the bottom of the canister: "I noticed that the bypass valve was actually about half way open!! This is presumably not good for filtration efficiency. On dismantling the bypass valve, it became apparent that the alloy valve body had been strained, probably by someone tightening up the filter assembly with something not seated correctly. I was able to straighten and reassemble the valve, and it looks like it should work as good as new."

OIL ADDITIVES: Don't use any. The quintessential article on the subject is "Snake Oil! Is That Additive Really A Negative?" by Fred Rau, ROAD RIDER, August 1992, Pg 15. Transcripts of this article appear in literally dozens of places on the WWW, any search should find one. A couple such places include:

http://www.performancemotoroil.com/truth_about_oil_additives.html

<http://www.carbibles.com/snakeoil.html>

For those who feel compelled to spend more money on oil than merely following the manufacturer's recommended change intervals, the following options are suggested:

1. Install a bypass filter system -- see page 115.
2. Change oil more often. In fact, changing oil ridiculously often using el cheapo oil is a very workable plan, but some consider it environmentally unwise. It's also a lot of work.
3. Use synthetic oil. Tests have indicated that synthetic oil coming *out* after the recommended change interval is often *better* than new regular oil.
4. Change the *filter* more often. They're cheap, and indications are they get plugged and begin bypassing long before the scheduled oil change interval.

On my car, I change the oil according to Jaguar's recommended interval (6000 miles), use synthetic oil (Mobil 1, 15W-50), and change the filter every 3000 miles.

Leaks

SEALING SUBSTANCES: If you would prefer that your Jaguar not leak oil, the first thing you must get through your thick skull is to ignore all guidance on sealants and gasket dressings provided in the official Jaguar publications. Most of their callouts are obsolete, many were wrong the day they were printed, and -- let's face it -- Jaguar has absolutely no credibility regarding leak prevention. To top it all off, Jaguar manuals and TSB's have a nasty habit of calling for some esoteric product that's only available in industrial quantities via special order. Forget the Jaguar sources and follow the guidance in this book instead.

Note that "gasket dressing" and "sealant" are two different things; a gasket dressing is used to help a gasket seal properly, while a sealant is used where there is no gasket. Nobody is strict about the use of these terms, but the wise mechanic will note how a product is intended to be used and avoid trying to use products for applications they are not suited for.

It's easy to get all wrapped up in which sealant or dressing is "the best", but all you really care about is that it doesn't leak. There are many products that will fill that bill for any particular application. Being readily available locally in small

quantities is a big plus. Here are some simple guidelines:

If it's a gortex gasket, don't use any substances on it; assemble it dry.

If it's a paper gasket, use a gasket dressing such as Hylomar on both sides.

If the joint involves two close-fitting metal surfaces with no gasket, use a sealant such as Loctite 518.

Those guidelines will cover almost everything that needs sealing in the Jaguar XJ-S. There are a couple of special cases, though. The sides of the rear main bearing cap require a gap-filling sealant that can be injected; for this, copper silicone sealant works well although it's not particularly easy to squeeze into the slots (the top of the rear bearing cap should be sealed with Loctite 518). The threads on the sandwich plate bolts with their heads inside the sump should be sealed with Permatex #2 non-hardening sealant. The head gaskets and exhaust manifold gaskets are metal sandwiched around a fibrous core and should be assembled dry.

GASKET DRESSINGS: As noted above, Hylomar is readily available and works just fine. Hylomar is a blue goo that never hardens. Jaguar mistakenly specified Hylomar for use as a sealant in gasketless joints, which is a large part of why these cars leak; it eventually gets blown out of such locations.

On gaskets, Greg Fronczak of Jag Services prefers a Toyota sealant, part number 023500102. This is a black substance.

Chad Bolles suggests a non-hardening sealer from a GM dealer, part no. 1050026.

Roger Homer suggests a Caterpillar product. "I'm not sure of its official name/number but I just go into the local Caterpillar dealer and ask for a tin of Cat Red." Bolles and Homer recommend these last two products primarily because of ease of disassembly later; the gaskets easily peel off the metal parts with no need for scraping.

SEALANTS: As noted above, Loctite 518 is readily available and works just fine. Everything that Loctite makes with a number starting with 5 is a sealant, though, and many of them will work in the Jaguar V12. Loctite 573 and 574 have both been used successfully between the tappet blocks and the heads. Steve Cranswick likes Loctite 5900 Flange Sealant. None of these are likely to be as easy to find as 518, though.

For those who can't seem to find Loctite 518, Karl Nelson says, "Permatex is now a division of Loctite, and Permatex 51813 is the same thing as Loctite 518. Permatex 51813 is widely available at NAPA stores, and is advertised as Anaerobic Flange Sealer."

Joe Bialy adds, "The '13' in 51813 signifies the size of the package the 518 comes in. For instance, IIRC, 51845 is a caulking gun sized package of 518."

Loctite's not the only source for sealants. James Teston points out that HERNON makes similar products, and there's a Loctite/HERNON cross-reference list on the www at

<http://hermon.com/crossref.htm>

SEALANTS VS. OXYGEN SENSORS: You should look for an indication that a sealant is "oxygen sensor safe" before using it *anywhere* on an engine fitted with oxygen sensors. Apparently some silicone sealants will emit something that gets in the oil and eventually into the exhaust and ruins the oxygen sensors.

LEAKY GASKETS: One of the improvements Ford made to the Jaguar product line after they purchased the company was that they "Fordified" the gaskets and seals for the V12. While all of the old style gaskets look like plain paper of various thicknesses, the new gaskets are often "Gortex" (teflon) sandwiched around metal foil. This upgrade is explained in Technical Service Bulletin #12-35 dated 8/92, which states that engines were fitted with these gaskets from the factory starting with engine #8S86317SA. All of the upgraded gaskets fit the older engines, so whenever engine work is being done it would be wise to use the newer gaskets.

Redesigned gaskets, along with the new part numbers:

	<u>Old P/N</u>	<u>New P/N</u>
Oil Filter Housing	EAC6337	EBC 9624
Oil Pan Gasket	EAC7251, GEG560	EBC 9623
Cam Cover Gasket, Right	C29428, TJM536	EBC 9628
Cam Cover Gasket, Left	C29429, TJM537	EBC 9627
Thermostat Housing, Right	EAC7048, GTG130	EBC 8330
Thermostat Housing, Left	EAC7047, GTG129	EBC 8331
Water Pump Gaskets	C29626, C36542	EBC 9629, EBC 9630
Water Pump Elbow	C36020	EBC 9636
Valley Cover	C29485	EBC 9631
Sandwich Plate Gasket	EAC7252	EBC 9637
Coolant Manifold Gaskets	C30344	EBC 9634
Exhaust Manifold Gaskets	C33921, GEG688	EBC 10199
Throttle Body Gaskets	C33280	EBC 9635

There are more, I just don't have all the part numbers.

The original valley cover gasket was a piece of thin paper, and the new one is a piece of thin Gortex -- black on one side, red on the other. This one isn't sandwiched around metal foil; it's really flexible, it even comes all crumpled up in a bag. Offhand it wouldn't appear to make any difference which way is up, but the TSB specifies that it should be installed with the black side towards the block. If you install the valley cover while the heads are off, trim the edges of this gasket wherever they protrude out from under the cover to make sure they don't interfere with head gasket seating.

Richard Francis indicates the gasket between the water pump and the timing chain cover is also rubbery, no metal. He also says the water pump elbow gasket "was not Gortex; it was black/red material again, though not paper, not metal, and really not that rubbery either." The TSB says that the water pump elbow gasket should be installed with the black side towards the block.

The TSB clarifies that all of the Gortex and Gortex sandwich gaskets should be assembled dry; no dressing should be used. It also specifies replacement bolts; "Revised bolts have flanged heads to prevent loosening. Do *not* use a washer on revised (flanged) bolts." The TSB only mentions replacement bolts for the oil sump, sandwich plate, and cam covers. See the cam cover sealing discussion starting on page 60 for more ideas on this bolt replacement. Also see the discussion on sandwich plate bolt sealing on page 48.

This author ordered a set of thermostat housing gaskets by the above part numbers, and received paper gaskets. They are black paper and kinda thin, while the older style is thicker red paper. The only other difference I can see is that the outside edge of the newer 3-bolt cover gasket lacks the bulge at one corner, so it can fit on in any of three orientations. I have been told that Gortex sandwich gaskets do exist for the thermostat covers, but part numbers are unknown.

The original coolant manifold gaskets were apparently very thin paper and later versions were really thick pink cardboard; the EBC 9634 gaskets are Gortex/metal sandwiches, and are pretty thin. There are 12 used on the engine, although because some are used under the coolant headers and others are used under blank-off plates they may be listed in catalogs as 8 needed in one place and 4 in another. Note that the steel blank-off plates tend to distort with stress and time, especially if they've been holding down the thick paper gaskets; prior to reinstalling, it'd be a good idea to run a flat file across the bottom to make the surface flat again.

A single design gasket is used on both sides of the throttle body, between the air filter housing and the throttle body and between the throttle body and the intake manifold, so you need a total of four. The EBC 9635 gasket is a Gortex/metal sandwich and has 7 bolt holes in it; four in a rectangular pattern, two more at 10 and 4 o'clock for the hidden bolts that hold the throttle body to the intake manifold, and a single loop that can either point straight up or straight down depending on which way you flip it. The TSB says they should be installed with the tab pointing downwards. The tab serves no purpose on the '83, and can either be cut off or left in place to hang out the edge of the assembled joint.

Mike Morrin says, "The top gasket set is Jaguar P/N JLM12229, and has all of the new style gaskets."

The new gaskets should be widely available. Be sure to check the part number or description of the gasket as some parts people may try to give you the old style to get rid of old stock. Given the proclivity of the pre-Ford Jaguars to leak oil, using the older paper gaskets -- regardless of how cheap you got them -- would be a poor decision.

Richard Francis ordered a rebuilt water pump in 2006. "Surprised at getting paper gaskets (plate to block and water inlet spout) with my rebuilt water pump from a reputable vendor, I called their president. He explained that while 1000's are sold each year, this is first time any customer asked to have the Gortex gaskets packaged with the part. Challenging him, he offered to make this recommendation to the outsourced company who actually rebuilds and packages the part for the customer. Wasn't TSB 12-15 issued in 1992?

"One disadvantage here, which may cause me to return this part, is that it is safe to say that the pump to plate gasket is paper as well.

"Of course, if you want the paper gaskets...otherwise put the Gortex in the same order.

INTAKE MANIFOLD GASKETS: During the Ford gasket upgrade, the 12 individual intake manifold gaskets C43354 or AJM687 were replaced with two gaskets; each serves all six ports on one bank. The part number is NNA-3020BA. The original gaskets were either a very hard thick cardboard or an embossed metal piece, and the new gaskets are a really thick, soft cardboard.

If you happen to have a pre-H.E., these new intake manifold gaskets pose a problem. Peter Smith reports that the sections of gasket between the intake ports interfere with installation of the vertical spark plugs used on the pre-H.E.. He also reports that the 12-piece gaskets are NLA. If you have a pre-H.E., here's a plan: set some 5/16" bolts on the floor standing on their heads and set one of the new gaskets down over them. Set the intake manifold over it, using the bolts to align the gasket with the manifold. Use a marker to mark the outline of the manifold onto the gasket. Then take a pair of stout scissors or sheet metal shears and cut that single gasket into six individual gaskets, throwing away the sections between intake ports. Let's face it, any portion of the gasket that isn't pinched between the manifold and the head is useless, it won't hurt anything to cut it away.

The spark plugs on the H.E. are canted inward and are a PITA to install, but the 2-piece gaskets don't make it any more difficult. Nonetheless, it still might be a nice idea to cut the gaskets into six pieces and discard the useless sections between ports; it results in a cleaner appearance in the vee, an area that's too cluttered already.

EXHAUST MANIFOLD GASKETS: The original exhaust manifold gaskets are sort of a metal/asbestos/metal sandwich with dimpled surfaces, and the newer ones are the same stuff except that they have added a collar around the center opening. This is a significant improvement; the earlier gaskets tend to erode from the exhaust passage outward.

DRY PAPER GASKETS: For the few places where paper gaskets are still used on the XJ-S, Walt Osborn of Vintage Jaguar (page 697) sends this tip: "When paper gaskets are stored for a certain period of time, they shrink and become hard and brittle. If you are in a hurry, just dip in warm water and pat it dry with a paper towel or shop rag. Keep doing it until it fits. If you have a little time put it in a plastic bag with a slightly damp rag. The gasket will usually reconstitute overnight. Once it is okay, remove the rag and seal the bag until ready for use."

PARTS BOOK CONFUSION: At the rear end of each intake manifold is an opening covered by a throttle linkage support plate and a triangular cover with hose connections for the crossover pipe, all held to the manifold with three bolts. It is plainly obvious that this assembly requires two gaskets, one between the manifold and the throttle linkage support plate and one between the throttle linkage support plate and the triangular cover. The August 1987 Jaguar Parts Catalogue shows this assembly on page 1C-15L and 1C-15R, but it shows only one gasket, EAC2650. It indicates two required, but all the other quantities shown on the page are per-car numbers, so one could conclude that it means one per manifold. Worse, many other sources, such as the catalogs from the mail order outfits, base their listings on this parts catalog and repeat this error. Ignore all this misinformation and order two EAC2650 gaskets per side, four total.

LEAKY SEALING WASHERS: Copper sealing washers work just fine -- once. The work-hardening properties of copper are rather extreme; when fully annealed pure copper is *very* soft indeed, but just bend or deform it a little bit and it gets very hard very suddenly. Copper sealing washers are intended to exploit this very feature; as the components are tightened down on them, they initially crush to form a good seal and then promptly get hard. If you try to reuse one, you almost might as well use a steel washer for sealing.

Craig Sawyers points out you can reuse copper washers if you anneal them. "Heat it up to cherry red in a flame (just a plumbing gas burner will do, or even the stove) and let it cool slowly. It will then be as soft as putty, and will tighten nicely without too much torque to give a good seal." Hanging the washers with little pieces of wire makes it easy to use a torch on them. Believe it or not, a butane cigarette lighter will work -- but you'll need to hold it on the washer a while, so it's best to have one of those long charcoal grille lighters that won't burn your thumb. Obviously, if the copper washers are boogered up, it'd be a good idea to file them flat before use.

Is it important to let it cool slowly? Nope! In fact, it's better to dunk it in water. Martin Lappin says, "Unlike steel, the copper will also stay soft if you quench it in cold water. The advantage of this is it removes the oxide scale from the surface." You simply cannot quench copper fast enough to cause it to harden, at least not without special equipment; dunking it in water isn't fast enough. If you don't dunk it, you'll have to sand the washer lightly after it cools to get the oxide off.

So why am I wasting space in this book to tell you how to save a few cents by reusing copper washers? Because you need to start annealing *new* washers. Sawyers: "They are supplied as stamped from sheet copper. In other words they are in half-hard anneal. I *always* heat treat new washers to put them in a state of soft anneal. Try it and you'll see what I mean."

By annealing each time, you can apparently reuse copper seals as many times as you like. People who use copper head gaskets in competition find this a very appealing prospect. For a ten cent washer, though, you'll probably want to replace them nearly every time anyway just because they eventually get pretty mangled.

XK's Unlimited (page 697) offers something called a Stat-O-Seal washer. It's an alloy washer with a rubber ring around the ID. They come in 1/8" increments. Michael Neal says, "The drain plug washer for the S3 XJ6 and XJ-S can be replaced with the transmission cooler line banjo bolt seal from an XJ40, EBC4896. This is a neoprene-lined washer that is reusable." You don't really have to seek out Jaguar parts sources, though; these type sealing washers are now commonly available in auto parts stores.

You can also assemble your own homemade equivalent with an O-ring and a flat washer. For example, to seal a 1/2 fitting you could slide on a 1/16" thick O-ring with a 1/2" ID and a flat washer with a 5/8" ID so it fits around the O-ring. Ideally, the flat washer should be just a bit thinner than 1/16". When you tighten down the fitting, first it contacts the O-ring and starts to compress it but then sits hard on the flat washer preventing you from overcompressing the O-ring. The O-ring ends up fully trapped within the flat washer so it can't blow out regardless of pressure. Such assemblies provide a reliable seal, and you can easily gather the parts to assemble one to fit any application. You can even put together really tiny versions if needed. And for optimum durability, you can opt for Viton O-rings (see below).

For the specific application of an oil drain plug, auto parts stores now offer a plug that has a built-in rubber seal under the head. It looks like a stubby washer-faced bolt, except the washer face is made of rubber. Obviously, if the rubber gets chewed up, you need to replace the entire plug.

The rubber-lined washer, the O-ring and flat washer, and the rubber-sealed drain bolt are all excellent sealing methods as long as the application doesn't get too hot for the rubber. The rubber will also deteriorate in a decade or so. Where things get hot or you need it to seal longer than a decade, the copper washer is the way to go. Now, let's move on to bad ideas:

If you find any aluminum sealing washers, throw them away. They cannot be reused. In fact, they're not all that great the *first* time.

Fiber washers work fine once or twice as long as you don't overtighten them, but eventually they tend to split open -- and not necessarily while you're tightening them; they may crack open later when you're 100 miles from home. They

are also generally unsuitable for high-pressure applications, although some fittings address this by enclosing the fiber washer within a recess to prevent it from blowing out.

Auto parts stores offer plastic sealing washers; sometimes they are packaged with a replacement oil drain plug. Sometimes they have circular ribs on them, apparently to improve sealing. Sometimes they have a little flag hanging off one side, apparently to stick out the side of the joint and tell you there's a plastic sealing washer in there. These things work for low-pressure applications such as an oil drain plug, but don't use them on any line that holds pressure. You must be careful while installing; you can overtighten them and squeeze them right out of the joint, especially if there's a little oil involved. In general, you'd be well advised to just throw them away.

LEAKY O-RINGS: The O-rings available at your local parts store are probably as good as the Jaguar originals -- which is to say not worth a damn. Whenever an O-ring is encountered during disassembly of the V12, it invariably is hard and brittle and has long since ceased sealing properly. Viton O-rings are the recommended upgrade, although you might not find them in your local auto parts store; you might need to visit a good industrial supply place to find them. They are often brown to distinguish them from normal O-rings, but they can also be found in black or any of several other colors. The price is always an indicator, though; they cost several times as much.

Andy Hutchinson reports: "Looked at my book today. It would seem the choice of "elastomers" (push for rubber) is Nitrile, Fluorocarbon or Fluorosilicon. Viton is Fluorocarbon. Excellent hot and chem resistant. Not so good cold. Fluorosilicon is good at both ends but not very tough (fixed surfaces only). Nitrile is a good all rounder and I suspect the standard material. Rubber, silicone, neoprene, etc. are dogs." As long as you're not building Space Shuttle solid rocket boosters, that lack of cold performance of Viton may be acceptable; on the Jag V12, it'd be preferable to leak only in freezing weather than to leak all the time!

Viton O-rings can be ordered from McMaster-Carr (page 711).

LEAKY BANJO FITTINGS: Banjo fittings require two sealing washers. The copper washers used to seal the banjo fittings at the back end of the tappet blocks are really thin, only about .010" thick. This is too thin for reliable sealing, so chances are pretty good that these banjo fittings will leak right after assembly.

If your local auto parts store has a rack of red cards titled "Help!", it probably has a package of sealing washers that are the correct diameter for these fittings but a *lot* thicker: Part number 66272, labelled "Brake Hose Bolt Washer". It says they are ID 25/64" and OD 5/8". These washers are about 1/16" thick and will seal just fine -- but will aggravate another problem.

Craig Sawyers pointed out that the alignment of the cross hole in the banjo bolt doesn't line up with the channel inside the collar as well as might be hoped -- see Figure 1. The collar is about 13/32" thick, with the channel right in the middle, but the cross hole in the bolt is located only about 5/32" from the underside of the head -- and the thickness of the sealing washer between the bolt head and the collar makes this misalignment even worse. The drawing at left includes a 1/16" thick copper washer, and the two passages barely overlap. Jaguar's fix: those really thin sealing washers described above.

A better fix is pretty easy, though: using a Dremel or some such, lengthen the opening on the cross hole in the bolt in the direction of the threaded end (basically, enlarge the chamfering in that direction). This will help the oil flow to the camshafts even if the original thickness washers are used. Ideally you will want to extend the edge of the cross hole to about 5/16" or 8mm from the underside of the bolt head.

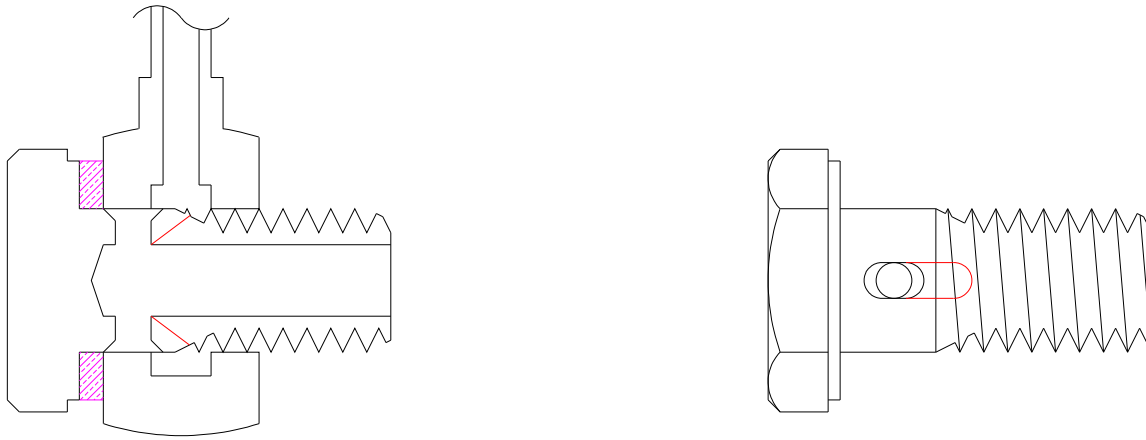


Figure 1: Banjo Bolt Modification for Better Flow

Craig Sawyers came up with a slightly different mod: “I added a single extra 2.5mm diameter hole (ie not all the way through, just until it entered the axial drilling) with a centre line 6.7mm from the sealing face. that puts it entirely in the channel in the oil feed line.”

Now that you’re practiced at this modification, do the same thing to the banjo bolt at the top right of the radiator -- see page 187.

If you’d prefer, Ron Kelnhofer (page 718) offers a custom banjo bolt to replace the OEM item. He includes a pair of copper sealing washers with each bolt that are 0.031” thick -- thicker than the OEM washers and thick enough to seal properly, but only half as thick as the Help! items described above. Kelnhofer located the cross hole in his banjo bolt correctly for his 0.031” sealing washers; if either the thin OEM washers or the thicker Help! washers were used with it the cross hole would still line up *better* than the OEM banjo bolt with the OEM thin washers, but nevertheless Kelnhofer suggests you use the washers he designed it for to ensure optimum flow.

He also made his banjo bolt a little longer. “1.015" long overall. The bolt was lengthened only an amount equal to the change in the washer thicknesses.” It is therefore *not* a solution for the stripped banjo bolt hole problem described below. “The reason behind this is that with the limited amount of space between the head and the firewall, I wanted to keep it as short as possible but still permanently address the real issue, leaking. I could have made them longer but actually can't see a real benefit as far as sealing is concerned by doing so. As far as stripping the head threads, my feeling is that it isn't really a problem if one uses common sense in tightening the bolt.”

Kelnhofer’s banjo bolt is made of stainless steel. You can look at a pic of this bolt at

<http://neptune.spacebears.com/cars/engr/banjoeng.html>

When tightening banjo bolts, be sure to hold the collar on the oil line still. Failure to do so will allow the turning of the bolt to twist the collar and bend the tubing.

STRIPPED BANJO BOLT HOLES: The banjo bolts thread into the back ends of the tappet blocks only about 0.35”. That’s not much thread engagement for screwing 3/8” bolts into soft aluminum, and combined with the fact that the banjo fittings often leak at assembly due to the thin copper washers, it’s only too common that a mechanic tightens them too many grunts trying to stem a leak and winds up stripping out the threads in the tappet block. This will require many pints to get over since it would normally require removing the tappet block to helicoil, and removing the tappet block requires removing the camshaft, and removing the camshaft requires fiddling with the timing chain tensioner -- see page 64.

Modifying the banjo bolt and using thicker copper washers, as described above, will solve the sealing problems and

make it unnecessary to go cranking on that banjo bolt so hard -- but it also means that there are even less threads engaged, so being judicious about tightening is highly recommended.

Nick Johanssen and Craig Sawyers report that the Jaguar Enthusiasts' Club (page 730) offers longer banjo bolts. "A get-you-out-of-trouble idea for a temporary way of avoiding the removal of the cylinder head if the original bolt's thread strips. This bolt has extra threads to take up with the deeper threads always present, but not always made use of." He means avoiding removing the tappet block rather than the cylinder head of course, but it's still a task to avoid.

Of course, it might not be a bad idea to install the longer banjo bolts *before* the threads strip.

Note: the JEC banjo bolts are nice and long, but the cross hole is still in the wrong place. Before installing, you will need to modify them per the guidelines above.

There are also questions about the quality of these parts. Sawyers says, "the thread had been made with a worn die. It was as rough as a badger's backside, and was too large (like a nut wouldn't go on with just fingers). So I had to run a 3/8 UNC die down it - curling out a spiral of extra metal in the process." Considering the soft aluminum tappet blocks these things screw into, finding such a die and chasing those threads is certainly prudent.

Classic Jaguar of Austin, Texas also offers longer banjo bolts, part number C5846L (the L is for Long). They're supposedly about 3/16" longer than the OEM banjo bolts. No word on whether the cross hole is correctly located or whether the quality is any better than the JEC items. They might actually *be* the JEC parts, just kept in stock on this side of the pond.

Some people have suggested simply making new banjo bolts from normal bolts; just drill one hole axially down the length of the bolt and another crossways. Sawyers: "The head of a standard 3/8 UNC bolt is 9/16AF. The banjos are 5/8AF - the increase in AF size for the head gives a larger land for the copper washer to seat." IOW, it might work, but you'll have less sealing surface under the head. Perhaps better to just buy the correct items -- unless you can find 3/8" UNC bolts with oversize heads.

Note that there is at least one report of longer banjo bolts being too long and bottoming in the threads before tightening down on the sealing washers, thereby causing a massive leak. It's all a function of how deep the hole was threaded. Hence, if installing a longer banjo bolt, it is recommended that it be trial installed without sealing washers first to make sure it'll screw in far enough. If they bottom too soon, the solution is obvious: shorten them a bit. Meanwhile, if you ever have the tappet blocks off, check the threads and if they're not tapped plenty deep, go ahead and tap them deeper while you can.

Things are tight back there, and problems may arise trying to get the longer banjo bolts in place with the engine in the car. Trying to get them in between the firewall and the fitting on the oil line is probably not going to work. Rather, gently bend the oil line upward until it clears the back end of the tappet block, insert the long banjo bolt with one sealing washer around it, then gently bend it back to the proper position. Use a length of dental floss to hold the second sealing washer in place, get the banjo bolt started, then cut the dental floss and pull it out.

This will work, but obviously you don't want to do it a dozen times; eventually the tube will crack and you will need a new one. To ease the stress on the tube, you could unscrew the banjo bolt from the oil pressure sender pedestal or unbolt the pedestal itself, which will allow moving the oil feed manifold around much more easily. This will allow moving the ends out from behind the tappet blocks more easily -- and if you're coordinated, you might consider putting the banjo bolts into the fittings for both tappet blocks at the same time rather than bolting one down and then bending the tube to install the second. Alternatively, you might do the right bank first -- it's the hard one -- and then you may be able to get the left one together without even having to move the oil line around.

LEAKY OIL PRESSURE SENDER CONNECTIONS: The connection at the block at the rear center of the V is a larger banjo bolt. For this fitting, Help! number 66265, "Brake Hose Bolt Washers" are a perfect fit. They are described on the package as ID = 33/64", OD = 45/64". These same seals fit the bolts that hold the heat shields to the exhaust manifolds -- see page 317.

The seal on the oil pressure sending unit itself is not the same size as on the banjo fitting. The sending unit fitting is the

same diameter as many common oil drain plugs, though, so it is easy to find a suitable seal in an auto parts store. Note, however, that if you're buying a new sending unit, it will usually come with a new sealing washer.

LEAKY OIL PRESSURE SENDER: When searching for sources of oil leaks, don't overlook the oil pressure sending unit itself, C46272. The unit can fail internally and oil comes seeping out of the electrical connector, a sure sign of trouble since there isn't supposed to be any oil within the electrical components in this unit. The author's car had this problem, and the gauge was still working just fine. The only solution is to replace it. A sender with silicone sealant around the connector is a sure sign that an incompetent mechanic has been involved.

For more on this sender, see page 56.

LEAKY OIL PRESSURE SWITCH: The oil pressure switch, which operates the warning light, is right next to the oil pressure sender -- and is even more notorious for leaking oil out through the electrical connection. The only solution is to replace it, but that's not difficult because the thread is standard and there are lots of cars that use very similar pressure switches. David Johnson says, "I screwed one from a Chevy in. The new one was a two wire type, so I simply connected one side to ground and it works fine."

OIL LEAKS AT FILTER HEAD ASSEMBLY: Peter Smith says "The oil would gather around the top of the filter less than a minute after starting the engine. I eventually took the head assembly off and found a blanking bolt fitted to the rear which had a failed fibre sealing washer. Replaced it with a copper washer - no more leaks. I had to take the head assembly off to see the bolt but when you know it's there it may be possible by feel."

OIL LEAKS AT CAM COVER/HALF MOON SEAL: Discussed on page 60.

OIL LEAKS AT TAPPET BLOCK: Discussed on page 70.

OIL LEAKS AT TIMING CHAIN TENSIONER ACCESS COVER: Before going any farther, please read the warning about having the cam covers off on page 59; the same warning about dropping parts inside applies here.

The access to the timing chain tensioner latch is via an opening on the timing chain cover, forward of the right bank and just above the support for the belt-driven fan. The purpose of this access is for locking or releasing the tensioner during overhauls; there is no need for periodic adjustment, as the tensioner is self-adjusting.

The rubber plug always seems to get hard and crumbly. People with the new one in hand sometimes assume there has been a material change, since the new one is soft and pliable while the old one appears to be Bakelite. Looking at the ears on the new one can also lead one to believe that it's a push-and-turn type of cover, like a radiator cap. No such luck; it's a simple round hole, and the ears are supposed to be flexed to get it in and out. The old one will probably have to be removed in pieces. If a piece or two falls down inside, don't worry about it, they're too soft to do any serious damage. They'll probably just come out in the next oil change; it's definitely not worth further disassembly.

Mark Jackson says, "Managed to get the hardened rubber bung out the hard way with wood screws and a home made tool made out of 1/8" round which I levered with a screw driver via a nut on the chain cover!"

Note that this is an opening into the crankcase and should be well sealed to prevent oil vapor leakage, as well as to keep the PCV system working properly to minimize oil leaks elsewhere. Chad Bolles suggests "...apply a thin coat of GM Gasket Sealing Compound part no. 1050026 (stuff never gets hard) and press in the new plug and you are good to go."

Jim Isbell didn't like how much grief was required getting the plug out after it had dried up, and determined it wouldn't happen again. "I have cut the tabs off of the rubber plug that fills the adjustment hole for the chain tensioner. I have

made a simple aluminum “L” shaped piece that fits under a water pump bolt and holds the plug so it won't fall out.”

If desired, the opening may be plugged with a compressible rubber type freeze plug. This may even be preferable to the original plug, since it will make a reliable airtight seal. Be sure that the plug does not interfere with the timing chain or the operation of the tensioner.

It isn't too difficult to make an aluminum plug for this hole with provision for fitting an O-ring for sealing. Figure 2 shows a design.

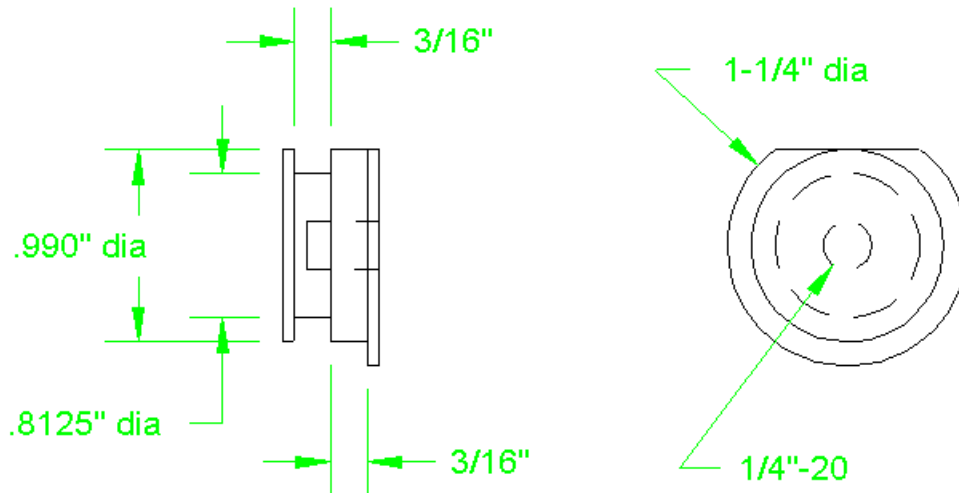


Figure 2: Timing Chain Tensioner Access Hole Plug

One such plug was machined by Ron Morse and successfully tested on the author's car; you can see a picture of this installation at

<http://www.jag-lovers.org/xj-s/book/TensionerPlug.html>

Note that, even though this plug fits snugly in the hole when fitted with a proper Viton O-ring (#210), it lacks any positive retention and therefore might blow out if pressure builds in the crankcase for some reason. Since you don't want to lose it after paying to have it made, something similar to Isbell's little tab under a water pump bolt is in order to make sure it stays put. The threaded hole in the center is to aid in removal when you actually want to get it out; just screw in a 1/4" screw and use it to pull or pry on.

If you don't want to make your own, Ron Kelnhofer (page 718) has some for sale. His are very similar to the illustration shown except that he has added a retention scheme, a checkball that can be engaged to grip the side of the opening so a separate tab under a bolt head is not necessary. You can see a picture of his plug at

<http://neptune.spacebears.com/cars/engr/tension.html>

OIL LEAKS AT SANDWICH PLATE BOLTS: The bolts that hold the sandwich plate to the bottom of the block are threaded into holes that open at the top to the outside of the block; if you used bolts that were too long, the ends of the bolts would stick up through the flange and be visible from outside the engine. This arrangement was no problem with the oil pan used on the SIII E-Type, since the bolt heads were likewise visible from outside the engine and the gasket would seal between the pan and the block inboard of the bolt holes, so the bolts themselves would remain dry. When the sandwich plate configuration was introduced in the XJ12 and XJ-S, however, a widened oil pan was provided at the rear end of the engine and the heads of some of the bolts holding the sandwich plate to the block are completely enclosed within the pan. These same bolts also hold a baffle tray in place, but since everything is inside the crankcase,

no gaskets are used.

The result is that oil can seep into the space surrounding the bolts and then upward through the threads and come out on the outside of the block. Not good. If the sandwich plate had been introduced with the V12 at the outset, they probably would have made the holes in the block “blind holes” so oil couldn’t leak through; this was done in several other places, as though someone was thinking about it at the time.

Jaguar apparently figured out the problem -- in 1994. That’s the date of Technical Service Bulletin 12-53, which describes a simple fix: Drain the oil, remove the oil pan, remove the guilty bolts, clean the oil off the bolts and out of the threaded holes, apply a thread sealant to the bolt threads, and reassemble. This is a snap, and well within the capabilities of anyone capable of changing their own oil -- and is convenient to do during an oil change, and won’t even add much time to the job.

The TSB specifies that “Loctite Primer” be applied to the hole threads. Apparently Loctite primers are essentially acetone- or heptane-based cleaners. You can use plain acetone on a swab to clean the threads well enough for a thread sealant to work.

For sealing, the TSB specifies that Loctite 545 be applied to the bolt threads. Note that 545 would mean a sealant, not to be confused with Loctite 600-series products that are threadlockers. Earl Huff found that Loctite 545 was an industrial product not generally available to the home mechanic, so he called Loctite for advice: “After learning what I intended to use the stuff for, the very helpful fellow I spoke with said that Permatex silicone RTV sealant or even the #2 sealant would probably work just as well.” This author used #2 for this job and it worked well.

The TSB indicates that there are 9 bolts involved on the XJ-S but only 7 bolts on the XJ12. It’s unknown where they got these numbers or why they would be different; on this author’s ’83, there are 8 bolts that required sealing.

The TSB mentions that the bolts and gasket involved were upgraded after engine 8S 86317 (or 8W 10641 on XJR-S cars), so if your engine is earlier than these numbers you’re supposed to replace the bolts and use the newer style gasket EBC 9623 when reassembling.

It’s probably not the same bolts that need upgrading and sealing. There are two types of bolts on and within the oil pan on a pre-metric engine (pre- 8S24175): 5/16”-18 Grade 5 bolts 1-3/4” long with spiral groove washers that go through the sandwich plate into the block, and 5/16”-18 washer-faced bolts 3/4” long that thread into the sandwich plate itself. The bolts that need sealing are the 1-3/4” ones with heads within the sump. The 3/4” screws have the dreaded triangulated threads that strip out holes in aluminum, so these bolts were probably the subject of that upgrade.

Chances are good that the bolt upgrades are similar to that for the cam cover (see page 60), so using the same strategies for non-Jaguar bolts described there would probably work here as well. You’ll need nineteen 5/16”-18 bolts 3/4” long. Grade 5 hex head bolts would work well, Grade 8 even better. Since you probably won’t have washer-faced heads, you’ll need washers as well -- the 8mm spring washers described on page 27 will work nicely.

Although it’s probably not necessary, you could also replace the 1-3/4” Grade 5 bolts with Grade 8’s. You’ll need fifteen. Finding 1-3/4” Grade 8 bolts is not always easy, so let me make it easier for you: get 2” bolts instead. They fit *better*. You can reuse the spiral groove washers.

Of course, you might also consider replacing all the bolts you can get to on the front half of the sandwich plate that aren’t associated with the oil pan. On a pre-metric engine these are 5/16”-18 bolts 1” long and there are eighteen of them, but you probably won’t want to try to get to four that are above the crossmember for the front subframe.

On metric engines, all of these bolts are probably 8mm instead of 5/16” and the lengths are multiples of 5mm. It’s probably the same number of bolts of each length, though. Remember that metric class 8.8 is roughly equal to Grade 5 and metric class 10.9 is roughly equal to Grade 8.

When sealing and/or replacing bolts that hold the sandwich plate to the block, it’d be a good idea to do one at a time since you don’t want to disturb the upper gasket.

SANDWICH PLATE GASKETS: If you’re doing the job described above to seal the sandwich plate bolts, it makes

sense to buy just the lower gasket. If you're addressing gasket leaks, one could argue that replacing the lower without replacing the upper is a waste of time. Of course, replacing the lower with the engine in the car is easy, replacing the upper is not. You could argue that replacing just the lower is worth a try, and if it doesn't work you can go back and do them both and buy a second lower gasket.

When you have the stamped sheet steel pan off, set it down right side up and clean up the flat upper surface. Inspect the holes closely. If they seem to be dished upward a bit from the bolt tension, set the ball end of a ball peen hammer in the hole and whack it with another hammer. The metal around the hole should end up slightly dished downward. When you tighten the bolts down the area will be pulled back flat, but compression will be applied more uniformly over the area of the gasket.

As a point of information: Jaguar didn't provide a sandwich plate between block and oil pan just to maximize leakage. The sandwich plate is structural; bolting it to the block makes the block assembly more rigid. Rigidity is very important; when an engine operates at high power, the pulses at alternating cylinders can cause the block to twist and flex. This can misalign the main bearings holding the crank and cause them to get wiped out. When a block is thick cast iron it might be rigid enough for everyday use, but when you're designing a long V12 block made of aluminum and intended for high performance work, you need to do what you can to maximize structural rigidity.

Craig Sawyers provides actual specs:

Torsional stiffness in lbft/degree
Bare block: 5445
Block with cylinder liners and sump: 40,830
Heads, block and sump: 111,700

"Now admittedly this was the original Series III E-Type engine, in which the sump was a large and deep aluminium casting. However, I believe that the general principle still holds: the sandwich plate is indeed structural."

Unfortunately, Jaguar may have dropped the ball here. If the sandwich plate is structural, the joint between block and sandwich plate needs to transmit shear loads. It should therefore have close-fitting dowels, probably a half dozen, to unite the block with the sandwich plate structurally. It doesn't, however, so only the bolts (which fit too loosely in the holes for transmitting shear loads) and the gasket itself hold the two parts united. The shear loads can be expected to be hard on the gasket, and putting a thick cork gasket in here in place of the thin OEM gasket would probably be a serious mistake. Reportedly a Ford engineer once opined that this joint will always be inherently prone to leakage.

SEALING THE DIPSTICK TUBE: The dipstick tube just slides into a tube on the crankcase and is held in place by a bracket bolted to the top of the head. It's not sealed. Of course, it'd be a nice idea to seal it; the fewer leaks, the better, and even if the dipstick itself doesn't seal perfectly (although it just might -- it is a decent design) it'd be a lot harder for oil to find its way all the way to the top of the tube than to leak out right there at the bottom.

Some ideas for sealing this thing: You might apply a sealant to the end of the tube before sliding it back in. Or, you might fit a small O-ring around the tube before installing it, and make sure that the bracket arrangement holds the tube firmly so it applies a little compression onto the end of the fitting on the crankcase. Of course, Viton is preferred. Or, if you can get your hands in there, you could slide a piece of hose over the joint and clamp it on both sides of the joint.

OIL IN AIR INTAKES: Robert Dingli explains the oil that always seems to collect in the air filter housings and around the butterflies: "What you are noticing is probably a mixture of a small amount of engine oil that has been forced out as a vapour from the crankcase by blowby gas which has then condensed within the inlet manifold. You may also get some residual fuel (usually the heavier fractions) leaving an oily film. This is normal even for new engines but will tend to get worse as the engine wears.

"On engines which have the inlet manifold sloping down from the head, there is usually quite a puddle sitting in the plenum. The first time I noticed this was when one of the vacuum lines became blocked. It turned out to be the line which connects to the underside of the plenum. I have since re-routed that line and plugged the connection. Whenever I

remove the plug, a thick deep red oily mess dribbles out. The red colour is obviously the remnants of petrol (leaded petrol in Australia is coloured red) which has run down into the plenum after the engine has been stopped. The lighter fractions tend to evaporate when the engine is next heated.

“Very occasionally, I have been known to pour a small amount of petrol into the plenum to dissolve the goo and then drain from the lowest point.”

FREEZE PLUGS: Apparently a US-only misnomer; English-speaking countries reportedly properly call them “core plugs”. Some US parts places call them “expansion plugs”. Alex Dorne clarifies, “I can tell you that the freeze plugs are not meant to rescue the block if the coolant freezes. Due to the casting process they were necessary to make mantling of the block possible.” Of course, that doesn’t mean they won’t pop out when the coolant freezes! However, in warmer climates the most common failure is rust-through.

If you need to replace these plugs for whatever reason, you will find several versions available, including simple steel or brass cup-shaped plugs and copper or rubber assemblies with a bolt through the center for compressing the plug to expand it into the opening. Dorne: “Most common material seems to be steel for automotive use but when working in the marine business I found out that copper is used on “factory built” marine engines to prevent corrosion problems when fresh water cooled.

Note that the original plugs are concave side out, but replacements are installed the other way. “Installing the plugs is a piece of cake (if the block is out of the vehicle, of course). Place the plug in its seat, convex side out, hold a ball ended hammer in the center of the plug, give it a hit with a second hammer. This flattens the plug and increases the diameter a little bit. I think it’s a good idea to use some non-hardening sealant on the seat before placing the plug.”

If the cupped plug is a little too tight to install, it is a simple matter to make it a little smaller. Set the plug in a large socket or box end wrench, put a steel ball (or the head of a ballpeen hammer) in the center and hit it with a hammer.

Since the Jaguar V12 has an open-top deck design, there is little reason for other casting openings and there are no plugs on the side of the block. There is one plug on the rear end of each bank, within the bellhousing. On the head, there are three 7/8” plugs on the exhaust side, four 7/8” plugs on the intake side (visible within the V), and one 1-3/8” plug at the back end.

PCV SYSTEM: The way a typical PCV system works is pretty simple: A scheme is provided that draws fresh air into one side of the crankcase and out the other side and into the engine intake. This serves at least three purposes: First (and foremost to emissions regulators) it prevents the vapors gathering in the crankcase from escaping into the atmosphere. Second, it provides fresh air inside the crankcase rather than yucky fumes, some of which may be corrosive or explosive. Third, the suction causes a slight vacuum within the crankcase, which causes leaks to leak air in rather than oil out. For these benefits, there are essentially zero disadvantages other than the minimal cost of the components. There once was a concern about effects on fuel mixture, but when carburetors were superseded by EFI that concern evaporated.

Unfortunately, this all describes a typical PCV system -- not the one in the Jag. Rather than the flow-through scheme of a typical system, the V12 has only one opening into the crankcase. This vent is connected to a chamber built into the LH air filter housing. The chamber has a fairly large opening into the air filter housing itself. The PCV valve is *also* connected to this chamber. Flow-through ventilation of the crankcase is clearly not possible. It’s doubtful such a system will apply a significant vacuum to the crankcase, other than when the LH air filter is plugged up. The only objective it will achieve is pollution control; vapors cannot escape the crankcase without going either into the air intake or into the inlet manifold.

LEAK CONTROL VIA PCV: In the July 1999 issue of Jaguar Driver magazine, Crispin Hales relates a story about a V12 E-type that had been converted from the original Zenith-Stromberg carburetors to SU’s by a previous owner. The car leaked oil badly, and one by one all the leaks were corrected except for the rear main seal. After procrastinating for

years about fixing the rear main seal, it finally occurred to Hales that perhaps the PCV system was at fault. Sure enough, whomever had converted the car to SU's had removed the PCV system in entirety. Simply installing a new PCV system caused the rear main seal to stop leaking.

It's unknown what the PCV system on the SIII E-type looks like, but it wouldn't appear that the system on the XJ-S would help reduce leaks this well. Of course, you should fix the leaks! But perhaps it'd be nice to achieve the leak reduction benefits of a typical PCV system on this V12.

It would be easy enough to make this system work like a typical PCV system: remove the PCV valve from the chamber on the LH air filter housing and plug that hole, leaving the crankcase vent connected to the air filter housing via the chamber. Install the PCV valve into the crankcase itself. That way, the PCV valve will draw air from the LH air filter housing into the crankcase through the metal mesh, through the crankcase, and through the PCV valve into the intake manifold.

Of course, there's no hole to connect the PCV valve to! You'll have to make one. As far away from the existing vent as possible is good, but not essential. You want to avoid any place where there's a lot of oil splatter that the PCV might suck up, but most engines put it right in the valve cover so installing it in the RH cam cover should work just as well. If you're good, you can drill a hole in the cam cover that's the same size as the hole in the chamber where the PCV valve was originally installed so you can install the same valve in the same grommet.

Other options would be to find a way to connect it to the plug for the timing chain tensioner or to a half moon seal. Either way would avoid cutting on expensive metal parts.

Remember that you're not bound by the original PCV valve. A check through the selection of PCV valves and grommets in an auto parts store may generate some ideas. Some PCV valves have a 90° fitting on them, which might be helpful.

If you manage to install the PCV valve somewhere in the right rear area of the engine, note that you should be able to take the tube connecting both intake manifolds to the PCV valve off and turn it around backwards and reinstall it, providing a ready connection to the right rear. Of course, you can just connect up some hoses to the same fittings and route them anywhere. Connecting to both manifolds is probably good, since you want to have the same effect on mixture on both banks.

Obviously, it is of considerable importance that the owner take care to maintain the integrity of the crankcase containment; an opening into the crankcase will not only cause an oil leak at that location, but it will also allow air to enter and reduce the effective vacuum in the crankcase and thereby cause oil leaks elsewhere. A classic location for such a leak on the Jaguar V12 is the timing chain tensioner cover (see page 47), but any opening into the crankcase will do it. Make sure your dipstick is seated properly, make sure your oil fill cap has a good gasket under it, etc., etc.

PCV FOR WORN ENGINES: In the course of maintaining a slight vacuum in the crankcase, the PCV system must deal with whatever leaks exist to allow air into the crankcase as well as blowby from the piston rings. With a very worn engine, the piston ring blowby may overpower the PCV system even if all the crankcase openings are properly plugged. The EPA doesn't really care as long as the air intake to the crankcase comes from the air filter housing; when the vapors overpower the PCV, the excess comes out into the air filter housing and gets pulled into the engine anyway. It just makes the inside of the air filter housing grungy. The systems the EPA don't like are the ones with a vented oil filler, where the excess vapors get blown all over the engine compartment and out the bottom of the car.

Of course, you might not care for the oil leaks that result when the PCV system is overpowered. It has been suggested that, even though an engine rebuild at this time is prudent, the addition of a second PCV system may help keep the oil leakage to a minimum until you can schedule enough time for an overhaul. Back in the days of carburetors, adding a second PCV system would have been troublesome because you would have to figure out how to get enough fuel into the engine at idle when all that intake air was bypassing the carburetor venturis. However, with EFI you really don't have anything to worry about; just install it and the EFI system will meter the fuel accordingly. You may have to adjust the idle speed screw a bit. Note that the piston/ring wear rates on the Jaguar V12 are so low that if you are considering this band-aid fix on an engine with less than 200,000 miles, you are advised to look for damage or leaks elsewhere first.

PCV VALVE: The genuine Jaguar PCV valve is part number C 44231, and the valve itself is stamped E7 AC 3848. This thing costs about \$40. That's extortionate.

Kelly Spongberg says, "I replaced ours with a generic jobber one made for older Ford V8 engines. It is exactly the same size, and seems to work fine."

A quick review of the selection of PCV valves at a local auto parts store revealed that it may be difficult to find a PCV valve that *won't* fit the Jaguar V12. There are a couple that appear nearly identical, such as the Fram FV202. There are a bunch more that are the same shape except they have a hose barb on the outlet end -- but since that end gets jammed into the grommet in the chamber on the LH air filter housing, you won't see it and it'll work fine. There are yet a few dozen other PCV valves that appear the same as these except that they have an "F connector" on them that allows the connection of two hoses; you can just pull the F connector off and install it in the Jag. There are even "generic" PCV valves that come with a selection of F connectors; throw all the connectors away and use the PCV valve as is.

Of course, there may be a good reason why there are dozens of PCV valves available that all appear interchangeable: they may have different innards, like different springs or port sizes so they flow differently at different operating conditions. Dave Osborne bought a valve that was visually nearly identical to the Jag valve for \$3. However, when installed the idle was 100 RPM lower than before. Apparently the Jag valve has a stronger spring in it that holds the valve a bit open at idle, while the Ford valve has a weaker spring and is totally closed off at idle.

Big deal? Perhaps not. You can simply readjust the idle. And, considering the way the PCV system works on this car, it's questionable if the PCV valve does anything of value anyway.

Fault Diagnosis

MISFIRE: With 12 cylinders, some people might not even detect a misfire. An easy way to check -- as well as to tell which bank is acting up -- is to fold a dollar bill in half and hold it over an exhaust pipe outlet and listen to the flapping that results; a misfire is usually obvious. Steven Draper adds, "According to the most recent Jaguar Repair Information Periodical, the official procedure is to use a one hundred dollar bill and send it to the dealer for evaluation. Unfortunately, the bill cannot be returned."

COMPRESSION CHECK: First, a brief description of how to properly perform a compression check on any car: The battery and starter must be in good condition. *All* of the spark plugs should be removed. Power to the ignition system should be disconnected, since an electronic ignition system may be damaged trying to fire with the spark plugs disconnected. And the throttle should be held at least part way open, usually by jamming something in the linkage. On a car with EFI, it would also be helpful to disconnect the power to the EFI system or fuel pump to prevent fuel flow. With a compression gauge fitted to one spark plug hole, the engine should be turned on the starter through several compression strokes, until the reading stabilizes at a peak value.

On the XJ-S, it would be most helpful to have the type of compression gauge that screws into the spark plug hole and has a lengthy hose. Trying to hold the press-in-place type on this engine is not easy. Also, since the A/C compressor usually has to be removed to get at the front plugs, you will probably have to run the test with a dangling drive belt; try to position it so there is no tension on it, and the crank pulley can turn within it without driving it.

On the US-spec pre-H.E. engine, the readings typically will be about 130-150 psi. The US-spec 5.3 liter H.E. engine has 11.5:1 compression, and will read about 200-220 psi. Note that readings will be lower at high elevations.

Keep in mind, however, that the absolute values are not as important as the relationship between them. There are dozens of factors that could affect the absolute values (including the calibration of your gauge), so if your readings are

all a little higher or lower than the above, don't worry about it. But they should all be nearly the same; one significantly lower than the others is not a good sign.

If one cylinder reads low, it is customary to add a couple tablespoons of motor oil into that spark plug hole and test it again. In theory, the oil will temporarily seal bad piston rings but won't seal a burned valve, so this test may indicate the level of disassembly needed. Of course, the oil probably won't seal a burned piston or a hole in a cylinder liner, so the results are best taken with a grain of salt. Either way, the head has to come off.

LEAKDOWN TEST: The leakdown test is gaining in popularity among mechanics, who feel that it gives a better indication of the actual quality of the sealing of the compression chamber than the compression check. To perform a leakdown test, compressed air at a known pressure (usually 100 psig) is fed through a device with an orifice in it and into a cylinder via the spark plug hole. The pressure downstream of the orifice is measured, and the leakdown rate is calculated as the percent which the pressure dropped across the orifice. If the leakage out of the cylinder is very low, the pressure after the orifice will be very close to the pressure before the orifice, and the percent of pressure lost will be low. If the compression chamber has big gaping openings in it, the main restriction in the flow will be the orifice itself, and the pressure after the orifice will be closer to ambient -- and therefore the percentage lost will be much higher.

When performing this test, it will be necessary to lock the crank still. The air pressure in the cylinder will try to turn the crank to BDC, but at BDC one of the valves is likely to be cracked open, making your leakdown readings meaningless. Try to lock the crank somewhere between halfway up on the compression stroke and halfway down on the power stroke.

Note that, when doing such a test on the Jaguar V12, it'd be a good idea to take the oil filler cap off the left cam cover. We wouldn't want a well-sealed crankcase (hah!) to cause unwarranted favorable readings. Also, just in case there's a leak in a head gasket, the radiator cap should be removed to prevent pressure buildup in the cooling system.

Kyle Chatman points out that if the leakdown test finds excessive leakage in a cylinder, it *might* be possible to determine whether the leakage is from the rings, the exhaust valve, or the intake valve by listening closely at the oil filler cap, the air intakes, or the exhaust pipe outlets. And a bad head gasket might cause bubbles in the coolant (especially if it's the center cap that was removed) or other motion in the coolant level.

It's entirely possible that the leakdown test is highly regarded simply because it gives results in percent. It should be pointed out, however, that the percent has no real basis and is entirely dependent upon the size of the orifice in the test device -- and Randy Wilson says "and there is no such thing as a standard orifice size." In order to be able to compare the results of one leakdown test against another, it would be necessary to confirm that the orifices used were the same size and had exactly the same flow characteristics and that the same air pressure was used for the tests.

Wilson adds: "Next question is: How much air leakage is acceptable? This all depends on how big the cylinder is. The bigger the bore, the more ring area there is to leak by. Typically, the valves are bigger, too. Here we could really use a percent of leakage vs. base volume, but our tester is effectively measuring finite volume of flow."

There are other concerns involving leakdown tests. For one thing, since the engine does not turn during the test, it really only gives an indication of the leakage at one piston position. While this is usually adequate, it may fail to identify certain types of problems such as localized damage on a cylinder wall. Perhaps the careful mechanic could slowly turn the engine over by hand while doing the leakdown test, and watch the gauge for variance in the readings.

The leakdown test does have the advantage, however, that if a mechanic is using the same leakdown tester at the same pressure all the time, he can get a *real* good idea of just what condition cars are in. While compression readings will always vary from car to car, the percentage readings from his trusty leakdown tester should give very consistent indications on cars in similar condition regardless of compression ratio or other variables.

HEAD GASKET CHECK: Michael Neal suggests two methods of checking the integrity of the head gaskets. First, remove the rubber hood that connects the PCV system to the engine just forward of the oil filler cap, and look inside it. Milky deposits are an indication that water is getting into the oil, usually a sign of trouble.

For a more definite check, Neal recommends removing the spark plugs, pressurizing the cooling system to 15 psi, and leaving it overnight. Then have someone turn the starter while watching the spark plug holes. Mist (or worse, a solid stream of water) coming out of a plug hole means it's time for engine work.

Of course, pressurizing the cooling system usually calls for a special tool. It basically is an adapter radiator cap and a hand pressure pump; Stant is the common manufacturer and it runs \$60 to \$70. In a pinch you could tee into the small hose on the center fill pipe and apply pressure.

TAPPET NOISE: Roger Bywater of AJ6 Engineering and formerly with Jaguar engine development, says, "In fact a recognised source of tappet noise on the V12 is excessive side clearance of the tappet in the aluminium carrier allowing it to 'rattle about'. Remember the XK used cast iron tappet sleeves and they expand and contract at the same rate as the tappet so the clearance remained more or less constant. This does not happen on the V12 and the minimum diametral clearance is set by the need for a top size (high limit of tolerance band) tappet to not jam in a bottom size carrier bore at minus 40 degrees in a Canadian Winter. The other extreme of a bottom size tappet in a top size bore could well be quite sloppy when fully warm and the way the cam moves it around can be very critical. Cam profile, tappet clearance, side movement, rotation and rock-over at peak lift, as well as valve seating geometry, all come into what is actually quite a complex phenomenon. For the record the range of diametral tappet clearances involved run from about 0.0005" to about 0.002" at room temperature. I wonder how many engine builders have even thought about measuring such things?"

OIL PRESSURE: An oil-fed sleeve bearing, such as used in the main and connecting rod bearings of automobile engines, is an excellent device -- much more so than most people understand. When the parts are rotating, the parts ride up on a film of oil, much like skimboarders skim easily across very shallow water and seem to coast forever. When operating properly, the metal parts do not touch each other, and there is essentially zero wear. The friction is entirely within the film of oil.

This system doesn't work at a standstill, however, the same way the skimboarder will sink to the bottom when he stops moving. The entire reason engine bearings have a soft, replaceable surface is because they must ride on this surface for a very brief time at startup, before oil is pumped to the bearings and before the bearings establish a film to ride on. The hard steel surface of the crankshaft should slide on the soft bearing with very little wear on either, but startups still account for the vast majority of normal bearing wear.

The shearing action of the oil tends to heat it somewhat; there is very little heat generated from shear, however, and many cars get by without oil coolers. The main cause of heating of the oil is by contact with hot parts, notably the bottom surface of the pistons.

The pistons are likewise supposed to skim up and down the cylinders on a similar film of oil. It doesn't work nearly as well, though, since the piston stops at each end of its travel for an instant, and because there is a less positive flow of oil to this area.

This system also does not work very well for the contact between the camshaft and the followers. This is because the contact area is a very thin line rather than a broad area. If one of the two parts were as soft as the crankshaft bearings are, the force at the contact point would quickly tear it up. In the Jaguar V12, these parts are immersed in oil during operation. This ensures they are adequately lubricated, even during startup since the oil stays there, but it also generates more heat churning the oil.

There are two primary bearing failure modes in any engine that result from lubrication problems. The first and most easily understood is excessive wear and damage due to lack of lubrication. The second is bearing overheating due to insufficient cooling oil flow. These two are very different; in the latter case, the bearing may have enough lubrication to prevent wear, but gets hot enough to melt the soft bearing material because the same oil is staying in there and getting hotter and hotter, rather than cool oil flowing through.

All engines tend to display a drop in oil pressure at idle; the pump moves less oil when the engine is turning slower, but the openings through which the oil flows are the same size no matter what the engine speed. The Jaguar V12 is no

exception, and sometimes shows lower oil pressure when hot and idling, especially when it has a few miles on it. The V12, when running on all cylinders, can idle very slowly, causing even lower pressure. This causes many XJ-S owners to panic, and some to take poorly conceived countermeasures.

There is no magic value for oil pressure. The only real need for any pressure at all is to get oil to all points in the engine, and this would only require a couple psi. Oil pressure is monitored simply to insure there is oil flow, which is essential.

If your car has always had low pressure at idle when hot, and it gradually over the years gets a little lower, don't worry about it. If it suddenly has much lower pressure than it used to, you may have a damaged bearing that is allowing oil to flow through too fast; the cause should be investigated. If your car suddenly has no oil pressure at all, stop *immediately*, do not drive it one more minute until the problem is located and corrected. Many motorists fail to understand the importance of this, so I will emphasize: If the red light on the dash comes on indicating that you have no oil pressure, it is not good enough to "take the next exit." You should pull over *immediately*, possibly even shutting the engine off while still moving. A towing fee, and even an illegal parking ticket, is a minor expense compared to an engine replacement, which is the inevitable result of driving with no oil pressure.

Do not add oil thickeners to your oil. While these may increase the indicated oil pressure at idle when hot, they do no real good and can do considerable harm. In particular, when cold the oil may be so thick that very little flows and most of the output of the oil pump is wastegated through the pressure relief valve. While there is good pressure, there is little flow to the bearings, and they may fail due to lack of cooling flow before the engine and the oil warm up. This is also a good reason not to run the engine too hard until it is fully warmed up.

OIL PRESSURE SENDER: The oil pressure sender on the pre-'92 XJ-S is notorious for leaking; see page 47. It's also fairly well known for electrical maladies. Tom Mackie says, "My oil pressure sender is getting flaky. I connected an ohmmeter and found that rather than nice varying resistance readings, it sometimes goes open. Which makes me wonder how accurate this particular unit has been all along."

If the connector on top is loose, Mike Morrin provides some insight: "The connector moving around is due to some little plastic pegs broken inside, and will cause the sender to read low. You can uncrimp the top and get inside to glue it down." Since uncrimping is difficult, others suggest cutting right through the circumference of the can to get the top off, fixing the innards, and putting the top back on with aluminum tape or JB Weld or some other mechanical means.

Ed Sowell provides electrical data to aid diagnostics: "Here are the measurements from my sender and gauge, for what it's worth:

Oil pressure sender (markings: PTR 1001/10/EC 700kn/m², 29-7 Part #46272):

Engine off: 350 ohms

Cold engine idle: 80 ohms (I believe the oil pressure is about 60-70 psig under these conditions)

Oil pressure gauge:

290+ ohms = 0 psig

55 ohms = 50 psig

10 ohms = 100 psig

short to ground = off top of scale."

I'd like to be able to tell you what commonly available sending unit can be used for a substitute, but I can't; nobody's worked one out yet. The pre-'92 Jaguar V12 uses a 0-100 psi oil pressure gauge while Jaguar 6-cylinder cars use a 0-80 psi gauge, so senders from other Jags won't work. Before trying a sender from any other car, make sure it has the 0-100 psi range. Electrical oil pressure gauges with 0-100 psi ranges are very common as aftermarket items, though, so perhaps the sender from one of those will work. Summit (page 720) and Jeg's (page 717) offer many such gauges, or you can probably find a fair selection in a local auto parts store or speed shop. Unfortunately, the senders are often included with the gauge itself rather than sold separately, but you *still* might get off cheaper than buying the Jag part even throwing the gauge away.

There are two issues that must be addressed to get an aftermarket sender to work. The first is physically installing it.

The threads on the bottom of the OEM sender are BSPP (see the section on the radiator drain plug on page 195), while the generic senders typically have 1/8" NPT fittings. You could buy a BSPP fitting and plumb a line to a remotely-mounted sender -- or just opt to replace the entire pedestal. It's possible the pedestal from the '92-on cars would work, or you could actually just *make* one from a block of aluminum. If you don't mind how it looks, you can simply plug the hole in the original pedestal by cutting off the bottom of the OEM sender, putting a bolt through the center, and screwing it back into the hole, and then tee off the fitting for the oil pressure switch (standard 1/8" NPT) to connect up a sender with NPT threads.

The second concern is finding a sender with the correct pressure vs. ohmage response. Unfortunately, neither Summit nor Jeg's provide such data; if you can't find such specs or talk a local shop into letting you check one out with a tire pump and a VOM, you may just have to take the risk and buy one to see what their electrical characteristics are.

For now, your best option may be to shop around the mail order places for the OEM part, since prices on this item seem to vary widely and it sometimes can be found for a quite reasonable cost.

If you have the '92-on with round gauges, you are in worse trouble. Read about steady oil pressure below.

REPLACING THE OIL PRESSURE SENDER: Julian Mullaney says, "Use a crow's foot and several thin extensions. It is a superb test of dexterity and patience, but I did it. To install the new one, I attached it to a coat hanger and started the thread that way."

Stefan Schulz says, "Have you tried a plumber's tool called a basin wrench? GBP5 at the nearest DIY store."

Craig Sawyers says, "What I did was undo the banjo bolt that links the camshaft oil feeds to the back of the alloy pedestal that holds the oil pressure sender. Then I undid the two 7/16" af bolts that hold the pedestal down and took the pedestal plus oil pressure sender out as a unit. Changed the sender, and reversed (as they say) the removal procedure. Made it all very easy, when originally it looked damned near impossible. The Jag ROM and Haynes were less than useless."

REALLY STEADY OIL PRESSURE: Bill Letter reports: "Today the kitty went in for a number of "adjustments", the most important of which was to determine why my oil pressure gauge always reads 58 psi at idle (hot or cold). On my last visit to the same dealer for the same problem, I was told that the gauge was working fine and according to Jaguar Spec. Today I was shown a TSB that explained that Jaguar changed the oil pressure senders on the XJ12 Sedan and XJS V12 (in 1996) to a new type which is actually not a sender at all. It seems (according to the dealer) that numerous customer complaints of their oil pressure gauge reading too low (less than 25 psi) when hot at idle caused Jaguar to discontinue manufacturing the oil sender and instead replace it with an oil switch which acts like an idiot light (when there is more than 7 psi pressure it will always read 'ON' or in my case 58 psi, when there is less than 7 psi oil pressure it will read 'OFF' or zero psi). So it was explained to me that the updated oil switch was installed in my car last year.

"It is Jaguar TSB Number 15-13 dated 06/95 and covers all cars with V-12 engines and some AJ16 engines on the XJS (MY '95 on). They removed the senders and installed a simple switch because of customer complaints that the needle would read lower oil pressure when hot at idle!"

You may have difficulty trying to undo this "upgrade" since the real sender is officially NLA. Gregory Wells of Coventry West, Inc. explains in detail: "The sender issue is confined to '88-on XJ40 cars and '92-on XJ-S with 4.0L, 5.3L, and 6.0L engines (VIN 179737 onwards). Jaguar has superceded all sender numbers (viz. DBC4418, DBC5513, DAC7879, DAC11141, LMD5640AB) to JLM20791, which looks like the old C42200 (now superceded to LHD5642AA) switch for the oil pressure light on the Series III cars. Included in the bag with the sender is a small harness which seems to only have a resistor in it. If one orders any of the above five part numbers from Jaguar, a JLM20791 will be supplied. I've checked the '88-92 XJ40 fiche, the '93-94 XJ40 fiche, the '87-91 XJ-S fiche, and the '92-on XJ-S fiche and they all show gauge sender part numbers that eventually supercede to the on/off sender p/n." However, if you're persistent, you may be able to find a dealer or supplier that has some of the real senders in old stock.

Note that none of this seems to apply to the pre-'92 XJ-S.

There are two things to note regarding the '92-on senders vs. the pre-'92 senders that may be relevant: First, the pre-'92 sender (C46272) has BSPP threads and requires a sealing washer, while the '92-on sender has the same tapered pipe thread that the oil pressure switch has (1/8" NPT). Second, the oil pressure gauge on the pre-'92 dash is the vertical indicator with a 0-100 psi range while the '92-on dash has a round gauge with a 0-80 psi range. Together this may mean that a standard Ford oil pressure sender might work in this car.

ENGINE WORK

ENGINE OVERHAULS: If you take your XJ-S to a disreputable dealer with major engine problems, they may tell you that a fine machine like this cannot be rebuilt, and try to charge you \$10,000 to put in a new engine. Of course, one of the features that make this a fine engine is that it *can* be rebuilt. It is not a disposable engine; all wear items can be replaced. Even the cylinder liners can be easily replaced, so there is no need for boring and honing or for oversize pistons. Of course, if you've overheated the engine and warped the block, or you've had a major engine fire, you will definitely need a new motor.

If the engine has to be rebuilt but you aren't up to the task yourself, you may find it challenging to find a mechanic you feel is competent to do the job. Fortunately, if you live in the US, there may be an alternative to taking your chances with the local grease monkeys or a Jaguar dealer: Crow Engineering, 1-800-537-4146. This is a very interesting business run by a British guy named Stewart Plant who apparently spends a few months each year in the US. By appointment, he and an assistant will drive to your house and rebuild your engine in your garage. He arrives in a panel van with all the tools and parts needed and will typically finish the task in a week or so. He and his assistant sleep in the van; the only accommodation they ask from you is to use your shower. Their services are not cheap, but they're undoubtedly cheaper than paying a dealer for a new engine -- and you're more likely to be told *why* your engine was damaged and how to avoid it happening again.

Rebuilding by the home mechanic is not out of the question. It's imposing at first; the engine compartment is crammed quite full. But with this book, a repair manual of some sort, a good set of tools, and time and patience it can be done -- and the money saved will probably be enough to *pay* for that good set of tools! The biggest disadvantage of going this route is usually the time involved; typically, a mechanic will disassemble the engine, figure out what parts he needs, order the parts, and then wait, and wait, and wait for the parts to show up -- only to find out that a few of them are incorrect and must be returned and reordered. And, of course, on reassembly he will figure out what he forgot to order. As a result, even though only a week or two of actual labor may be involved, the car may be scattered all over the place for a couple of months or more.

If you decide to tackle such a teardown, note that the V12 weighs something like 700 pounds as it is pulled from the car. You don't want to be working with flimsy hoists or engine stands; obtain the heavy-duty stuff, perhaps even items intended for trucks.

ENGINE ASSEMBLY LUBE: When an engine is first started after assembly is when much of the wear occurs -- in the several seconds it takes before oil pressure and flow to the bearings is established. To counter this problem, there is a product called "Penrite Camshaft & Engine Assembly Lube". This is made specifically for use on all plain bearings (mains, big ends, etc.) as well as on cams, when assembling a rebuilt engine. It claims to withstand loadings "greater than 200000 p.s.i.", which is almost 100 tons per sq. inch. It is an Australian product, but equivalents may be available in other countries.

Another idea is to simply fill the freshly-rebuilt engine with oil through the galleys instead of the filler cap, thereby lubing all the bearings before it ever turns over. All you need is a pressure vessel capable of holding at least 3 or 4 quarts with a tire valve at the top and a hose out the bottom with a selection of fittings that will thread onto the oil filter fitting. After reassembly, you thread the thing onto the oil filter fitting, put new oil in the tank, close it up, and apply compressed air to the tire valve. The pressure will blow the oil into the galleys and on into the bearings. After enough oil has been blown in to establish steady oil flow through the system, the feed is cut off before the tank empties and blows air into the

galleys. Then install a new filter and add the rest of the oil necessary the normal way to establish the proper level in the crankcase prior to startup.

Andrew Holley describes what he did with a motorcycle engine: “What I did was get hold of an old fire extinguisher, the water/stored pressure type. Has about a 15 litre capacity; the handle has a tyre valve built into it with pressure gauge as well. After draining and cleaning, filled it with oil and attached the hose via a suitable fitting to one of the oil cooler lines. With about 60 psi of air in the tank, it forced the oil through all the passageways. Simple and effective.”

Tom Amlie: “Prelubing a rebuilt engine is sometimes difficult, but in this case it was easy. There is a pipe plug on the little pedestal that holds the oil pressure sender and the idiot light switch. As best I could tell, it was 1/8 NPT. Got a cheap (\$13) plastic garden sprayer and cut the hose to match 1/8 pipe. Put 8 quarts through it. Worked great.”

You might want to use a good assembly lube *and* pre-oil the engine before startup. Blowing oil into the galleys will do wonders for reducing wear in bearings and cam followers during that first startup, but you won't get any oil on the cylinder walls until the crankshaft is spinning. So having a good assembly lube on the cylinder walls is a good idea.

Engine Work -- Top

MANIFOLD CROSSOVER PIPE HOSES: On the author's '83, the intake manifold crossover pipe is connected to the manifolds with a short, straight piece of 1" hose at each side. However, sometime before '89, the assembly was changed so that pieces of hose with 45° bends are required. A cursory look at the two assemblies leads one to believe that the parts themselves are in fact unchanged, and the later cars were merely assembled with elbow hoses to relocate the crossover pipe higher across the back of the engine. This might actually be helpful in making condensation drain out of the crossover pipe back into the manifolds rather than into the vacuum line to the ECU, which really messes things up.

If you have the earlier straight hoses and need to replace them, it's obviously pretty easy to find pieces of 1" hose. As for the later parts, Jeff Elmore says, “The dealer quoted me \$22 apiece for these three inch long, 7/8-1" diam hoses with a 45 degree bend in it. Bennett Auto Supply had a Goodyear coolant bypass hose that fit perfectly for \$2.62 apiece. Part number #gyy 63064.”

Whatever you fit, note that the vacuum inside these parts is considerable, and long unsupported sections of rubber hose will be sucked flat. With the earlier design with straight hoses, it appears to be sufficient to merely be sure to insert the hoses far enough onto the fittings that there is only a short area of hose that *doesn't* have fittings within it. If you must have longer sections, you may need to insert a piece of wire coiled like a spring to hold the hose round, or perhaps just a short section of tubing.

RUNNING WITHOUT AIR FILTER HOUSINGS: Frank Perrick points out that if the engine is to be started without the air filter housings bolted on, the bolts themselves must be screwed in. The bolts that hold the air filter back plate onto the butterfly housings actually go all the way through the housings and are threaded into the intake manifold. If these bolts are left out, the holes provide a major butterfly bypass and the engine will overrev.

CAM COVER WORK: If you need to get down to the cam covers or beyond, Victor Naumann sends this awesome tip: Remove the PCV crossover manifold, fuel rail and injectors, air injection manifolds, both fuel pressure regulators, the ignition amplifier, the intake manifold crossover pipe, both butterfly housings, and both intake manifolds *as one piece*. Be sure to disconnect the butterfly return springs before lifting.

CAM COVERS OFF?: If you remove the cam covers for any reason that is not intended to involve further disassembly of the engine, it cannot be reiterated too many times that every bolt, nut, tool, or whatever that is in this vicinity should have a string tied to it with the other end tied to your finger. If a metal part falls down into the timing cover while you're fiddling around, see the section on timing cover removal on page 93. Peter Smith suggests “I shove a big rag

down the timing cover on each side to catch the bolts if they fall. I find this to be a nerve-racking part of the job - if the damned things fall in it can really test your sense of humour!"

The repair manuals provide complete instructions for timing chain disengagement and camshaft removal, except they neglect to remind you that you might want to measure the valve clearances *before* disconnecting the timing chain and removing the cams. The assembly must be together to make the measurements, so measuring before disassembly will save you having to slap it back together to measure it later. Of course, if you plan on reseating valves and the like, the measurements won't do you any good anyway.

You *might* be able to replace the timing chain without removing anything beyond the RH cam cover. See page 95.

CAM COVER DECORATION: Some of us think those Jaguar decals on the cam covers are not in keeping with the general class of this automobile. One suggestion is to remove the decals and attach some brass insignias with screws -- making sure not to cause a leak. Might even find just the right key fob to use.

A suggestion from Steve Averill: "If you want to find something a little better looking than the Jaguar decal on the valve cover, why not either get it photo etched or alodined? That'd be more apropos than sticking on something that'd probably wind up looking "tacked on" & you could pick any pattern that appeals to you."

If you have them off anyway and have a milling machine at your disposal, you might consider skimming the top of the ribs, leaving the black paint in the grooves between the ribs. It'll really make it look snazzy.

CAM COVER GASKET/HALF MOON SEAL: This joint is one of the most notorious sources of oil leakage on the Jaguar V12, although it's possible some of that blame is misdirected; between the tappet block leaking (see page 70) and the banjo fittings leaking (see page 44), sometimes it's hard to be sure just how much of the oil is actually coming from the cam cover gasket or the half moon seal.

Many owners are surprised that the cam cover gasket is a thin piece of cardboard (or, later, a thin Gortex sandwich), expecting to see a thick layer of cork or some such. The thick layer of cork is typical on engines with stamped steel valve covers, but the cam covers on the Jaguar V12 are a quality aluminum casting with precision machined mating surfaces. A thin gasket should seal just fine. Of course, the original cardboard gasket won't, but it's not because it isn't thick enough; it's because it's a cheap cardboard gasket.

Most of the newfangled gaskets introduced by Ford are only moderately expensive, but the Gortex sandwich cam cover gaskets are obscenely expensive. Apparently as a result, some of the mail order places continue to stock the old paper versions. There is irony in that, since Ford updated nearly all the gaskets wholesale whether they were notorious for leaking or not but the ones that probably needed the update the most were the cam cover gaskets.

Also involved in this joint is the half moon seal, a semicircular rubber plug used at the back end of the tappet block to fill an opening made while machining the cam bearing journals. This plug is set in the opening, the cam cover gasket is set on top of it, and the cam cover is installed to hold them both in place.

There is an inherent problem with this combination of gasket and half moon seal. In this author's opinion as an engineer, a reliable sealing of the cam cover is not possible when assembling as Jaguar intended -- even using the later gortex gaskets. A gasket -- any gasket -- will only seal properly when securely compressed between two hard surfaces. Above the half moon seal the cam cover gasket is *not* compressed; the rubber plug does not provide a hard surface for the cam cover to press the gasket against. Instead, the rubber plug merely deforms a little, leaving the gasket locally uncompressed. It's no surprise that leaks are common. The most common leak path may actually be between the gasket and the cam cover above the half moon seal, rather than around the half moon seal itself.

To effect a reliable seal, we will be departing from Jaguar's instructions for installing the cam covers. I will suggest three different methods. The first -- and cheapest and simplest and quickest -- method is to use the OEM rubber half moon seal but omit the cam cover gasket entirely. Seal the entire kit 'n kaboodle with Loctite 518, including all the way around the rubber half moon seal, and bolt the cover on. The rubber half moon seal will therefore be sealing against metal both top and bottom, and should work fine. Likewise, Loctite 518 should provide a reliable seal in the joint

between the machined aluminum tappet block and the machined aluminum cam cover. This method should keep the cam covers sealed until the rubber half moon seal rots and falls to pieces, which should actually be a good long time.

The other two methods involve providing a rigid surface for the cam cover gasket to be compressed against, and then use the Gortex cam cover gaskets. Paper cam cover gaskets are not recommended, period.

John Napoli says, "I figured it was better to fill them than to play games with those silly seals. Anyway, I filled the half moons up with Marine Tex. I clamped wood on both sides, faced with wax paper, and positioned so that the goo stood proud of the mounting face. After it set, I filed it down flush. Seems to have worked. I buy Marine Tex at marine supply stores." If you have the cam covers off anyway, you might want to go ahead and pull the camshafts and the tappet blocks so you can do this job on the bench. Marine Tex dries hard, hard enough to serve as a base for compressing the cam cover gasket properly. JB Weld might be an acceptable substitute, available in most auto supply houses. Napoli points out that the only reason you would ever need this opening again is for boring out the cam bearing journals to an oversize, and if this is necessary then it won't be difficult to use the boring machine to remove all the Marine Tex. After completion of the reboring, you'll probably want to install some more Marine Tex!

Edwin Hyatt did this job: "Used two old credit cards and a couple of miniature C clamps on the outside and inside of the U and piled the JB on. Filed flat the next day."

Bob Gallivan: "After you mix up the JB Weld use a hair drier to heat it up until it flows easily then fill the halfmoon spot, may even want to heat the tappet block in that area to help any air to escape."

The mold-in-place idea will probably only work with the tappet blocks out of the car. When they are on the engine, they are held at an angle, so you'll have trouble getting the JB Weld to stay in the recess while it sets up. Of course, you could jack up one side of the car 30 degrees and fill one side at a time!

John Ashcroft went a slightly different route: "Got some body filler and filled an egg cup to the top, pressed the old seals in to just under surface; when filler was hard, removed h/moons, perfect female mould. Mixed up some JB weld, heated with heat gun and poured into mould. Removed from mould after 24hrs. and they are perfect, even have the little groove for some Ultra Copper RTV, just have to dress the top so it is flush with tappet block. Checked the fit with prussian blue, had to file just a fraction of what was left of the ridges."

The third method is a more difficult and expensive but esthetically pleasing route. This author designed some aluminum plugs to replace the rubber half moon seals, and Ron Morse was kind enough to fab up a set for testing the idea. Figure 3 shows an updated design.

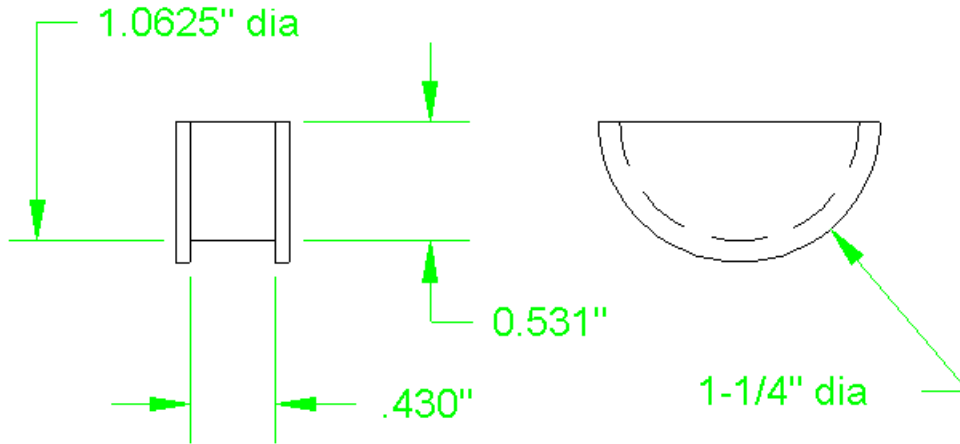


Figure 3: Aluminum Half Moon Seal

There are no tolerances shown on the drawing, so a description of which dimensions are critical is called for. The 1.0625" diameter fits very snugly in the opening, and the opening itself is rather precisely machined as a cam bearing journal diameter. It might be acceptable to make this diameter a hair smaller, but it cannot be any larger or it won't fit in the hole.

The 0.531" height dimension is critical, since it locates the platform for the cam cover gasket to be compressed against. This dimension should be held even if the 1.0625" dimension varies.

The .430" width is necessary to fit around the boss on the tappet block. This dimension can be made larger, but if made smaller it can make the part difficult to install. Since the width of the boss was not held to tight tolerances by Jaguar, if possible you should measure it *before* having this plug made and widen that .430" dimension even more if necessary.

Apply a coating of Loctite 518 or 573 or 574 to the curved mating surfaces before installing the plug. Don't apply sealant to the flat top surface; the gasket will seal against this surface, and Gortex gaskets should be installed dry.

Or, you could consider installing the plugs with JB Weld or Marine Tex. Getting them out later might prove to be a challenge, but they shouldn't ever need to come out.

If you don't want to make these aluminum plugs, Ron Kelnhofer (page 718) has some for sale.

Using aluminum half moon plugs and Gortex gaskets should keep the cam covers sealed until the sun burns out. Of course, if you have to remove the covers later for valve adjustment, you'll need new Gortex gaskets -- and those suckers are pricey.

It is not recommended that you attempt to use the aluminum half moon seals with no cam cover gaskets. The height of the flat surface of the aluminum half moon seal would need to be very precise indeed to seal properly with no gasket.

It has been suggested that it may be simplest to just heliarc weld the openings in the tappet block shut and machine the gasket surface. There is no way I would recommend this, though; the distortion likely to result from such welding would surely compromise the seal between the tappet block and the head as well as play havoc with the alignment and concentricity of the cam bearing journals and tappet holes.

CAM COVER BOLTS: Once we've addressed the shortcomings of the half moon seal, we still have other problems to deal with. Neal says, "New bolts are also necessary. Unfortunately these parts are only carried by the dealer."

Before ordering bolts, determine whether your engine requires SAE bolts or metric bolts. Judging from the 1988 Jaguar Parts Catalogue, the change from SAE to metric took place with engine number 8S24175. The part number for the new metric cam cover bolts is FS-106251/J.

The replacement of the bolts may not be as much due to the excellence of the new bolts as to the lousiness of the old bolts. The original bolts -- both SAE and metric -- have a "triangulated" thread that presumably helps it to drive into the aluminum housing, but probably is also very effective at boogering the aluminum threads up. Martyn Sandbrook says, "I recognise these as "taptite" screws. We used to use these in the telecoms industry way back in the seventies. They are like selftappers but they "form" a thread rather than cut one and are supposed to be better. You don't see them these days. I thought they were junk when I first came across them. Seems strange to be using them in a leak-critical area as they only grip on the outer lobes once the thread has been formed and won't take much tightening torque."

If you'd rather not pay Jaguar prices here and seek other sources for bolts, note that 7/16" hex heads will not do, you can't get a wrench or socket on it; either 3/8" (or smaller) hex head, socket head (allen wrench drive) or Torx drive bolts will be necessary. And you might want to look at the access before you select bolt head styles, since you may want to retorque them a while after replacement. Of course, buying el cheapo grade-zilch bolts (like most slotted head screws) is not a good idea; not only will they rust pretty badly, they may not hold enough tension to keep the cam cover gasket from leaking.

An alternative bolt that would work on SAE threaded engines was found at a Home Depot in their "specialty fasteners" rack. It is called a "serrated flange bolt"; it has a 3/8" hex with a washer face and a row of serrations around the bottom of that washer face. The biggest problem will be finding enough of them to do the job; often such racks in hardware stores only contain a half dozen or so.

Another alternative SAE bolt: This author bought a box of 1-1/4" "alloy steel" 1/4"-20 "socket head cap screws" from a local industrial fastener supplier -- less than \$20 for a box of 100. These fasteners are jet black. Strength is not a problem, alloy steel cap screws are *stronger* than Grade 8.

The original SAE bolts were 1" long, so replacing them with 1-1/4" bolts provides enough length for some washers under the heads (and perhaps for thicker gaskets, if you find something non-OEM). There's no problem with bolts being too long, since the end just comes out the back side of the flange on the tappet block. Using the longer screws also makes use of all the threads available in the tappet block, including the ones at the bottom end that haven't been worn by the lousy OEM screws.

If you need M6 socket head or flange bolts, finding them locally may be more troublesome -- at least here in the US. Craig Sawyers says, "Well, here in the UK, the challenge is to find *non*-metric SS screws!" Again, going with slightly longer screws than the OEM 25mm items -- perhaps 30mm -- might be a good idea.

Dave Oxenreider says, "I found a whole slew of 18-8 stainless steel socket head cap screws in both metric and English in the McMaster-Carr catalog. Averaging about \$25 per box of 100." Joe Bialy opted for non-stainless (no good reason for stainless here, actually): "Part #91290A332 for \$7.34" See page 711.

Another source would be Barnhill Bolt; see page 710.

If you have a local Grainger outlet (page 711), the Grainger catalog doesn't seem to list any suitable M6 socket head screws but they carry "button head socket screws" which use a smaller Allen wrench but will work. The box of 100 screws 30mm long is stock number 3L184 and costs less than \$20.

On the other hand, if your cam covers need M6 screws, it might not need screws with unusual heads. The typical generic locally-available M6 screw has a 10mm hex head. It appears that a 10mm socket will actually fit in the recess, making the search for socket heads or flange bolts unnecessary.

An idea that might work with either 7/16" or 10mm hex head screws: If you can find some sleeves with a length of perhaps 10mm, 1/2", or 15mm, you could use them together with screws that are proportionately longer (40mm, 1-3/4", or 45mm) which would raise the location of the hex head enough to enable you to get a socket on it with less trouble. A cursory inspection of this author's engine indicates you certainly wouldn't want to go any longer than 15mm -- you'd start interfering with the bottom of the intake manifold. There is a spot at each end of each manifold where a bolt hole boss is provided (holds fuel pressure regulator at the front, other stuff at rear) and it might actually help to grind away a

bit at the *bottom* of this boss. No reason not to, although it might not be that helpful either. The bigger problem is with the center runner of both the front three and the rear three runners on each bank, which go right over a cam cover bolt. Any taller than 15mm would most assuredly cause interference here.

If you can avoid interference, having the heads up higher might actually make it possible to retorque these bolts without pulling the manifolds off! It wouldn't be easy by any stretch, but it might be possible.

With the socket head cap screws, the author used split ring lock washers *and* flat washers. As noted on page 27, flat washers are *always* recommended when a bolt head or nut sits on aluminum. (Note: TSB 12-35 specifically prohibits the use of washers under the special Jaguar bolts in this location. Put that down as a fundamental disagreement between their engineers and this engineer -- and note that this engineer's cam cover bolts haven't come loose and the gaskets don't leak, claims which several other owners report cannot be made about the official Jaguar assembly procedure.) This author found some very suitable flat washers on a bubble card in a Wal-Mart: They are size 12, also known as 3/16". If you ask for 1/4" flat washers, you get washers that fit so loosely on the screw that it looks like a socket head might pull through the hole! Also, the OD of the standard 1/4" washers are bigger than the flat area on the cam covers, so you'd have to cut them down to get them in. Conversely, these #12 washers fit perfectly on a 1/4" bolt and are the correct OD for the cam cover flats. Make sure you find *cheap* #12 washers; better quality ones might have closer tolerances and not fit a 1/4" bolt.

Should you use lock washers? This author thinks so; after all, they can't hurt. Craig Sawyers replaced his cam cover gaskets with new paper gaskets, and they shortly began to leak; when he went back in there, he found the bolts loose. Why? Well, maybe it's because the paper gaskets compress and relax the tension on the bolts, and therefore switching to the Gortex sandwich gasket is the fix; or it may be because these bolts are simply too short to stay tight without lock washers (see page 27) or some other retention scheme. The situation is rife with opinions, but note that it's really hard to retorque these fasteners without removing the intake manifolds. This is not a place to save money or weight; if it *might* help avoid problems, do it.

You can buy enough flat washers and lock washers to do this job for less than two bucks total.

Another type washer that will work on the cam covers is the 1/4" spiral groove washer used in a couple other places on the V12 -- if you can find a supply of them. These washers serve as both a flat washer and lock washer in one. Also, the 6mm wavy spring washers mentioned on page 27 as a substitute for the spiral groove washers will work nicely.

There is one other benefit to going with longer screws with spacers. Longer screws have more "stretch" when tightened to a particular torque, and therefore hold tension better and are less likely to vibrate loose. It might still be a good idea to include lock washers, but providing yet another scheme to help keep tension on those cam cover gaskets can't hurt. The spacers might omit the need for flat washers, depending on the wall thickness of the spacers and therefore how well they distribute load onto the aluminum face.

As always, be sure to use anti-seize compound on the threads when assembling.

TSB 12-35 specifies that the cam cover bolts be torqued to 9.5-11.5 N-m (7-8.5 ft-lb). They didn't mention whether this was for the later metric bolts or the earlier SAE bolts, but hopefully it won't make much difference. It's also probably a good spec whether you're using their special bolts or some of the generic substitutes described above. It's not really a place where torque is critical, however; just tightening until they feel tight should be good enough.

TIMING CHAIN TENSIONER: To replace the tensioner requires removal of the timing cover which would put this section under "Engine Work -- Front". However, the problems occur when retracting the tensioner, which is usually done when removing the cams or the heads -- so it's here in the "Engine Work -- Top" section.

There are few design features of the Jaguar V12 as poorly conceived as the material the arch of the timing chain tensioner is made of. If you manage, on your first try, to retract the tensioner and reengage it successfully without breaking this arch, you should consider yourself lucky. The arch apparently works well when new but gets brittle with age or heat, and an old one can be broken very easily. Michael Neal, who works on Jaguars every day, says "I've become so paranoid of old tensioners, my failure rate has been very high as of late. I'm not too surprised though, most of the cars have been approaching ten years old. I've been as careful as possible, knowing exactly what I was doing, and

have watched the damn thing crack on one of the pivots.” Obviously, if you have the timing cover off for other reasons and the tensioner is intact but has a few years on it, it may be advisable to replace it anyway.

The problems may have to do with the V12’s proclivity towards overheating. Craig Sawyers says, “The V12 chain tensioner is, according to the technical article that was published when the V12 was launched in the early '70s, made from molydisulphide-loaded nylon. Just looking up the spec for something else, I found that Nylatron GS is just such a material. All the characteristics that are listed makes this a sensible choice for the tensioner blade, apart from a continuous working temperature of 100°C maximum, with maximum non-continuous temp of 145°C.

“I’ll wager that embrittlement of the blade is due to a combination of the oil environment *and* overheating. I have only the evidence of one piece of information: My engine had never overheated, and the blade, although grooved where the chain had worn it, was still flexible after 160,000 miles.”

Other engines have arched timing chain tensioners in which the arch itself is made of spring steel. It would seem a simple matter to design a replacement arch for the Jaguar V12 tensioner made of spring steel, thereby eliminating the fracture problems permanently; if noise or wear is a concern, the spring steel arch could be faced with Teflon or some such. However, despite more than two decades of trouble with this piece of crap, apparently neither Jaguar nor any aftermarket companies have opted to offer an improved part.

You can see what this tensioner looks like at

<http://www.jag-lovers.org/xj-s/book/tensioner.html>

For those without access to the www I will attempt a description of the tensioner, since it is well hidden and its configuration may not be apparent until it is too late. Basically, the tensioner consists of a plastic arch that the timing chain slides over top of on its way from the crankshaft sprocket to the right side cam sprocket. This is the slack side of the chain, so it’s the proper place to put the tensioner. Between the legs of this arch is a spring that pulls the legs together, making the arch steeper and taller and therefore taking up slack in the chain. The end of the arch nearest the crankshaft is located by a pin on the block, while the end near the cam sprocket has a steel foot attached that is free to slide up and down on the inside of the housing as the arch changes shape.

Alongside the spring is a latching assembly that consists of a rod that is attached near the pinned end of the arch and passes through a hole in a rocking latch attached to the steel foot on the other end of the arch. The aforementioned spring is actually attached to this rocking latch, slightly off center, so that it not only applies tension to the chain but also causes the latch to rock in the CW direction (as viewed from the front of the car facing rearward). This assembly serves two purposes: First, the rod going through the hole in the rocking latch makes a very effective one-way lock; the rod can easily slide in the direction that allows the tensioner to take up slack, but it *cannot* back up and allow more slack. Second, when the mechanic has manually retracted the tensioner, a step at the end of the rod provides a catch for holding the tensioner in retracted mode while working on the car.

When removing the camshafts or the heads, the tension on the chain must be disengaged. However, the chain is not removed; the sprockets are simply unbolted from the camshafts and supported in place by special brackets provided for the purpose. The heads are removed in this state, leaving the chain and sprockets hanging there in mid-air.

Before proceeding, please reread the warning on having the cam covers off on page 59. Also, don’t do *anything* until you’ve read through this entire section and the following section on disaster avoidance and understood them.

To retract the tensioner requires a pair of tools collectively known as Jaguar tool JD.50. One tool is inserted from the top of the engine where the cam cover has been removed, underneath the cam sprocket, and hooks onto a hole in the steel foot at the top end of the tensioner; this tool is for pulling the tensioner back to the disengaged position, and has a handle shaped to rest against the top of the sprocket for leverage. The other tool is inserted through an access hole in the front of the timing cover and is used to manipulate the rocking latch. The rocking latch has a slot in it, 3/16” wide by a little over 1/2” long and roughly parallel to the chain line, for inserting this tool.

Improvising both tools is fairly easy. For the first tool, a sturdy hook is required; a standard battery hold-down bolt may be a good place to start, but you’ll need to trim the hook as shown in Error: Reference source not found in order for it to fit the hole in the tensioner properly. Robert Louis Woodling says, “I used a long hanger for a peg board...” Adding a lever that rests on top of the sprocket isn’t too hard, you can even make it out of wood; just drill a 1/2” hole near the

center of a 1" x 2" board about a foot long, insert the battery hold-down bolt through it, and put a fender washer and a wing nut on the end. The hole needs to be about 1/2" to allow the battery hold-down bolt to tilt relative to the board.

Alternatively, Thomas E. Alberts says "I tried the lever style tool like the manuals show and didn't like it much. I made one with a long 3/8" bolt (~12in) and a steel tube (~1.5in dia). I formed a hook by grinding away most of the bolt head, padded one end of the tube and put it against the valve cover mating surface and with a washer and a nut on the threaded end and the bolt running through the tube and into the chain tensioner, I was able to gently apply the required tension. It worked well."

For the rocking latch tool, it appears that a common screwdriver may be used if you can get it in there. A better idea may be a standard "brake tool", the lever used to turn the star wheel on self-adjusting drum brakes. You might also check to see what you have in tire irons, especially those intended for bicycles. And of course, one of those right-angle screwdrivers might work, especially if you can find a large one. You should note, however, that while these items may get the job done, none of them are likely to work smoothly enough for you to get a good idea of what you are doing to that tensioner by feel.

You can easily make a more suitable tool: Buy a piece of strip steel 1/8" thick x 1/2" wide (commonly available at hardware stores), and cut off a piece about 7" long. Then, about 2" from one end, make a sharp bend of something less than 90 degrees -- see Figure 4. Then cut away one side of the tool -- the side that will be pointed toward the cam cover opening -- about 3/16" as shown. This is because as you retract the tensioner, the latch moves upward with it and this side of the tool will contact the edge of the access hole. This contact confuses the "feel" and can leave you wondering if the tensioner is fully retracted or not.

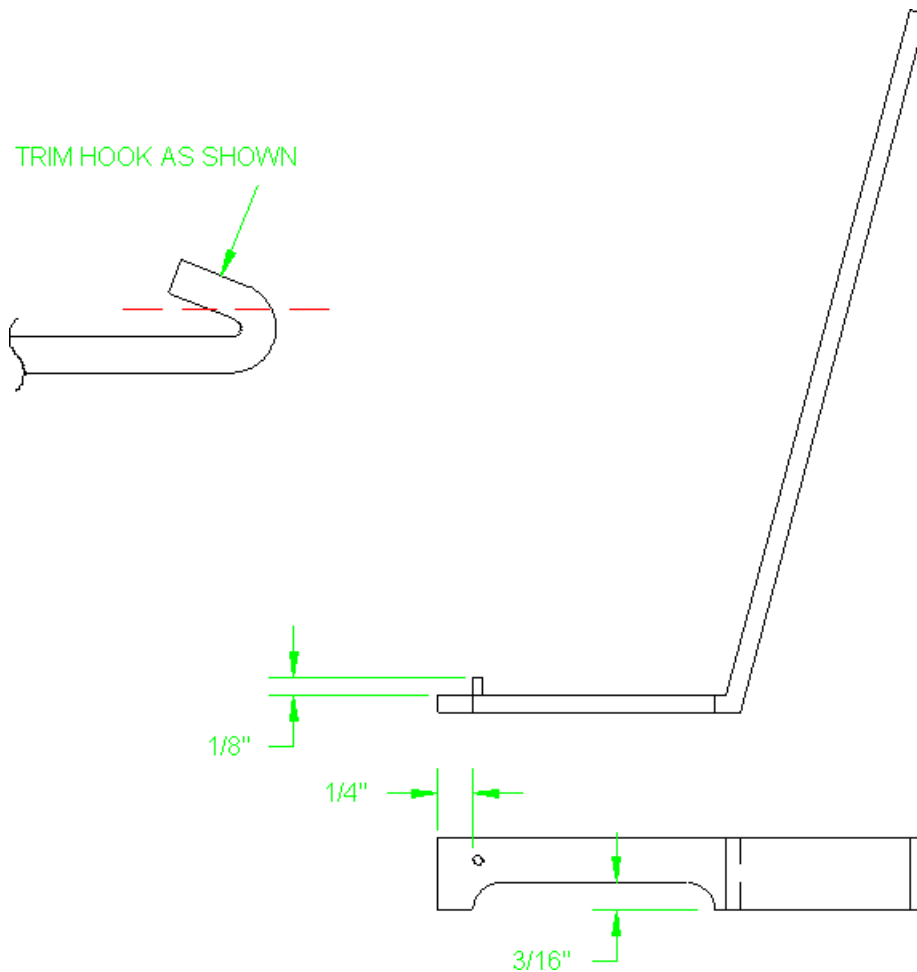


Figure 4: Improved JD.50 Timing Chain Tensioner Release Tool

Of course, you could avoid having to cut away the side of the lever by simply making it out of 3/8" wide strip steel to begin with. However, this is not recommended. The portion of the rocking latch above the slot is not very thick, so having a lever a full 1/2" wide to insert in the slot ensures that the tool contacts the rocking latch near the ends of the slot. If a narrower tool is used, applying torque to the lever can cause one edge of the tool to push up on this thin portion of the rocking latch near the center of the span rather than near the edge, greatly increasing the chances of actually breaking the rocking latch. Breaking this portion off doesn't really affect the normal operation of the latch, but it will make it even harder to release, and if that broken portion falls down into the crankcase you're gonna be upset about it.

The other feature shown in Figure 4 is a small pin sticking 1/8" up from the surface of the lever. The purpose of this little pin is to prevent insertion of the tool farther than 1/4" into the rocking latch, where it may get involved with other parts. A tiny roll pin could be used here, or perhaps a small screw. You can even omit this feature, if you are careful not to jam that lever in farther than it needs to go.

Bob Gallivan reports: "The drum brake adjusting spoon is the right way to go, just under 1/2" wide, cheap & easy to drill a hole in for the roll pin stop."

The actual operation of disengaging the tensioner requires using both tools simultaneously. To begin with, I suggest using the latch tool by itself to try rocking the latch CCW just to get the feel of it. It will not rock very far, but it

shouldn't take too much force to rock it, and you should be able to feel the spring. Old tensioners always seem to have bent or damaged rods or latches, and it's difficult to imagine how the damage occurs other than people applying *great* force to this rocking action. You should also note that, if everything is working properly, rocking this latch alone will have no discernible effect -- no clicks, pops, clangs, or anything else.

Don't bother testing the other tool by itself. Trust me, you won't be able to move the tensioner toward the retracted position without simultaneously rocking the latch CCW -- unless, of course, the tensioner is already broken.

Now, to actually retract the tensioner: First, rock the latch CCW and hold it rocked; it doesn't need to be held hard CCW, just so that it is prevented from returning to the CW position. With the latch so held, pull up on the retracting tool; you should feel it smoothly moving against a fairly stiff spring tension. In order to lock the tensioner in the retracted position, you will need to pull as far as it will go. At this point, it should suddenly become possible to rock the latch a bit farther in the CCW direction. While holding the latch firmly in this full CCW position, carefully release your pull; it should lock in that position. Once it does, you can rest assured it won't move by itself; you can go on and do other things.

When it comes time to reengage the tensioner, do not simply trip the latch to restore the tension; the tensioner will shatter like a dried twig, and you will need several bottles of high-octane elixir to get over it (see the section on timing cover removal on page 93). Use the special tools to gradually release the tensioner into its normal position. Pull on the tensioner to remove tension from the latch itself, and use the rocking tool to hold the latch near the center of a rock -- not fully CCW nor fully CW, sorta halfway in the middle. While holding the latch mid-rock (and perhaps rocking it back and forth a little), gradually release the pull; it may take a couple tries before the latch is successfully released and the tensioner starts moving. Once it does, you may quit fiddling with the rocker altogether, it'll take care of itself, but continue to use the puller tool to gradually allow the tensioner to assume its final position.

TIMING CHAIN TENSIONER -- DISASTER AVOIDANCE: Jaguar designed the latch so that the tensioner must be retracted as far as it can possibly go before it can be locked in the disengaged position. This bends the plastic arch, normally fairly curved, into a nearly straight shape -- and therefore stresses it far beyond what it normally sees. Even if it doesn't break immediately, this stress may start small cracks that cause the tensioner to break shortly after reassembly.

Simple solution: *Don't* retract the tensioner! When it comes time to take the sprockets off the camshafts, just do so and set them on the holders -- allowing the tensioner to take up the slack in the chain. During reassembly, simply use the latch release tool to hold the latch CCW as you pull the sprockets back up into position on the camshafts. This method has been tried and works fine.

All this means you will only need one of the two tools shown in Error: Reference source not found -- and since you won't ever get near the fully-retracted position, you won't need to grind the side off the lever.

It is of utmost importance that the latch on the tensioner be rocked CCW in order to allow the tensioner to release the tension it took up during disassembly. In fact, it'd probably be a good idea to rock that latch on at least two separate occasions during reassembly. First, obviously, it should be rocked during the reinstallation of each sprocket. Finally, after the distributor has been reinstalled and there's no more need to leave the crank in a particular position, the latch should be held in the CCW position as the crank is turned by hand through a complete turn or two.

Failing to do this reportedly results in a whirring sound from up front when the engine is started. Amazingly, it apparently does not destroy the tensioner; just realize what you forgot, go back and rock that latch once, it goes "pop" as the excessive tension on the chain is released, and all is well. Craig Sawyers says, "Precisely what happened to me a year ago. Saga was that during replacement of skinny washers at oil feed, I stripped the thread in the back to the tappet block. Tore it off to get an insert put in, and when I got the thing back together there was a worrying whirring noise from the front of the engine related to the revs. Aargh. But - pulled the rubber plug and stuck a screwdriver in (using a piece of mirror and a flashlight to see exactly what was going on) and "pop" went the tensioner. All was A-OK after that. Now during the reassembly process I could've sworn that I'd released it -but obviously not enough."

CAMSHAFT SPROCKET REMOVAL: The V12 has a cute little bracket just forward of the camshaft sprockets that

holds the sprockets (and timing chain) in place during removal of the heads or camshafts. The sprocket hubs have little stubs to sit on these brackets, and grooves for a clip to secure the sprocket on the bracket.

The clip, also known as tool JD.40, can obviously be improvised with sheet metal or even a normal 1/4" E-clip, perhaps with a 5/16" flat washer behind it. Note: The size of an E-clip is the size of the shaft it typically fits, *not* the diameter at the bottom of the groove it fits in. The diameter at the bottom of an E-clip groove on a 1/4" shaft is about 3/16", so that's the ID of a 1/4" E-clip. The stubs on the front of the cam sprockets are 5/16" in diameter, but they have exceptionally deep grooves and the OD at the bottom of the groove is about 3/16", so 1/4" is the correct E-clip size.

Note that if you purchase a "head set" -- a set of gaskets intended to include everything you need when you take the heads off -- the set will not include the locking plates for the cam sprocket bolts, C33917. You will need four new ones, so make sure to order them at the same time.

CAMSHAFT TIMING: The repair manual describes how to adjust the camshaft timing; this is just some clarification. To adjust the camshaft timing, obviously the chain can be moved over one tooth on the sprocket -- an extremely coarse adjustment. The camshaft sprockets have a splined inner hub that contains the four mounting holes. A circlip can be removed, allowing the separation of the inner hub from the sprocket, and the hub can be moved over one spline -- a fairly fine adjustment. However, the hub has an odd number of splines, so rotating the hub 90°, 180°, or 270° will effectively relocate the four bolt holes in 1/4-spline increments -- an extremely fine adjustment.

The engine is designed so that the crankshaft and the camshaft can be located where desired, the timing chain put in place and the tensioner activated, and then the mechanic can fiddle around with the sprocket hubs until the bolt holes line up. Jaguar provides an alignment notch on each camshaft and a special tool for setting the camshaft position. This special tool, C3993, costs under \$20 and is not easily improvised. It is recommended that anyone who has an engine apart far enough to use one have it on hand.

If the engine in question has a few miles on it, it may even be a good idea to go through the procedure of setting the camshaft timing while there. Wear in the timing chain will cause the camshaft timing to gradually move. What's worse, the timing of the right camshaft will move more than the left.

It is very important that you check the condition of the damper before relying upon it to set camshaft timing -- especially if it's a later car with the Bosch alternator, which tend to shear the damper as mentioned on page 91. If the damper shears while running it may squeal or affect battery charging but otherwise isn't too serious, but if you rely on the marks to time the camshafts and the marks are wrong due to a sheared damper you may crunch pistons against valves when you hit the starter.

TAPPET BLOCK REMOVAL: Sections 12.13.29 and 12.13.30 of the ROM describe how to remove the tappet blocks, and both procedures end with "Lift off tappet blocks carefully, retrieve tappets and valve adjusting pads." The Haynes manual provides a similar procedure. Both make it clear that the tappets must be reinstalled in the same locations they came out of, but if you yank that tappet block as described I dunno how you'll avoid having tappets everywhere. If you have a decent magnet on hand, it might be a better idea to use it to remove the tappets *before* unbolting the tappet block from the head. If you don't have a magnet, you might want to at least use a magic marker to mark the tappets before disassembly.

Sidetrack: If you need some really good magnets, tear apart a scrapped computer hard drive.

When reinstalling the tappet block, the manuals say you should tighten the bolts and nuts in order, but don't specify a torque. Later on, you'll be installing the bearing caps on the camshaft, and there is a *max* torque value specified there -- 9 lbf.ft. or 1,24 kgf.m. Since the nuts are the same size and all actually hold the tappet block to the head, it might make sense to tighten *all* of these nuts to the same specified torque. However, the fact that the cam bearing cap torque spec is a max rather than a range, plus that it's rather low for a 5/16" nut, indicate that this value is specified in order to prevent distortion to the soft aluminum bearing caps and probably isn't valid for the other tappet block fasteners. Hence, it may make more sense to use torque values specified for other typical 5/16" UNF nuts -- typically 11-13 lbf.ft. or 1,52-1,80 kgf.m. Later, while torquing down the cam bearing caps, you might wanna go back and retorquing these other nuts and

screws.

The upper row of fasteners on the tappet block are different, though. If the car is a pre-'84, they are a coarse thread rather than a fine thread, so the torque values aren't necessarily equal. The objective should be to achieve the same bolt tension, but the difference in threads means it will take a different torque to achieve the same tension. Judging from other similar applications, it appears that coarse thread fasteners should be tightened to a slightly higher torque than fine thread, so torquing these to perhaps 12-15 lbf.ft would be in order.

They are also socket head cap screws, meaning that it requires an Allen wrench to tighten or loosen them. Loosening is no problem, but tightening to a specified torque with an Allen wrench is tricky since you can't put your torque wrench on it. There are a handful of options, though. First and most properly, you can find a tool that looks like a short hex key built into a socket so it can be attached directly to a ratchet or torque wrench. These are fairly common, but the size needed here -- 7/32" -- is not quite so common. Sometimes you need to buy an entire set of these tools to get the one you need, and you are hereby advised that many such sets *don't* have the one you need! Be sure to check before buying. Discount Auto Parts sells a pack of four such tools on a card labelled "Brake Caliper Hex Bit Set" by Performance Tool, and one of the four is the 7/32" you need. These are really heavy-duty to fit 3/8" drive ratchets (most of these type tools fit 1/4" drive ratchets) and have an unconditional lifetime warranty.

Another option is to check for bits for electric screwdrivers. These bits are 1/4" hex shafts about 2" long to fit in the chuck of an electric screwdriver or drill, and there are all kinds of tips to drive almost anything. If you can find a bit with a 7/32" hex tip on it, you can put it into the head of the bolt and drive it with a torque wrench connected to a 1/4" socket. Unfortunately, finding this particular type bit may prove a little difficult.

A third possibility is to cut a piece off the end of your 7/32" Allen wrench, stick it in the bolt head, and drive it with a torque wrench connected to a 7/32" socket. This makes for a really flimsy assemblage of tools, but it should work OK. Don't drop that little hex piece!

From '84 on, the socket head cap screws are metric and require a 6mm Allen wrench. It might actually be *easier* to find a 6mm hex driver that will attach to a torque wrench than a 7/32", but if not the above ideas will work -- just change the sizes accordingly. Sam Lysinger reports that you can get a 6mm Allen drive socket from Sears or Snap-On, either individually or in sets.

These cap screws don't have any lock washers under the heads, since a lock washer wouldn't fit down in the hole. This doesn't seem to pose a problem, however; there are no reports of these bolts backing out.

Good luck torquing the bearing cap nuts to 9 lbf.ft. with a 150 lbf.ft. torque wrench, which is the only thing available at most auto parts stores. J. C. Whitney (page 694) offers a torque wrench with a 0-600 in.-lbs. (0-691 cm-kgs.) range, catalog number 15xx01148. Lysinger reports that NAPA offers four different models of torque wrenches with a 20-150 in.-lbs. range ranging from cheap junk to premium, and that Sears also carries one.

TAPPET BLOCK SEALING: There is no gasket between the tappet block and the head. Although this joint must be sealed to prevent oil leaks, perhaps Jaguar felt that the camshaft support and the valve clearances would not be secure enough with a gasket underneath the whole assembly.

So, how do we seal it? The ©1975 ROM, sections 12.13.29 and 12.13.30, says "Smear mating surfaces of tappet block and cylinder head with Hylomar." Michael Neal says, "Hylomar is a sealant that does not harden over time. It is still readily available and is blue in color. It is commonly used to seal the liners into the V12 motor and the cam towers to the heads. I've stopped using it to seal the cam towers because a good blast of carb cleaner or an aggressive steam cleaning can dislodge it and cause an oil leak that leaks directly onto the exhaust manifolds. Not only does an oil leak like this make a mess but it also causes the exhaust manifold gaskets to erode." Note: See page 102 regarding the liner sealing.

The Haynes manual merely says to use "jointing compound", perhaps recognizing the shortcomings of Hylomar for this application. According to Craig Sawyers, his repair manual (*Jaguar VIII Service Manual*, AKM 9006 Ed 5, ©1988) "...says to use Loctite 573. I used 574, which the Loctite website (www.loctite.com) has as practically the same stuff. TWR Jaguar in Oxford (Tom Walkinshaw's dealership, who manufactured the XJ220. I believe they know a thing or

two about Jags) use 574.”

A call to Loctite (1-888-LOCTITE or +1-203-571-5100) and a discussion with a tech rep revealed the following: First off, Hylomar (which is also made by Loctite, under license from Marston Bentley Ltd.) is intended as a gasket dressing, *not* to be used without a gasket at all, and is *not* recommended for this application. As Sawyers says, either 573 or 574 is suitable; the chief difference is in difficulty of disassembly, since 574 will glue the parts together pretty well while 573 is designed to be easier to get apart.

573 is bright fluorescent green and 574 is orange -- the stuff itself, not the tube it comes in. Loctite products all seem to come in red tubes.

Sawyers reports that you'll need about 50ml to do both banks. 573 in a 50ml tube is Loctite part number 21455 and 574 in a 50ml tube is part number 24018. Unfortunately, neither 573 or 574 is commonly sold in auto parts stores. Finding it will normally entail calling Loctite at the above number and getting the name and number of a local distributor; Loctite will not sell it direct. Neither of the substances is cheap, but worse yet you may end up facing a minimum order requirement of 10 tubes or some such, so you might want to talk your local Jag club into placing an order for the group.

Now, according to Neal, apparently Jaguar has changed its mind again about what to use on the tappet block/head joint -- perhaps because Loctite 573 and 574 are too difficult to find. “I'm more partial to Loctite 518 which, by the way, is red. Loctite 518 is a metal to metal sealer and dries to a rubbery texture. It is what Jaguar now recommends for sealing the cam towers to the heads. Most auto parts stores carry it, just get the big tube.”

Joe Bialy says, “I have a copy of "Loctite Worldwide Design Handbook" 1996/97 edition. 518, 573, and 574 are all from the same family of gasketing materials. 573 cures slow and fills gaps up to 0.2mm. 518 has moderate cure time, fills gaps to 0.5mm. 574 is fast curing, good for 0.5mm gaps. They are intended primarily for structurally rigid close fitting flanges. Being anaerobic, they only cure between the flange faces. Excess material is dissolved in "most fluids" thus flushed away. "Passages or channels will not be blocked.”

“The book makes no mention of Hylomar at all.” Interesting, since Loctite manufactures Hylomar under license.

“I also saw a Jag tech bulletin (#12-51) that now specifies Loctite #518 for the tappet block-to-head joint. It was dated 8/94.”

“Also according to their book for 510 type gasket compounds (509, 510, 518, 573, and 574): "Anaerobics cure rapidly between metal surfaces...To ensure gasketing success, all fasteners must be torqued to specification immediately (<3 minutes) after assembly". I dunno how you'd torque *any* assembly to spec within three minutes, especially one with as many fasteners as the tappet block-to-head joint, especially if you include the cam bearing caps in that spec. Nevertheless, the substances do seem to provide a good seal.

Steve Cranswick suggests Loctite 5900, as described on page 40. I know, too many recommendations, but the point is: just about *any* Loctite 500-series product will probably work here. What *won't* work here is Hylomar, which is what is recommended in the early ROM's and was probably used at the factory on early cars.

Whatever sealant you end up using, think a little bit before applying it. There is no need to smear it all over everywhere, and in fact that type of application is not recommended because it can result in air bubbles. Keeping the bead thin might also help you get it compressed properly with the first few bolts before the sealant sets up. You also don't want to get any inside the tappet guides. The instructions on the tube of 573 say to apply a bead to one part only, which makes it easier to apply than Hylomar; trying to “smear” it onto the head itself would be tricky since all those studs are in the way. Basically, you need to apply one continuous bead of sealant completely around the edge of the tappet block, making sure the bead pattern is such that it will always contact a mating surface on the head. Some flat areas on the tappet block correspond to gapping holes on the head, so a random guess is *not* acceptable; make very sure you are applying the bead in the correct place. Pay special attention to the area of the inside corners right behind the cam sprockets, where the forwardmost cam bearing studs are located; each side of the tappet block requires a slightly different treatment, and the left bank is a bit different than the right.

Now, think a little more before applying the sealant. Note that the bead should be routed *inside* of each of the 10 holes (one row of 6 plus the 4 surrounding the sprocket) for the studs on which the nuts are located *outside* the cam cover. Unfortunately, depending on the casting tolerances of your particular tappet block, the amount of surface area just inside

the 6 holes may be tiny indeed; you will need to exercise considerable care to make sure that particular location seals properly when assembled. Also note that the bead must be located *outside* of the other 20 holes, otherwise oil might get under a nut, run down a stud and leak out -- a serious potential on the studs that hold the cam bearing caps, since oil is being fed under pressure between those parts.

If all that wasn't perfectly clear, I have provided an illustration showing where that bead of sealant should be located; see Figure 5.

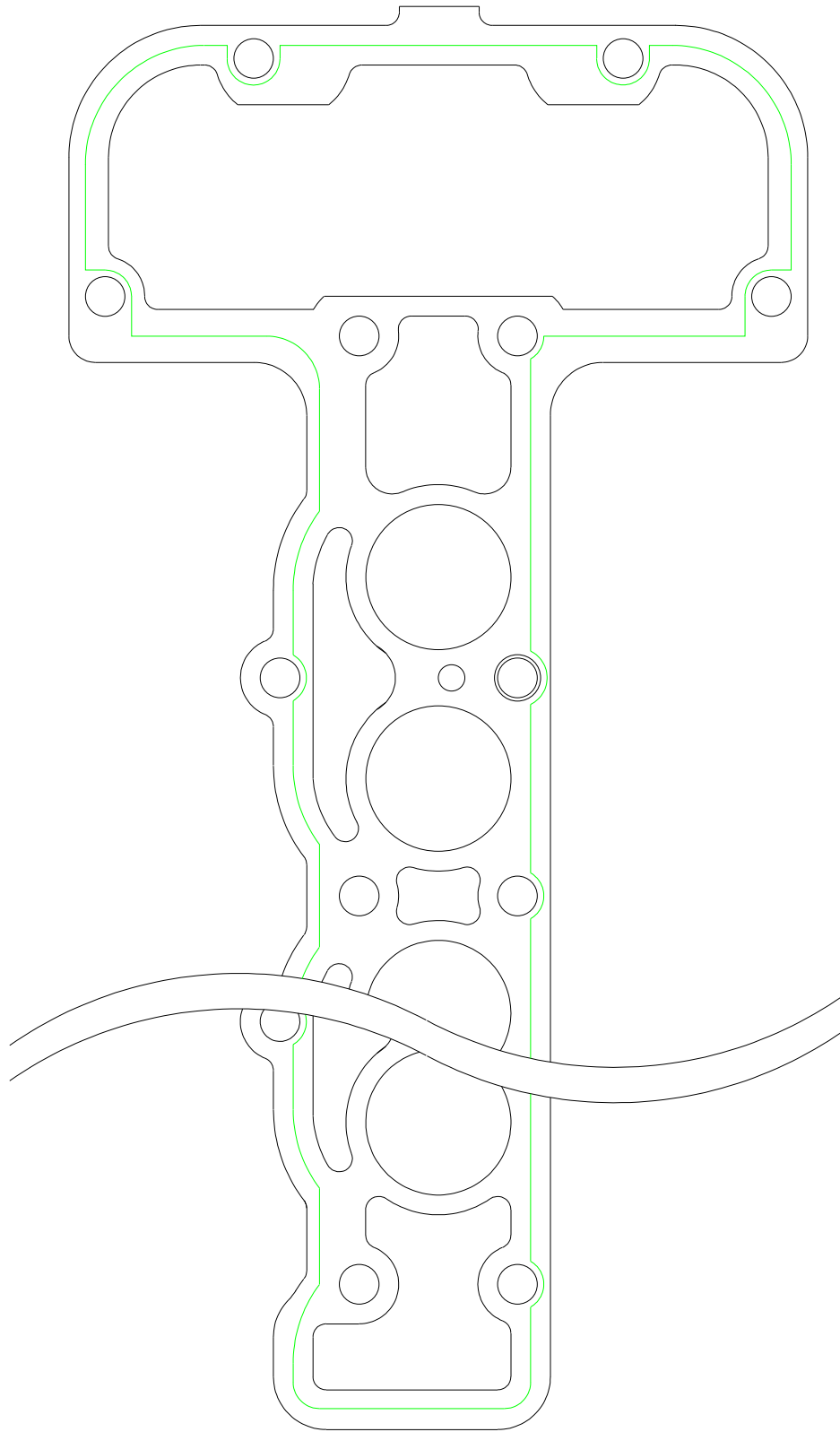


Figure 5: Sealing the Tappet Block

If you have a pre-'84 car with 5/16" studs, the 4 studs surrounding the cam sprocket have been sealed with cap nuts and copper washers. However, if the bead of sealant is applied to the tappet block correctly inward of these studs and the cam cover gasket does its job, there will be nothing within these stud holes to leak. From '84 on, these 4 studs are metric and use normal nuts and spiral groove washers with no attempt at sealing the studs, so they must have figured out it wasn't necessary.

VALVE CLEARANCES: In order to adjust the valve clearances, you must tear a considerable amount of hardware off the top of the engine. Also, since adjustment is via shims, the measurements must be made, the assembly torn apart and the shims removed and replaced, and the gaps checked again after reassembly. The shims themselves cost about \$3 each. Having a dealer perform this work reportedly costs over \$600, and is probably a reasonable charge considering the number of hours that will be required. Before doing the work yourself, see the tip on clearing off the top of the engine on page 59.

The wear rate on this valvetrain is slow, so this adjustment doesn't need to be done very often. However, when they *do* need adjustment, it's likely because the clearances have closed up! Wear between cam lobes and tappets or between tappets and valve stems causes the gaps to open up while wear between valves and seats causes gaps to close, and apparently the latter is predominant in this engine. This means that there won't be an annoying ticking to tell you that the valves need adjusting.

If you wish to check clearances, it is recommended that you obtain a set of feeler gauges that has a bend in the blades. You can't get a straight blade in there, but sets are available wherein the entire set of gauges and the holder they come in are bent about 45° in the middle.

A minor tip: The valve adjusting pads come in sizes varying in .001" increments and (the genuine Jaguar parts anyway) indicated by a letter etched on one side of the pad. As a favor to the next guy who'll be working on this engine, install the pads with the letter facing outward (toward the tappet). Years later, the letter will still be legible. If installed with the letter facing the end of the valve, it will be difficult or impossible to decipher the letter later on.

Roger Bywater of AJ6 Engineering (and formerly with Jaguar) says, "we knew back in the 1970s that running with the exhaust valve clearances set at 0.016" gives a slight but measurable gain in mid-range torque and reduced fuel consumption. Noise is not excessive at this setting because the actual running clearance closes up with the higher temperature of the exhaust valves compared to the inlets which must be set as normal.

"Anyone wishing to measure a V12 cam, as I have done in the past, will find that the timing quoted for the H.E. occurs at 0.010" lift whilst the timing at the point at which 0.012" clearance is taken up is an almost unbelievable 36,78/78,36. The difference in overlap between 0.013" and 0.016" clearances is about 12 degrees so the need to avoid tight clearances will be obvious and although the extra lift may be insignificant it can profoundly effect the HC emissions generated, quite apart from the modest effect on torque. In my view the best compromise regarding noise and performance is to aim for 0.013" for inlets and 0.015-0.016" for exhaust which, because of greater expansion of the exhaust valve stem, results in a similar true running clearance for both.

"...If mid-range torque could be improved by just opening up the clearances, why did the factory not do it in production? Well maybe they did (I am not prepared to be more positive than that) - but you will not find any manual telling you so because the reason for doing it would have been to reduce HC emissions at a critical time, at the risk of introducing more tappet noise problems."

CYLINDER HEAD REMOVAL: First, a bit of clarification: It is possible to remove each head with the camshaft and tappet block in place, and this may make sense if the reason for disassembly is farther down. This is the procedure outlined in both the ROM and the Haynes manual. On the other hand, if you plan to work on the tappets or valves anyway, you might choose to remove the camshaft and tappet block *before* removing the head. It makes the head lighter for lifting, and it makes it safer to set down -- there won't be any valves sticking out the bottom.

The following are a few comments/corrections to the ©1975 ROM, Sections 12.29.11 and 12.29.12, along with corresponding sections of the Haynes manual:

In Section 12.29.11, which is about pulling the B bank head, step 19 deals with moving the transmission dipstick tube outta the way. The dipstick for the BW tranny is on the B side, but on the cars with the GM400 the dipstick is over on the A side, so this step needs to be moved to Section 12.29.12. The same thing might be said of step 14 in Chapter 1, Section 19 of the Haynes manual -- that it should be moved to Section 20 -- but if you have a later car, you should probably be following the procedures outlined in Chapter 13, Section 3 anyway.

In Section 12.29.12, which is about pulling the A bank head, step 5 says to remove the auxiliary air valve. The AAV is on the B side, and doesn't need removal for working on the A head only. The same correction applies to Chapter 1, Section 20, step 5 in the Haynes manual.

Steps 8 and 12 in section 12.29.11 and steps 10 and 14 in section 12.29.12 instruct you to position the engine at TDC on cylinder 1A (by using the cam aligning tool on the notches in the camshafts) and then unbolting the sprockets from the camshafts. You will find this job goes easier if beforehand you rotate the crank one full revolution from that position (TDC on cylinder 6A, notches on cams pointing downward towards the head) and pull two bolts and one locking plate off of each sprocket. They're easier to get to when pointing up than when pointing down. Step 7 of Section 12.13.01 and step 6 of Chapter 1, Section 10 of the Haynes manual hint in this direction without making it as clear as they might.

Both manuals talk about removing heat shields, but beyond the big obvious one on each side don't really clarify what they're talking about. In all probability they're referring to the heat shield on the downpipe on the LH side as well as the heat shields around the boots on the power steering rack. The heat shields on the rack need to be removed in order to deal with the downpipes.

Neither manual even mentions the front exhaust manifolds. It's probably a matter of choice; they can either come off with the head or separately. If left attached to the head, they provide a nice handle for grabbing, but they do make the assembly heavier to lift.

CYLINDER HEAD REMOVAL -- ENGINE IN CAR: The conundrum facing anyone pulling the heads with the engine in the car is the fact that the rear exhaust manifold on each side is too close to a portion of the chassis. If the head is slid up the studs with the rear manifold still bolted to it, it will hit the chassis long before the head clears the studs. This problem can be addressed in two ways: 1) the rear manifolds can be removed from the head first; or 2) the motor mounts can be disconnected and the engine moved around until the manifolds clear the chassis as the head comes off. Sections 12.29.11 and 12.29.12 of the ROM describe the first option. Section 12.29.12 for the A bank head also describes pulling the starter, which is probably entirely to gain access to the lower nuts on the rear exhaust manifold on that side; if the head is removed with the rear exhaust manifold attached, the starter does not need to be removed.

If you choose the path of removing the manifolds first, you'll run into the same problem: the chassis is too close. The manifold won't come over its own studs without hitting the chassis first. Of course, sections 30.15.10 and 30.15.11 of the ROM just list the step-by-step instructions as though each step is easily completed. After all the fun you'll have getting a wrench on the nuts on the bottom side of the manifolds, you'll be just tickled pink to find that you have to undo the motor mounts and tilt the engine *anyway*.

This manifold removal problem also has two possible solutions: A) move the engine on its mounts again; or B) unscrew the studs so the manifold can come out vertically without having to clear the studs. Of course, unscrewing the nuts is hard enough, unscrewing the studs is likely to be seriously difficult. Here's an idea: Remove all the nuts first, then back the manifold up against the chassis so you have a gap between the manifold and the head. Using a thin pair of pliers, reach between the gap and unscrew the top three studs and then the bottom three studs. This method has the advantage that you will be gripping the studs near the middle and therefore not boogering up the threads where they're actually used. Note that two of the studs on the bottom of each rear exhaust manifold cannot come out through the manifold; they will either have to be removed with the manifold or the manifold will have to be repositioned -- perhaps downward, perhaps tilted -- to get those studs out. All the while, keep in mind that you will have to put this manifold back on somehow.

Clearly, removing the heads by leaving the manifolds on the heads and tilting the engine has its benefits. For one thing, you can leave the starter alone, there's no reason to mess with it. This author got his heads off by unbolting the motor mount on one side, putting a jack under the front of the engine and jacking, causing the engine to rise and tilt. After one

head came off, the engine was lowered, the mount reconnected, the other mount unbolted, and the engine jacked back up so it tilted the other way to remove the other head.

David Johnson says, "It was easier for me to remove both motor mounts and *lower* the engine to get enough clearance." Johnson goes on to say that, even though he pulled the heads with the manifolds still attached, he went the other way on reassembly. "I did that because I couldn't get 2 nuts off the bottom because some &^%\$\$ had galled up the threads and the nut wouldn't come off, and the stud was trapped. Now that I replaced the studs with new, and with the ever-present anti-seize it was *much* easier to put it on after."

Whatever method is used to deal with the exhaust manifolds, make sure to take enough notes to be able to reinstall the heads and reassemble the car.

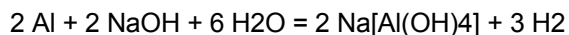
Tip: If the tappet block is off, you may find it helpful to unscrew and remove the rear pair of cam bearing cap studs to ease clearing things while getting the head in and out of the engine compartment.

STUCK HEADS: When you actually get to pulling the head off, if it's never been off before you'll probably find it stuck. In general, being stuck means one of two things: The head and block are glued together at the gasket, or the studs are stuck in the holes. The difference becomes evident when you actually get it loose: If it was stuck at the gasket, then once it's broken loose it slides easily off the rest of the way off the studs. This is typically *not* the case with the V12 heads, which have metal-faced gaskets that don't stick much, but the crud really builds up around the studs (several of which are immersed in coolant) and makes it difficult to get the head off every bit of the way. You might get it an inch up and *still* be having difficulty moving it.

This author will express an opinion here: The stuff plugging the openings around the studs is very likely the Barrs Leaks that Jaguar recommends putting in the coolant. Heads that have been off before and never exposed to Barrs Leaks again typically come right off without any more effort than lifting by hand. Of course, rust particles or other deposits in the coolant might also contribute to the jamming, but careful maintenance of the coolant seems to avoid those problems.

Loren Lingren sends this tip: "With all the nuts removed, try to wiggle the end of each stud by hand. The stuck ones will not move. Begin soaking each stud with a *good* penetrating oil. Get several 7/16 SAE nuts (Don't use the head nuts unless you have extras) and an air hammer with a tie rod tool attachment. The idea is to vibrate the studs with the air hammer, protecting the threads with the disposable nuts. Caution must be used *not* to bend the studs or gouge the head surface. Continue to apply penetrant as work is done. As the studs loosen, the penetrant will disappear down between the head and stud. I have used this procedure successfully for several years in removing even the most stubborn heads, 6 or 12 cyl, without any expensive side effects."

Other substances suggested for loosening the crud in the stud holes include oven cleaner, alloy wheel cleaner, phosphoric acid, Nitromors, lemon juice, and Coca-Cola. Dr. Karsten Eller, chemist, says to forget about the oven cleaner: "Oven cleaner is mainly caustic soda, i. e. NaOH. The sodium hydroxide attacks the protective alumina coating on the aluminium and also dissolves aluminium metal:



"Use of oven cleaner is therefore strongly dissuaded from."

Eller says acid will be fine, however. Mike Morrin says, "Someone suggested using phosphoric acid (rust killer) as it dissolves the rust without damaging the aluminium. He also suggested moulding little dams in plasticine to hold the stuff around the studs."

Regarding the use of Coke, Craig Sawyers says, "Now here's an interesting connection. Coke contains phosphoric acid (that is why it rots your teeth)." The stuff worked just great for James Dichter: "You know it's amazing what a little Coke will do. I'm beginning to wonder if we should be drinking this stuff. I'm also contemplating marketing it under a different name for the purposes of unsiezing head bolts..."

John Warr says, "Nitromors is not actually acidic - It contains dichloromethane, which will remove most hydrocarbon based gunge. It plays havoc with the skin however, and the vapour will go across most types of glove.

“I think alloy wheel cleaner will do the trick quite well.”

Of course, another fine idea would be to unscrew the studs and take them out. Probably not even worth trying, though; you can't get very good access to the studs with the head in place, and they are likely to be trouble to remove -- see the section on replacing head studs on page 81.

The April 1987 issue of *Skinned Knuckles* magazine included an article on removing aluminum cylinder heads by Earl Reynolds. The primary suggestion is citric acid, with an editor's note mentioning phosphoric acid and Coca-Cola as well. But the article provides yet another idea: using an electric arc welder to heat the studs. “Attach the rod holder to the top of the stud and the ground clamp to any other part of the engine block. Run the machine for a minute or two and the stud will become extremely hot and expand in diameter, crushing the fuzzy corrosion products in the process. When the stud cools and contracts, a void space is produced between the stud and the cylinder head. One minute with the heat on and five minutes of cooling the cable down will do the trick.” Note that, since there's probably no good way of knowing just how hot the welder got the stud, it'd probably be a good idea to replace all the studs that were heated in this way just in case they lost strength in the heating. With any luck, the heating also made it easier to unscrew them. It is suggested that you review the prices of these studs *before* you choose to attempt this method.

If persuasion fails, use force. Malcolm Scott suggests, “I bolted on to the exhaust studs a heavy metal plate that had sufficient rise in it so that I could use a hammer. This separated the head from the block and loosened the head from all studs along the exhaust side. However, two studs near the rear under the inlets were clearly holding things up. On the HE heads, the inlet tract protrudes over the smaller studs. I put the nuts back on the two offending studs and put solid packing between the nut and the bottom of the inlet. I then carefully wound the nuts off and the heads pushed off easily. Because the studs had grown into the head, they would not let go until the head was about 0.5 inch off. This required loosening of the nuts and adding solid packing (I used other nuts and washers).”

Richard Chapman suggests that you remove the cam so that all the valves are closed, then feed rope into the spark plug holes on cylinders 1 and 6. Turn the crank over and let the pistons push the head off. Might also work on cylinders 2 and 5.

John Napoli: “There is a technique that we used successfully on much lesser cars. The trick is that you need to try this before you disassemble very much. The trick is to loosen as many head nuts as you can access, and then run the engine!! One good stab of the throttle is usually all it takes. The head quickly 'pops' a bit. Shut it down and then remove the heads normally. You only need to loosen the nuts a couple of turns, and it often doesn't matter if you can't get to 'em all. We used to do this on engines where, for whatever reason, we anticipated problems in getting the heads off.”

If nothing else works, John Goodman describes a homemade tool that *will* get the heads off: “1/2” steel plate slightly wider and longer than the cyl head. Drill two rows of holes down the centre to line up with the camshaft bearing cap mounting holes, bolt plate onto camshaft carrier using the existing bearing cap studs. Screw long bolts through threaded holes in the outside edges of this plate which line up with the cyl head retaining studs, the ends of these long bolts had “cups” to locate them over the cyl head studs. Next just torque down evenly with a few smacks from a BRO hammer and the heads come off.” If you have the tappet block off, you might be able to use it as a template to mark where to drill holes in the plate.

Alternatively, a smaller, more compact set of tools that work essentially the same way as Goodman's massive plate can be fabbed up quite easily. First, purchase a length of steel bar 1/2” thick and 1” or 1-1/2” wide and cut two pieces 4-1/2” long from it. Drill two holes and drill and tap two other holes in each piece as shown in Figure 6. Into those tapped holes, thread 3/8”-16 bolts that are at least 5 inches long and threaded all the way to the head.

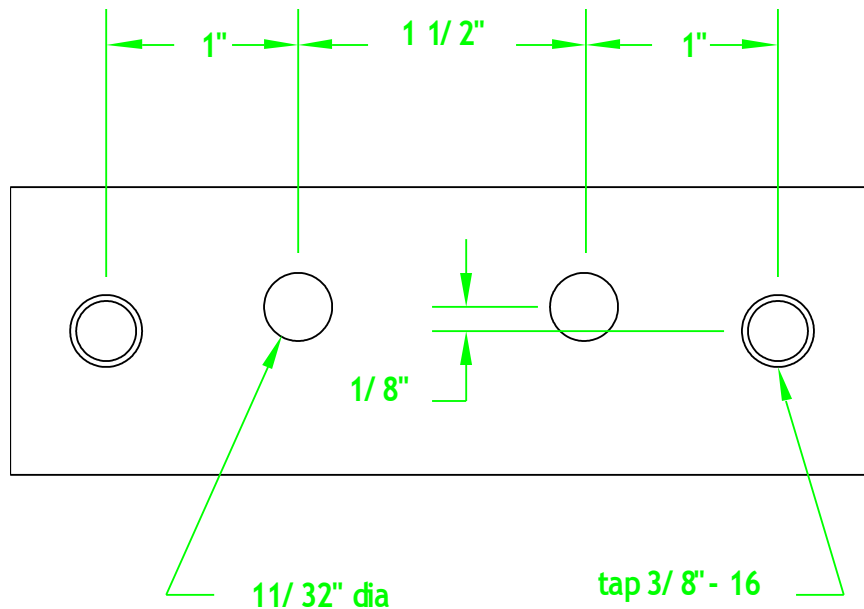


Figure 6: Head Jacking Tool

If you want, you can use 3/8" fine thread bolts and tap the plate accordingly, or even 8mm metric stuff -- whatever is easiest to find in your area. You can use threaded rod, but you'll need to find a way to turn the threaded rod -- weld a nut onto it, bend it 90° at one end, whatever. If you don't have a tap or don't want to bother, you can just drill 3/8" holes and put nuts on the back side of the plate, but it'll make the tool a little clumsier to use.

The tappet block should be in place, and you'll need to remove the bearing caps and the camshaft. If you've already removed the tappet block, just slide it back on; without the tappet block, it's too easy to bend the studs using this tool. There are seven pairs of studs for cam bearing caps on each bank; this tool can be used on the 2nd, 3rd, 5th, or 6th pair. Fit these two plates to the 2nd and 6th pairs and put nuts on to hold them in place. You might need to put some spacers under the nuts on the studs -- 3/8" nuts work fine.

To begin with, install some generic nuts on the top of each of the four head studs that will be involved, threading them on only a couple turns. When the jacking screws are inserted into the center of these nuts, the nuts will keep the screws from walking off the end of the stud. However, when the head has been lifted to the point where these nuts keep it from coming any further off, you'll have to stop everything and remove the nuts. Things may be moving well enough by that point to continue without anything to hold the jacking screws centered, but if not a few small pieces of 7/16" ID tubing slid over the studs will help -- or maybe some 1/2" nuts. Once the jacking screws enter the holes in the head, there is no further need for such things, the head itself will hold the jacking screws aligned.

It may be possible to get a mildly stuck head loose with only one tool by fitting it to the 2nd pair of studs, getting that end loose, then relocating it to the 6th pair and getting that end loose. But since the trouble is likely to be from junk packed around the studs and will be trouble all the way up, it'll be a lot easier to make two of these tools and jack both ends simultaneously.

When jacking, take care not to allow the head to tilt inward or outward; tighten both jacking screws on each tool evenly. If the head cocks, it just jams worse on the studs.

Note that the weak point on these contraptions is probably the cam bearing studs themselves. Don't go cranking real hard; if the head just won't come loose, find a way to apply more lift elsewhere -- don't just pull the studs out of the top of the head. Since they're only attached to two studs each, these little tools won't apply the lifting force that Goodman's massive plate will, but it should get most heads off. If more force is required, two more plates could be fabbed and installed on the 3rd and 5th pairs of studs to apply more oomph. You could even fab a fifth plate with no 1/8" offset

between the pairs of holes to use on the 4th (center) set of studs.

Matthias Fouquet-Lapar quotes the "XJ-S issue" (Volume 8 Number 3 January/February 1996) of *Jaguar World*, page 57 :

"Cylinder heads can be a nightmare to lift due to the inter-action of steel studs and alloy heads. However, Classic Spares do market a tool of their own design that makes light work of the job. Be warned, you will need it."

See page 693 for Classic Spares. There are also reports that John's Cars (page 717) offers such a tool.

ONE HEAD OR BOTH? If a valve seat drops in one bank, some people want to know if they can just pull the head from that bank and leave the other one alone. If the seat only drops a bit but stays in place, you might get away with it. If the seat actually falls out and breaks up, apparently not. Greg Wells of Concours West says, "If one or more seats has dropped and shattered, you must pull both heads, as the pieces will always have been tossed into the other head by the strong intake plenum reversions."

Aw, c'mon, that's gotta be BS! The two intake manifolds are completely separate, connected only by a 1" balance pipe. Parts of a valve seat would have to go through that balance pipe to get to the other side! "That's the only explanation I can offer. This is not based on supposition but is something I have witnessed several times. The seat pieces in the other bank (opposite the dropped seat) are pretty small and since the balance pipe is the only connection, I have to assume this is the case.

"The last one I recall had dropped a single seat on the LH bank. Two of the LH pistons had shard embedded in them; four of the RH pistons also did. The only seat missing was on the LH side and the broken seat pieces were small, on the order of 1/8" or so."

More testimony from Chad Bolles: "Yes, it is possible for broken pieces of valves and seats to end up on the other side of the engine. Been there done that."

And Roger Bywater: "What seems to cause it is that if the exhaust valve is unable to seat and if there is a vacuum in the inlet manifold then exhaust gas will get drawn back out of the exhaust manifold and backflow through the inlet valve when it opens. At moderately high engine speeds at light throttle this backflow could be quite considerable and might easily pull debris with it up into the manifold. The good cylinder bank will be pulling better vacuum so there will be flow across the balance pipe and if circumstances are right then bits will end up making the journey across.

"What seems at first to be impossible is actually not at all unlikely if the car continues to be driven in the damaged state."

SO YOU HAVE THE HEAD OFF: Be sure and clean up the spark plug threads while you have the head off. One excellent method is to get a suitable wire brush shaped like a "bottle brush" and screw the brush through the hole. Places that sell shotgun cleaning tools have an excellent selection of suitable brushes. When clean, the spark plugs should spin all the way down by hand. You might also want to address any spark plug threads that may be damaged; it's easier to install an insert now than later on when the engine is together.

If you have the A bank head off, it is suggested you go through the procedure of setting the location of the timing mark plate described in the section on ignition timing starting on page 126.

If the block hasn't been turned upside down in the midst of this job (!), there will be little puddles of coolant surrounding the liners. Make sure you get this coolant out, and then scrape the bottom of these pockets with something pointy. You'll probably find a lot of junk, perhaps looking like sand. It might actually be sand left over from the casting process. David Johnson says, "I discovered that there was no coolant flow around the last cylinder on my A side! The last liner is so close to the jacket that *yuck* had built up to the point that coolant would have had a hell of a time trying to flow around it. I'd bet only about 1/2 the liner had coolant touching it!" Whatever you find, get it outta there. Small accumulations probably don't hurt anything being there, but these pockets may serve a useful purpose in catching new crud floating around in the cooling circuit, and maybe once they're full stuff starts plugging the radiator or something.

On the bottom of the heads where they come in contact with the gasket, there are several openings for coolant to flow from the block through holes in the gasket and into the head. One row is round openings, the other row is oblong holes. Several of these holes may be rimmed with casting flashing; apparently the core meets the form right at the hole, and there was little effort to clean away the flashing at the factory. When the head is off, take a Dremel and clear away this flashing to ensure the holes are fully open. Might not be a big deal, but couldn't hurt.

With the Jaguar V12, with just the heads off you might be able to accomplish several things that would require opening the bottom end on other engines. The first possibility of note is that you can reseal the liners to the block. Use the liner retainers (or some reasonable facsimiles) to hold 11 liners in place. Turn the crank until the piston in the one unrestrained cylinder is at the bottom of its stroke, and then continue turning the crank while encouraging the liner to come up with the piston. When the piston is at TDC but still at the bottom of the liner, the ledge on the side of the liner that sits on the block will be higher than the head surface. You can then carefully clean the surface on the liner and the block, apply new sealant, and slide the liner back into place. David Johnson actually used this method to reseal a liner that had accidentally come loose, and ended up knocking a few more loose just to make sure they were all properly sealed. In fact, it might not be a bad idea to turn the crank a little with no retainers in place, just to see if any liners are loose enough to move. Or, succumb to the temptation to reseal them all whether they need it or not. See page 102 for notes on sealants to use here.

Now we move on into theoretical, since as of this writing the following ideas have not been tried and reported back on; attempt at your own risk. The next suggestion is that you may be able to replace the liners from above. This is a bit harder than the resealing idea, since it requires taking each liner completely out. The challenge is getting the piston rings back into the liners when reassembling, since even with the piston at TDC you're working in too tight a place to use a conventional ring compressor. However, you may actually be able to finger the rings into place one at a time. Squeeze the top ring, slide the liner down on it, and move on to the second ring. John Napoli suggests you might even go ahead and cut a small taper into the bottom end of the liner before installation to make it easier to get the rings in. Or, you might be able to fashion a homemade ring compressor that will work in this space, perhaps from a hose clamp and some shim stock, or maybe from a pair of needlenose pliers and some shim stock.

If that idea works, the next idea should work too: Replacing the piston rings. If you have the liner out and the piston is flopping around above the opening in the block, it shouldn't be too difficult to carefully remove the old rings and slip on some new ones.

I'd like to report that you could even replace the pistons themselves, but reportedly the piston does not come up high enough for the pin to clear the ledge that the liner sits on.

CLEANING HEAD STUD HOLES: Before reinstalling the head, it is of utmost importance that the holes for the studs be thoroughly cleaned. Any crud remaining in these holes may be kicked loose when the head is slid down over the studs and it might fall out the bottom and sit on top of the head gasket while you're closing it up, and you'll have a bad seal.

For cleaning the stud holes, a suitable item would be a wire brush shaped like a "bottle brush". If you're real lucky, you might find one in an auto parts store, and if you're even luckier it might be somewhere near the correct size. Forget about luck and visit any sporting goods store or department and look at the tools available for cleaning rifle and shotgun barrels. Outers and Hoppe's make cleaning tools involving 3-piece shafts and little copper wire brushes that screw onto the end for very reasonable prices. Buy one shotgun-cleaning brush assembly and additional interchangeable brass wire brush attachments for 10, 12, 16, 20, 28, and .410 gauge shotguns, and you'll be able to clean just about any size hole you encounter. You can opt for the rifle and pistol cleaning tools as well for cleaning smaller holes yet, but note that the threads on the brush itself might be different and therefore require either a different rod or an adapter. Also note that Outers and Hoppe's shotgun brushes are not interchangeable, so you'll need to choose one brand for all the brushes you buy.

As opposed to the items found in an auto parts store with handles that are merely a continuation of the twisted wires that form the brush itself, the shotgun brush assemblies have a finely machined 3-piece aluminum shaft. Hence, it becomes quite reasonable to chuck one section of the shaft up in the variable-speed drill and clean those stud holes up in a hurry!

REPLACING HEAD STUDS: Some of the head studs on the V12 are immersed in coolant. If the coolant has not been maintained properly (changed on schedule), some of these studs may get corroded. A small amount of surface corrosion is no big deal, but large-scale erosion can significantly reduce the cross-sectional area of the stud -- which is a formula for blown head gaskets.

Head studs can be thought of as springs. When you tighten the nuts to the specified torque, you are stretching these springs to a particular load value. Even though parts may expand a little with changes in temperature, the studs are designed to be long enough that this growth is minor compared to the stretch of the studs so the compressive force on the head gasket is maintained. But if the shanks of the studs start corroding away, this preload is reduced. And if the engine is reassembled without replacing such corroded studs, it may prove impossible to apply the specified torque; the bolt may yield at the narrowed section first.

Peter Hyslop shares experience with these studs: "This applies mainly to old V12 engines (ie >20 years old) with a few miles on them and which have never been apart:

- 1) The studs can get stretched if over-torqued by some fool trying to take a short-cut on a head gasket leak ... this is an unusual degree of incompetence, so never use that mechanic again (and if you did it yourself, give up, there's no hope for you).
- 2) The studs immersed in the coolant can corrode and pit. The others are usually fine.
- 3) The studs immersed in the coolant can become adherent to the block and become brittle. Some of these studs stand a reasonable chance of snapping off when you try to remove them ... yes, you read it correctly, the stud will snap *before* the aluminium block gives way.

The solution:

- Make sure that you really want to go this far before you start, and are prepared to stick it out when the going gets tough.
- Leave the studs not in the coolant alone.
- Pull the studs in coolant only if corroded.
- Expect some of the corroded bolts to snap and land you with a big machinists' bill.

How do I know?...I'm up to my arse in the alligators right now with items two and three above (yup, snap, snap snap)!"

Note that the AJ6 6-cylinder engine used in some XJ-S's has an entirely different theory in head studs. They are designed to be tightened until they yield, which provides a very closely controlled amount of compression on the head gasket -- but requires that the studs be replaced whenever the head is pulled.

VALVE REMOVAL: Jan Wikström says, "The normal generic valve compressor from K-mart will do fine; there's nothing special about the V12 valves." Apparently, K-mart is a quality tool source in Australia where Wikström lives; here in the US, the vast majority of valve spring compressors on the market are either cheap junk, designed specifically to fit a Chevy and nothing else, or both. Trying to use cheap junk on valve springs can be seriously dangerous; if that thing snaps loose or breaks while holding the springs fully compressed, it can fire keepers and collars around the room like bullets.

Some of these pieces of junk are intended to be operated from above only, which may be handy if you are trying to replace seals without pulling the heads, but these tools try to hook onto the coils directly; they compress part of the spring rather than the whole length of the spring, and they don't compress the inner spring at all -- you have to push down on the tool to get the keepers in and out. And you must hold the valve itself in place by other means, possibly applying compressed air to a spark plug hole or even inserting some rope and turning the engine around until the piston pushes it against the valve head.

If you have the head off, Gerald Foster recommends a valve spring compressor sold by Sears. It costs less than \$20, is a

substantial tool that wraps around the head (like a big C-clamp) to push on the spring and the valve head at the same time, and is a Craftsman tool with a lifetime warranty.

When using the C-clamp type compressor, you'll find it helpful to tighten down on the spring a little bit and then give the top of the spring a little rap with a plastic hammer to pop the collar loose from the keepers. Then you can proceed to compress the spring further.

VALVE SEAT WORK: It's why you're reading this section, right? Well, when replacing the seat, the first thing you need to get right is the fit. In the General Specifications section of the ROM under "Valve Guides and Seats", there is a spec for "Interference fit in cylinder head" of 0.002"-0.006". This is *not* for the valve seats -- it's the spec for the valve guides. The correct interference fit, 0.003", is in the ROM, but not here; it's in section 12.29.18, step 14. It's followed by instructions to heat the head before installing.

The ROM also talks about two oversize seats being available, but here in the US good luck finding a machine shop that cares. The boring tool used to ream the hole in the aluminum and the sintered iron valve seats are both standards of some sort and they will use their own, not Jaguar's. If they're any good at their jobs, they will machine the ID and the seat area of their insert to the same configuration as the original so you really wouldn't know the difference unless you interrogated them about it. It's not like you have any good reason to insist on genuine Jaguar seats here; those were genuine Jaguar seats that fell out!

Craig Sawyers talks about the hot/cold fit: "Assuming that the temp difference between the seat and the head is 130°C, the differential contraction is 10ppm/°C and the seat OD is 1.5 inches, there will be a 1 thou interference under these conditions. If the seat was chilled in a freezer to -40°C, it would be a precise fit. Cooled to liquid nitrogen, it would just drop in.

"Machining to give a greater interference than 3 thou may be counterproductive, as the seat would have to be driven home, and shave the aluminium on the way in, reducing the interference again (to about 3 thou?)."

You need to make sure they cut the seat properly in order to ensure that the valve itself sits the same "depth" into the head, for two reasons. First, the position of the closed valve greatly affects the combustion chamber volume and therefore the compression ratio in that cylinder; the farther off it is, the more fiddling somebody's gonna have to do to cc the heads to make sure that each cylinder has the same volume. When you see what these guys do to get these volumes the same, you'll wish they had seated the valve right. Of course, the correct valve position may be even more important on the H.E. engine since they are part of the swirl configuration of the head.

The second reason has to do with adjusting the valve clearances. The shims are only available in a limited range of sizes, and grinding away on the valve stem is a no-no.

VALVE TRIMMING: After the valves and seats have been machined to renew the contact surfaces, the valve will obviously sit lower in the head. This closes up the valve clearances at the tappets. Jim Cantrell points out: "Often, people at this point will then cut the valve stem to get the additional clearance. This will then cause the valve stem's life to be reduced since the stems are hardened. This hardening only penetrates a few thousandths of an inch and cutting it off exposes the softer valve material." The proper solution to inadequate clearance is to replace the valve, the seat, or both.

SO YOU'RE DOING A VALVE JOB: To many of us, doing a valve job means pulling the heads off the car, taking them to a machine shop, picking them up later, and bolting them back onto the engine. However, the valves are a prime place for easy improvements when the heads are off. I will mention a few ideas.

The valve guides are sleeves that are press-fit into the heads, and protrude a little bit into the inlet and exhaust ports. Jim Isbell suggests that, before you install the valves, you take a hand grinder and grind off the protruding parts of the guides flush with the surface of the port.

The valves and seats on the Jaguar V12 are supposed to be machined with $44\frac{1}{2}^\circ$ angles. Most machine shops will suggest that the seats be “triple cut”, in which additional cuts are made at angles greater and less than $44\frac{1}{2}^\circ$ in order to control the width and location of the contact area. Typical angles for these cuts would be 32° and 60° and the contact area width should be about $1\frac{1}{2}$ mm wide. Chad Bolles suggests that a similar triple cut on the valves themselves would be beneficial.

John Milne suggests that, after the valve contact surfaces have been machined, some machinist’s bluing be applied and the valve trial fit to determine the location of the actual contact on the valve surface. Then, carefully avoiding the contact area, the inner edge of the machined surface should be blended to form a smooth continuous surface with the “tulip” shape of the valve. This helps the flow through the valve, since it makes a smooth passage instead of that corner. It also slightly enlarges the opening, since the smallest flow area when the valve is open is between this inner corner and the seat. “It’s kinda like getting a little extra valve lift for free.” Blending the inner edges of the machined surfaces of the seat may have similar benefits.

Of course, every high-performance enthusiast will suggest that you do a little “porting” while you’re in there. This means carefully enlarging the intake and exhaust passages. In the case of the intake passages on the Jaguar V12, however, this may produce undesirable results. These intake passages are designed to provide a certain amount of resonance-induced flow enhancement, and this requires that the flow rates be fairly high. Enlarging the ports makes for slower flow, which means better flow at high RPM but less boost at low RPM. In other words, enlarging the intake ports may increase high-speed horsepower at the expense of low-speed torque.

The next automatic suggestion is “polishing”. Quite literally, the passages may be polished using successively finer abrasive compounds until a mirror finish is achieved. This supposedly will reduce surface friction of the flow.

Before you reinstall the head, Jim Isbell suggests you “cc” it. This means that you measure the volume of each combustion chamber, and grind a little metal away here and there to make sure they are all the same. This makes for a smooth running engine. To measure the volume, you can set the heads upside down on a level surface and fill each chamber with a carefully measured amount of light oil.

Cc’ing must be done after the valves are installed for the final assembly. Clearly, if valves are ground or relocated after cc’ing, they will sit at a different level than they did before and this would significantly change the volume of the chamber. And this is the reason that cc’ing is recommended whenever the valves have been redone.

If you happen to be working on a pre-H.E., cc’ing doesn’t apply. The head is flat, so there are no chambers to cc.

TEFLON VALVE STEM SEALS: Michel Carpentier says, “Teflon valve seals are the way to go. They last forever, plus you can fit them on the exhaust guides as well. Less blow-by, reduced crankcase pressure, no more oil leaks, and cleaner oil to boot.

“Our engines came from the factory with 24 valves but only 12 valve stem seals. Jaguar probably realized that the British rubber intake rendition would soon fry on the exhaust side.

“Why would any (effective) exhaust valve seal affect crankcase pressure? When the exhaust valves open, gases gush out of the combustion chamber with tremendous pressure. Even though the valve itself acts as some sort of an umbrella, there is still a significant pressure differential between both sides of the exhaust guide. Any clearance between valve and guide will let exhaust gases into the crankcase area. Jaguar old trade secret to keep engines leaking oil!”

Of course, the decision to switch to Teflon seals, and to install 24 instead of 12, may not be quite that simple. This author had some discussion on the phone with the rep at Silver Seals about the differences between Teflon valve stem seals and normal nitrile seals. There is apparently a functional difference: the nitrile seals always leak, and the leakage allows a small amount of oil down the valve guides to lubricate them. The Teflon items will not leak, so the valve guides run dry. According to the rep, this is a problem on some cars and not a problem on others. I’m betting it’s not a problem on the Jag, since it uses good materials on both the valves and guides. Also, the action of the cam on the tappet applies no sideways load to the valve stem, as there is in any valve train with rockers. Still, recognize that you may be trading oil burning for faster valve guide wear when you install Teflon seals.

Does anyone make Teflon valve stem seals for the XJ-S? Carpentier: "Perfect Circle does, although unwittingly since I doubt they ever considered Jaguar engines as a possible application for their product. Our valve guide diameter is 0.502 to 0.501 in, that's essentially 1/2" or sixteen (16) thirty secondths of an inch. Valve stem diameter is 0.3092 to 0.3093 in, and that's within 3 thou of 5/16" or ten (10) thirty secondths of an inch. These dimensions are a bit unusual but luckily match those of the first generation Chrysler Hemi engines. Call Perfect Circle (they are a DANA subsidiary) and they will tell you: "Yes, we manufacture such Teflon seals, part number D1610, available at any NAPA auto store".

"There is a catch: if you go to NAPA and ask for this reference, they look it up in their computer and tell you it does not exist (never mind telling them what kind of car it is for...). The last time I was in the US, I finally found a place in Los Angeles that would order them for me. The seals actually came from a company called Silver Seals Products/Whip-L Products, Trenton, Michigan, 1-800-521-2936; their reference is DT1610 but the seals carry the Perfect Circle logo." This author called that 800 number, and had a set of 24 Teflon valve seals on order in a matter of minutes and in hand in a week at a cost of less than a dollar each. For those outside the US where an 800 number won't work, their regular phone number is +1 (734) 479-2255.

The OEM nitrile seals on the inlet valves are pressed over the valve guide until they snap into a groove around the guide just above the surface of the head. The exhaust valve guides have no such groove. This turns out to be a non-issue with the Teflon seals; these seals press fit onto the OD of the valve guide, and therefore do not use the snap groove. While the OEM seals are a simplistic piece of rubber, the Teflon seals include a metal ring on each diameter to provide a secure fit on the guide and on the valve stem itself.

Besides the diameters of the guide and stem, there are a few other things to consider whenever fitting a non-OEM valve stem seal to an engine. In this case, the OD of the base fits within the inner spring just fine. The Teflon seal is a little taller than the original seal, which makes for a really close fit; the valve lift is 3/8", and that's pretty much right where the valve keepers sit down on the top of the seal's lip. If you intend to run an aftermarket cam with more lift, you'll need to either use the shorter OEM seals or make some other changes, like shortening the keepers or the guides.

Installation is not as simple as with the nitrile seals. Carpentier: "You cannot push them in as you would plain vanilla seals. With your package you should get a clear and rather flimsy plastic tube closed at one end. Slipped over the valve stem, it protects the seal as you first push it over the stem end (push with your thumb with a slight rocking motion to get started) then slide it over the cotter groove. Trim this sleeve so it still covers the groove but does not stay trapped under the seal when fully home." Note: on the valve stems, just below the groove, the part number is engraved; might as well leave the sleeve long enough to cover the number too, just to make sure you don't damage the seals going over it.

"When you start, remember (24 times!) to put the spring seat first as it does not fit over the seal. This is especially important as a teflon seal cannot be removed without being destroyed: 1) it is hard to pull it from the guide without distorting it and 2) as it goes back over the cotter groove, the sealing surface between stem and seal will be damaged." Clearly, you need to have the valve in place before installing the seal and you can't remove it afterward, so make sure you are actually at the final assembly stage (all lapping completed, etc.) before installing seals.

"Now you need to push the seal over the guide. Use a tube (e.g. a deep socket) with ID greater than the narrow upper section and a rubber mallet. A first blow will get you over the guide chamfer, then tap it all the way in. Don't hammer too hard though or the upper portion will shear off as you hit bottom." Note: this author has done this job, and it's a lot easier than it sounds.

EXHAUST FLOW LIMITATIONS: Roger Bywater explains an inherent shortcoming of the H.E. engine: "The small and pocketed exhaust valves are the real problem and is why all the high performance racing V12s have been based on the old "flat head" design. Putting big exhaust valves in doesn't help because the chamber walls are so close and leave no room for flow around the edge of the bigger valve head. In fact if the HE were not of abnormally high compression ratio, always a useful trick to get a bit more top end power out of an engine that doesn't breathe, it would struggle to produce the barely adequate power that it gives as standard. You can build an HE to 6 or more litres (we used to do a 6.3 using 98 mm bore and standard crank) but all you really get is more torque low down but not much more power."

SODIUM-COOLED EXHAUST VALVES: Roger Bywater continues about the H.E. head: “As an economy measure the HE was outstandingly successful (helped by the 2.88 axle) but the severely shrouded position of the exhaust valve certainly hinders the pursuit of high power and increases the thermal loading the valve is subjected to. To withstand the rigours of sustained high speeds on German autobahns sodium cooled exhaust valves were introduced on cars for the European market.

“All but the early European H.E. V12s and also the H.E. headed 2.9 AJ6 engine had sodium filled exhaust valves under the same part number EAC 7318 for both engines. They were introduced first on the V12 for Germany/Switzerland then later for UK, etc. I am not aware of any corrosion problem but it would surely be a bigger problem at high temperatures rather than while standing.

“The valve stem is roughly half filled with sodium which melts and acts as a "cocktail shaker" increasing the rate of heat transfer from the valve head to the stem.”

HEAD GASKETS: The OEM head gaskets are a metal-fiber-metal sandwich. Payen makes such gaskets. However, Clough (England) makes head gaskets for the Jaguar V12 that are the opposite: a fiber-metal-fiber sandwich. One report: “One was extremely difficult to get over the studs - I believe made wrong or shrunk some. It ripped!”

The Jaguar V12 rarely suffers head gasket trouble, which may mean pretty much any head gasket will do the job, but it also might mean that the OEM gaskets are really good. Try something different at your own risk.

Martin Walker says, “H.E. gaskets don't seem to fit the pre-H.E. heads. I bought a complete H.E. gasket set from a Jag dealer and had to return it because the coolant passage openings in the head don't all line up properly.”

Can you just cut suitable openings in the gasket? Don Miles: “Don't do it! Don't do it! I repeat again, don't do it!

“What happens is, you allow the internal softer material to rot/crumble and to have a very large edge to escape. Not a problem to start with if you are one of the crap screen users as it will be prevented from junking the rad. However, when the soft material crumbles at the 'fire ring' around the cylinder head the 'nip' is reduced and gasket failure follows. On a race engine with 10:1 or more this can be in 2 weeks. On a normal road V12 it will clearly be longer but this is pretty immaterial (pun intended) as the loose soft part would have long since junked your engine as it blocks both screens. Without the screens it will cost you a new rad.

“How do I know this? Don't ask, but we astonished ourselves and changed the offending gasket in 35 mins and won the race. The other gasket was done later at a more leisurely pace.”

FIDDLING WITH THE TIMING CHAIN: If, for some reason, your timing chain isn't sitting on the sprocket on the holding bracket when you put the head on, David Johnson says, “if you have already installed cam, be sure that you take the moment and hook the cam chain over the bracket meant to hang sprocket on. I looked at it and told myself, "Why bother? I can simply reach down there and pull it up." Ain't so. The flange and bracket are just this much too close to squeeze the chain through.”

CYLINDER HEAD NUTS/WASHERS: The thick washers under the 7/16” nuts are quite suitable for the job, and the thin washers under the 3/8” nuts under the intake ports seem to work well enough. The same thin washers used under the 3/8” nuts along the exhaust manifold edge of the head don't cut the mustard, though. They are likely to be “dished” where the nut has been pressing them down into the soft aluminum of the head. The implication: as the washers distort and the local area of the head is dished, the tension on the stud is relaxed, reducing compression on the head gasket and increasing the chances of a head gasket failure.

To improve this situation, one of three tactics is recommended: Replace the washers with thicker washers; replace the nuts with washer-face nuts that will contact the original washer across most of its surface; or -- as a minimum fix -- install two washers under each nut. CarQuest auto parts (and undoubtedly some other better auto parts shops, but notably *not* some of the discount or bargain auto parts stores) offers a Dorman “manifold stud washer” number 685-050

which is quite suitable for this task. Note that these washers are not found on a bubble card on a rack, but rather in a case of heavy red and black metal drawers that form the Dorman display -- often found behind the counter. Look in the drawer labelled "manifold studs". This washer is about 1/8" thick (like the washers under the 7/16" nuts), fits very snugly around the 3/8" stud, and has a somewhat larger OD than the flimsy original washer.

With these washers under the original nuts, you can actually feel the difference as you're torquing them up. It feels much more solid, attaining the specified torque promptly and securely, rather than feeling mushy.

TORQUING THE CYLINDER HEAD NUTS: The nuts holding the heads to the block, as in other engines, require careful torquing in progression to ensure proper sealing of the head gasket. However, there are two groups of head nuts on the Jaguar V12 that cannot be tightened with a socket on the end of an extension, meaning they are difficult to use a torque wrench on. One such group of nuts is the row of 9/16" nuts on 3/8" studs along the top edge of each head, within the vee; these are underneath the intake ports. The other group is the row of 11/16" domed nuts on 7/16" studs just under the tappet block on each side; these would be a snap if you were torquing the head nuts without the tappet block on there, but with the tappet block in place you can't get the socket over the nut.

This job calls for a tool called a crowfoot (or crow's foot) wrench. This tool looks like just the business end portion of a wrench with a square drive hole for attachment of a ratchet and extension. Since they are useful tools anyway and come in handy in other hard-to-reach places, it is recommended an entire SAE or Imperial set be purchased. If you wish to buy only the crowfoot wrenches you need for this job, Sears sells crowfoot wrenches individually. The nut and stud sizes mentioned above were apparently maintained throughout the life of the Jaguar V12, even when many of the other fasteners on the engine switched to metric.

There are actually at least three different types of crowfoot wrenches, so you might want to consider your choices before buying. The most common type looks like the business end portion of an open end wrench, so it can be slid onto the nut from the side. It operates on only two corners of the nut. The head area must be made fairly broad (like any open-end wrench) in order to give it adequate strength to prevent it from spreading and rounding off the nut under torque. Sears Craftsman crowfoot wrenches are this type.

David Johnson suggests that, if you can find a set, buy box end crowfoot wrenches, since the torque applied to the 3/8" head nuts threatens to spread the 9/16" open end crowfoot and round the corners of the nut. "Mine are from Snap On." He's right about the threat; this author used an open end set successfully, but there was clearly very little strength to spare. Box end crowfoot wrenches (like other box end wrenches) cannot go on a nut from the side, they must come down on top.

The third type crowfoot available is halfway between the open end and box end; they look like the business end of a "flare nut wrench". In other words, they look like the end of a box end wrench that someone has cut a slot through at the end. It looks like the crow was pigeon-toed; maybe they should be called pigeonfoot wrenches! They cannot go on a nut from the side, but they *can* go onto a bolt (or metal brake line) from the side and *then* come down on the nut from above. Most such wrenches are "six point", meaning they have five points -- the slot takes away one of the six points, so this type wrench operates on five corners of the nut.

There is another functional difference between the open-end style crowfoot and the flare nut style. The open end style is symmetrical when looked down on from above; if you flipped it over, it wouldn't make any difference (except for a raised area where the square drive attaches). So, you will need to have enough room to turn the nut 60° at a time, slide the wrench off and move it back to the next flat and go again. But the flare nut style, despite being a six-point style, offers another option. The square drive attachment is 30° off one flat of the hex, so if you can't turn the nut the full 60°, you can take the crowfoot off the end of the square drive extension, flip it over, and turn the nut the next 30°. That would make for a long, slow job of tightening a nut, but it'd be better than being unable to tighten it at all.

Finally, one more functional difference worth noting. The open end type of crowfoot wrench, like an open end wrench, can be used while held tilted a bit upward or downward from square on the nut. Since they only contact on two opposite flats, they can withstand a considerable amount of misalignment during use. With a crowfoot, this means that you don't need to be holding the ratchet extension perfectly parallel to the centerline of the bolt or nut, but you can tilt it away from that centerline or towards it a little bit. The box end or flare nut types of crowfoot, on the other hand, fit

very securely on a hex. If misaligned, you won't even get it on. This can be a blessing or a curse depending on what you're doing, but mark my words, whichever type you get you will eventually find a situation where you wish you had the other.

Although listed third here, the flare nut style crowfoot wrenches are perhaps easier to find than the box end style. John Robison says, "Here is the link for the set I bought..."

<http://www.tools-plus.com/hand-tools-pliers-wrenches-wrenches-crow-foot.html>

J. C. Whitney (page 694) offers both open end and flare nut style crowfoot wrenches in SAE or metric sets -- for about \$10 a set! Really high quality stuff, obviously.

When using crowfoot wrenches in conjunction with a torque wrench, the crowfoot should always be attached to form a 90° angle with the handle of the torque wrench. The effective lever length of the torque wrench (distance from the handle to the centerline of the bolt or nut being torqued) is not changed. If the crowfoot is attached in line with the handle, the lever length is altered, and the torque readings will be inaccurate.

For some reason, some people have arrived at the conclusion that extensions make a difference in torque wrench readings. They do not; use whatever extensions you need to get the job done. Swivel joints *can* make a difference in torque readings; if you absolutely have to use a swivel joint with a torque wrench, at least attempt to hold it as straight as possible.

With the 11/16" domed nuts under the tappet block, the box end and the flare nut type crowfoot wrench may cause trouble. The problem at this spot is that the domed nut is tall and comes up pretty close to the surface of the tappet block. Since these two types of wrench have to go over the nut to get on, they must be thin enough to fit between the nut and the tappet block at that point. Craig Sawyers bought an expensive flare nut type -- actually a 12-point flare nut type -- that didn't work. By lining up the gap at the end, he could get it on, but as soon as he turned the nut he effectively trapped the tool; it wouldn't come off. "If you get one flat of turn on it, it won't come off the nut. If you back it off slightly so that it clears the nut, you can't get it back on for the next turn. Britool AFC687... This beast is 0.525" thick, and the diameter of the surround to the socket part is 1.275". The open end is 0.57" wide and parallel. And it is 12-point and was not cheap - I bought this sucker to do up those 11/16" nuts under the tappet block, and was not pleased when it didn't work out."

Sawyers found an alternative to the crowfoot wrench for the 11/16" domed nuts: "I ended up getting a friend with a lathe to turn a shoulder on a standard socket so that it would snug under the tappet block. Worked a treat." Of course, cutting on that fancy crowfoot probably would have worked, too, but the socket was cheaper -- and since it worked, the socket was arguably preferable to the crowfoot for this job. In fact, if you plan to retorque these nuts later, you'll find this modified socket *vastly* preferable. Basically, Sawyers machined the square drive end of the socket down to about as small as he could get it, leaving the large diameter portion as short as possible. "The part around the socket, 0.935" diameter (ie, as supplied) and 0.7" to the turned shoulder. The turned down part (where the 3/8" drive fits) is 0.67" diameter and 0.49" long from the shoulder to the top." Note that the 0.7" dimension is what's critical, and the maximum that will work may actually vary a bit from car to car. If you start with a socket that is too tall, you won't be able to cut the shoulder that far down without cutting the socket in half -- but you can shorten it up by simply grinding off the end of the socket until it goes on.

There are also problems using a crowfoot on the 9/16" nuts. These nuts sit in a ledge cut into the head, but Jaguar didn't cut the ledge any deeper than they had to. There's very little clearance between the points of the nut itself and the machined surface behind it. This is part of the reason the open end crowfoot threatens to spread; if you put the crowfoot all the way onto the nut, you can't turn it very far before the wrench runs hard against that machined surface, so instead you pull the crowfoot back a little and tighten the nut with the tips of the crowfoot. Using a box end, as Johnson recommends, will mean it needs to wrap all the way around that nut and therefore must be pretty thin-walled -- but box ends are generally pretty thin-walled, especially from companies like Snap-On. The flare nut style may have more troubles, since the claws of the crowfoot have to be beefier to make up for the loss of strength that comes from opening a gap at the end, and so may have trouble turning without jamming against the machined surface. It may be possible to use either box end or flare nut style crowfoot wrenches by fitting them to the upper half of the nut only, staying above the surrounding metal of the head; since they're grabbing 5 or 6 points they should still be able to apply

adequate torque. Results may vary from casting to casting.

One other solution may be to replace the nuts with new nuts with the same thread but a smaller hex. Make sure they're Grade 8 or equivalent; you don't want cheap, soft steel nuts here.

Martin Karo: "Better than the crowfoot solution, Hazet makes a tool for precisely this purpose. It has 12-point box at one end; the shank is then bent vertically 90 degrees, and runs up 6 to 8 inches, depending on the size; then another 90 degree bend brings the shank back over the box end, and a 3/8" square drive hole is bored in, directly over the box end. This clears over-nut obstructions, and the torque values are correct no matter what the wrench angle. I rented one the last time I replaced a cylinder head, and it worked great. To buy, however, I dunno... if it's a Hazet, you can be sure it ain't cheap."

You could, of course, *make* a wrench that fits Karo's description. Find a box end wrench that fits the nut, and heat it up and bend it 90° straight up. Cut the other end off and weld on a socket, any socket, to provide a square drive connection.

The purpose of torquing head nuts to a specified value is to obtain a certain amount of tension on the studs themselves. Whether or not the threads on the nuts are lubricated makes a *huge* difference in how much tension results from a given torque, as does whether or not the contact between the nut and the steel washer it sits on is lubricated. Unfortunately, the manuals are not as clear as they might be on whether or not the specified torque is intended to mean with or without lubrication. In its section on General Fitting Instructions, the ROM does say "Always oil thread lightly before tightening to ensure a free running thread, except in the case of self-locking nuts." This makes sense, since tension obtained from lubricated threads is more consistent than from non-lubricated threads; if the threads aren't lubricated, there's no telling how much tension you'll end up with. There seems to be little or no official guidance for lubricating the washer face, though.

This author recommends you lubricate the head stud threads with anti-seize compound; this may not sound like oiling lightly, but the amount of friction in the threads when installing should be comparable. Plus, the anti-seize compound will ensure the threads are not damaged when retorquing or removing the nuts later on.

This author also recommends you apply a non-hardening sealant to the contact areas between the washer and the head and between the nut and the washer on the 7/16" studs *only*. On ten of the fourteen 7/16" studs per head, these contact areas seal the coolant circuit; that's why these nuts are cap nuts, since coolant can't leak through the threads on a cap nut (and you thought Jaguar used cap nuts to make it pretty!). While not originally intended as a lubricant, the sealant will provide a fairly consistent amount of friction between the nut and the washer and therefore a consistent application of tension to the stud. By using a non-hardening sealant, you hopefully leave open the possibility of retorquing later on -- although presumably you could retorque by removing the nut completely, applying fresh sealant, and reinstalling.

On the 3/8" studs, apply anti-seize compound between the washer and the nut. You can leave the contact surface between the washer and the head dry, apply sealant, apply anti-seize compound, whatever, it shouldn't make any difference.

Needless to say, if any of the threads on studs or nuts are boogered up enough that the nut won't spin on freely, they must be cleaned up or replaced before torquing.

When torquing down the nuts, aim for the low end of the spec range, and be alert for signs of stud yielding: the nut continues to turn without the torque increasing any more. If the specified torque is attained in a smooth and progressive manner, there is nothing else to worry about; the head is on and secure, and there is sufficient tension on the studs to make sure the head gasket will remain sealed. On the other hand, if either the threads or the washer face is assembled dry, you won't know how much of your tightening torque was lost there, so you won't know just how much tension actually got applied to the stud -- and therefore you won't know how long your head gasket is going to last.

Engine Work -- Front

CRANKSHAFT DAMPER/PULLEY REMOVAL: First note that, contrary to the repair manuals, it is *not* necessary to remove the crank pulley to get the water pump off.

Also note that what looks like a bolt head in the center of the crank pulley is actually a hex fixture for turning the engine by hand. Two smaller bolts must be removed to remove this hex, and the real pulley retaining bolt is underneath. Then one more note: Since you already have the belts loose or off, you can remove two more small bolts and remove the pulley from the crank damper entirely. This provides much better access to the big crank damper bolt so you can use a box end wrench or some such.

What size wrench fits that bolt head? Craig Sawyers: "That damned thread is a 7/8 inch BSF. The AF measurement is 1.300 inches for that thread. I got a 7/8 BSF, 3/4 Whitworth socket to do the job." See page 26 for more info on Whitworth/BSF, including ideas on finding tools.

If you can find a 33mm socket, it'll fit perfectly. Unfortunately, even numbers are the standard in larger sizes, so it's pretty hard to find anything closer than 32mm or 34mm. Hard, but not impossible; Jan Wikström says, "I have a cheap Taiwanese socket set from the flea market; it has every mm size from 12 to 35. There are far more sockets than the ISO standard sizes, but the odd ones can come in handy."

Bob Christie says you can get 33mm sockets from MSC.

Apparently 33mm is a common size for truck lug nuts, so that's another avenue of pursuit.

You might want to avoid the smaller drive sizes here. Robert Warnicke says, "I broke two 1/2" drives before I finally removed the bolt with a pipe wrench."

If nothing else works, you can use a file or grinder on the hex to make a 1-1/4" or 32mm socket fit. You can just use a big adjustable wrench (or Warnicke's favorite, the pipe wrench) to get it loose, but you will still need to find a socket that fits to carefully torque it during reassembly -- which is of considerable importance, as described in the discussion of key failures below.

To loosen and retighten the bolt, it is necessary to hold the crank still. You can remove the starter to jam the flywheel, but that is definitely the hard way. An easier way would be to use the access hole on the left side of the engine, the one with a rubber plug and intended to provide access to the torque convertor mounting bolts. Michael Neal provides an even simpler access: Just remove the cover from the bottom of the torque convertor housing.

Of course, on *my* car I can just put it in 5th gear with the emergency brake on!

Matthias Fouquet-Lapar suggests: "Once you have removed the upper part of the pulley (the one which drives 3 belts), you can easily use its 2 screws to attach a home-made bar on the damper." This is perhaps the best method of all, since pulling this lever and the torque wrench together works really well when trying to carefully torque that bolt up on installation.

Besides holding the crank still, there's also the problem of getting the bolt loose. One idea that solves *both* problems would be to use an impact wrench -- the way an impact wrench works, the inertia of the crank is all that's necessary to hold it still. But there's not enough room in the car to use an impact wrench, so that will require either pulling the radiator or the engine.

Shane Mantoszko says "use a good long-handled socket/torsion wrench, put it on the front crank nut, brace it on a strong part of the engine bay, disconnect the coil, and then turn your ignition key for a few quick bursts, and viola, the crank nut will be loose..."

Dale Knaus says, "I used what we call a "slug wrench". It is a box end wrench made extra heavy with a striking pad on the other end. It is made to hit with a hammer to tighten and remove nuts. I borrowed the tool from the industrial plant where I work; they are probably available from industrial tool supply companies."

Regardless of how well these methods may work getting the bolt loose, remember that you'll still need to deal with

reinstallation. Since the bolt torque is critical, you'll definitely need a suitable torque wrench and socket and you'll probably need that restraining lever Fouquet-Lapar suggests. All that being true, you might as well go ahead and acquire those items and see if they'll get the bolt off to begin with.

CRANKSHAFT PULLEY - SHEARED WOODRUFF KEY: Paul Konitshek, Michael Neal and several others report that the woodruff keys that align the crankshaft damper/pulley are a known problem area. The keys may become worn or totally sheared, allowing the pulley to reposition itself around the crank.

The immediate effect of this slippage depends on which ignition system you have. If you have a pre-1989 car with Lucas ignition, you might not even notice unless things get really bad and start chewing up parts. Neal reports: "It almost never gets to the point where the pulley comes loose." If it merely slips, it usually won't become apparent until you try to set the ignition timing; the timing marks are now completely wrong, so you'll get really confused. If you have the later Marelli ignition system, the damper slipping will immediately screw up the ignition timing since the sensors are on that damper.

Note that there are two keys used. There is a "split cone" that is similar to those used on industrial pulleys. The pulley fits onto the outside tapered surface of the cone and is aligned with one key. The cone slides over the crank and is aligned with another key. When the bolt securing the pulley is tightened to specification, the split cone compresses securely onto the crank like a collet in a chuck.

Roger Bywater, who was in charge of belt drives for the V12 at Jaguar at one time, explains: "The purpose of the keyway is purely for location and accurate alignment during assembly. In almost all assemblies of this type the key is not intended to transmit any torque, indeed it is not strong enough, the friction of the tightened joint is meant to do that. There must always be some clearance around the key so if the joint comes loose torsional vibes will always fret and destroy the keyway. Many later engines do not have keyways anywhere, relying only on friction. The Jaguar V8 camshafts are typical with the timing sprockets just placed on the end, timing marks all lined up, and nipped up very tight with a central bolt - that's it. If they come loose the sprocket can just spin round - only it never happens.

"The answer is to make sure the friction inside and outside the cone cannot fail so the bolt needs to be tight to the point of yield to keep the whole assembly under tension. Possibly the bolt tightening figure is marginal at the lower tolerance quoted of 125 ft-lbs so maybe the top figure of 150 ft-lbs should be the rule. In fact the AJ6 manual quotes 203 Newton Metres (with no tolerance) which equates to 150 ft-lbs for the same size bolt which seems to support this view." Note that the threads need to be "lightly lubricated" for the torque readings to be anywhere near correct; this author recommends anti-seize compound, which will also help get it apart next time.

If the torque is supposed to be transmitted via friction between crank and cone and between cone and damper, obviously it'd be a good idea not to put any anti-seize compound on those mating surfaces. In fact, you might want to be careful there's no oil on them -- although hopefully it'd get squeezed out while torquing.

So, if the torque is supposed to be transmitted via friction, how come the Jaguar V12 has a history of key failures here? Neal: "It seems only to happen if water has gotten into the nosecone on the crank. The area is always very rusty when the front pulley is removed. The woodruff key is either broken or eroded away from the rust." Of course, this area is exposed to the elements, there's no keeping water out of it; whether or not these parts rust probably depends on whether the crank seal is keeping them well oiled. Perhaps they *all* rust, and Neal only notices the ones that have sheared keys are rusty because those are the ones he has to work on.

The failure history could be because the engineers at Jaguar screwed up, either underestimating how much torque this joint would need to transmit or overestimating how much torque the joint could handle. However, it's entirely possible that most or all of these failures came from somebody not torquing that damper bolt down adequately. Even presuming they were torqued correctly at the factory (!), mechanics are always fiddling around in this area -- such as when replacing a leaky crank seal. Perhaps some of the mechanics are not being as meticulous as they should be in applying full torque during reassembly. Take a lesson: make *very* sure you torque that bolt properly! Just zipping it on with an impact wrench is unacceptable.

Neal: "In some cases the slot in the crank is widened a bit but a new key usually secures it substantially." If the crank

has been boogered up too much by the damper slipping, of course you have to install a new crank. Yeah, right. Even Bywater himself reassembled an engine with a damaged keyway in one of his AJ6 development cars by “drilling and pegging” the split cone during installation. “Obviously loctite or similar would create difficulties in any future strip down so if everything is clean and in good order and fully tight there should be no need for it. Where things are less than perfect then pragmatism must rule.” It might help if you file the high points off the gouges on the crank and use a new split cone.

CRANKSHAFT PULLEY - GETTING THE KEY OUT: Sometimes the keys won’t come out, notably the key on the crank itself. Suggestions include using a pair of angle cutters to grab it and walk it upwards, and using a suitable chisel to cut under the key to pry it out. The suitable chisel needs to be a hair narrower than the key, and can be made from old lathe bits or “cut nails”. Cut nails are made from flat stock, giving them a sort of trapezoidal shape, and are really hard for pounding into masonry. Greg Guillaume: “Here’s what I did: Get a 1” chisel, lay it on the crank, perpendicular to the crank, up against the key. Then whack away with a hammer on the opposite side of the chisel. The shape of the chisel is just right so it bites into the key, the 1” width hangs over the end of the crank, and you get a lot of room to swing the hammer. Of course, the chisel is a little beat up, but it worked great.”

CRANKSHAFT PULLEY - SPLIT CONE PROBLEMS: Dan Jensen says, “The split cone was broken in three places. Rather than pay \$\$ for a replacement, I just stuck it back into the damper/pulley with Hylomar sealant and gently replaced it. It centered properly and has worked great for 35K miles.”

CRANKSHAFT PULLEY - RUBBER DAMPER PROBLEMS: Chris Yewdall owns a ’91 convertible, and started having noise when operating the roof. “When lowering the roof with the engine running, a squealing noise is heard from under the hood until the roof is fully lowered. After a few more months/miles the squeal happens most times you start the car for a few minutes until the revs build up as you drive away. Eventually, the voltage on the battery charge gauge on the dashboard drops to 12V (about 1/4 of the way up the gauge) and the battery goes flat. Occasionally, the alternator will charge normally or just below normal, particularly on a freeway journey.”

Sounds sorta like a loose belt problem, but it wasn’t. After wasting too much money on things like an alternator rebuild, the problem turned out to be the crank damper itself. When he got the failed part back from the mechanic, he reported on it: “On inspection, it is the bond between the inner pulley (which keys onto the crankshaft) and the rubber damper which has failed since the inner pulley rotates freely on the inner surface of the damper. The rubber has hardened to the point where it has cracked in lines between the inner and outer pulley. It feels more like bakelite or plastic and has no flex at all. Believe me, it’s not hard to spin the outer by hand.” The other three belts are driven by rigidly-mounted pulleys but the alternator belt is driven directly from the outer ring of the crank damper, so this rubber breaking loose causes drive problems for the alternator. A heavy alternator load, such as operating a convertible top, aggravates the problem.

If you’re having trouble confirming if your damper has sheared, put a mark on the center portion and a mark in line with it on the outer portion. Run the car for a while, then shut it off and check the marks. If they are no longer aligned, you need a new damper.

Interestingly, this type failure was apparently unknown on the earlier cars with Lucas alternators driven by V-belts. Those cars also had Lucas ignition systems, and the timing marks for setting the ignition timing were on the outside edge of the crank damper. As a result, such a slippage between the inner and outer portions of the damper would have made correct timing impossible. Most of the cars with the later Bosch 115-amp alternators and ribbed belts (see page 574) also have Marelli ignition, and the timing is not adjustable -- but is established by a pickup at the front damper. This pickup senses trigger points attached to the inside portion of the damper, so they are unaffected by slipping of the outer ring and the engine runs normally.

It’s easy to blame these damper failures on the higher loads imposed by the 115-amp alternator or even on some change in build quality between the V-belt dampers and the multi-groove dampers, but there is one more possible cause for

these failures. As described on page 574, there is a flaw in multi-groove pulley design that results in them slipping and squealing even when the belt is tight. Obviously, most mechanics will address a squealing problem by tightening the belt -- and since that won't fix this problem, they may respond by tightening the bejeezus out of it. An overtightened belt applies a considerable radial load on the rubber portion of that damper, and this load cycles around the damper as the crank rotates. It would be logical to assume that such a cyclic load could rip that rubber loose from the metal in a fairly short while. All owners of Bosch alternators are advised to have that alternator pulley modified at the next convenient opportunity, and then adjust the belt to a reasonable state of tension.

FRONT OIL SEAL REPLACEMENT: Peter Cohen points out that the Jaguar repair manual's procedure for replacing the front oil seal involves removing the radiator -- which, in turn, supposedly requires depressurizing the A/C freon circuit. Boy, I hope you read this first! Depressurizing the freon circuit is totally unnecessary to get the radiator out (see page 197), and if you don't mind working in tight quarters, taking the radiator out is unnecessary to change the front oil seal. Matthias Fouquet-Lapar says, "I've done this in my garage without pulling the radiator. Once all the belt-driven hardware is removed, there is enough space. I did not even take out the fan shroud." Brian Sherwood says, "I replaced mine without pulling the radiator -- not very convenient, but possible. The most difficult parts were: 1. removing the old seal (finally had to prick a small hole in it, and screwed in a sheet metal screw to pull on), and 2. getting the pulley bolts thru the lock plate, pulley, and into the crank damper -- can't see these at all, have to do by feel."

Tom Amlie had trouble getting the new seal installed in tight quarters. "If I kept trying to do it like the books said, I would still be at it. Book says to tap the new seal in. Not possible. Go to Home Depot or similar and get a PVC drain pipe fitting (reducer) to fit the seal. Carve on it until it works. Then use that huge bolt that holds the pulley/damper to push it in. Works like a charm."

When you buy the front seal from Jaguar, you get the seal and the spacer sleeve it rides on in one box; this may be a recent development, apparently a new part number has been issued. Matthias Fouquet-Lapar says, "The new part at least includes the spacer. The part number is JLM 10613." However, if you buy a generic seal somewhere else (or maybe older stock from Jaguar), you'll probably get just the seal. You can look at the condition of your sleeve and see if you think this will cause a problem. Peter Smith says, "If the spacer appears worn it can simply be reversed on refitting because the seal does not ride at the half way point. The new seal will then ride on an unworn part of the spacer." Whatever, you will want to take the sleeve out, because the proper order of assembly is to install the seal and *then* install the sleeve.

You might also consider putting some sealant between the crank and the spacer prior to installation to prevent oil from travelling between the crank and the sleeve and leaking out the splits in the split cone under the pulley. There are no reports of leaks along this path, but if it did leak people would think it was the front seal, so who knows? Maybe it's a common leak!

Cohen adds, "When I did my front seal 7 years ago, the collar that came with the seal had to be tapped into place, even though the old one slid right off. The dealer assured me that that's normal, they loosen up with time. This is not true. I had to drive the collar off after 7 years and 70,000 miles. It's a good thing the timing cover was off, because I don't know if I could have gotten a grip on it from the front." Who knows, maybe Jaguar figured out how the oil was leaking out so new seals come with a coating on the inside of the sleeve to seal it.

Also of note, illustrations in the repair manual indicate that the sleeve has a keyway, but according to Alex Dorne they lie; "The sleeve is not keyed."

V-BELTS: Most V-belts are available in either solid or notched varieties. There is no appreciable difference in strength, since the strength of all V-belts comes from a layer of cord unaffected by notches. The cord is in the outside edge, making that part stiff to force the softer, inner portion of the belt into the groove in the pulley.

The notches in the inner surface help the V-belt flex, and are beneficial when the belt must turn around a small pulley. It is therefore recommended that a notched V-belt always be used for the alternator belt on the XJ-S.

The notches in a belt can cause noise. For this reason, most V-belts use an unevenly-spaced series of notches rather than

evenly-spaced because an uneven spacing eliminates whine. For the same reason, cooling fans have unequally spaced blades and tires have unequally spaced tread patterns.

POWER STEERING PUMP INSTALLATION: Jim Isbell points out that the bolt holding the belt tensioner to the power steering pump should be installed from the rear to the front. “The bolt, if put in from the back with the nut end toward the radiator can be removed with the pulley in place. If put in backwards it cannot be removed with the pulley in place.”

FAN BELT IDLER PULLEY INSTALLATION: Jim Isbell says: “The bolt that connects the adjuster screw to the idler pulley must be put in from the back with the nut toward the radiator. If this is put in backwards the adjustment range of the idler is greatly reduced.”

TIMING COVER REMOVAL: If you want to remove the timing cover to replace the front oil seal, don't waste your time; the front oil seal presses in from the outside, and Jaguar even provided some prying slots for removing the old one. See the info on seal replacement on page 92.

If you do need to remove the timing cover, Section 12.65.01 of the ROM lists 13 steps, the first two of which are as follows:

1. Remove engine and gearbox assembly from the car.
2. Remove cylinder heads from the engine.

Fortunately, there is an alternate method. To remove the timing cover with the engine still in the car and the heads in place, proceed as follows:

1. Remove the belts, fan and its mounting bracket, A/C compressor front bracket, and all the other ancillary stuff in the way.
2. Remove the front crank pulley -- see page 89.
3. There are three studs threaded into the timing cover that protrude upward through the front edge of each head. Remove the nuts and washers, then grab the studs with a pair of Vice-Grip pliers and unscrew them. Note: Some of the studs are trapped and cannot be removed; once these are unscrewed, merely retain them (with duct tape) in a raised position while the cover is being removed. Once the cover is off, they can be removed.
4. Remove the retaining bolts holding the timing cover to the block.
5. The timing cover is essentially pinched between the heads and the sandwich plate. Michael Neal, who is a Jaguar mechanic and uses this method regularly, says “I loosen as many of the sandwich plate bolts near the front as possible. I believe it works out to about 4 or 5 back, going between the subframe and the motor. I then use a Snap-On medium sized ladyfoot prybar and go in the hole where the oil cooler adapter bolts onto the sandwich plate. I pry against the bottom of the tube that the adapter goes into and the inside of the sandwich plate. This pulls down the right front corner of the sandwich plate and allows some space for the timing cover to move. The prybar over-centers and locates itself while holding the plate down. It is very important not to pull down too far. The bolt holes are very prone to cracking and the break will spread out toward the center of the sandwich plate.” See page 97 if you wish to remove the sandwich plate entirely.
6. **REASSEMBLY:** Since your studs were all boogered up by the Vice-Grips, buy new studs with the same threads but longer. Saw or grind them off until they are 1/4" longer than the originals. Then, grind flats on this 1/4" to ease the reinstallation and any future disassembly. Be sure to clean up the threads so the nuts go on easily. Remember to slide the trapped studs in place before installing the

timing cover. Be sure to use anti-seize compound on all studs.

7. Before reassembly, carefully trim the timing cover gaskets flush with the upper corner of the timing cover.
8. Since the head gaskets are not being replaced, it is a good idea to apply some sealant to the bottom of them to help them seal against the timing cover. The only stress on this portion of the head gasket is a slight crankcase vacuum; the integrity of the head/block seal is unaffected. Make sure to apply sealant in the corner of the two mating surfaces.
9. Neal provides this tip for getting the timing cover back in between the heads and sandwich plate: “On reassembly I use sheets of .003” shim stock on the upper surface of the sandwich plate gasket and the underside of the front of the head gaskets. You have to trim the stuff to clear, but it prevents damage to the gaskets and lets the timing cover slide back in easily. The head gaskets are...very prone to wrinkling if you don’t use the shim stock pieces to slide the cover back in.”
10. When threading the new timing cover-to-head studs into place, remember there is no reason to tighten them into the timing cover. As long as they have been threaded in several turns, the nuts will torque properly. Tightening the studs into the timing cover merely makes them harder to remove next time.
11. During reassembly, progressively tighten the timing cover bolts along with the nuts on the studs. The cover must be brought up against the heads as it’s being pulled against the block. Tightening one set before the others will cause leaks.

Note that if the engine is still in the car but the heads are off for some other reason, the timing cover should be removable without too much additional trouble, basically following the rest of the steps in the repair manual and skipping step 5 above. Hence, you might consider going ahead with removing it, replacing the chain and tensioner, checking out the oil pump, etc., depending on the age and wear on the engine. You might also consider installing the longer studs as described in step 6 above while you’re there.

TIMING CHAIN DAMPENERS: These are the steel plates mounted alongside the chain along several of the straight sections between sprockets. The Haynes manual, Chapter 1, Section 42, Step 5, suggests using quick-drying paint to mark their locations before removal. Craig Sawyers says, “Nice idea, but no dice. Have a look at the bare block and you will see that the dampers fit onto raised bosses. There is no accessible metal to either paint or scribe a line on to show the original position of the dampers.”

If you move them, the use of an elaborate (and undoubtedly expensive) special tool JD.38 is required to properly position them. Advice: Don’t move them!

You already moved them? Sorry, at present I can offer no help. I am including this section to describe what they are and how they work.

A roller chain is a fairly decent and reliable drive mechanism at low speed. However, 6500 RPM is another story; at higher speeds, chains can whip, flutter, buzz, and otherwise dance around their path around the sprockets. At certain resonances, a chain whipping back and forth can cause very high tension stresses, resulting in damage to the chain, sprockets, camshaft bearings and tensioner.

These plates are designed to prevent this. If the chain is moving smoothly and along a straight line like it should, it shouldn’t even touch the plates. But if it starts to whip, it hits a plate -- which absorbs the energy of the whip, and allows the chain to return to a calm motion.

Based on this theory, it would be logical to assume we could just bolt the plates on so that they are immediately adjacent to the chain without touching it. There are a couple problems with this plan. First, if you follow the official Jaguar assembly order, the plates must be installed and the timing cover bolted up before the heads are installed, so having the chain in place -- meaning the tappet blocks, camshafts, and camshaft drive sprockets in position -- is not possible. Of course, you could always trial fit the heads, tappet blocks, camshafts, sprockets, and timing chain in order to set the plate positions, then tear it all apart again.

On page 93 I describe how to remove the timing cover with the heads on and therefore there may be an opportunity to adjust the dampers with the chain in place -- although it may be a rare case when the plates need to be positioned but the heads *don't* need to come off.

The second problem is that I'm really not providing enough information for proper positioning. I'm only providing the theory; presumably, during development of this engine, the optimum positions of these plates were precisely determined, and they may be far more critical than simply "close to the chain without touching it." Improper positioning of these damper plates could be catastrophic, causing a broken timing chain which in turn causes pistons to impact valves in open position. You see, the real purpose of this section is not to save you effort; it's to discourage you from assuming the position of these plates is unimportant, skipping important steps, and causing yourself a great deal of heartache down the road.

TIMING CHAIN REPLACEMENT: The timing chain in the Jaguar V12 is a conventional double-row roller chain. Typically, the wear on chains of this type is much more significant than on the sprockets, and usually the chain can be replaced without replacing the sprockets. This is in sharp contrast to the "silent" timing chains used in many American V-8's, where it is customary to replace the timing chain and sprockets as a set.

Another characteristic of typical roller chains is that wear on the sprockets increases with the use of worn chains; if the chain is renewed regularly, the sprockets can last almost indefinitely. The Jaguar timing chain is so cheap that it is recommended that it be replaced whenever the engine is disassembled far enough to do so. The sprockets are so expensive that you will want to do whatever it takes to keep from having to replace them.

In general, the sprockets don't need replacing unless an inspection shows signs of serious wear -- one side of each tooth looks different than the other side.

Per Jan Wikström, "According to a Reynolds chain handbook that I mislaid some time back in the seventies, so my memory may be slightly off here, the way to determine whether a sprocket warrants replacement is to hang the new chain over the sprocket and apply a strong pull (that's an Imperial strong pull, not a US strong pull!) in the normal drive direction. If more than three links ride up noticeably on the teeth, the sprocket is too worn."

Once you've decided to replace the chain, the next question is whether to pay Jaguar prices or simply drop into an industrial supply store and buy generic chain. You don't want cheap chain, that's for sure -- but most industrial supply stores actually carry really good chain, probably as good or better than the chain sold through Jaguar. Many of these stores will also happily explain to you why you want a good chain rather than a cheap one and perhaps even show you examples of each.

When ordering a chain from some parts houses, the chain they offer is a length of generic industrial chain and a master link to put the ends together. This leads many owners to question whether they want to do this or pay for the Jaguar part which is a loop without a master. Those aren't the only choices, actually; if you think a master link is a problem, that same industrial supply store will offer to make the loop for you. They have the special tool on hand to properly roll the end of a pin over to make the chain into an uninterrupted loop. And this will still save you perhaps 2/3 of the cost of the Jaguar part. Remember, Jaguar isn't fabricating custom chain for this application; the chain they sell was purchased from an industrial supplier and made into loops.

Some argue that having a master link is a real problem, as though they are weak or some such. They are not weak; they are typically stronger than the other links. They do, however, have some history in motorcycle applications of failing catastrophically. This isn't because they're weak but rather because they can be taken apart; whatever clip or cotter pin is used to hold them together can come out and cause the master link to fall out. This is especially a concern on a motorcycle where running over some brush might knock the clip loose on a master link. There's also the concern that some motorcycle mechanics are meatheads who can't figure out how to get the clip on the master link securely.

Of course, there is little chance of foreign interference in a master link inside the Jaguar V12 block. If you are offered a chain with master link, simply look over the retention scheme. If it looks like something you could get together and trust that it won't fall apart at 6500 rpm, go with it; don't worry that it's somehow not as strong as the other links. If it looks like something that might come apart, consider having the chain permanently made into a loop at the shop rather

than risk fiddling with the master link.

Some master links are held together with a clip that slides over one pin and snaps onto the other. There's no known history of these coming loose, but the fact that they involve a groove around the end of both pins suggests a possible improvement: you can simply discard the single clip and install two tiny E-ring clips instead, one on each pin. There's little chance that an E-ring clip would come off in use, and both of them would have to come off before the chain breaks. They are prone to getting dropped during installation, though, so be sure to tie a thread to each one before installing.

Of course, you need to find the correct size chain. Tony Bryant says, "One possible gotcha is the old Brit vs US standard thing. It appears there are two standards for 3/8" duplex chain: BS288/ISO606/DIN8187 and ANSIB29.1/ISO606a. The differences are subtle but probably serious. From the Reynolds chain book, the differences are (BS vs ANSI):

Roller width (i.e. between the inside plates) 5.72mm vs 4.68mm

Roller dia 6.35mm vs 5.08mm

Plate height 8.26mm vs 8.66mm

Plate outer width 1.04mm vs 1.3mm

Pin dia 3.28mm vs 3.59mm

Pin length 23.8mm vs 25.65mm

Breaking force 18500N vs 20000N

"So make sure you get the right chain, or I'm guessing very bad things™ will happen."

It's possible to replace the chain by removing only the right side cam cover and without bothering the timing cover at all, but this requires the use of a master link -- if contemplating, make sure the chain you purchase isn't already formed into a loop. Retract the tensioner, then break the old chain on the top of the cam sprocket (grind the end off two pins and slide a link out) and connect the new chain to the end of the old one with the master link. Have someone turn the crankshaft slowly while you feed the new chain in and the old chain out, being sure to keep the cam sprocket engaged at all times. When the master link comes around again, disconnect the old chain and connect the new chain back to itself.

It is highly recommended that the latch on the timing chain tensioner be rocked after, or preferably during, this timing chain replacement on the chance that the new chain is significantly shorter than the old worn one was and therefore the tensioner needs to back up a bit to allow it to sit properly.

OIL PUMP CLEARANCES: If you happen to have the Haynes manual, the clearances specified for the oil pump don't seem to make sense. So, I will include the values from the ©1975 ROM here:

Driven gear to housing: < 0.005" (0,127mm)

Drive gear to crescent: < 0.006" (0,152mm)

End float - both gears: < 0.005" (0,127mm)

Note that, according to the ROM, all measurements are taken with the pump removed from the engine. Since the crankshaft is therefore not holding the drive gear in position, it is free to move as far away from the crescent as the tightness of the gear teeth will permit. It appears a rare case that it will meet the 0.006" limit; 0.040" is more likely! Despite the clarity of their measurement procedure, it is probable that the specified values represent clearances in place, with the crank holding the drive gear in its correct location.

Mike Morrin: "I cannot believe the figures in the Jaguar manual. The endfloat on the gears in my pump was over 0.020". At the time I was rather alarmed, as the engine had by all accounts only done 55,000 miles. I carefully inspected the old parts for wear, and found that the factory machining marks were still visible on the gears, and the wear on the pump housing was negligible. This pump must have left the factory with clearances way beyond the published limits. So I put the old pump back and crossed my fingers. The oil pressure seems OK (when measured with an

accurate gauge).

Of course, if endfloat is the only problem, some of us have been known to skim a little metal off the mating surface of the housing to bring it back down. With a little care, it's even possible to perform this fix on aluminum housings by laying a piece of sandpaper on a plate of glass and sliding the housing back and forth on it.

OIL PUMP REPLACEMENT: According to Thomas E. Alberts, the 1992 upgrade of the V12 included a new design oil pump -- and that the old design oil pumps are no longer available. "The original part number is C38453 or C40177. That part was officially superseded by EBC3163 which is the pump for 1992 on. EBC3163 is supposed to fit the older engines but some pieces are required to adapt it. This pump is at least twice as expensive as the earlier version, and the adapter (they call it a pump collar) is \$45 plus some additional bolts are required."

Engine Work -- Bottom

Note: If you only need to replace piston rings and/or liners, you might not need to do bottom end work on the Jag V12. See the ideas on page 79.

OIL PAN REMOVAL: The crankcase bottom is actually two pieces, a pan and a sandwich plate. The pan, which exists only at the rear of the engine, comes off easily enough. However, any hope that this will get you anywhere is quickly shattered. The crankcase is fully baffled (necessary to prevent foaming, reduce heat buildup and power loss, and insure proper oil flow to the pickup in a high RPM engine), and there is one baffle the length of the engine that cannot be removed without removing the sandwich plate.

Contrary to the manual, the sandwich plate can be removed without pulling either the front suspension assembly or the engine out of the car. It's a real pain, though, so you might still consider one of those options. To remove the sandwich plate:

1. Unbolt the steering rack without disconnecting hoses, steering column or tie rods. Lower the rack a few inches and let it hang there.
2. Remove the fan to allow the engine to be raised without hitting the shroud.
3. Remove the nuts from the two main engine mounts, and use a hoist to lift the front of the engine as far as possible.

With all this done, the sandwich plate will just barely come out rearward. Putting it back in, with new gasket in place, will also be a lot of laughs.

While you're in there, replace all the O-rings you can find, such as those in each end of each oil tube. If they leak they just leak into the crankcase, but each leak reduces oil flow to the engine. Use Viton O-rings, so you won't have to go back in there anytime soon.

OIL PAN/SANDWICH PLATE BOLTS: Technical Service Bulletin 12-35, which introduced the upgraded gaskets used throughout the engine, also specified new bolts for holding the sandwich plate and the oil sump to the engine. The explanations given applied to both the sump and the cam covers, so it is probable that the same sort of generic bolt & washer substitution described at length for installing the cam covers starting on page 60 could also be applied here -- although these bolts are a size larger, so the specific parts mentioned won't do.

See also the notes on TSB 12-53 on page 48 regarding sealing the threads on the sandwich plate bolts with heads inside the oil sump.

TSB 12-35 specifies a torque of 21-27 N-m (15.5-20 ft-lb) on the sandwich plate bolts and oil sump bolts. No mention

of later metric vs. early SAE bolts; hopefully, it's a reasonable torque for either. It's also probably a good spec whether using their special bolts or generic substitutes.

MAIN BEARING REPLACEMENT: If you find yourself needing to replace the main bearings without removing the crankshaft, the job can be accomplished the same way as most cars: Roll the upper bearing shell around and out. If it's difficult, insert a cutoff head from a nail into one of the oil passages of the crank and turn the crank to roll the bearing around. However, when installing the new bearings, remember that the Jaguar block is aluminum. It is recommended that the outer leading edge of the bearing shells be smoothed slightly with a file to prevent them digging into the aluminum when installing.

REAR OIL SEAL: If you think your rear oil seal is leaking, you might want to check again. The rope seal used up to VIN 160010 has proven to be very reliable indeed; an informal survey of owners on the internet indicated that the rear oil seal was often blamed for leaks, but the leaks were always later found to come from other sources. The upper mating surface of the rear bearing cap is one possible source, as Jaguar didn't see fit to seal it at all -- see Error: Reference source not found below. The sides of that cap were sealed with "hockey sticks" on early cars, but later assembly instructions call for injecting silicone instead; apparently the hockey sticks would dry up and harden and start leaking. Besides these possibilities right near the rear seal, there's also the half moon seals (page 60), oil pressure sender (page 47), tappet block banjo bolts (page 44), and a host of other items that may be leaking above or around the rear of the engine and dripping down to look like a rear oil seal leak.

If your rear oil seal is leaking, please see the note on the PCV system on page 51.

REAR OIL SEAL -- UP TO VIN 160010: Up through engine number 8S.66782, the rear oil seal was a "rope seal", a chunk of waxy rope crammed into a groove surrounding the crank journal. This is sometimes called the "two-piece seal" since there's one piece of rope crammed into the journal on the block to form the upper half and another piece of rope crammed into the bearing cap to form the lower half.

At first it seems apparent that the upper half of the rear oil seal cannot be replaced without removing the crank. However, Dick Russ reports that there is a tool called "Sneaky-Pete", P/N 2700 by the Lisle Company in Clarinda, IA, that will enable the seal to be replaced without removing the crank. The tool costs only \$6 or so and is available at Pep Boys, AutoZone, etc. It consists of a length of music wire and some tiny grippers that can be used to bite into one end of the new seal and pull it into place around the crank.

In the March/April 1995 issue of *Jaguar Journal*, Russ describes in detail how to replace this seal with the crank in place; the same article is reprised in the December 1995 issue of *British Car*. It also can be viewed online at:

<http://www.terrysjag.com/seal.html>

The procedure was developed by Phil Long and not only uses the Sneaky-Pete but also uses the seal from a 1968-78 Ford 460. The reasoning is apparently that the Ford seal is longer than the Jaguar original. After using the Sneaky-Pete to pull the new seal around the upper half of the crank, the end that has been boogered up by the grippers of the Sneaky-Pete can be simply cut off. If a Jaguar seal is used, the gripper must be carefully removed and the seal backed into the recess, no easy task.

Russ also suggests that the cap be trial fit and torqued down, and then removed and inspected to make sure none of the seal is getting in between the joining faces of the cap and block and holding them apart. Any fibers or edges of the seal interfering with the fit can then simply be cut away before fitting the cap up final.

Note that Long's 44-step procedure was actually written for the Series III E-type, so a few of the steps need revision to apply to the XJ-S. For example, steps 6 and 39 deal with the E-type's oil-to-coolant oil cooler which doesn't exist on the XJ-S.

In the September/October 1995 issue of *Jaguar Journal*, John F. Quilter and John W. Yerger of Jaguar responded to the

above procedure, claiming it was not only unacceptable but would invalidate the warranty on the engine. They insist that the only acceptable method of replacing this seal involves removing the crank so that a special Jaguar tool may be used to “size” the seal prior to assembly. The seal is not supposed to actually touch the crank at all, but to reside very close to it. The scroll carved into the crank then feeds inward, preventing oil from going outward. Contact will result in “burning”, as confirmed by many who have found the white rope seals somewhat charred. Roger Bywater seems to feel that the big problem is not burning of the seal itself, but burning of the rear main bearing; he says the crank rubbing on the rope seal gets the metal hot enough to damage the bearing.

Note that the original Jaguar seal is a waxy white rope, while the Ford 460 seal appears to be impregnated with graphite. Perhaps this helps avoid that burned look -- or camouflages it. There is at least one report of an owner asking for a seal for a Ford 460 and being handed something in a rubber seal; make sure what you get is in fact a dark-colored piece of rope. John Holmes says, “The Ford Rope seal is Part #C90Z-6701-A and contains 4 lengths of rope seal. Each one measures in length 17cm, 11mm by 5.5 mm in cross section. It truly looks like a piece of rope that has been flattened from a circular cross section. The surface of the pieces are dark grey, presumably with graphite (it feels to be such) but the graphite does not penetrate very much beneath the surface. The rope pieces are quite flexible to the hand.”

If you are concerned about contact between the rope seal and the crank, perhaps a minor revision to the Sneaky-Pete installation is in order. It shouldn't be difficult to slip a piece of thin shim stock around the crank before pulling the new seal into place. This will not only hold the seal away from the crank a few thou and hopefully help the seal form to that shape much the same way as the special Jaguar tool would, but it also helps protect the crank while installing the seal. A similar piece of shim stock could be used when trial-fitting the bearing cap to “size” the lower half of the seal, where Long's procedure calls for the use of the special Jaguar tool.

Hey, if the engine is under warranty, let the Jaguar mechanics do it their way; it's their nickel. However, if *you're* paying, I'll bet you opt for the Sneaky-Pete. Jaguar's way requires removing the crank, which means pulling the engine and tearing it apart. Long's way only requires removing the oil pan and sandwich plate, not easy but possible with engine and transmission in place -- see page 97.

HOCKEY STICKS: The rear main bearing cap not only holds the bearing shell, it also fills in a rectangular opening in the rear of the block. It hence must be sealed around its perimeter or oil will leak out of the crankcase. When the Jaguar V12 was first introduced, the sides of this bearing cap were sealed against the opening in the block with "hockey sticks". These sticks fit into grooves in the side of the bearing cap, and the "foot" of the hockey stick wrapped around the top surface of the bearing cap so as to pull the sticks into place with it during installation.

Somewhere along the way, Jaguar realized the error of this scheme and omitted the hockey sticks in favor of simply injecting some sealant into the groove after the bearing cap was bolted in place. Because there's a gap at the top corner, just keep squeezing the sealant in until it starts coming out the gap. This sealant injection method should be used on *all* 5.3 litre Jaguar V12's during a rebuild, even if they originally came with hockey sticks.

Rodney Spratt discovered that the machining of the rear bearing cap changed with the introduction of the injected sealant. The early bearing caps had little recesses in the upper surface for the feet. Once hockey sticks were no longer used, there was no longer any reason to machine the little recesses, so they were omitted. You couldn't install a hockey stick in a later engine if you wanted to.

REAR BEARING CAP UPPER JOINT SEALING: When bolting on the rear bearing cap, think about how the sealing of the crankcase itself is accomplished. The oil seal theoretically forms a seal around the shaft, and the injection of silicone sealant effectively seals along the two sides of the bearing cap. However, the top surface of the cap is sealed only by the metal-to-metal contact. It is suggested that a thin line of sealant be applied to the top of the bearing cap, starting at the oil seal and ending at the silicone groove on each side, prior to assembly. See Figure 7. Be sure to use some type of sealant that won't space the cap away from the block, such as Loctite 518 or perhaps the Loctite 573 or 574 used on the tappet block (see page 70). Note that the sealing of this horizontal joint definitely calls for a *different* sealant than the two vertical joints, which need a silicone-type stuff such as RTV.

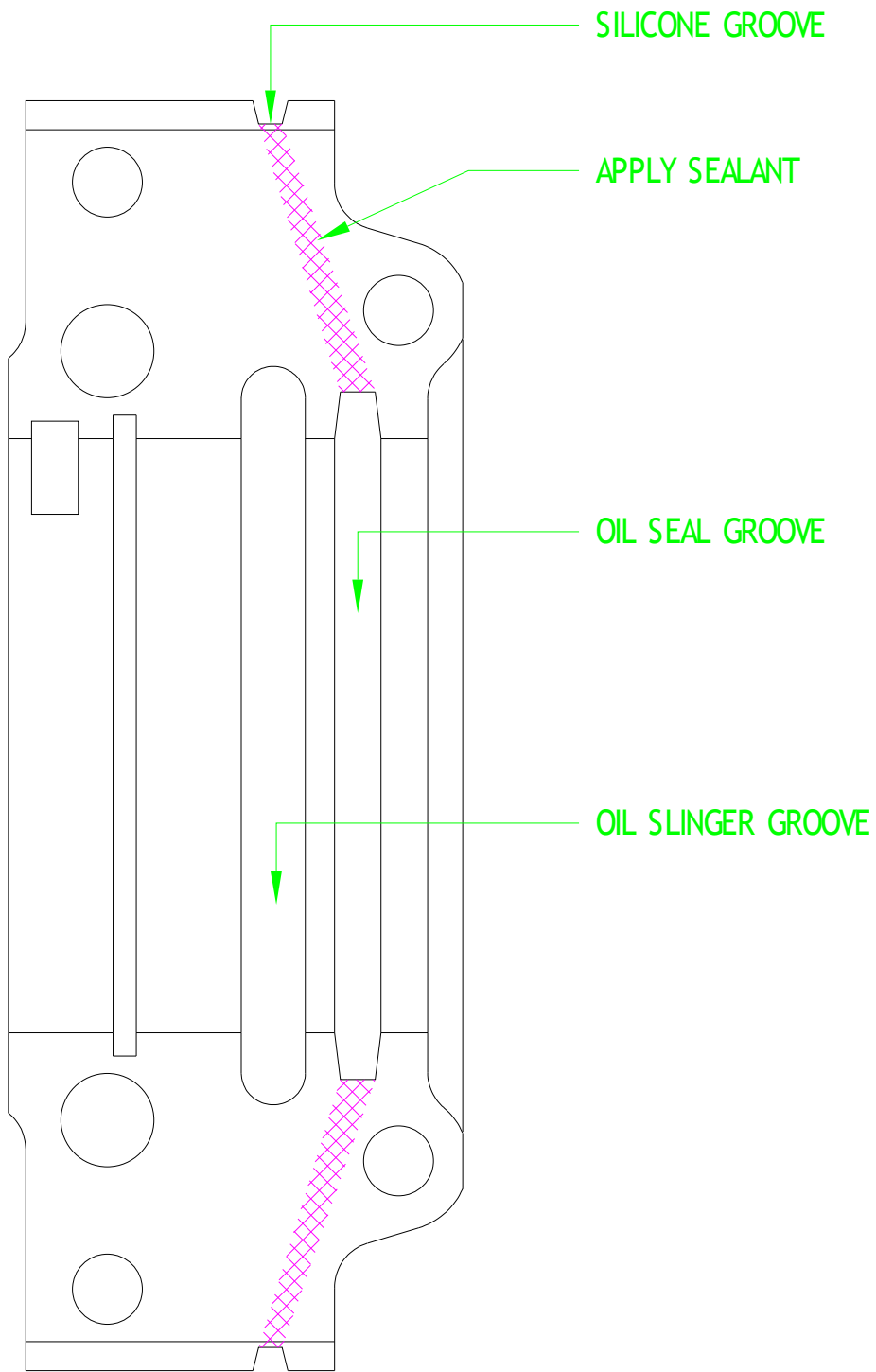


Figure 7: Rear Main Bearing Sealing

REAR OIL SEAL -- VIN 160010 ON: According to Phil Bates: "In 1989, starting with engine 7P.02073, Jaguar fitted a new one-piece rear main bearing oil seal to replace the previous rope type." That 7P number refers to engines for the XJ12; for the XJ-S, Greg Wells says "My microfiche shows that the rope seal was used up to engine number 8S.66782 and that the one-piece rear main seal began at engine number 8S.66783." Jon Jaspersen quotes a Jaguar TSB saying this corresponds to VIN 160010.

The TSB also calls for a new tool, JD 163, for installing or removing this new seal. Replacement of this later type seal does not require removing the engine or crank, but it does require removing the transmission.

Chad Bolles: "No way to retrofit, already tried that, block was recast. Crank was redesigned also. Seal is about 5-3/8's OD and 4-7/16's ID. Main bearing the same."

Unfortunately, the newer design seal seems to have its own problems. There have been several reports of it "blowing out", creating a *massive* oil leak. The seal itself appears undamaged (although most people will choose to replace it anyway after going through the effort of removing the transmission); it apparently simply pops out of its hole. Anyone with this type of seal who is working in the area -- because it blew out or for other reasons -- would be well advised to secure that seal. Perhaps a Loctite retention product would help make sure it doesn't go anywhere, or maybe it's possible to add some small screws around the edge to secure it in place.

PISTONS & CYLINDERS: In general, you can buy pistons for the V12, or you can buy cylinders with pistons. Generally, you *cannot* buy cylinders alone. Make very sure you don't need a cylinder before you buy a piston alone. You cannot get pistons oversized by a few thousandths for reboring cylinders; if the cylinder is worn or damaged, it must be replaced.

Fortunately, the cast iron used in the cylinders is apparently very hard and wear is usually insignificant in engines with less than 150,000 miles, in which case the pistons alone can be replaced. If rebuilding, the best policy for saving money may be as follows: Don't order parts until the heads are off. Check for a "ring ridge", the step created about 1/4" from the top of the cylinder by the wear from the rings. If a ring ridge is detectable, order new cylinders with pistons. If not, order pistons alone.

The pistons and liners are available in an "A" or "B" size, which differ by a microscopic amount. The difference is a result of tolerances in manufacturing, and neither is really considered an oversize for the other. Each piston *must* match the liner it's installed in. There is no reason not to ensure that all cylinders within the same engine match, although differences probably wouldn't be noticeable.

The alloy piston in the V12 has a couple of steel inserts cast into the inside of the skirt. These inserts are a thermal expansion control device; they not only help control how much the piston expands when hot, they also help prevent it from ovalizing, which most pistons normally do due to the geometry of the pin bosses. When the engine goes from cold to hot, this piston design helps maintain a close tolerance between the piston and the cylinder. This, in turn, reduces ring leakage, piston/cylinder wear and noise. The fact is, these items make forged aluminum pistons look like lawn mower parts. The owner seeking to replace the pistons would be hard pressed to find better ones than the originals.

ALUMINUM CYLINDER LINERS: Apparently aluminum cylinder liners are available for the Jaguar V12 from GKN Squeezeform in the UK. Such use would require the replacement of the pistons as well, since the stock pistons are designed (via the use of a special alloy, as well as steel expansion-control inserts) for the expansion rate of the stock iron liners.

Jeffrey Gram contacted Rob Beere Engineering, which reported: "In the 1980's the Jaguar Group C endurance racers used aluminum liners. It is actually not pure aluminum but a compound called nickasil or similar. This material is very light and is treated (don't know with what). In 1986-1988 the alu-liners were not used anymore for endurance races since the wear was too big and inferior to cast iron. Apparently this nickasil material has a tendency to pick up material by which the pick-up process is accelerated and the material wears out quickly. The nickasil was only used on race engines with frequent liner renewal."

The V8 engine used in the XK8 and XJ8 comes with nickasil cylinders.

PISTON & CYLINDER CLEARANCES: According to Bob Tilley, “Under the Group C TWR build instructions for the V12, the piston to bore clearances for cylinders 1A through 5A and 1B through 5B is .0045-.005, whereas the clearance for piston to bore in cylinders 6A and 6B is .0055-.006.”

These absolute values may be of little use to the normal V12 owner, since this is referring to racing engines where the pistons and the liners are likely to be significantly different than stock. The implications are fairly obvious, however: The rearmost cylinders are more likely to develop clearance problems due to poor cooling. There is no history of problems in the street application, but the information is included here for those who might make use of it. Perhaps the anal-retentive might choose to measure the clearances in their piston/liner sets and put the largest clearances at the back.

PISTON RING END GAPS: Technical Service Bulletin 12-33 is a correction to the piston ring end gap specs given in the ROM. It says, “Insert the correct piston ring end gap specifications into the XJS Repair Manual, sections 12.17.10, 12.25.26, 12.41.05 and the Piston Ring Data in section 05 (Engine Tuning and Data).” Well, it’s already off to a bad start; 12.25.26 doesn’t exist at all (at least not in the ©1975 ROM), 12.41.05 doesn’t mention the end gap spec, and 12.17.10 refers to Section 05 -- which is an incorrect reference in both the ROM and the TSB, those specs are in section 04!

Which page in Section 04? Another good question. These pages are printed sideways, evidently copied from some other document. When you get to the bottom of the left column of page 04-5, proceed to the top of the left column on page 04-6. When you reach the bottom of that column, proceed to the top of the right column on page 04-5, and then proceed directly downward through the right column on page 04-6. It will be helpful to mark arrows on these pages to remember this.

The piston ring specs start at the bottom of the left column on page 04-6 and continue at the top of the right column on page 04-5. The gaps in question are actually near the top of the right column on page 04-5. Revise as follows: The spec end gap for the top ring should be 0.016”-0.021”, and the spec end gap for the second ring should be 0.016”-0.026”. The spec for the oil ring is not mentioned in this TSB.

TOTAL SEAL PISTON RINGS: Total Seal, Inc., makes a type of piston ring set in which the second ring is a two-piece ring. Effectively, it puts two rings in a single groove with the gaps staggered -- so gases cannot pass either gap. As a normal ring wears, the gap gets larger and the leakage increases accordingly. With Total Seal rings, the gap is covered by the second ring, so it won’t leak no matter how much it wears.

Apparently, these rings are highly recommended by just about everyone who has ever used them -- including high percentages of competitors in several types of racing. Testing shows considerably less leakage even compared to new conventional rings. Not only will performance improve, but the reduced blowby should result in less contamination of the oil.

SEALING LINERS TO BLOCK: The liners (cylinders) are slid into openings in the block, and the head is bolted down on top of them. The upper portion of the liner is thick while the lower “skirt” is thinner, so there is a step on the OD where it goes from thick to thin. The thick portion of the liner is pinched between the head gasket and the ledge in the block, with the thinner skirt protruding down inside a bore in the crankcase. The head gasket seals the joint at the top, while the joint at the ledge at the bottom of the thick portion of the liner is sealed only with a sealant applied when assembling. There is very little pressure across this joint, but it nevertheless needs to be reliably sealed since there is coolant above it and the crankcase below. A sealing failure would result in coolant in the oil pan.

The ©1975 ROM, Section 12.41.05 step 74, says to use Hylomar when installing the liners. However, as described in the discussion on sealing the tappet block to the head on page 70, Hylomar is not recommended by its manufacturer for metal-to-metal joints since it is supposed to be a gasket dressing and will not harden; it eventually oozes out of joints,

allowing them to leak. The ©1975 ROM recommends Hylomar for the tappet block as well, but later editions recommend Loctite 573 and apparently 574 or 518 will also work.

The liner-to-block joint, like the tappet block-to-head joint, is metal-to-metal. However, the later ROM apparently never changed its recommendation from Hylomar for the liner installation -- perhaps because any leaks that have occurred were not obvious and didn't result in complaints, or perhaps because the liner-to-block joint is a much higher compressive stress joint than the tappet block joint and therefore may be expected to seal reasonably well regardless of sealant -- the iron liner will just dig into the soft aluminum block. Regardless, Loctite 573, 574, or 518 should be a much better choice than Hylomar for sealing the liner-to-block joint.

Joe Bialy points out that the application guidelines for 600-series Loctite products may be confusing. "The Loctite book specifically states that the 638 family of compounds (603, 620, 638, 641, 648, and 660) will "retain cylinder liners". The Jaguar V12 liners are "cylinder liners", but 600-series Loctite products should *not* be used here. 600-series Loctite products are intended to *retain* the type of cylinder liners that are pressed into bores in a block. The Jaguar V12 liners are not pressed into bores; they are slip-fit into openings and securely held in place by the head. Retention is not an issue; the only necessity is sealing -- which calls for the 500-series products.

Just in case it isn't clear enough in the ROM: The sealant on the liner-to-block joint should be applied *only* under the step on the liner or on top of the ledge in the block, *not* down the sides of the liner or on the inside diameter of the bore in the block.

Performance Upgrades

COMBUSTION CHAMBER MODIFICATIONS: With an advanced combustion chamber design, the H.E. engine has 11.5:1 compression and runs on 89 octane unleaded (Unleaded Plus). Almost any mods to the engine internals would endanger the integrity of this design, and the owner would risk having to lower the compression radically and/or face buying octane boosters (\$\$\$). His fuel economy would get worse, and if he didn't do his job right his performance would get worse, too.

One modification possibly worth considering is to install the European pistons, raising the compression to 12.5:1. According to Chad Bolles, the only difference in the engine is the piston, which has a slightly different pin bore location. This change will obviously require higher octane fuel. The European XJ-S H.E. reportedly produces about 30 more HP than the US version, but much of this is probably in the lack of catalytic convertors and other emission considerations; Mike Morrin says, "I would estimate that the extra CR alone is worth 5-8HP."

ENGINE ENLARGEMENT: There are two ways to get more power out of an engine: tune it to obtain more horsepower per liter, and enlargement to provide more liters. Of the two, enlargement has some definite advantages: if the horsepower per liter is not changed significantly, the durability may not suffer; the "manners" of the engine, important in street applications, may remain as stock or even improve; fuel economy may remain nearly unchanged; and the use of higher octane fuel or octane boosters may not be necessary.

Indications are that the Jaguar V12 has a *lot* of room for expansion. A 5.3 liter (90mm bore x 70mm stroke) for two decades, it was enlarged by Jaguar in the early 90's to 6.0 liter (90mm bore x 78mm stroke). AJ6 Engineering (see page 713) once offered engines bored and stroked in sizes up to 7.1 liter and 405 BHP.

The room for expanding the bore seems to be limited to around 98mm. The stroke, however, can go a long way, and since it is so over-square to begin with, getting too under-square is not a problem. Bill White (see page 721) has prepared a Jaguar V12 for use in a 3/4-scale replica of a Spitfire fighter plane. He expanded the bore and stroke to 96mm x 95mm -- almost an inch of additional stroke -- for a displacement of 8.4 liters! This was done without significant modification to the block, and the stock H.E. heads were used. At 3000 rpm, this engine produces 500 ft-lb of torque in naturally-aspirated form, and 820 ft-lb when supercharged as it is in the aircraft.

According to White, that isn't the limit by any means. He reports that an outfit in the UK called Forward Engineering

prepares Jaguar V12's for use in offshore racing boats. They install a spacer 3/4" thick between the block and the head, and use liners the same amount longer than stock to provide longer cylinders. Longer studs hold the head on, and since 3/4" is the length of a link of the timing chain the addition of four links allows an otherwise completely stock timing chain scheme to be used. White says the engines so assembled are 9.3 liter, and are very successful at offshore boat racing.

Changes to the engine displacement require modifying or replacing the EFI. The stock EFI is hard to modify; it has a fixed (trimmable, but fixed) map for intake manifold vacuum and RPM versus fuel. If the displacement is altered, this relationship changes. One solution is an aftermarket EFI system that is completely programmable and re-programmable (see page 310). Most choose to ditch the EFI at this point for carburetors, introducing the problems outlined on page 310. And the emissions inspector will not smile at them.

LOTS VALVES: There have been experiments to adapt the 4-valve DOHC head from the Jaguar AJ6 engine to the V12. The cylinder spacing and bolt patterns are the same -- according to Roger Bywater, not because the AJ6 was derived from the V12, but rather because there was a plan to put the V12's H.E. head on some versions of the AJ6. If the DOHC heads are just bolted onto the V12, on one side the intake ports will be on the outside and the exhaust ports will be toward the center -- not good. So, one of the AJ6 heads must be turned around backwards -- and some complicated fabrication work is required to get such things as the cam sprockets rearranged. Bill White (page 721) has worked with this idea, among others.

Steve Averill reports that the Autumn 1988 issue of Jaguar Quarterly has an article on "a 60 valve DOHC V12 that was under development by Warrior Automotive Research. They expected to achieve 100 bhp/litre in low tune with a 5.8l engine. The head had 3 inlet & 2 exhaust valves per cylinder." No word on what's happened since, but Warrior's phone number was given as 061-928 3284 in Cheshire if anyone wants to try a call.

BOOST: There has been at least one experiment in Australia in turbocharging the XJ-S, but the results were apparently not good. Officially the problems were blamed on the inability to assemble a drivetrain that would handle the 1000+ hp for more than a few seconds.

Chris Sleeman (also in Australia) reports on a 1998 endeavor: "When I picked up my Daimler Double Six yesterday from my local Jaguar specialist, he showed me an XJ-S he is working on. It is a '76 model, with a 6.8 Litre Twin Turbo V12. The motor was built by them, and the customer is apparently going to enter it into the Targa Tasmania in April. The motor is being dynoed next week, but they say it puts out around 700hp. It is running 0.8 bar of boost at the moment, and will be using Motec injection."

Somewhere out there, Bradley Smith is driving around his XJ-S with twin belt-driven Whipple superchargers.

NITROUS: Martin R. Fooks has a nitrous system in his XJ-S: "The Nitrous system was supplied by Trevor Langfield (page 719) and is a customized "High Power Nitrous" system. Because of the size of the hit to the engine (150BHP) they installed a progressive controller, which fits neatly in my car where the trip computer used to be. This enables me to control the way the extra power is delivered to the engine, such as starting power, ending power, time delay and time from starting level to ending level.

"I am very happy with the Nitrous installation, which really seems to be very smooth on the V12. Trevor's people have the computer equipment to work out power and 0-60MPH times and that is where the figures came from. As a side note, it ran 5.3 seconds 0-60 with a standard TH400 and only 75BHP jets in the NOS system instead of the 150 jets.

"Nitrous got a very bad press in the past, caused mostly by people adding too much power to their engines, or by not richening the fuel mixture when the NOS was injected. The casualties in my case have been the torque converter and the rear IRS mounts, which were all bar 1 ripped off." (See page 402 regarding rear suspension mount weakness.)

"The engine is stock except for the exhaust and intake, and I have had no problems at all with it (unlike the torque converter).

“The builders of my system told me that they do not recommend putting any more than 50-75BHP into your engine without using a progressive system as avoidable damage to the engine could result.

“Their main concerns with adding 150BHP were not with the engine as they believe it to be a very strong and reliable item. The standard transmission and torque converter were their main objection to the increase which as it turns out was well founded.”

“The amount of power provided in total by the NOS system can be changed by installing new jets at an English price of 7 pounds per pair, so if 150BHP proves too much to handle, you can always fit a smaller pair taking very little time and expense. 200BHP is the maximum obtainable by my kit. My suppliers stated to me that as a rule they do not fit systems with more than 50% of the original engine power (which is why I’m only using 150 Jets instead of 200). Obviously this is not the case if you bullet-proof your engine.”

CAMSHAFT REPLACEMENT: Most performance enthusiasts will agree that replacing the camshaft (or camshafts; the Jag V12 has two, some cars have four) is the most effective way to change the performance of an engine. The entire personality of a car can be radically altered by merely changing the camshafts.

Chad Bolles reports that Isky makes high performance camshafts for the Jaguar V12.

Rob Beere Racing Services (see page 714) also offers hot cams, as well as tappet shims in extreme thicknesses that may be necessary for such installations.

Note that any camshaft alterations should be accompanied by an EFI system modification; there will be increased airflow at wide open throttle, but since the feedback circuit is disabled under those conditions the fuel supply will remain at the original fixed map with no trim. The engine will therefore run lean at full throttle, a situation that begs for burned pistons and valves.

There has been some confusion regarding the difference between pre-H.E. and H.E. cams, since published valve timing data on the two engines seemed to differ. However, Bywater points out that they actually use the same part number camshafts. “When the V12 was launched the valve timing was quoted in Walter Hassan’s SAE paper 720163 as being 17,59/59,17. When the H.E. version was launched in 1981 the supplement to the manual quoted cam timing as 13,55/55,13. In fact, the same cam profile had been in use since the early 1970s and continued through into the 1990s under part numbers C42176/7, therefore all EFI V12s were produced with these cams. Now it is not widely known that for some time the V12 was mildly plagued with excessive tappet noise and in the course of dealing with the problem the quietening ramps on the cams were altered at least once around 1972-3. I was personally involved in an investigation into the causes of a spate of tappet noise around 1978 and am not aware of any cam change ever being made to the V12 in production for any other reason than to reduce valve gear noise.

“Measurement of true cam timing is not a straightforward matter and it has been accepted practice to measure from the point where the quietening ramp ceases and the lift curve proper commences. For those who are not familiar with the term, a quietening ramp is an area at the flank of the cam where the rate of lift is small, at around 0.0005” per cam degree, and to be fully effective must extend rather higher than the widest clearance likely to be encountered. The idea is that any reasonable running clearance found in use it will always be taken up at a predetermined velocity which should not give rise to noise. If the ramp geometry is changed, as we know happened on the V12, then the timing as measured at the top of the ramp could also vary and this accounts for the small difference of timing quoted at different times in its life.”

Mike Cogswell elaborates: “Duration itself can be misleading, since almost nobody measures duration from the instant the valve leaves the seat until the instant it returns. Instead, duration is commonly measured at some point where there is noticable flow, albeit typically a very low fit. This is important, since different cam grinders measure duration at different lift, hence one man’s long duration might be less than another’s short duration. Caveat emptor, as always.”

Bywater again: “It is perhaps of interest to note that over the years Jaguar used virtually identical valve timing on all their mainstream engines. Consider the following:

SS 2.5 & 3.5 litre 16,56/56,16

XK 3.4,3.8,4.2	15,57/57,15
V12	17,59/59,17 (13,55/55,13)

Clearly having found something that worked there was great reluctance to change from it, although the smaller displacement engines often had softer timing to beef-up the low speed torque as the following examples show:

SS 1.5 litre	10,50/50,10
XK 240 saloon	10,50/50,10 (5/16" lift)

Note also that hot cams might not have the expected effect. AJ6 Engineering (page 713) once offered a *milder* cam than stock, and the result was higher mid-range torque and a nearly one full second quicker 0-to-60 time. Bywater explains: "...we introduced some short duration cams for the V12 back in about 1984. They certainly boosted mid-range performance, especially appreciated with the 3 speed BW and GM transmissions, but suffered a marketing problem because they gave slightly less peak power so we eventually discontinued them. We sense that attitudes are changing and many drivers are realising that a performance gain around 40-70 m.p.h. is far more valuable than adding to a rarely seen top speed so we may well offer a modernised version of such a camshaft again in the near future."

TORQUE LINK: When the engine/transmission turns the driveshaft, the reaction is a twisting force trying to tilt the engine/transmission assembly on its mounts. There are only three mounts, two soft rubber mounts under the engine and the complicated spring assembly under the tranny. The tranny mount really does little to counter this force; the torque is entirely taken by the two motor mounts.

Since the mounts are soft, the torque can move the engine around quite a bit. If the car is not stock and producing more torque than originally intended, the left-side mount may actually be damaged since it is put in tension under extreme conditions.

A racing trick is to add a fourth connection between the engine and the chassis. By adding a link, torque can be taken up before the engine moves very far or stresses the mounts too much. Newer FWD cars are usually designed with such a link, but front-engine/rear-wheel-drive cars typically rely on rubber in tension.

Under torque, the engine twists, which means the top moves to the right, the left side moves up, etc. A link can be added anywhere that restricts this movement, but it is usually preferable to put it either on the left side of the engine connecting downward to the chassis, or from somewhere near the top of the engine connecting to the left side of the compartment. Either of these locations puts the new link in tension (preferable for such parts) and helps keep the motor mounts in compression (protecting the rubber).

Backyard mechanics have been known to accomplish this fix by bolting a length of chain between the left-side exhaust manifold and the chassis. Under normal conditions, the chain is slack and does nothing but rattle. When the engine tries to lift, the chain pulls tight and stops the motion. This method does work, but it is hardly a suitable fix for an XJ-S; the chain makes too much noise, and the sudden jolt when the chain gets tight is not conducive to an impressive ride.

To do a professional job, a better idea is to install a link made from threaded rod with some rubber bushings (available at any auto parts store), washers, nuts, and some fabricated brackets to provide holes for the bushings to fit into. Rubber bushings are essential, since a rigid connection would transmit vibration directly to the chassis. If necessary, shield the rubber parts from radiant heat from the exhaust system.

Alternatively, the ingenious mechanic may find a way to make a link from one of those FWD cars fit.

It should also be noted that the motor mounts on the XJ-S are not actually between the engine and the chassis, but between the engine and the front suspension subframe. This provides two layers of isolation between engine vibrations and the chassis: the motor mounts and the subframe mounts. Hence, adding a torque link from the engine directly to the chassis would defeat some of this isolation and perhaps expose the occupants to increased noise and vibration. If possible, it would be preferable to connect the torque link to the subframe as well. Or, use really soft bushings on it.

Intake Upgrades

AIR FILTER REPLACEMENT: K&N Engineering, Inc., makes permanent air filters consisting of special fabric sandwiched between aluminum mesh and treated with oil. They have much less flow restriction than stock paper filters while providing *improved* filtration. Tests on race engines show only a slight drop in power compared to no filters at all! Since these filters are permanent and cleanable, they can even save money in the long run.

The K&N part number is 33-2011 for any V12 XJ-S. Note that stock air filters changed when the ABS brakes were added; since the housing shifted forward, the blank-off area over the throat had to move rearward. The K&N filters have no blank-off area, so the same part number fits either application.

Note that the 33-2011 filters will also fit most XJ12's, but not the last couple of years. The XJ40- and X300-based XJ12's (1993-on) went to a remote filter housing similar to that used on the 6-cylinder XJ40 and X300, except that they have two of them -- one on each side of the car. If your car has air filter housings that are mounted right on the butterfly housings and uses filters that are 16.5" x 5.75", you need the 33-2011. If your filters are 8.37" square, you need 33-2003. The K&N catalog also lists a 33-2579 as fitting some V12's, but this is apparently an error.

IMPORTANT: The K&N's look like they can go in either way outward and either end forward, but you *must* install them with the flat side towards the butterfly. In other words, install the filter into the cover so it sits flush with the bulk of the element within the cover, and then install the cover onto the engine. Installing the other way, with the bulk of the filter nearer the butterfly, can cause the butterfly to get fouled with the filter element. This would be seriously bad, possibly causing the throttle to jam wide open. The concern is exacerbated with AJ6 Engineering's enlarged butterflies, but there's no reason not to be careful with the OEM butterflies.

Needless to say, if you've been running these filters the wrong way around, you should clean them before reinstalling them correctly. Otherwise you'll be putting the dirty side of the filter facing the butterfly.

Installed correctly, the K&N's don't seem to cause a problem with the OEM butterflies because they are pretty stiff. If you want to be safe, it is a simple matter to fab a device to positively keep the filter element and the butterfly apart. This author used stainless steel wire 1/10" (2.5mm) thick from an old radio antenna. Just fashion a loop in the wire to fit over one of the four bolts that hold the air filter housing to the butterfly housing, then a gentle arch over to the diagonally opposite bolt. Make sure the butterfly moves freely underneath the arch before buttoning up the assembly. If the air filter element decides to distort, the arch will keep it out of the butterfly.

The correct end of the K&N filter forward is not as critical, but you might as well get it right. The flat edge is a bit longer on one end than on the other, and the longer edge goes towards the front of the car.

Roger Bywater of AJ6 Engineering says, "...we gave up using K&N filters some time ago because they fall to bits around the edges where the air box clamps up. We raised the matter with K&N Europe, for whom we do consultancy work on occasions, but they claim not to be aware of the problem..." AJ6 Engineering now offers their own design permanent washable foam air filters.

Glen E. MacDonald notes, "Roger Bywater gave up using K&N filters because "they fall to bits around the edges where the airbox clamps up". True enough. However, I was determined not to trash an otherwise perfectly acceptable (and expensive to replace) pair of filters. The fix I found was to take four suitable lengths of windshield washer hose, split lengthwise. These are then slid over the edges of the filter, after cleaning off what's left of the 'bits' Bywater refers to. I made this alteration over 3 years ago and haven't had any problem since."

Of course, K&N filters come with a "million mile warranty", so another option would be to gripe to K&N about the problem.

For some of us, performance is not the issue with air filters; the wear rate of an engine can be closely related to the filtration of the air intake, and any risk of inferior filtration would not be worthwhile. K&N claims that a NASCAR stock car fitted with its filters will outperform a car with no filters over a 500-mile event, since the deterioration of the engine due to contaminated air over 500 miles will exceed the power loss due to the intake restriction of a K&N filter. K&N claims excellent filtration -- although there have been some contradictory reports from other sources. K&N filters

contain a layer of cotton soaked with sticky oil; as the air passes through the cotton, particles should stick to the oil. Such a system normally is not described as a particular size micron filter, since it really should stop *all* particles regardless of size. The stock paper filter, on the other hand, is a porous media filter, and particles below a certain size are free to pass right through.

Either K&N or the stock paper filter is probably acceptable from a filtration standpoint. However, speaking as an engineer, I must express doubts about the filtration efficiency of most of the foam filters I have seen (I haven't seen the AJ6 Engineering foam filters). A foam filter works on a similar theory as the K&N, the foam providing a media for the air to pass through that is coated with sticky oil. However, the passages between the cotton fibers on a K&N filter are very tiny indeed, it's hard to imagine how a speck of dust could get through without sticking, but some foam filters you can *see* through. And even some of those you can't see through appear to have passages that are quite large. And I've also seen foam deteriorate, with crumbs of foam breaking off and going into the inlet. And even if the chunks of foam don't harm the engine, note that each chunk leaving leaves an opening for more dirt to pass through the filter unimpeded.

OPENING UP THE AIR INTAKES: Each of the air cleaner housings has a long tapered tube with a relatively small opening for the air intake. The purpose of the small intake opening is to accelerate the air to near Mach 1 at wide open throttle. This prevents intake sound from coming forward through the intake. In other words, it makes the car quiet.

Unfortunately, the air is now moving fast, and there's an air filter up ahead. If the air is allowed to simply run into the filter, the energy associated with the speed will be wasted, and the result is a loss of pressure. Therefore, Jaguar provides the tapered tube to gradually and efficiently slow the air down, recovering most of the energy and pressure. Jaguar designed this tapered tube as long as they could fit under the hood.

Also unfortunately, once the air reaches Mach 1, the passage is "choked" and all the sucking the engine can manage will not increase the amount of air flowing through it. The opening therefore forms an absolute control on the maximum amount of air going into the engine -- and therefore the HP generated.

If you cut off this intake tube and form a large opening for the air intake into the air cleaner housing, you will eliminate this restriction. If you interfere with the mounting of the temperature sensor in the left side intake tube, relocate it into the housing itself (drill a hole and use a nut on the inside); it can sense the air temperature anywhere in there. Because the EFI system detects manifold vacuum, the system will automatically compensate for the increased airflow; no tuning modifications are required. There is no effect on emissions, so there should be no complaints from inspectors.

At part throttle (most of the time with an engine this powerful), the butterfly acts as an air-accelerating restriction, and no sound gets out anyway. The car will sound like it did before. However, when you open it up, you will be greeted with a sonorous growl from under the hood. This is a very sexy sound, but some Jag owners may not like it.

The performance improvement goes along with the noise. In any situation where there is still no sound, there is no change in performance either. When the engine growls, there is more airflow than there was before.

This mod will have no effect on fuel economy, except when you hear the growl; at that point, increased fuel use accompanies the increased airflow and increased power.

You can give this mod a trial run without much effort. Unscrew the air temperature sensor, then reconnect the wire to it and tape it down anywhere convenient. Then, remove both air filter covers and tie the air filters in place with some wire. This setup will provide the same performance (and a little more noise) than the intake tube removal described above.

OPENING UP THE AIR INTAKES - VERSION 2: AJ6 Engineering (page 713) has gone through several variations on air filter housing intakes attempting to provide an optimum balance between unrestricted flow and noise. What they now offer with their induction upgrade kits are replacement covers that appear largely unchanged from OEM except that there is an additional intake opening on the bottom with a hose leading to another little bellmouth intake mounted in the vicinity of the front anti-sway bar. Perhaps AJ6 Engineering will sell these covers separately, or perhaps one could just adopt the idea and fab similar additional intakes.

OPENING UP THE AIR INTAKES - VERSION 3: FasterJags (page716) offers a replacement air intake system called the Growler. It replaces the entire air filter housing assembly with a pipe that curves forward and has a cylindrical K&N filter mounted on the front end.

COLD AIR INTAKE: Any engineer will tell you that an internal combustion engine will run more efficiently (more power *and* better fuel economy) on cooler intake air. Most automobiles nowadays (including some Jaguars) have hoses directing cool outside air into the air cleaners rather than the hot air of the engine compartment. The XJ-S is a notable exception; perhaps they felt that the hoses would make their engine compartment less attractive.

While opening up the intakes on the air filter housings as described above, a flange can be provided for an intake hose. The author's installation used 3" exhaust pipe, but 2½" pipe would work nearly as well (still four times the area of the stock inlet) and would probably be easier to install. Intake hoses in many sizes can be found at most parts stores, and some have built-in clamps. Remember to provide flexibility in the system, since the engine moves around on its mounts.

All of that was easy. The hard part is routing the intake hoses somewhere. One possibility on the XJ-S is the back end of the headlight compartments. By making a hole and providing a flange for the hose (2½" or 3" pipe again), cool air can be routed from existing openings just inside the grille through the space behind the headlights and into the intakes. An opening must be made in an unseen panel within the headlight compartment to permit air flow. The modification will also require relocating the headlight relays. Be sure to clean up the intake path as well as possible when you're finished, and check your air filters for debris after driving a while.

On cars with ABS brakes, the air cleaner assemblies are essentially unchanged except that they are moved forward to avoid the brake system. The same basic mod works; the intake hose just needs to be a bit shorter.

The good news here is that this mod will reduce the noise from the Version 1 mod. The intake hoses, as well as the sheer length of the intake path, will help dampen the growl.

Since the EFI temperature sensor will detect the cooler intake air temperature, once again no tuning mods are needed. The cooler air provides improvements at all operating conditions, and will improve fuel economy. There is even less tendency to overheat. The only effect on emissions is a *reduction* in nitrogen oxide emissions.

Peyton Gill reports, "I used a Dremel to cut the horn out of the air filter cover and then rounded the "not so perfect hole" with a grinding stone mounted in a drill press. I did not use the exhaust pipe Kirby mentioned, I went to Home Depot and got 2 inch gray PVC couplings. The ones I got came from the electrical dept. The couplings I used have threads on one side and open for a PVC pipe on the other. The conduit works good because you can get a "nut" that fits the threaded side. This nut I'm talking about is more like a threaded ring, it is very common in the electrical conduit world. The rounded hole you leave when you cut the horn out is close to the same size as the threaded side of the coupling and the nut inside the air filter holds the coupling tightly in place. The hole I cut was not perfect so I sealed any openings with black RTV (silicon). I did have to relocate the ballast resistor pack on the right hand side and managed not to have to relocate the relays on the left hand side.

"I used a hole saw (maybe 2 1/4 inch) or whatever size slightly larger than the conduit coupling threads to cut holes in the panels behind the headlights. Since the hole was only slightly larger than the threads so they screw fairly tightly in plus a little more RTV to be sure they hold. I got a flexible hose from Pep Boys (they have hoses made for air filter intakes). I took my conduit coupling with me and found a hose that fit snugly over the pipe side. The hoses have clamps that snap into place and one of the hoses fit my conduit perfectly.

"All that was fairly easy; the good part comes when you attack the "hidden panel" described in Kirby's book. This panel is between the headlight opening in the front and where the hole was cut in the engine compartment. You can see it easily enough when the headlight assembly is removed. Seeing the panel is one thing, cutting a hole in it's another. There is not much room to work or cut. I got a 12 inch extension for my drill and put the hole saw on this and cut a couple 2 inch holes in the panel.

"The air temp sensor also has to be relocated. I drilled a hole in the air filter cover and placed the sensor in the direct air

path. I did not have a nut with the same size threads as the sensor so I cut the fitting off the old horn and used it as a nut. I don't think the threads are anything special, I just did not want to make a trip to the hardware store to get one. I had to extend the wires a little."

Pictures of both the author's, Gill's, and several other installations can be viewed at

<http://www.jag-lovers.org/xj-s/book/ColdAirIntake.html>

John Goodman reports that sometime in the early 90's an access panel was provided within the front wheel wells to enable changing the headlight bulbs without removing the assemblies from the front. On the earlier cars, such an access wouldn't have helped because that panel inside the compartment would have blocked access anyway. So, in conjunction with providing the access panel, the unseen panel was also changed; it now has a "hand hole" in it. That being the case, the task of providing this cool air intake scheme might have gotten easier, since the hand hole should serve for an air passage.

COLD AIR INTAKE - VERSION 2: Scott Horner, apparently before he became aware of this book, designed his own cold air intake system: "I based the cold air intake on my car on a friend's XJ-S race car's set-up. He has approx. 4" tubing going into the front of the inner guards, with the air filters mounted within that panel (in front of the wheels). But this is a bit rough for a road car as all you can hear is induction roar...

"For my car, I visited a panel beater friend to modify the guards, etc., as I wanted the mod to look as if it had come out of the factory...

"I'll try and describe this without pictures...We used 2 1/2" tubing which is bent to come out of the inner guard and face up to the original air intakes, which have been cut down (with new tubing) to just a stub and attached via flexible tubing.

"Within the guard, the tubing is bent down (to vertical) which then meets up with another piece of tubing (via flexible hose) that is welded into the valance on the outer corners. These tube holes are cut just under the bumper, so are fairly unobtrusive and with the angle of them look fairly sexy anyway...

"The great thing about them (apart from the cold air), is if you get someone to give the engine a rev while you've got your hand over one of the intakes, you can really feel the engine sucking! There'll be hell to pay the day I hit a sparrow!"

COLD AIR INTAKE - BOLT-ON VERSION: John Goodman reports: "My (unmodified) '89 XJR-S 6.0 has different air cleaner boxes (part numbers SPE 1008 and SPE 1009) with large bore intakes. These take I believe the standard air filters and fit the standard intake manifolds. In other words it's all simple bolt-on improvements for any V12.

"Even more interesting is a special very neatly designed radiator top crossbeam (part number SPD1164) which has quite large smooth oval air intakes incorporated in it. The air intakes in this crossbeam line up perfectly with the air boxes.

"It all looks very neat, but they are JaguarSport parts and won't come cheap!!!"

Regarding that top crossbeam SPD1164, Goodman adds: "I *think* the part no. has been superseded with SPD 1428. This is the part no. listed for '93 XJR-S (American spec). The only difference AFAIK² is that this part has mounting holes for the location of the Ign power amp, (necessitated because the manifolds were different) and rubber connecting hose. There is a good picture of this component in *Jaguar World* vol.2 no.2; anybody handy with a welder could modify a standard one."

IMPROVED THROTTLE BORES -- HOME MACHINIST VERSION: If you have access to a machine shop, you can make a minor improvement in intake airflow with little fuss. Remove the air filter housings, and remove the butterfly housings. You will need a #30 Torx screwdriver to remove the butterfly housings. NOTE: The ports the hoses connect to may look similar, but they may be different! Be sure to carefully record which hose connects to which port

² AFAIK is Internet shorthand for "As far as I know".

prior to disconnecting the hoses.

Referring to Figure 8, machine a rounded edge on the inlet into the butterfly housing. This modification should not be attempted by hand, as smoothness and consistency is important. It is important that the radius blend smoothly into the inner surface of the passage, but it will form an edge with the air filter mounting surface.

Before starting, ensure that the machining will not interfere with the butterfly seat nor with any of the vacuum ports near the butterfly seat; by avoiding machining more than 3/8" into the throat, problems should be averted. Also, avoid cutting into the openings for the two bolts that hold the butterfly housing onto the manifold; while doing so wouldn't cause any leakage, it may cause a whistle as the air flows past the opening. Keeping the outer diameter at 2-13/16" should be acceptable.

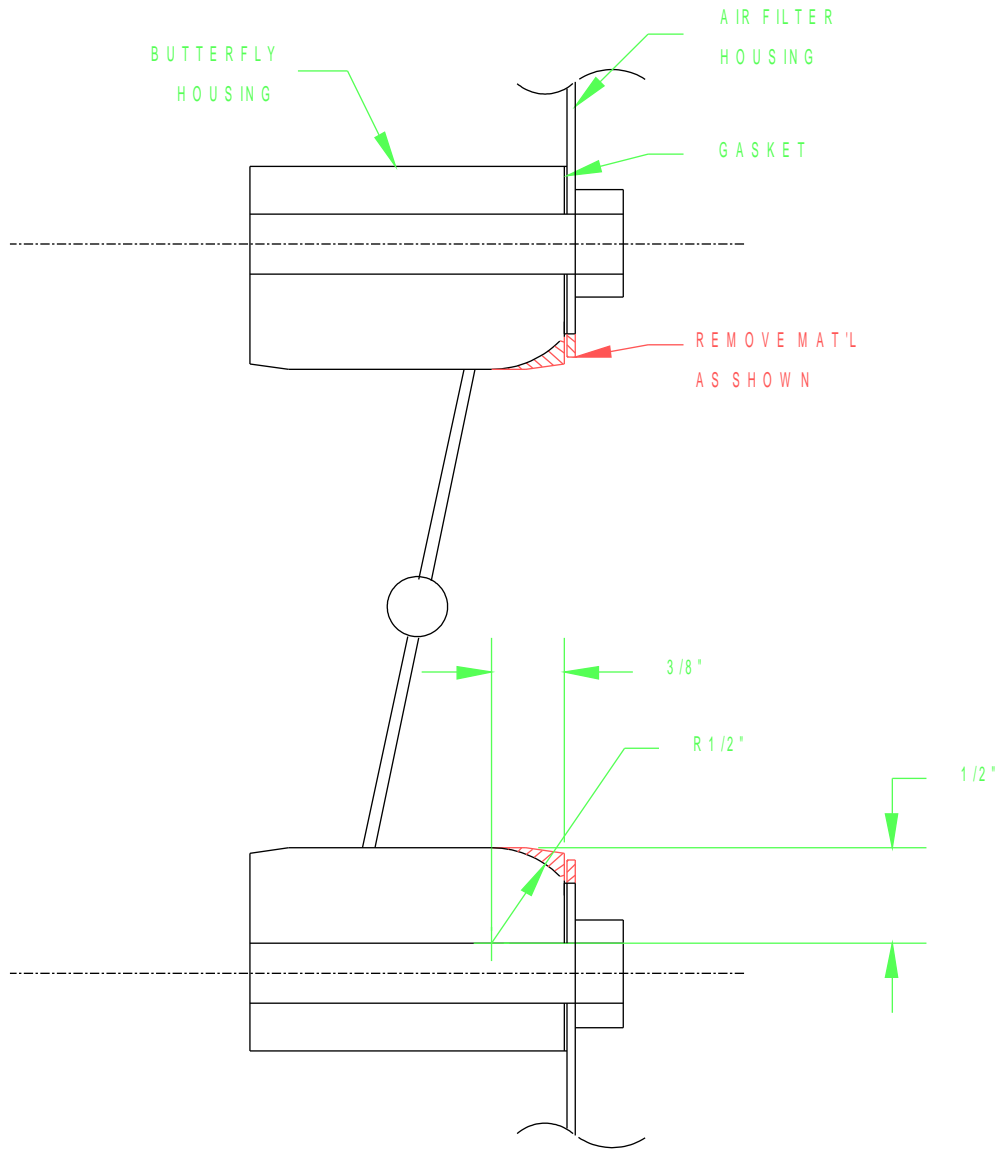


Figure 8: Butterfly Housing Airflow Improvement

Enlarge the opening in the air filter housing to 2-13/16". The gaskets typically are already this size, but final trimming can be done after assembly by using a razor knife before installing the filter.

This modification has not yet been tried, so performance improvements are unquantified. In theory, this mod can provide an airflow improvement (and hence a horsepower increase) of several percent. Considering the proximity of the blanked-off section of the air filter, the improvement may be even more significant. There should be no change in

performance other than at wide-open throttle. Since the ECU senses and corrects for changes in manifold vacuum, no tuning changes are required.

ENLARGED THROTTLE BORES: AJ6 Engineering (see page 713) offers revised butterfly housings on an exchange basis in which the entire bore is enlarged from 2-1/2" to 2-7/8" (32% airflow area increase) and larger butterflies are fitted. Note that their kit includes low-loss foam filters and air filter housings with additional intake openings, fulfilling some of the other suggestions above. The kit also includes an electronic gadget to revise the ECU response, since the larger butterflies will have different airflow characteristics than the stock ones relative to throttle position. AJ6 Engineering claims a 20-25 horsepower increase with this kit.

Roger Bywater describes the product: "We produce the large disks ourselves by firstly, cutting blank disks out of brass sheet, then, using a special fixture we machine them to exact size and to get the correct closing angle in the enlarged throttle bore. They are not simply turned disks and it is important to get the geometry right so that the correct signal is generated across the throttle edge vacuum ports which are themselves critical on size and position. Boring out the throttle bodies exposes a larger diameter portion of the tapping so we install new tapping inserts drilled to produce the required vacuum signal from the larger passage.

"We also machine the spindle slots which otherwise would not accept the larger throttles and we then rebuild the whole assembly with new bearings and seals, centralise the disks and adjust to the requisite 0.002" closing gap.

"The radiused entry which we machine on the throttle body is important to ensure that the throttle bore passes the maximum flow by not creating turbulence at the entry point - which is what happens with square edged entry of the standard throttles. We supply a set of specially made gaskets to match the large bore where it joins the manifold and also for the larger radiused entry joint to the filter assembly."

Chris Carley says, "I bought just the throttle bodies without the filters or cans. I had to drill out the backs of the filter cans to 3-1/8" and also to my surprise had to grind out the tops and sides of the manifolds to match the ID of the throttle bodies. Note the bigger throttles will jam against the standard air filter at wide open - AJ6 & K&N clear though."

INTAKE MANIFOLD MODIFICATION: AJ6 Engineering (page 713) offers an enhancement called the Plus Torque Conversion where they cut the intake manifolds open and install little intake horns into the openings into each runner, then weld the manifolds back together. This apparently not only provides a smooth entry into each runner inside the manifold, but it also makes all 12 runners the same length -- by making the shorter ones (the middle four) as long as the longer ones (the outer two), thereby increasing the Helmholtz resonance benefits for all and enhancing the EFI system's feedback strategy to keep all six cylinders on each bank operating at an optimum fuel/air mixture.

David Buchner claims that the revised intake manifolds introduced in the early 90's -- identifiable by the huge "Jaguar V12" lettering across the top -- already have the improvements offered in the Plus Torque conversion.

Other Modifications

OIL COOLING: The standard oil cooler on an XJ-S is a "relief" unit, meaning it only cools the oil that doesn't go through the engine. However, as pointed out by Bob Tilley, the XJ-S sold in Germany is fitted with a "full flow" oil cooler system, and the parts are available through Jaguar. We can make assumptions about why the German cars would be different than other cars, possibly involving those Autobahns.

John Goodman adds, "It's worth pointing out to others who own later model V12's who may not be aware that *all* V12 HE engines after engine no. 8S44317 had full flow oil cooling, can't remember the year this was introduced."

Both oil systems, as well as almost any other in automotive use, work like this: Oil is drawn from a pickup in the sump into the oil pump. The oil pump is a positive displacement pump, meaning it will move a particular amount of oil for each rotation, regardless of how much pressure it has to apply to move it; if something gets plugged up or the oil is

really thick, the oil pressure could skyrocket, blowing seals, pipes, whatever. So, the oil goes straight from the pump to a pressure relief valve, which relieves enough of the oil flow to prevent excessive pressure in the system. The relieved oil goes back to the sump, while the remaining pressurized oil goes through the filter (which has its own relief bypass in the event of clogging) and into the galleys that feed the bearings, cam followers, and other parts of the engine requiring lubrication.

In the basic relief oil cooling system in the Jaguar V12, only the oil that is relieved by the pressure relief valve is piped to the oil cooler in front of the radiator, and from there back to the intake of the oil pump. In the full flow system used in German cars, the oil destined to go to the galleys is piped to the oil cooler at the front of the radiator and then back to the filter head assembly to continue through the filter and into the galleys.

Physically, the distinction is like this: in the relief system, oil feeds out of the outlet elbow at the bottom front of the filter head to the right side of the cooler. From the left side of the cooler, it goes to a fitting on the bottom front of the sandwich plate on the crankcase. It doesn't simply return into the sump here, but instead goes directly into the inlet elbow on the bottom of the oil pump. Hence, the oil pump actually draws suction from two places: the sump pickup and the return from the cooler.

The front of the full flow filter head has a pair of fittings that don't exist on the early style relief filter head and are sealed off on later style relief filter heads -- the change probably due to the desire to use the same casting for both relief and full flow filter heads. In the full flow system, oil to the cooler starts at one of these fittings on the filter head itself instead of the outlet elbow; the outlet elbow still exists, but the port on the front is sealed off. The oil feed is piped to the right side of the cooler. From the left side of the cooler, it goes back to the other fitting on the filter head. The oil pump therefore has only one intake, from the pickup in the sump, and the bottom of the sandwich plate either has no hole or has a blank-off cover on it.

The relief system has an inherent shortcoming in that it tends to vary the amount of cooling incorrectly. When the oil is cold, it is also thick, and the pressure relief valve has to relieve a great deal of it in order to limit the pressure. As a result, flow through the cooler is high -- precisely when not needed. On the other hand, when the oil is hot and thin, very little or none at all is relieved, and hence flow through the cooler is minimal -- precisely when it is most needed.

The full flow system always flows the oil through the cooler before it goes through the engine, so there is always cooling. And, the coolest oil in the system is the oil fed to the galleys, so it can be expected to reduce the incidence of burned bearings.

The relief system has another trait that causes consternation. In order for a relief valve to work properly, it really needs to relieve to a place of zero pressure -- such as directly into the sump. Because this system relieves through the oil cooler, there may be a significant amount of pressure on the back side of the relief valve -- the backpressure caused by the flow of thick, cool oil through the tiny passages in the cooler. The pressure of the oil the engine sees -- and therefore the gauge sees -- is the relief pressure of the valve *plus* the backpressure of the oil cooler. The backpressure of the oil cooler will vary *greatly* with oil temperature; when cool and thick, the pump will be trying to push a great deal of oil through it, but when hot and thin it may see little or no flow at all. The combination of the viscosity changes and the flow changes make for extreme backpressure differences. As a result, the oil pressure registering on the gauge will vary quite a bit more between cold and hot than on most cars. This doesn't seem to cause any harm, but it does cause owners to get overly concerned.

If you wish to retrofit the full flow cooling system to a car that came with the relief cooling system, you will need the following parts. The corresponding part numbers for the relief system are also shown:

<u>Part</u>	<u>Relief p/n</u>	<u>FF p/n</u>
Oil Suction Pipe	C35512	EAC6424
Oil Suction Elbow	C33869	EAC6422
Oil Suction Elbow Gasket	C31063	C31063
Relief Assembly	C42796 or EAC7755	EAC6398
Relief Outlet Elbow	C38802	EAC6789
Oil Cooler	C43923	CBC2692

Oil Feed Pipe	EAC1380	EAC8954
Oil Feed Pipe	C38074	CBC2690
Oil Return Pipe	C38075	CBC2691
Oil Return Pipe	N/A	EAC8956
Retainer	N/A	EAC6413
Bracket	N/A	EAC6414
Clamp	C34608 (1)	EAC6800 (2)
Sleeve	N/A	EAC6790 (2)
Bracket	EAC1381	EAC6419

Plus a few bolts, nuts, O-rings, etc., all of which can be purchased locally. If you're the industrious type, you can probably improvise all those clamps and brackets too.

You might also be able to avoid buying the relief outlet elbow; you can reuse the old one if you can plug the opening in it. You will have the part that screws into it, oil feed pipe EAC1380, laying around doing nothing if you want to cut the fitting off and make a plug out of it.

The 1987 Parts Catalogue shows the same sandwich plate used for both systems; a square blank-off plate EAC6420 and gasket EAC6421 are used to cover the unused hole under the oil pump elbow on cars with full flow cooling. In all probability, later on when all cars were fitted with full flow oil cooling, the sandwich plate was altered to omit the hole. But anyone doing the retrofit is probably going to prefer simply bolting on the blank-off plate to replacing the entire sandwich plate. And they could easily make a blank-off plate and gasket rather than buy them.

To replace all these parts would require pulling the sump off the engine to replace the oil suction pipe and the oil suction elbow. However, in theory anyway, these replacements may not be necessary, and the retrofit might be accomplished without pulling the sump. The difference in the oil suction elbow is that the one for the relief system has the second inlet on it, and this inlet is readily accessible via the opening in the bottom of the sandwich plate. If this second inlet is securely plugged, it will serve the purpose of the EAC6422 part. This can be done by making a suitable part that plugs both the second inlet on the oil suction elbow and the opening in the sandwich plate, or by using a separate plug -- perhaps like the rubber expansion-type freeze plugs -- on the suction elbow, along with a simple blank-off on the sandwich plate. In fact, the original sump inlet adapter C37882 can be used if you find a way to plug it. Going this route would not only reduce disassembly requirements, but it also eliminates the need for purchasing a new oil suction pipe, oil suction elbow, and oil suction elbow gasket -- as well as bottom end gaskets you'll have to replace when you open it up.

Note that the difference in the oil suction pipe -- which is, in fact, the pickup -- is unknown. But there is no reason to believe the one designed for the relief system won't work properly for the full flow system. Perhaps the design was changed slightly to fit the revised oil suction elbow.

OIL PRESSURE RELIEF HOSE: While fiddling with the sandwich plate off, Karl Huff was told by a Jaguar shop that "while I'm in there I should replace the oil filter pressure relief hose (?) with a new one from the 6 litre engine." This is probably referring to the question mark shaped line.

OIL FILTRATION MODS: Much of the following was pilfered from an article by Nigel Calder in the March/April 1994 issue of Ocean Navigator magazine. It was primarily about auxiliary engines for sailboats, but the issues discussed here apply to any piston engine.

Oil contamination is divided into two categories: chemical and physical contamination.

Chemical contamination degrades the oil, causing a loss of lubricating properties, and also may introduce substances that attack engine parts. Heat and age can cause oil to oxidize and thicken, encouraging the formation of sludges and varnish. Water can be introduced even in a tight engine by condensation within the crankcase, and causes emulsification. If there happens to be any sulfur in the fuel, some can find its way past the rings and combine with water to form sulfuric acid which promptly attacks engine parts. Unburned fuel coming past the rings also dilutes the oil, lowering its viscosity.

Chemical contamination is combated by additives in the oil. Eventually, however, the additives are consumed and fail to counteract the contaminants. At this point, the oil needs to be changed.

Physical contamination refers to metal particles and dirt in the oil. The metal particles come from wear between moving parts. The dirt comes through the intakes, and a portion makes it past the rings. The problem is obvious in that such particles will increase the wear on bearings and the like.

It is tempting to take comfort that the oil filter is preventing the particles from getting into the workings of the engine. Unfortunately, it is not as effective as one could hope. The typical paper-element oil filter will catch particles down to about 30 or 40 microns, but damage is caused by particles down to about 2.5 microns. These smaller particles build up in the oil and pass right through the filter, cycling through the engine again and again.

The full-flow filter cannot be made with a tighter mesh because the restriction to oil flow would be too great. In addition, if the filter gets clogged, either the element breaks open (dumping all the dirt into the engine), or the flow is inhibited. Usually a relief valve is provided to allow oil to bypass a clogged filter, allowing crud of all sizes to circulate through the engine.

There are two excellent ways to combat physical contamination. The first is by installing a bypass filter. A small percentage of the pressurized oil from the outlet of the full-flow filter is diverted into a separate filter with a tight mesh element to stop particles down to 2.5 microns, and from there right back into the sump. An orifice is provided to prevent an excessive amount of oil from taking this route, which might starve the engine. If the filter gets plugged, no problem -- the flow stops, and 100% of the oil goes through the galley as before. But as long as a small amount is going through the bypass filter, within only a few minutes *all* of the engine oil is cycled through it and the amount of suspended particles is greatly reduced.

The other method is essentially the same, except that the bypass filter is replaced by a centrifuge that causes the particles to collect on the inside of a spinning cylinder. These are typically only available for larger engines.

These solutions are even better than changing oil at short intervals. Even with frequent oil changes, particles appear in the oil immediately and continue to build up. The bypass filter, however, continuously keeps such particles from causing engine wear.

Note that a bypass filter does not address chemical contamination. Such an installation would be effective at reducing engine wear, but the oil needs to be changed at the same intervals to prevent the additives from failing.

An outfit called TF Purifier (page 719) offers a package that includes a bypass filter system along with a small heater that boils off water, fuel, and coolant to minimize the chemical contamination so the additives last longer.

Surfing the WWW, Mike Claus found that other products are available from Baker Precision Bearing (page 714), Fram and Amsoil. "Fram offers an automotive by-pass filter in its product line that features a pleated-paper element and easy "spin-on" replacement similar to original-equipment-type units. Ask for the Fram "PB50" with mounting hardware.

"Amsoil's bypass unit is connected to the oil pressure sending unit and returns oil to the pan, thus requiring some mechanical ability or the services of your mechanic for the initial installation. The company states that its bypass unit, which employs a user replaceable, pressed-fiber element, refilters all the oil in an engine every five minutes, and keeps it analytically sparkling clean for the (recommended maximum) element life of 25,000 miles! It even extracts and contains any *water* that has (inevitably) condensed into the oil...which if allowed to remain in circulation will often result in the formation of corrosive acids."

Of course, one might immediately ask: if a bypass filter is such a good idea, why didn't such a quality automobile as a Jaguar come with one from the factory? Well, you have to consider the options the way the manufacturer does. The lack of a bypass filter will not cause engine failure before some extended mileage, especially if the owner has been paying the dealer for oil changes on a regular basis -- and even if the engine does fail due to dirty oil, the manufacturer is not likely to incur any liability. The additional cost, multiplying the cost per car times the thousands of cars sold, is significant. And the additional risk of failure -- one of the oil lines to a bypass filter blowing open or some such -- may be more than the company wants to accept. Just having to tell prospective buyers that there are *two* oil filters that need regular changing may be seen as a marketing disaster, especially in this era of drive-it-and-forget-it cars.

You, as the owner of the car, may think differently. You have a significant investment in your car, the risk of a blown high-pressure oil hose is no big deal to you (messy, but not particularly expensive), and you are the guy who will have to pay for a new engine when this one wears out. Basically, if you are the type to own a Jaguar for the life of the car, a bypass oil filtration system would be a wise investment. Of course, if you plan on selling the car soon, or plan to crash it rather than wear it out, it'd be a waste of money.

PRE-OILING BEFORE STARTUP: A lot of the wear on any engine occurs at startup, when the engine must run for a few seconds before oil pressure is established. Russ Lehman sends this tip: "I've got a "Pre-Luber" on my van because it only gets driven about once a week or so, and the pre-lube brings the oil system up to pressure by pumping oil through the engine before starting. These pumps are fairly common on marine engines for the same reasons.

"The pump is fed from a line attached to the oil pan and pumps into a tap where the oil pressure sender is attached. The pump allows oil to pass through the normal routes for normal engine operation, while not allowing oil to pass backwards through the pump (I think it's a piston pump). The motor is switched through the ignition key in the aux position (controlled by MOSFETS), and will stop when the engine ignition is switched on."

There are other systems, including a simple pressure reservoir that holds pressurized oil after shutdown. During startup, a valve is opened, pressurizing the system before the starter is engaged.

Note that such systems may be of limited benefit. While the bearings in the bottom end of the engine may experience much less wear, it is not usually worn bottom-end bearings that require an engine rebuild. More often, it's worn pistons/rings/cylinders that eventually convince an owner it's time for an overhaul, and a preoiler does little or nothing to reduce piston/ring/cylinder wear.

ADDING EMISSIONS CONTROLS: Huh? Well, Germany now has a taxation system that penalizes cars without emissions controls so severely that many German XJ-S owners are seeking to retrofit. For many years the German version had no catalytic convertors or oxygen sensors even though they were provided in the US.

According to Jeffrey Gram, the following outfits (all in Germany) will install emission controls in cars that were not originally equipped with them:

Ernst Apparatebau, Hagen, Tel +49 (0)2331 3600-0

GAT-Abgastechnik, Gladbeck, Tel +49 (0)2043 24021

Gutmann, Breisach, Tel +49 (0)7667 1091

G+M Kat, Gladbeck, +49 (0)2043 42410

HJS Abgastechnik, Menden, +49 (0)2373 9870

Oberland, Garmisch-Partenkirchen +49 (0)8821 1036

Oettinger, Friedrichsdorf +49 (0)6172 7053-55

Walker, Viernheim, +49 (0)6204 738-0

Waschkuttis, Wiesenthau, +49 (0)9191 96495

Wurm, Stuttgart, +49 (0)711 420071.

IF ALL ELSE FAILS: Most Jaguar owners feel that if you want a Chevy, you should buy a Chevy. But there are those who think otherwise, and for them there are several outfits that offer kits for replacing the Jaguar V12 with a Chevy V-8. John's Cars (page 717) offers two kits for the XJ-S, one for a small block Chevy and one for a big block. Another outfit to check with is Jaguars That Run (page 717).

The 90° V-8 is an excellent engine layout; it has even firing order, and its primary and secondary imbalances are 100%

correctable by simply casting counterweights into the crankshaft. The problems with the classic Chevy “lump” are not that it’s a V-8, or even that it’s cast iron; it’s problems are: A) It has pushrod-operated valves, which require compromises in cam profile, which in turn generally means it’ll either produce lots of power or have a good idle but not both; and B) It employs a timing chain with no tensioner, which results in an engine that runs rougher and rougher as it wears. Both of these problems were addressed and corrected by all major European automakers in the 1960’s, and by all Japanese automakers in the 1970’s. Both Ford and Chevy finally introduced V-8 engines with overhead cams and intelligent camshaft drive systems in the 1990’s, apparently in response to competition from Lexus and Infiniti.

Sir William Lyons, founder of Jaguar, apparently didn’t like V-8’s. When Jaguar bought out Daimler in 1960, Daimler had two V-8 engines in production, and Lyons scrapped one of these immediately and the other a few years later. When it became apparent that the venerable Jaguar XK inline 6 would no longer cut the mustard, Lyons responded with the V12.

If you must shoehorn a cast iron V-8 into your Jaguar, do yourself a favor and purchase some cast aluminum valve covers. They will absorb a lot of the noise of the valve train. A cast aluminum timing chain cover will also help reduce racket. Replacing the timing chain with something with less slop, like a set of gears, will make the engine run smoother.

Of course, a better idea yet would be to opt for the newer cast aluminum Y-block Chevy V-8’s. Not only are these engines far superior mechanically to the cast iron models (despite retaining the pushrod valve train), they also come with modern EFI and ignition systems and improved automatic transmissions.

IGNITION SYSTEM

SPARK PLUG REPLACEMENT: Note that this task is much easier on the pre-H.E. because the spark plugs are vertical. On the H.E., the plugs are tilted inboard just enough to make the job truly miserable. Most of the tips below were developed to deal with the H.E.

First problem is getting the plug wires off -- and back on later. Jan Wikström, who owns a pre-H.E.: “I’ve made up a pair of “pusher” tongs out of a bent piece of 4mm high-tensile fence wire. Same idea as the common barbecue tool, but the jaws originated as a short piece of 9mm copper pipe split lengthwise and brazed to the wire. This gets a good grip on the cable just above the rubber cap on the terminal. This tool needs to be bent to a slight angle above the jaws.” The same idea might work on the H.E., but expect to have to vary the details to make it work well.

Another idea is to use a length of 1/4” steel tubing and some bicycle brake cable to make a “snake grabber”.

If you have access to a wet/dry vacuum cleaner, use the hose with no attachments to clean around the plugs before removing them. Just poke the hose over the end of the plug. Compressed air can also be used. John Bertsche adds: “I came up with a cool tool for cleaning out the crud around (and in) the spark plug holes. A turkey baster -- pull off the bulb, duct-tape the other part to your shop-vac hose, and you’ve got a high-intensity, pinpoint (well, almost) vacuum nozzle that’ll fit right into the spark plug hole. Works great! You can use it to scrape dirt and crud out of almost any nook and cranny, and it won’t scratch the aluminum.” Note that you can purchase a set of small vacuum attachments at Wal-Mart intended for cleaning things like computer keyboards, and those attachments would also work well here.

Using normal tools, it generally requires removing the cruise control actuator and unbolting the A/C compressor on the H.E. to replace the 1A and 1B plugs. Matthias Fouquet-Lapar says, “Jaguar offers a tool, it’s in the rear-section of the XJ-S parts manual. It fits perfectly and you don’t need to remove the A/C compressor.” Steve Holst says, “I ended up using the official Jaguar spark plug removing tool that came with the tool kit to replace the plugs. It worked wonderfully and I didn’t need to move the A/C compressor one bit. I ended up unbolting the cruise bellows only. I’m very glad I gave it a try.” This plug wrench (CAC5368) comes in the XJ-S tool kit, but it’s amazing how often used cars don’t have a tool kit. If you need to buy the plug wrench, shop carefully; they supposedly can be had for under \$20, but Jaguar dealers have been known to ask much more than that.

Ah, but things are never that simple. Peyton Gill says, "The tool's socket well was too shallow for the NGK plugs I installed." Graeme Mawson concurs: "My car is an '85 V12 with NGK plugs; the tool provided does not fit over the plug, i.e. the stem of the plug is too long for the barrel of the tool! Perhaps there are two different tools!"

After much discussion about differences between types of spark plugs, it turns out that Mawson is correct -- there are two different tools. The earlier tool, CAC5368 -- used up until at least Peyton Gill's '86 -- will not fit a spark plug. However, sometime later Jaguar revised the tool so it *would* fit a spark plug. The two wrenches appear to be identical in construction, but the later version, CBC4096, has a hole in the top of the socket that goes all the way through; when a spark plug is in place, you can peer in between the pivot joints and see the top of the electrode. Brian Schreurs says, "It does not come with the T-handle so one would have to buy a piece of rod and cut to fit." The T-handle is C36612/2, a part number for a straight piece of steel rod.

Apparently, the spark plug tool part number was superseded again by CCC4813. It's not known what that difference is.

It may be possible to modify the earlier tool by simply drilling a hole through it. You'd hope that it's not -- you'd hope the tool is made of harder steel than that -- but in fact it appears pretty soft and cheap and may be drillable. John Bertsche says, "The factory tool I had in the trunk fit on them fine...just wasn't up to the stupendous amounts of torque required to crack them loose." David Littlefield says, "The factory tool is very cheaply made, frankly. Mine has a big sticker on it with a British flag and says "Thanks for buying British!" I kept ending the phrase in my mind with "in spite of the fact that you are spending half your weekend trying to change impossibly located spark plugs with the incredibly cheap, POS tool we supplied you.""

There are T-wrenches sold for 5/8" spark plugs, and a good one might actually do the job. Unfortunately, all this author has found are cheap ones -- even poorer quality than the Jag OEM tool -- and the swivel invariably breaks as soon as torque is applied with the swivel in any position other than straight, which makes them worthless for this task. Mawson says, "I have bought several box type tools to undo the plugs but as indicated above they always break or 'round off' long before all 12 plugs have been removed. Furthermore on the V12 without removing the likes of fuel lines, A/C compressor, cruise control, distributor or throttle mechanism, when the tool does break (with stupendous amounts of torque applied) it is more than likely that other things get broken as well (usually fingers or knuckles)."

Littlefield says, "Another suggestion for an under-the-compressor tool might be to cut down an old spark plug socket that has the flats on it, and maybe even enlarge the ratchet hole so it can fit further down the plug." Using this idea, Larry Barnes made a tool that actually works: "I took a regular spark plug socket and:

1. Removed the rubber thing in the inside.
2. Ground off *both* ends so an open-end wrench would still work on the top part, and the bottom would still come to the "nut" part on the spark plug.

"I use this modified plug socket for plugs 1A and 1B only. Works great without removing the compressor." On the H.E., make sure to start with a 5/8" spark plug socket; most spark plug sockets are 13/16". All in all, this is probably the best way to go; it is easy to find a 5/8" spark plug socket in whatever quality you desire, they don't cost all that much, and most of them have an external hex on the top. Once you get the socket suitably cut down to fit past the side of the A/C compressor and onto a plug, you can simply use a box-end or open-end wrench on the external hex to get the plug loose. Most importantly, if you're careful you can apply serious torque without the slightest sideways force on the plug; many owners have ended up with plugs broken off at the top of the threads, which is not fun to fix.

There is one more possibility in spark plug tools. J Harper points out that Eastwood Tools (page 704) offers a telescoping spark plug socket. This thing collapses into a little hockey puck which you position over the plug, and then telescopes into a socket shape around the plug. Cute.

Even with a workable tool, you might want to move the compressor anyway. Fouquet-Lapar, despite having the plug tool, says, "I still remove the compressor and the throttle pedestal, mainly to clean things up at the same time." Littlefield left the compressor in place and says, "after this experience, I think I know what surgeons go through during an operation. Working through a narrow hole with long instruments, trying hard not to break something vital. I was even using forceps to hold tubes and wires back to get to the areas I needed to go!" Craig Sawyers says, "I have that Jag tool. However, I have always found it impossible to use under the aircon compressor. The problem is that the

swivel joint is operating very nearly through a right angle, and is very inefficient as a result. Besides which, even if it is possible to get the plug out with the tool, it must be fraught with danger of cross-threading when putting it back, or replacing with new. In fact, the last XJS I moved the compressor out of the way to do the plugs (my brother-in-law's) had three chunks of broken plugs lurking under the condenser. So I now always move the compressor (a ten minute job) and the throttle pedestal (a further ten minutes) and make the whole process more clinical. Besides which, after vacuuming the crud from the centre of the V, you can then use a nice deep socket, and a torque wrench to get the things in "by the book".

If you decide to remove the throttle pedestal, John Napoli says, "Rather than removing the coil, throttle switch, etc. separately, consider removing the whole ball of wax as one. Simply remove the four bolts holding the throttle stand to the engine valley, and it all comes out as one."

You may run into problems getting those four bolts out as well. It's not too difficult to remove in the midst of an upper-engine teardown when you're taking everything out of the way anyway, but for the spark plug job you'd like to remove *just* the pedestal without removing things like the oil pressure sender. The problem is the two bolts at the rear side of the pedestal; they are easy to see, but not so easy to get a wrench on. First tip: obtain a 7/16" swivel socket -- or a 10mm swivel socket if the later engines have metric bolts here.

The first time you have the pedestal off, saw off the lugs on the right side that were apparently originally intended to hold a coil. That will make access a *little* easier next time.

Napoli decided to make some access holes in the pedestal: "On my car, I modified the throttle stand further to lighten it, improve airflow in the area, and make it easier yet to get in and out. I drilled a series of large holes all over. Cleaning it all up and polishing a bit makes it look nice, improves gas mileage, reduces emissions, and decreases quarter mile times."

Peter Cohen says, "The last time mine was out, I slotted the holes for the two rear bolts so that I could start the threads and then mount the pedestal."

As long as you're going to the effort of taking the plugs out, it wouldn't be a bad idea to go ahead and perform a compression check. It's a good way to keep a watchful eye on engine condition.

Before installing the new plugs, it is recommended the time be taken to carefully inspect the threads. Competition is fierce among the plug manufacturers and they generally cannot afford to spend a lot of time and effort making perfect threads every time. One small burr on a steel spark plug can wreak havoc on the threads in the aluminum head.

Be sure to use anti-seize compound on the threads. Do not use normal grease, as this may hamper proper grounding of the plug, and it also may get hot and form a crust that makes it even harder to remove the plugs. And do not use a graphite-based lubricant, as graphite may react with the aluminum and weaken it.

When installing spark plugs, it is helpful to use a piece of 3/8" hose to get them started. Press the hose firmly over the top of the plug and use the hose to feed them into place and thread them in finger tight. Then the hose can be pulled off and a socket used for final tightening.

There are warnings not to tighten the plugs past 8 ft-lb. of torque. 8 ft-lb. is not enough to turn the plugs loosely in the threads unless they have been recently cleaned and chased, but the point is well taken. It is an aluminum head, and tightening "three grunts" is both unnecessary and costly. Just tighten until you feel them seat, make sure they're snug, and quit.

SPARK PLUGS: A quick survey of a group of Jaguar experts clearly indicates that NGK is the plug to use. The study may have been unscientific and the reasons may have varied, but the consensus was clear and overwhelming.

The H.E. engine uses taper seal plugs; the pre-H.E. engine uses washer-seal plugs. For the H.E., NGK used to make at least two plugs, TR5 and BPR6EFS. Both were resistor type, but the TR5 was a "V-Power" plug with a little notch cut in the center electrode. Jim Moore says, "They go by numbers now; an NGK 2238 is recommended by NGK for my '85 XJ-S, turns out it has TR5 written on other end of box and on the plug."

There are many gimmicks used to sell spark plugs. One common feature that may be of some benefit: It is easier for a

spark to jump to an edge or point than to a flat surface. This is why lightning rods are pointed. Many of the cute configurations of spark plugs result in there being more edges on the electrodes instead of flat surfaces. The notch in the center electrode of the NGK V-Power plug is such a feature.

Supposedly, it's actually more important that the sharp edges be on one electrode than the other. With old-fashioned ignition systems, the center electrode was always the anode and the ground was always the cathode -- and the sharp edges really need to be on the cathode, which means they're on the wrong electrode with the V-power plugs. Apparently NGK fixed that; Richard Mansell quotes from a Jaguar publication on the changes for the 1992 model year:

"A new design sparkplug, BR7EF, incorporating a V groove earth electrode, is fitted to improve efficiency and provide better firing consistency."

Note that very little else changed about the Jaguar V12 for the 1992 model year; one can safely conclude that the upgraded spark plugs would work well in older H.E. engines.

NGK certainly isn't the first company to offer multiple sharp edges on the ground electrode. ND plugs have had a grooved ground electrode for years. A highly-advertised plug called the Splitfire charges several times as much as regular plugs for providing a couple of extra edges for the spark to jump to.

If you happen to have a distributorless ignition with double-ended coils (only offered on Jaguar V12's in the mid-90's, and only in the saloon) then half the plugs have their polarity reversed, and the sharp edges need to be on the center electrode again! You can't win.

Another idea in spark plugs that gained popularity in the 90's is platinum electrodes. Platinum is an obscenely expensive metal -- makes gold look cheap -- but it doesn't take much of it to make a spark plug electrode, just the tiniest dot at the gap. And that dot makes the plug last several times as long, which is the reason some modern cars can claim 100K miles before the first tune-up. Note that while platinum-tipped plugs may cost considerably more than standard plugs, they do not offer any improvement in performance at all; their entire benefit is in durability.

Following the crowd, NGK has introduced new plugs for the V12, similar to their earlier offerings but with platinum in the tips. As a result, it is increasingly difficult to find non-platinum NGK plugs. David Buchner doesn't like platinum because he feels you should get in there and check things more often than every 100K miles, but even with such an attitude one might be forced to use platinum plugs and just regap and reinstall them! Might wanna be careful about filing the gap, though; platinum isn't all that hard, a few passes with a file and the little dot might be gone!

Bosch Platinums were among the first platinum-tipped plugs to make a name for themselves -- and it was a bad name. Randy Wilson says "I've found that Bosch standard plugs do not perform quite as well as Champions or NGK, but are better than most common American plugs. I have, however, never had any success with their platinum plugs. If the engine is running well, they don't seem to make any improvement, and if the engine is not well, they foul easily and are not cleanable." But don't let the bad reputation sour you on either platinum or Bosch plugs; Bosch has since introduced the "Platinum +4" plug, which has four ground electrodes (more edges!) but also seems to have corrected the problems the earlier Platinums had.

There is no appreciable disadvantage to using resistor plugs. The resistance limits the current flow, which in turn reduces spark plug wear and radio interference. Prior to the actual spark, there is no current flow so the resistance has no effect on the voltage available at the electrodes.

SPARK PLUG GAPS: The proper gap for the H.E. engine is 0.025" -- you can confirm this by checking the decal on the underside of the hood. Most plugs come out of the box with a 0.032"-0.035" gap. The gaps *must* be checked prior to installation. Oversize gaps can cause poor performance at high RPM, but worse they can contribute to rotor failure and resulting catalytic convertor meltdown in cars equipped with Marelli ignition -- see page 161.

Reports are that some dealers are installing spark plugs with 0.035" gap. If your dealer is doing this, the least you should do is never darken his doors again. Better yet, file a complaint with the EPA, since spark plug gaps are an "emission critical" specification (that's why it's on the decal under the hood) and it is *illegal* for them to be violating it. If you happen to suffer a catalytic convertor meltdown as a result, *please* sue the dealer and help put him out of business.

STRIPPED SPARK PLUG HOLES: Since you have read this book, used anti-seize compound on the spark plug threads, and didn't overtighten, *you* will never strip spark plug threads. However, the PO³ or the idiot you've been taking the car to for service may not be so careful and leave you with plugs that simply won't come out without bringing the threads with them. Aaargh!

The official Jaguar fix involves recessing, drilling and tapping the holes for larger threads, installing an insert, and installing a small pin to prevent the insert from unscrewing. Note that the inserts will be different for H.E. and pre-H.E. engines, since the pre-H.E. used washer seal plugs while the H.E. uses taper seal plugs. Generic inserts may work fine, but regardless of insert used the head surface should be recessed prior to installation to ensure that the tip of the plug will be positioned at the same level as before. If the surface is not recessed, the plug will seat in a slightly retracted position and result in a lower compression ratio on that cylinder as well as possible effects on the swirl pattern in the H.E.

Mike Morrin reports success using helicoils to repair the H.E. plug threads -- something one wouldn't expect would work, since it would appear to require drilling out the hole far enough to destroy the taper seat. "If drilled carefully, about 30% of the taper seat is lost. I think the remaining seat is still enough for a good seal."

SPARK PLUG INDEXING: Does "anal-retentive" have a hyphen? If you answered yes, you may be interested in knowing that "indexing" spark plugs may improve performance in the H.E. engine. In the H.E. combustion chamber, the compression stroke squeezes the fuel/air mixture out of the area over the inlet valve and into the area over the exhaust valve, causing a swirl. This fuel/air mixture is swirling when the spark occurs. If the ground electrode on the spark plug happens to be positioned with its back side into the swirl, then the spark is partially hidden from the fuel/air flow, possibly hindering proper ignition.

To avoid this, mark the side of each spark plug with an indelible magic marker to indicate where the ground electrode is. The position you want to *avoid* is with the back side of the ground electrode aimed toward the nearest end of the head; in other words, you don't want the electrode on the spark plugs in the front three cylinders on the forward side and you don't want the electrodes on the spark plugs on the back three cylinders on the aft side. If any end up in these positions when installed, then exchange that plug with another.

Please do not use a lead pencil to mark the plugs. Graphite conducts electricity, and will cause "tracking" down the side of the ceramic and short out the spark plug. Your engine will run much worse than before you indexed the plugs.

SPARK PLUG WIRES: If your ignition wires need replacing, there's really no reason to buy the Lucas originals; several companies offer aftermarket sets to fit the Jaguar V12. Or you can purchase two 6-cyl or 8-cyl ignition wire sets from any auto parts store and combine them into a set for the V12. Here are some tips:

You can get anything from a roll of wire and a package of connectors all the way to completed, ready-to-install sets; I used a "semi-tailored" set -- one end of each wire comes with the spark plug connector attached, but you cut the other end to length and attach the distributor cap connector yourself. The wires on the V12 are shorter than most, and this permits the right length so you don't have lots of excess wire laying around.

Another feature to look for is the angle of the spark plug connector. Some are straight, some are 90 degree, a few are 45 degree. What the V12 needs is a slight bend; the ideal kit has connectors that are straight to begin with but can be bent to whatever angle is needed. This allows providing different bends at different cylinders -- working on these plugs, you need all the help you can get!

There is also the issue of bends at the distributor cap end of the wires. Some wires have straight connectors so they come straight upward out of the cap, while others have 90° bends here so the wires come off the sides of the cap. Either will work on the XJ-S, both are a pain to install and route.

³ "PO" is a car collector's term for "Previous Owner". It is often used with a derogatory connotation. Sometimes the abbreviation "DPO" is used.

There is also the choice between 7mm and 8mm wires. Ideally, one would choose 8mm wires, since the Jaguar ignition system is really hot and it's all but impossible to route the wires away from other things. Magnecor (see below) offers a 10mm set!

Most aftermarket kits seem to be bright colors. Deal with it.

Jim Belkoff writes, "I found that Pep Boys can special order a custom set of 8mm silicone wires that are made in the US by Borg-Warner. I paid the \$45 in advance and picked them up a day later. They are of high quality and include three wires with 90-degree plug boots (for the number one wires at the compressor and another location - your choice, I guess). The kit even came with a tube of dielectric grease.

"For those of you who don't like the bright aftermarket colors, take heart - this set has tasteful light grey wires, black plug boots and dark grey distributor boots.

"The length was very close on most, and exactly spot on with some of them. Even the ones that were a shade long weren't so huge that they flopped every which way. I have had problems with aftermarket wires in the past (mostly semi-custom 7mm sets) and these are the closest in length and the highest quality I have used so far."

John Smith of Brisbane, Australia says, "I noticed that most parts shops have made up spark plug wires in a variety of lengths. I bought a set, nice blue colour, that had 90 degree connectors for the distributor and straight connectors for the plug ends - the same as the original wires.

"I measured the various original wire lengths and these are:

1A	38cms	(15 inches)	1B	43cms	(17 inches)
2A	25	(10)	2B	35	(14)
3A	28	(11)	3B	17	(7)
4A	30	(12)	4B	25	(10)
5A	40	(16)	5B	38	(15)
6A	38	(15)	6B	46	(18)
Coil	19	(8)			

These wires were 8mm and fitted perfectly."

Greg Benjock bought an 8mm Belden Wire set from NAPA and was *not* very happy with it. "The custom ordered kit came with wrong terminations (all were 180deg). All 13 terminations on the distributor cap in fact must be 90 deg type. And terminations and boots for plugs 1A, 6A, 1B, and 6B are best fitted with 90 degree units. It looked very much like an inexperienced person put the job together." Of course, maybe the cap connectors are a matter of opinion; this author's are all straight connectors and work just fine!

All that said, it should be noted that the original Lucas wires are usually not very expensive; the only valid reasons for using aftermarket wires are availability, a need for a dash of color, and a healthy contempt for all things Lucas.

SPARK PLUG WIRE THEORY: When the 12V power to the coil is cut off, the magnetic flux causes a spike in the voltage at the high tension lead. When that voltage rises sufficiently to jump the gaps in that circuit (one between the rotor and cap in the distributor, another at the plug), current begins to flow.

Once a spark begins, the air is ionized at both gaps. This drastically lowers the electrical resistance of the gaps themselves. With 50,000 volts or so to work with, the current flow can rise dramatically. If allowed to rise unrestrained, this has several detrimental effects. First, the high current flow drains the energy stored in the coil quickly, so the spark doesn't last as long. Second, the high current flow tends to erode the spark plug electrodes faster than necessary. And third, the high current flow causes a considerable amount of radio interference due to EMI radiating away from the plug leads. Besides all these negatives, there are absolutely no positives. High current flow is not beneficial to the ignition process, only the voltage needed to start the spark is necessary. Advertisements talk about getting "energy" to the plug gaps (energy is voltage x current x time), but that's usually a sign of a company trying to peddle snake oil; the only place in an ignition system to be concerned about energy is in building up the field within the coil (the energy the Lucas "Constant Energy Ignition" and the GM "High Energy Ignition" are referring to).

It's easy to limit the current flow once the spark occurs, though: Put a resistor in the circuit. A resistor won't affect the onset of spark at all, because before the spark occurs there is no current and therefore the resistance is of no consequence. But once the spark begins and current begins flowing, the resistor comes into play and limits the current flow.

There are several places to put resistors in this circuit. Using "resistor" type spark plugs is common. Also common is the use of spark plug wires with a carbon-impregnated core, which offers some amount of resistance per inch of lead. Perhaps not so common, it is possible to purchase resistors that fit into the wire between the coil and the distributor.

Plug wires are all different lengths within the same car, so use of common plug wires will result in a different amount of resistance between one plug and another. This doesn't matter, as long as there is some resistance.

Some people think spark plug wires with copper conductors are a good idea. Clearly they fail to notice that such wires are generally the cheapest available -- yet do not come on *any* cars as original equipment. If used with non-resistor plugs, there will be no resistance in the circuit at all, and the plugs will be eroded quickly -- if the coil doesn't burn up first. Copper core plug wires should be avoided for all applications, except perhaps fitting a new lead to your timing light; the copper is easy to solder.

A more recent development is the spiral core plug wire. The core of these wires has a very fine stainless steel wire coiled into what looks like a long, skinny spring. Stainless steel isn't an excellent conductor as metals go, but it nevertheless would provide an essentially zero-resistance current path if it were straight; the current limiting factor here is evidently the coiling. Magnecor (page 707) offers such wires but is mum about the theories on which they work, claiming that too many competitors want their information. Judging from their descriptions, they appear they work like this: The spiral core behaves as a long inductance coil. Before the spark occurs, there is no current flow, so the inductance is of no concern -- same as the resistance in the standard setup. Once the spark begins, the high inductance of the leads prevents the current flow from rising instantly but permits it to rise gradually instead -- and the ignition coil runs out of energy before the current flow can rise to a dangerous level.

Magnecor claims several benefits to this design. One claim is that they will outlast the standard wires, because stainless steel is more durable than the carbon-impregnated silicone core. Another benefit is that these wires are more flexible, and several XJ-S owners have reported this is true and a blessing in the top of the V12. Perhaps the flexibility is a large part of their longevity as well, since neither stainless steel or carbon-impregnated silicone should deteriorate before the insulation layers do on either type wire, but bending the carbon-impregnated silicone wire too tightly will damage it for sure.

Magnecor also claims reduced radio and electronics interference. This is important because modern cars with EFI can get all screwed up if the spark plug wires emit enough EMI to cause spurious signals in pickup leads. The spiral core wires have the theoretical benefit that the magnetic field generated is aligned with the lead rather than radiating away from it in all directions. Franck Guilloteau says, "On their claims; the idle stumble that I had was reduced noticeably, but my stereo has developed an annoying noise....so much for RFI shielding!" Perhaps a good idea would be to use spiral-core wires in conjunction with resistor plugs, just to be sure.

CAP AND ROTOR RENOVATION: Most of us just buy new parts periodically, but Danny Rearden says, "High tension ignition components such as distributor caps and rotors are generally only faulty if they are cracked, or have carbon tracks on the surface. Even both of these conditions are usually repairable if you are prepared to invest a few hours. My dad specialized in repairing obsolete vintage and racing ignition systems and magnetos where parts were completely unobtainable.

"Clean the part, first with solvent cleaner, then with strong hot detergent solution and dry thoroughly. Inspect *very* carefully, with a magnifying glass if your vision is not 20/20, looking for any surface marks which were not intended to be there.

"If there is no visible sign of high voltage tracking, go to polishing. Otherwise use a hobby knife and scrape the surface until you get to totally clean material, even if this means making a hole in the component.

"Grooves and holes can filled with epoxy filler. We always used Epiglass Low Density Filler, designed for boat repairs.

It seems to have very good thermal and electrical properties, and it does not run while curing. File and sand the repair back to original profile.

“Polish out any marks (both in the original part and any repair), using abrasive paste, such as perspex polish or cutting compound. These surface marks, if not removed, will be future failure points.

“If the part has a dull, porous look to the surface, a light spray of a suitable clear paint may be in order, but don't overdo it. If the repairs were to a visible part, then coloured paint can be used.

“In the 25 years my dad was doing these repairs, I can only recall 1 or 2 items failing again, out of several hundred, and these were subject to 'owner abuse'.

“The important things are:

- remove any trace of previous tracking
- polish or fill any holes, cracks or scratches which could accumulate dust and moisture
- stop moisture getting into the ignition in the future”

KEEPING THE IGNITION SYSTEM COOL: Possibly the worst area for heat problems is within the “V” on top of the engine. Early XJ-S's had so much trouble with cooking the ignition amp that Jaguar created a relocation kit to move it out of this area. Cracked distributor caps have been a problem. Seized centrifugal advance mechanisms are a problem. The wiring harnesses within the V always seem brittle. All of these are symptoms of excessive heat.

Maintaining a good airflow through the engine compartment does wonders for minimizing such heat-related problems on components. However, airflow to the V is largely blocked -- not by the A/C compressor so much as by the plate supporting the front of the compressor. See page 505 for notes on correct installation of this plate.

One simple way to improve things would be to cut a big hole in this plate. Be careful to leave enough metal to properly support the compressor, but this will still allow a substantial opening. Since this area is directly behind the main fan, the hole should allow some airflow under the compressor and throughout the V area.

IGNITION SYSTEM TYPES: There have been four distinct types of ignition system fitted to the XJ-S. The first two were Lucas systems, so you can't simply refer to the “Lucas ignition system” without causing confusion.

Up to 1982, the XJ-S was fitted with the same Lucas OPUS system that was used in the Series III E-Type. This system uses a plastic disk with 12 ferrite inserts within the distributor to trigger the ignition. From 1982 to mid-1989, the Lucas Constant Energy Ignition system (Lucas CEI for short) was used; this system uses a 12-pointed iron star wheel inside the distributor. These two systems can be distinguished by the amplifier; the OPUS amp is a finned aluminum block that may be located between the banks, on top of the radiator top support, or any of several other places; the Constant Energy amp is a black, flat rectangular item bolted to the top of the left side intake manifold.

It must be clarified that the most obvious distinction within the Lucas distributors has nothing to do with ignition types. Up until 1980, the XJ-S had a Bosch D-Jetronic EFI system that required a trigger board within the distributor and a rotor with a magnet in the counterweight. From 1980 on, the Digital P EFI system was used, and it merely picked up the ignition pulses -- no trigger board required. So, the same four screw holes in the distributor housing were used to mount a clear plastic anti-flash shield, and a new rotor with no magnet was used. A different cap was introduced to go with the new rotor. The OPUS ignition system, with the plastic wheel, continued in use for two more years.

The XJR-S was fitted with a Zytex ignition system.

In mid-1989, the Lucas Constant Energy Ignition system in non-XJR-S cars was replaced with the Marelli, which is an all-electronic system -- there are no mechanical or vacuum advance mechanisms, the timing is handled by an electronic control unit based on crank sensors. The Marelli system still uses a distributor, but it only serves to allow two coils to fire twelve cylinders; it does not include any timing or triggering functions. This distributor is very distinctive in that the cap has connections for two separate ignition coils, one at the center and one off-center, and has no vacuum advance

module.

There is a fifth type of ignition system fitted to the Jaguar V12, and that is a Nippondenso distributorless system used the last year the engine was made. However, reportedly this system didn't make it into the XJ-S; it was used exclusively in the last year of the XJ12.

IGNITION SYSTEM REPLACEMENT: Replacing an ignition system isn't automatically an improvement; exactly what an ignition system replacement accomplishes depends on what you are replacing and the sophistication of the system you're installing. The pros and cons of ignition system replacement are therefore covered within the discussions of each type of ignition system found on the Jaguar V12.

Lucas Ignition (OPUS and CEI - up to 1989)

IGNITION SYSTEM DESIGN: An ignition coil requires a certain amount of time to build up enough energy to produce a spark. The faster an engine is turning, the less time there is between sparks, so the output of an ignition coil starts to drop off. It is also apparent that the more cylinders there are, the less time there is between sparks, and the output of the ignition coil drops off even faster.

Another lesson in physics is that the higher the compression, the more resistance there is for electricity to jump a spark gap, so higher voltage is required.

The Jaguar V12 H.E. has 12 cylinders, turns at 6500 RPM, and has 11.5:1 compression, making it one of the biggest challenges for an ignition system in production automobiles. To cope with this, Jaguar has incorporated some sophisticated ignition technology. Also, Jaguar uses a spark plug gap of only .025" to make it easier for the electricity to jump the gap.

ROTOR REPLACEMENT: Replacing the cap is straightforward enough, but getting the rotor off is likely to be somewhat difficult since it tends to jam. All you can do is twist, rock, and pull, and hope you get lucky and don't break it. Or just have a spare on hand. On the Digital P cars, there's not enough room between the rotor and the anti-flash shield to get a good grip on it, so Ned Wesley says, "if you need to remove the rotor, the method I use is as follows: make two loops of string or wire about equal in length to the rotor. Place one loop over the front of the rotor and the other over the back. Bring the loops together so that pressure is applied equally to both sides of the rotor. Give the loops a slight tug and the rotor will come off."

If the rotor carrier shaft seems to want to come upward with the rotor, the rotor carrier shaft retainer is broken. You need to try to hold the rotor carrier shaft down while pulling on the rotor by inserting a screwdriver through an opening in the anti-flash shield or some such. This is a good idea anyway to *avoid* breaking the rotor carrier shaft retainer. Once the retainer lets loose, pulling upward on the rotor carrier shaft will stretch the centrifugal advance springs far below, and you will be in for a distributor recalibration.

IGNITION TIMING: The proper advance setting is indicated on a decal in the engine compartment. If it differs from the book, believe the decal. The Haynes manual on page 329 seems to indicate that a N America 1981-on Digital P car should be timed at 25 to 27° BTDC at 3000, which doesn't seem to have any basis in reality; the underhood decals always indicate 18° BTDC at 3000.

The next thing to confirm is that the woodruff keys that align the front pulley with the crankshaft are in good condition. They are a known problem, and clearly if the pulley is allowed to reposition itself on the crank, use of the timing marks will be a disaster. The woodruff key problem is discussed further on page 90.

Before you get under the car with the engine at 3000 RPM, you might want to note what the timing mark actually looks

like on the damper. There is a simple line with the letter A next to it. Unfortunately, the timing indicator plate covers most of this up, so when you're trying to set the timing all you see is the tip of each so it looks like VI. Trying to figure out whether you're supposed to be using the I or the point of the V to indicate the timing can be confusing. An illustration in the Haynes manual makes it clearer: You must use the I mark.

On the Jaguar V12, the timing indicator itself is adjustable. If there is any chance it has been tampered with (the oil pan and sandwich plate have been removed), then the position of the indicator must be calibrated before checking the timing.

The official method for setting this indicator is to do it when the right side (A bank) head is off. A dial position indicator can be set up to determine when the 1A or 6A piston is at TDC. If a position indicator that will fit through a spark plug hole is available, this same method can be used with the head in place by removing the spark plug from either cylinder 1A or 6A. Once TDC is determined, loosen the two sandwich plate bolts that hold the timing indicator plate in place, and slide the plate on its slotted holes until 0° lines up with the mark on the pulley.

If you happen to have the 1A head off and are going through this setting procedure, Craig Sawyers has an idea to make the setting more accurate -- or, conversely, to make it accurate enough using non-precision measuring tools: "The manual says to set piston 1A at TDC by using a dial guage, but even this is highly inaccurate. If the dial guage has an accuracy of 1 thou, this corresponds to a setting accuracy of 2 degrees for a 70mm stroke engine. If, with a screwdriver, you can guesstimate to say 0.5mm, the angle error will be nearly 10 degrees, all of which makes the slotted holes on the guage plate a bit of a joke.

"What I did when rebuilding my engine was this. When piston 1A is at TDC firing stroke, piston 6A is at TDC exhaust, and pistons 2A through 5A are half way. I forget which stroke they are on, but two of them are on their way up, and two are on their way down. So I set the crank up so that all four of these pistons were exactly the same distance down from the top of the cylinder liners. If this can be measured to 1 thou, the crank angle error will be 0.04 degrees. The trick is to carry out the measurement at the point of maximum sensitivity (half way down a stroke) rather than the point of zero sensitivity (top of a stroke).

"I'm not sure how you could achieve this with the engine in and the heads on, but if you could fashion some feeler and probe the piston positions in 1A to 5A with an accuracy of 0.5 mm, you could set the position of the gauge to an accuracy of 0.8 degrees, which is more than adequate."

There is an alternate method to set the timing indicator that doesn't require the position indicator or removing the head. All that is required is a device that will obstruct the motion of the piston near the top of its stroke. Such a device can be made from an old spark plug by breaking the ceramic out of it and installing a bolt through the middle. Ideally, the length of the bolt into the combustion chamber should be just enough for the piston to hit it only a few degrees from TDC. If you make this device strong enough, it might also come in handy for removing the crankshaft pulley someday -- see page 89 -- although for that purpose it would be better if it hit the piston farther away from TDC.

Turn the engine a ways past TDC, and then screw this obstructing device into the spark plug hole of either 1A or 6A cylinder. Then turn the engine backwards until the piston hits the device and you can't go any farther. Note the reading from the timing marks. Then turn the engine forward through one complete revolution until the piston hits the device again, and note the reading of the timing marks. The two readings should be exactly the same amount before and after TDC. If they are different, loosen the sandwich plate bolts holding the indicator plate and move it an amount corresponding to one half the difference between the two readings.

Bob Egerton provides another method of finding the true TDC: "Get an old plug and beat out the ceramic centre. Then braze in a length of copper or other fairly small bore tube (you could probably use a really good-fitting bit of polythene tube if you cannot get access to brazing kit) long enough to see from where you are when turning the engine over by hand with your extra long wrench. Apply a small amount of soap or detergent solution to the end of the tube and *slowly* turn the motor forwards. When the bubble is largest you are at TDC." Note again that it may be easier to use the 6A plug hole than the 1A. And, obviously, there are many possible variations on this idea, including threading a fitting into the spark plug base and the use of a balloon instead of soap. Note that this method won't work if you're at the top of the exhaust stroke instead of the compression stroke, so if you seem to be having trouble you might want to give the crank one complete revolution and try again.

The ignition timing on the V12 is checked with the engine held at 3000 RPM. Although a pain, this method insures the

timing is accurate at operating speed rather than at idle, where timing is less critical. However, proper timing by this method requires that the tachometer be at least reasonably accurate. It's not very critical, since it would have to be in error by about 300 RPM to cause an error of 1° in the timing. Nevertheless, if one ever finds his car hooked up to one of those fancy, super-accurate computerized engine analysis machines, it is suggested that the location of the tachometer needle be noted when the engine is running at a real 3000 RPM. That point can then be held whenever the timing is checked in the future.

When checking the ignition timing on the V12, the vacuum line to the distributor vacuum advance *must* be disconnected and plugged. The vacuum advance capsule is at the bottom rear of the distributor, making it quite difficult to get to this line (the larger hoses connecting to the distributor cap itself are for the distributor ventilation system, and do not affect timing). Do yourself a favor and cut the vacuum line somewhere convenient and reconnect it with a small piece of tubing. From then on, all you have to do is disconnect it at the break and plug it when checking the timing.

Since the battery is in the trunk, connecting the power leads of the timing light requires ingenuity. Of course, you could just use your jumper cables as an extension cord to connect your timing light to the battery, but perhaps that isn't necessary. The ground lead can be connected anywhere on the car. The positive lead must go to 12V, which exists at any solid brown wire. There are two terminals on the firewall adjacent to the valve covers, and a terminal on the back of the alternator -- all difficult to get at. Peter Smith: "I connect my timing light to the 12V power source at the headlights fuse box."

David Littlefield says, "Another solution for your timing light problem was just "illuminated" on the MG list, since both MGA's and MGB's have inaccessible batteries. One fellow attaches his timing light to his 10 amp battery charger. Says he had done it for years with no ill affect. Perhaps a better solution than dragging jumper cables and C clamps around."

Since disconnecting the plug wire from cylinder 1A is difficult, disconnect the wire from the distributor cap instead; make a small jumper from an old ignition wire to use to connect the timing light. Or, just buy an inductive timing light. If it's more convenient, you can also check the timing using the signal from cylinder 6A.

Since you must crawl under the front of the car while an assistant holds the engine at 3000 RPM to read the timing, it is suggested you put an extra long ignition lead on your timing light so you can route it around the fender rather than feeding it through the engine compartment. Interference with moving parts at 3000 RPM would be memorable. Cheap ignition wire with metal conductor works well for making a long timing light ignition lead, and is available by the foot. Steve Chatman came up with another idea: "When checking the timing on the XJ12, I discovered that I was either going to extend the wire that clamps the plug wire or feed the light through the engine compartment. I didn't really like those alternatives and instead simply ran the timing light over and down the outside right front wing. From there, I could shine the light under the car, using my left hand. With my right hand, I held a mirror to reflect the light vertically. Worked fine and seemed very safe. Of course, you should correct for the increased distance traveled by the light, but you knew that. I was in a poorly lighted garage at night. Better lighting could make this approach difficult or impossible to use."

Michel Carpentier provides another way of dealing with the inconvenient location of the timing marks: "Make a pointer out of sheet metal, which you fit under one of the water pump nuts (pointing from above towards the crank pulley). Now position the crank so it is in firing position at 3000 RPM and put a dab of white paint opposite your pointer. From now on you can check your timing from above."

Timing is adjusted using a long screwdriver to turn a small eccentric cam on the side of the distributor underneath the cruise control actuator. There is a locknut on the adjuster, and this is a place where a crowfoot wrench will come in very handy.

The Jaguar V12 design eliminates most wear items that would normally cause ignition timing to vary, such as ignition points or sloppy camshaft drive systems. The only remaining reason for the timing to change would be wear in the timing chain itself, and the Jaguar timing chain normally wears so slowly as to be insignificant. If the timing in your car is way off, it is highly recommended you determine *why* rather than simply readjust it. For example: If your centrifugal advance unit seizes in the idle position, then when the car is revved to 3000 RPM the timing will be retarded by 15° or more. If you merely adjust the timing rather than correcting the problem, then the timing will be 15° too far advanced at idle!

If your eccentric cam timing adjustment won't go far enough, the distributor base must be repositioned. Remove the distributor cap and insert a long allen wrench to loosen the three mounting bolts at the very bottom of the unit. Rotate the entire distributor housing in the direction needed, then retighten. Please remember that this much adjustment should *never* be necessary, and causes should be investigated.

HOLDING A HIGH RPM: Michael Minglin sends a tip: "Every time I went to check the timing, alternator, etc. the book says to set the rpm to such and such. Reaching down to that auxiliary air valve when the engine is hot is not my idea of fun. What I did was to weld a nut on top of a short bolt. Threading a longer bolt into this nut gave me a "T" with a long top and short leg. The short bolt goes into the RHD throttle cable bracket (not used for anything on my '84 XJ-S), Then I use the long bolt to adjust the bell crank to the rpm I want. To make it even easier, I forced a short piece of vacuum hose onto the long bolt, at the head. This makes it easy to adjust the bolt with your fingers." This plan will work on either LHD or RHD cars, simply using whichever cable bracket is unused.

CENTRIFUGAL AND VACUUM ADVANCE DATA: When checking distributor advance versus tables, make sure you are looking at the H.E. or pre-H.E. tables, as appropriate. The H.E. system develops less advance in the centrifugal mechanism and more advance in the vacuum mechanism than the pre-H.E..

Page 05-1 of the ©1975 ROM and page 05-1 of the ©1982 Supplement list data for the centrifugal advance mechanisms for the pre-H.E. engine. Both of these charts -- as well as the centrifugal advance data on page 112 in the Haynes manual -- begin with a listing that says "No advance below 900", which would seem to indicate that the entire chart is talking about the amount the advance changes from idle or static settings. However, Roger Bywater points out that this is not the case; the other entries in these charts are actual crank degree readings based on the proper 10° BTDC baseline timing at 500 RPM. For example, the chart in section 86.35.29/4 says that the distributor should advance 6.0-8.0 degrees at 1000 RPM; since these are distributor figures, that corresponds to 12.0-16.0 degrees at 2000 RPM at the crank, and when added to the 10 degrees of baseline advance we get the 22-26 degrees of advance listed in the charts. The charts would have been clearer if they had simply said "10° below 900" instead of that "No advance below 900" stuff.

Regarding the charts for pre-H.E. advance, Mike Morrin says, "I suspect the service manual only has data for one of the distributor variants fitted (probably C44663). The parts book shows that there were 5 different models of distributor fitted to pre-HE XJ-Ss, and I think that the only difference was the advance curves.

C.43735	Australia (this is the one with the peculiar vacuum retard system).
C.44663	California to car 2W54183
C.43735	California from car 2W54184
C.44663	CDN/USA to engine 8S5461 (ie the 4460th engine what year??)
	All other countries to engine 8S5202
C.46173	CDN/USA from engine 8S5462
	All other countries from engine 8S5203
DAC1609	California from engine 8S11161 and Australia from 8S11800
DAC1380	All other countries from 8S11262

"Note that my parts book does not cover the [pre-H.E.] Digital-P cars, so there are probably 2 more I have not counted.

"On reflection, I am surprised that there is not a clearly different distributor model (advance curve) for 8:1 and 9:1 compression engines. As far as I can see, the distributor seems to change according to degree of emission control, not compression. For example: Australia (9:1) and California (8:1) get the DAC1609, all other countries presumably including the UK (9:1) and the rest of the USA (8:1) get the DAC1380."

For our information, Morrin also provides part numbers for the distributors on the Series III E-Type:

C33148	up to engine 7S4663 (emission control) or 7S4879 (no emission control)
C37443	from above.

“The carburetted distributors of course have no FI trigger assembly.”

TIMING THE PRE-H.E.: The procedure is described in the ROM, section 86.35.29/7. Basically, you disconnect the vacuum advance, lower the idle to make sure you’re off the bottom of the centrifugal advance curve, and set the timing at 10° BTDC. Much easier than the H.E. procedure!

Unfortunately, there’s probably a very good reason the H.E. went to setting the timing at 3000 RPM instead of at idle. Roger Bywater speaks of distributor build quality problems: “Back in the early 1980's we encountered V12 distributors which could over advance beyond spec by as much as 10 degrees at 6000 revs!” What this means is that with the timing set correctly at idle, it may still be way off at highway speeds. You’re not likely to burn pistons at idle; it is far more important that the timing is correct at highway speeds. The H.E. procedure minimizes the implications of the problem: Even if the distributor isn’t quite within tolerances, the timing will be correct at 3000 and will merely be off at idle instead. Much safer.

So, why don’t we adapt the H.E. timing procedure to the pre-H.E.? That way, those cars will enjoy proper timing at highway speeds as well. Bywater: “What you are saying is absolutely correct and setting the timing at low speed before any advance takes effect is just about the worst way of doing it, but to be honest I've never really thought much about it before. In all normal operating conditions the advance could in theory be 4 degrees out yet still be within spec. Allowing for wear and tear, not to mention questionable original build quality, the error could easily be more than that.”

All we need to do is figure out what the timing should be at 3000 (or some other point in the middle of the curve somewhere) and set it there. The fact is, we could provide a spec for timing at 2000 or 4000; it wouldn’t make much difference. As long as it’s set somewhere along the curve rather than at idle where you’re not even on the curve, the advance will be much closer to correct where it’s important than it would have been with the timing set at idle. Bywater suggests that it’d be best to check the timing right at the peak torque, since this is where it will be most critical due to maximum cylinder pressures. Ideally, the timing should be checked at *several* places to make sure none exceed an acceptable advance, but let’s not get carried away.

To generate mid-curve timing specs, we can combine the idle timing specs with the distributor advance mechanism specs. The specs in the ROM for checking the distributor advance mechanism provide a 4° tolerance range. A 4° tolerance band may be good enough for checking to see if the distributor is working but it’s not good enough for setting the timing; we need to know what point within these tolerances is the optimum timing point. We could assume that the tolerance is $\pm 2^\circ$ and specify timing based on the midpoint, but Bywater suggests this might not be right. “With regard to the tolerance spread it is worth remembering that all engines must be safe with the worst possible condition which implies that the most advanced point is the one to work from rather than mid-range. I am not sure how tangible the benefits would be but if it makes it possible to run safely with 2 or 3 degrees more advance then the overall performance, response and economy should be improved. I am sure it is worth trying but maybe a period of trial is called for with a few willing volunteers who can report back before advocating it on a wider scale.”

Bywater went on to provide timing specs for all pre-H.E. V12’s:

Carburetted V12’s	35° BTDC @ 4000 RPM
D Jetronic:	33° BTDC @ 4000 RPM
10:1 CR pre-H.E. Digital P	24° BTDC @ 3000 RPM

Are these correct? You just can’t get a better authority than Roger Bywater; he was the guy leaning over a screaming V12 in an engine testing room at Jaguar dialing the advance up and down by hand to *develop* these advance specs. But anyone can make a mistake. So, after you set the timing using these guidelines the first time, check the timing at idle. If it’s only different by a couple of degrees -- notably if it’s *more advanced* by a couple of degrees -- the spec was correct, get in the car and drive. If it’s off by ten degrees, check to see if your advance mechanisms are working properly. If they’re OK and the timing is really that far off, perhaps it’d be wise to rethink this whole idea before putting your foot in it.

Yes, the numbers for the pre-H.E.’s sound like a lot more advance than the H.E.; that’s the nature of the beasts -- the

H.E. gets less advance from the centrifugal mechanism and more from the vacuum capsule than the pre-H.E.

So, for those unfamiliar with timing the H.E., here's the procedure: Warm up the engine, disconnect and plug the vacuum advance, have an assistant rev the engine up a little past the specified RPM and then come back down to it and hold it there, and set the timing to the specified advance.

Of course, one problem is that the scale on the timing plate doesn't go far enough. So, set the crank at 20° BTDC and paint a new mark on the damper at 0°. Then you can use this new mark to set the timing at the spec minus 20°.

UNDERSTANDING THE VACUUM ADVANCE SYSTEM: Between August 1998 and June 1999, Kelsey Publishing (page 723) published six issues of a magazine called *XJS Bulletin*. Issues 1, 2, 3, 4, and 6 contain a series of articles called "Advancing by Vacuum" by Roger Bywater of AJ6 Engineering (page 713) that are arguably the best explanations of the vacuum advance systems used on the Jaguar V12 available. For those interested in obtaining back issues, here is a brief synopsis of what each issue's article covered:

Issue 1: General concepts of vacuum advance systems

Issue 2: 1976-80 V12 vacuum advance systems, including California and Australia

Issue 3: 1980-81 vacuum advance systems (pre-H.E. Digital P cars), Emission A and B

Issue 4: Advance concerns related to the H.E. engine

Issue 6: H.E. vacuum advance systems, Emission A and B

After June 1999, *XJS Bulletin* was discontinued as a separate publication and a distinct section of *Jaguar World* magazine was provided instead, with pretty pictures of cars but little in the way of useful technical information.

VACUUM ROUTING DIAGRAMS -- WHICH IS WHICH? Good question. The following is an attempt to clarify the applications of diagrams that appear in several documents; here's hoping I don't make any errors here, since that would really compound the confusion!

In the ©1975 ROM, there are no vacuum routing diagrams. For the vast majority of cars of the time, the routing for the vacuum advance was simple: Straight from the throttle edge tap on top of the right side butterfly housing to the distributor. The air pump, where fitted, was apparently uncontrolled -- on all the time. In California and Australia, the system was more complicated, but not covered in the ROM.

The ©1982 Supplement has two descriptions, one labelled "Emission B" and the other labelled "Emission A & C". These both apply to the H.E. only, but the Emission A & C version only applies through 1982; for 1983, a vacuum regulator was added to the system.

The H.E. supplement in the back of the ©1984 Ed 4 includes a description of a system labelled "Emission A & C - Federal, Canadian & Japanese Specification 1983 on" which includes the vacuum regulator omitted in the ©1982 Supplement.

The Haynes manual (©1986) actually contains a fair assortment of vacuum routing diagrams, enough to put the ©1975 ROM and ©1982 Supplement to shame. Of course, they're not labelled clearly enough, so here goes: Figures 13.29 and 13.30 apply to the 1980-81 pre-H.E. engine with Digital P injection. Figure 13.31 applies to the pre-1983 North American H.E. Figure 13.32 applies to the 1983-on North American H.E. Figure 13.33 applies to the Emission B (non-North American) H.E. Figure 13.33 is labelled that it applies to the Australian models, but it's not the same system that Bywater's *XJS Bulletin* # 2 article shows for the 1976-78 Australian cars; presumably it's for the later H.E. models.

VACUUM ADVANCE MODULE: On most cars, it is a simple matter to determine if the vacuum advance module is intact: Connect a hose and, using your mouth, suck and watch the mechanism move. While in advanced position, put your tongue over the end of the hose and see if it holds vacuum and stays in position.

On the XJ-S H.E., the first half of that test -- sucking and watching the mechanism move -- works, but the tongue test to hold vacuum may not. On the H.E. there is a vacuum regulator in the line to the vacuum advance module, and such regulators cannot be depended on to work properly with no flow. Therefore, the vacuum advance module on the mid-80's XJ-S H.E. has a deliberate bleed hole; the module will not hold a vacuum even when in perfect condition.

Of course, there are several different vacuum schemes used in the XJ-S over the years and around the world, and even some vacuum retard schemes. Many of these do hold vacuum; if the vacuum advance plumbing doesn't include a vacuum regulator, there's no need to put an orifice in the diaphragm.

Roger Bywater says, "Of course the high temperature situation also gives the vacuum capsule a hard time and they usually need replacing every couple of years or so but a lot of so-called mechanics seem to miss that one."

Note that a vacuum advance module that isn't leaking may still need replacement. Val Danilov says, "My diaphragm was fried rock hard, I broke it trying to test the rod movement (CRRRACK!), so I think it wasn't leaking."

The earlier vacuum advance modules came with an adjustment screw on the top. This screw permits adjustment of the limit of travel of the module -- but was supposedly set at the factory to the correct travel. This is not intended as a user-adjustable feature; the only reason to be messing with it is a suspicion that someone else has already messed with it. Later replacement modules don't even have the screw.

VACUUM ADVANCE MODULE REPAIR: The following procedure for rebuilding a vacuum advance module is credited to John Napoli and Val Danilov.

Before removing the vacuum advance module from the engine, you might want to take note of the best position for the vacuum line connection when it is reassembled. And after removing the vacuum advance module but prior to taking it apart, it is suggested that you first carefully measure the distance which the actuator rod extends out of the unit. Also, push the rod back into the unit (fully retracted position) and measure that as well.

Raw material is a generic replacement vacuum advance from a Chevy V8 -- dirt cheap at any auto parts store. Take the Chevy unit apart by prying open the case; Napoli suggests it may be easier to open the case by grinding the case all around its periphery to weaken the metal, but be careful not to get it too hot and damage the diaphragm. What you want to get ahold of is the diaphragm/rod assembly.

Open up the stock Jag vacuum advance by prying around the crimped-on case. In this case, you'd like to reuse everything *except* the diaphragm/flat link assembly, so try to do as little damage as possible to the casing; if you'll read ahead to understand how you'll be reassembling it, you may decide to simply cut or grind the lip off the edge to avoid mangling the dome itself. Even though the diaphragm/flat link won't be reused, keep it on hand for taking measurements.

Cut the rod from the Chevy diaphragm/rod assembly to the same length as the Jag original, then set it down on an anvil or something and pound a flat spot at the end with a hammer. No problem -- it's a Chevy part, remember?

Reassemble the vacuum advance unit using the new diaphragm/shaft assembly and all the old Jag parts. If the casing wasn't damaged when disassembled, you may be able to simply clamp the unit together and gently bend/hammer the dome shut. This works but the cannister will become work-hardened so you will never be able to do this repair this way again.

If the edges were too mangled (or you cut them off), drill the body and dome for eight fasteners; Napoli suggests 3/4" long 3-48 fillister head screws and nuts, but notes that the exact sizes aren't critical. Sandwich the body, diaphragm (poke a hole through for the screws with a needle), spring, and dome, and bolt it all together, being careful that the flattened section of the rod is aligned properly. This method has the distinct advantage that it permits repeated repairs later -- important, since the heat in the valley of the V12 will eventually bake the Chevy diaphragm as assuredly as it did the original.

Check that the unit responds to vacuum and pulls the shaft in.

Measure carefully the extended length of the rod, mark, and drill a hole in the flattened area the same size as the hole on

the original part. Check the retracted length as well, and if there is an adjustment screw on the dome adjust it to provide the same total travel (if your extended length was off a little bit, make the retracted length off by the same amount; the variance can then be corrected by setting the timing normally). If you don't have an adjustment screw, don't worry about it, the total travel will probably be close enough.

Reinstall on the distributor. Be sure to check the timing; the timing procedure requires that the vacuum be disconnected, but the module still has an effect -- you might not have gotten that extended length as perfect as you thought you did.

Note that the original diaphragm may have had a tiny orifice built into it to provide a deliberate leak. This will usually be evident as a tiny hole through the metal disks on either side of the rubber diaphragm itself. The vacuum advance plumbing includes a vacuum regulator and such regulators don't work reliably when there is no flow, so the orifice is in there to provide a little flow. It appears that this orifice may not be necessary, since some genuine Jaguar replacement vacuum advance modules reportedly don't have it. If having an orifice proves to be necessary, it can be added anywhere in that branch of the vacuum advance plumbing; you might wanna make the hole in the dome rather than in the diaphragm itself. It might make more hiss, but you can seal it later if you decide to with a small piece of aluminum tape. Or you may be able to fit a separate device with an orifice with a tee connection into the vacuum line. You could, for example, take a piece of brass tubing, drill a tiny hole in the side, and connect it in the line *to* the vacuum advance module.

If, for some reason, you are unable to reuse other parts of the original Jaguar vacuum advance unit, you may be able to use the corresponding parts from the Chevy unit. Note, however, that doing so may result in differences in the advance curve and/or limits. Use of a different spring will change the advance rate. Use of a different dome with a different depth, and therefore a different place where the spring seats, will also affect the advance rate. And use of a different dome may also affect the retracted length, allowing the diaphragm to travel too far or preventing it from travelling far enough.

If the Chevy dome happens to include a limit adjusting screw, you may be able to adjust the full-retract position after assembly to make sure it is the same as the original was. If there is no adjusting screw, you might actually be able to add one, being careful to seal it when done to avoid vacuum leaks. If the Chevy dome is shorter and compresses the spring too much, you may want to add a spacer ring between the diaphragm and the dome to space the dome back. If the Chevy dome is taller and compresses the spring less, you might want to insert something within the dome for the spring to sit on.

Napoli adds, "I have seen in this month's Jeg's catalog (see page 717) that Accel manufactures a replacement Chevy vacuum advance that is adjustable. The ad copy states that the unit is adjustable for total advance and rate. It comes with instructions. The unit looks just like the generic replacement I used, so the same repair approach should work." This fancy aftermarket Chevy part is *still* cheaper than the stock Jaguar vacuum advance module by a long shot.

If you tore things apart and *then* read the suggestions to take measurements first, Napoli sends some reference measurements from a junk unit he had laying around: "For reference, the measurements were taken with 1/16" of the adjusting screw exposed. That is, from the face of the adjusting nut to the top of the unmolested screw is 1/16". Also, this is a stock '88 V12 advance (non-Marelli) from my donor engine and the unit does not operate (won't build vacuum). With the unit relaxed, the length from the end of the housing to the center of the hole in the actuating rod is exactly 2 inches. Full compression of the rod reduces the length by 5/16" (i.e., 5/16" maximum travel)."

VACUUM REGULATOR AND DUMP VALVE: A vacuum advance mechanism applies more advance as vacuum increases, which means there will be minimal advance at full throttle (to avoid knocking) and lots of advance at light throttle (where knocking isn't a problem, to provide optimum fuel efficiency). This also means a lot of advance at idle, but this can be problematic. The manifold vacuum at idle may vary as the RPM rises or falls a bit, and this will move the vacuum advance in a direction so as to accentuate those fluctuations. The result can be an unstable idle, sometimes even stalling.

The time-honored fix for this is to use a "throttle edge tapping" for the vacuum source. The vacuum line to the vacuum advance, rather than simply connecting to a port on the manifold, is connected to a port located near an outward-opening edge of the throttle butterfly. Whenever the throttle is open, the edge of the butterfly itself is on the air filter

side of this port, so the port is seeing manifold vacuum. As the butterfly approaches the closed (idle) position, however, the edge of the butterfly passes over the port, leaving the port exposed to atmospheric pressure rather than manifold vacuum. The result is *no* vacuum advance at idle. This results in a stable idle, and also makes it a bit easier to adjust the timing -- you don't need to disconnect the vacuum line first. This setup was very common on carburetted American V8's of old, and unfortunately resulted in an entire generation of mechanics who don't believe it's necessary to disconnect the vacuum advance when setting the timing.

If you'd like your Jaguar V12 to operate this way, it's very simple. Just throw away all the vacuum advance control devices and connect a single hose from one of the ports on top of the right hand butterfly housing directly to the vacuum advance module. This will work fine, although the total lack of vacuum advance at idle will make it use more fuel and generate more waste heat when idling. This shouldn't be a problem; the cooling system should be able to handle the additional heat, and the fuel economy reduction is small -- especially if you don't sit around idling much. It may affect emissions tests, but ironically it may help them; in general, retarding timing seems to make it easier to pass emissions tests. Note that most of the 1976-80 V12 models (except California and Australia) apparently did operate their vacuum advance exactly this way, and some later models did as well except that they added controls to shut off vacuum when the engine was cold to help it heat up quicker.

With later models, Jaguar used a better idea here. Rather than providing *no* vacuum advance at idle, they used a vacuum regulator to provide *some* vacuum advance at idle. Because the regulator provides a fixed amount of vacuum regardless of how the manifold vacuum is fluctuating, the instability problem is avoided. In such schemes, one hose to the regulator comes from the manifold itself to provide a vacuum source, while another hose connects to the throttle edge tapping to provide a "reference" to regulate to. When the engine is at idle, the manifold vacuum is high but the signal from the butterfly housing shows no vacuum, and the regulator throttles the vacuum to the advance capsule down to a fixed amount above that reference. When the engine is at part throttle, both the manifold vacuum and the signal from the butterfly housing show high vacuum, so the regulator does nothing; the advance capsule gets full manifold vacuum. At wide open throttle, both the manifold and the throttle edge tapping see very little vacuum, so the advance capsule doesn't get much either.

This is a really good system, providing a goodly amount of advance at closed throttle so the engine idles efficiently. It also results in less of a step coming off of idle; rather than the vacuum advance going from no advance to full advance all of a sudden, it merely goes from partial advance to full advance. The effect is smoother throttle response.

There is one problem, however: A vacuum regulator is a throttling device, and therefore cannot provide a great deal of flow suddenly when needed. The specific case of concern here is when the throttle is suddenly floored. In a car with simple hoses connecting to the vacuum advance capsule, the sudden lack of manifold vacuum would result in a similar lack of vacuum advance just as quickly, and the engine could proceed at full throttle with the timing properly positioned for that condition. But with this regulator in the line, a sudden opening of the throttle will require a second or two for the vacuum to bleed off the advance capsule through the regulator. For that second or two, the engine will be running at full throttle with too much advance, and the engine will be knocking something fierce.

The solution is another device, the dump valve. This is a vacuum-operated valve that merely opens the line to the vacuum advance capsule to atmosphere when there is no vacuum in the manifold.

There is one other minor detail, and that is the fact that a regulator generally works better with a little flow through it; it may have difficulty regulating vacuum in a deadheaded line. So, the vacuum advance capsule may have a tiny internal bleed orifice, small enough that the vacuum system can still apply a vacuum but preventing it from holding a vacuum.

A little guidance on plumbing: The North American models use a vacuum regulator EAC5157, and it has three hose connections. One connection is labelled "DIST", and this line is connected to the vacuum advance capsule; a tee in this line should lead to the dump valve EAC4069 and connect to the fitting farthest from the flat side. Another connection is labelled "CARB"; this should be connected to the throttle edge tapping, which is a port on the top of the right side butterfly housing. The third connection is labelled "DELAY", and this one should be connected to the intake manifold; it typically is connected through a whole series of valves and controls that provide less vacuum when the engine is cold. Basically, the regulator and the dump valve are the only things in the vacuum advance control system that are operating when the engine is warmed up; everything else in the plumbing has to do with cold starting.

Note that other markets use a different vacuum regulator, but the idea is the same.

The connection on the dump valve nearest the flat side should be connected to the intake manifold; in some cars it appears to be connected to the bottom of the right side butterfly housing, but this fitting is a ways behind the butterfly and will see manifold vacuum in all but nearly wide open throttle, and at wide open throttle it should see nearly atmospheric pressure either way.

The various emission control diagrams available invariably show the controls for the air pump on the same diagram, primarily because some of those vacuum control devices used for cold starting also affect air pump operation. Don't get confused; other than the fact that both systems are vacuum-controlled, they really have little to do with each other. The descriptions above only apply to the vacuum advance system.

VACUUM REGULATOR CHECKING: Stephen Tyler says his vacuum regulator was bad; "At the top of the unit is a metal disc & in that disc is a small hole. If you apply a vacuum to the input side of the unit, you cannot obtain a vacuum out if the tell tale hole is sucking in air. The hole is for an indication if the internal diaphragm is damaged. I removed the metal top & found that the diaphragm had a hole in it. There are probably many units like this, considering the age of these cars." This has grave implications for the fuel economy of a lot of cars out there.

15-MINUTE TIMER: The 15-minute timer is a feature of the "B Emission" H.E. cars, which means UK/Europe spec, 82-88 or so. If the coolant temperature is below 38°C when the car is started, the timer is engaged. This disables the vacuum advance at idle and runs the part-throttle vacuum advance through a delay valve for 15 minutes. If the coolant temperature is above 45°C when the engine is started, the coolant temp switch is open and the timer is not engaged. 38°-45°C is the "dead band" of this switch -- whether it's closed or open depends on whether the engine was cooling down or warming up when it entered this band.

15-MINUTE TIMER -- LOCATION: Everybody wants to know what this thing looks like and where it is. Craig Sawyers reports: "It is a black box with ventilation slots, 2"x1.5"x1.5". It has a single fixing hole at one end, and an edge connector at the other.

"Location in UK cars is:

- XJ12 -- under the driver's side (rhs) underscuttle, up high. It is more or less behind the speedo, and a fight to find and remove.
- XJ-S -- under the passenger side (lhs) underscuttle, much lower and easy to get to."

Steve S says, "the US 45 sec one would be located to the right of the passenger side small fuse box under the scuttle. Nothing is fitted in this space in the UK spec. The UK 15 min job is to the left of the passenger side small fuse box but located on a different plate to the small fuse box set closer to the firewall (bulkhead); US spec cars have something to do with the seat belts located where the 15 min timer goes."

15-MINUTE TIMER -- REPAIR: The timer itself is reportedly unreliable. Tony Bryant: "My '85 NZ Spec (= RHD Euro) had this 15-minute timer in the LH side of the LH footwell. Cheap and nasty piece of trash. It's a pertronix unit, based on a CD4020 cmos 14bit counter, and a CD4069(?) hex inverter with one of the inputs floating(!). Floating input pins on CMOS are just begging for a blown up chip. I replaced it with the 74HC equivalent, and tied the unused input to ground - before I ditched the whole system."

15-MINUTE TIMER -- DITCHING: The 15-minute timer apparently causes really bad fuel economy during those 15 minutes, especially aggravating for owners whose driving patterns happen to have them within those 15 minutes most of the time they are driving. Craig Sawyers says, "Admittedly, the V12 is thirsty, but a certain amount of that is to do with

the 15-minute timer on the vacuum advance. Before that cuts in I get 14 (UK) mpg. When it cuts out it comes back to 19-20.” Mike Morrin says, “My weekday commute is only 3.5 miles each way, the thermal switch operates after about a mile and totally disconnecting the 15 minute circuit gave me a 2 MPG overall improvement.”

If you’re sick of using so much fuel, disconnect the timer! The car will run just fine with full vacuum advance when cold, it just won’t warm up as quickly. Since the timer energizes the 3-way solenoid valve, the 2-way solenoid valve, and the supplemental air valve (see page 304) and de-energizes them when the 15 minutes are up, you can merely disconnect the wires from the timer or the coolant temp switch and the car will never lack vacuum advance again. The easiest way to disable it is to just pull one of the wires on the thermal switch on the rear end of the right side coolant manifold. This is obviously easy enough you can try it and see if you like it.

Once you decide to make this change permanent, you can make things neater by removing all of those valves and plumbing up the vacuum advance system with the same routing that effectively existed after the 15 minutes had expired. You can also trashcan the timer itself if you want, and replace the coolant sensor with a plug.

The 2-way solenoid valve and the 3-way solenoid valve are involved in killing the vacuum advance at idle during cold starts, but the purpose of the supplemental air valve is to boost the idle RPM to compensate for the lack of vacuum advance. Disabling the cold start solenoid valves theoretically eliminates the need for this idle boost (the Auxiliary Air Valve is intended to provide idle boost for cold starting), but if you find the car idling too slowly when cold you might consider leaving the supplemental air valve connected and disconnecting the solenoid valves only. In this regard, this system may serve as a patch for a weak or deteriorating AAV (see page 265).

Also note that, on later cars, the same supplemental air valve was used to boost the idle when the A/C compressor was engaged. This is a really nice feature, and one might consider keeping the supplemental air valve in place for that purpose. If your car is an earlier model lacking this A/C idle boost, you might want to wire it up! See page 304.

15-MINUTE TIMER -- MODIFICATION: The only problem with ditching the 15-minute timer is how long the engine takes to warm up. The vacuum advance makes the engine run efficiently, so it doesn’t generate as much waste heat. Killing the vacuum makes the engine inefficient so it generates a lot of waste heat and warms up quickly. Richard Mansell says, “I disconnected mine recently and found that it seemed to take a lot longer to warm up. It is now reconnected. I may disconnect it again for the summer (if we actually get one this year).” Awwww, little Ricky’s gotta have his heat!

Craig Sawyers suggests a compromise: “If you unplug the timer and link together the grey and pink/white wires, this connects the 45°C switch directly to the valves. So the valves will operate until the engine reaches 45°C and then switch off. I did this with my brother in law’s XJS when his module blew.” This is a really neat fix, since it means the car will get to 45°C in a hurry and then get good fuel economy from then on.

Of course, 45°C isn’t all *that* hot, so the heater will still not be working as well as some might like. So, there are other possible fixes. The most obvious would be to replace the coolant temp switch with something with a higher cut-out temp, like 70°C. It must be stressed that the switch really needs to cut out *before* the thermostat temp is reached; otherwise, there’s a chance that the idle vacuum advance will *remain* disabled indefinitely!

Another idea would be to leave the timer in place but shorten that 15 minutes to something more reasonable. Sawyers describes how to modify the OEM timer: “The counter is a 14-bit binary counter. The most significant bit is used to trigger the valves. So you can select a delay of 7.5 minutes by reconnecting diode D1 internally to pin 2 instead of pin 3 on the MC14020 timer chip. Or if you connect to pin 1, you get 3.75 minutes.

Daniel Lethiais elaborates: “You will find inside this unit a small electronic plate with integrated circuits. Near the HEF4020B is the diode D1. If you want a delay around 4 minute you just have to cut the connexion between pin3 to D1 (with a cutter, knife...) and connect pin 1 to diode D1. It is very easy to do.

“Yesterday I have tried a connexion between Diode D1 and pin 15. I have checked my unit outside the car with a separate power supply and an oscilloscope. The timer is now around 2,5 mn.”

Sawyers: "You can get intermediate times by changing the oscillator frequency. This is set by the values of either C3, or R6/R7. The timing is in inverse proportion to the parallel combination of R6 and R7, and to C3. So halving the value of either will double the time, etc. For instance, changing R6 from 820k to 470k (leaving other components unchanged) will reduce the time from 15 minutes to 9 minutes."

Of course, you could just try to find a replacement timer instead of getting into the schematics.

When considering shortening or eliminating the vacuum advance disable, one must consider its original intention. Unfortunately, there's no telling what that was. It looks like an emissions feature and in fact is part of the scheme called "B Emissions", but the UK and Europe supposedly had no emissions requirements at all when these cars were built. It could be argued that its purpose is to get the engine warm quickly to minimize wear, but one would have to remember why a cold engine has high wear: there's too much fuel running through it. Since this system clearly increases the amount of fuel running through it, it's questionable whether it does any good in that regard. All in all, the entire purpose of this system may be to make the heater work as quickly as possible. That's an expensive heater, especially since this thing provides 15 minutes of lousy fuel economy even in *warm* weather.

VACUUM ADVANCE MODULE -- PRE-H.E.: Mike O'Neill noticed that the vacuum advance module from an MGB will fit the pre-H.E. distributor. However, John Nuttall found that the MGB advance unit -- as well as some units for Triumphs -- look similar and will fit, but provide differing amounts of advance at different vacuum levels. So, if your engine is largely stock and you want to keep it that way, you probably should seek a Jaguar advance unit. On the other hand, if your engine is not stock and you need to provide nonstandard amounts of vacuum advance, this provides some places to look. Also, these units might provide materials for rebuilding your old vacuum advance module in much the same way Napoli used a Chevy part in the procedure described above.

VACUUM RETARD: According to the article "Advancing by Vacuum" by Roger Bywater in *XJS Bulletin* Issue #1, a vacuum retard module is typically connected to a throttle edge tapping on the *inward*-opening side of the butterfly. Hence, vacuum is applied at idle, but as the throttle is opened the edge of the butterfly passes over the port so it sees ambient air pressure. The system therefore provides a few degrees of retard at idle, but does nothing at other throttle positions. This helps make the engine idle better, since some engines have trouble igniting the charge at high vacuum; according to Bywater, the carburetted V12's fit into this category. By waiting until the piston is closer to TDC, the charge is more concentrated and compressed when the spark occurs. Obviously, such a retard scheme would help emissions at idle by ensuring good ignition.

Ian Macfarlane, regarding his 1985 XJ-S: "In Australia the distributor has a retard connection on the vacuum module which is supposed to operate for about 15 min. after starting via a solenoid valve. But the wire leading to the solenoid valve had been cut (as had the wire to the supplemental air valve). Thus, even though the distributor timing was correct with the vacuum tubes disconnected, the engine ran at about 6 deg retarded under normal conditions.

"Although this would not exactly apply to other emission systems it is another option for those with an overheating problem - if the vacuum system was not working properly it is feasible that overheating could occur due to retardation."

Having the vacuum retard system activated when it shouldn't be is a valid concern, but this author isn't convinced that cutting the wire to the solenoid valve will do it. According to the schematics of this system, the solenoid valve controlling the vacuum to the retard side of the vacuum capsule is a "normally closed" type, meaning that cutting the wires should render it always closed -- no vacuum retard.

Mark Jackson, who owns an '87 Australian model, says, "I have been told (and have the proof on the car) that the local dealers got so fed up with people complaining about poor performance on start-up, that they just bypassed the electronic valve mounted under the RHS manifold by routing the vacuum pipes past it."

CENTRIFUGAL ADVANCE - SEIZING: At this point in this book, I used to report how the pre-Marelli Jaguar V12 centrifugal advance was highly prone to seizing. However, with more and more readers reporting back, I can say with

relative certainty: Unless your distributor has been overhauled, *it is seized right now*. Period. This has proven to be a 100% failure rate, every time, every car, there simply is no doubt anymore. And a seized advance unit results in low power, overheating and major engine damage if not corrected. If you are not absolutely positive that your distributor has been overhauled already, it is imperative that you schedule an overhaul as soon as possible -- and drive the car very gently or not at all until it's done.

Folks, this is probably the single most important item in this book. Centrifugal advance seizure may be the cause behind most of the problems the Jaguar V12 has -- overheating, dropped valve seats, etc. -- and the reason behind most owner dissatisfaction, low resale value, Chevy engine swaps, you name it. Is there any way I can convince you, the XJ-S owner, to take action *now*? If it'll make you feel better, give me a call, I'll tell you in person: Overhaul the distributor *NOW*.

Sad to say, reports are that this failure mode -- notorious as it is -- is *not* widely known among Jaguar dealers and mechanics. Despite the frequency of charging customers \$10K for a new engine, it has never occurred to many of these shops that the engine failures were preventable. Some people have reported that their Jaguar dealer overhauled or replaced several unrelated components before finally figuring out that the centrifugal advance was seized. Others *never* figured it out. Perhaps their fancy diagnostic computers don't blink "centrifugal advance seized". Perhaps they just like collecting those fees for new engines. Whatever, keep in mind that just because you have had your car "checked out" by the dealer doesn't mean you don't have the problem. It's not even a certainty that the advance is OK if you specifically asked them to check it; some of these mechanics don't even know how to check it. For those who have mechanical abilities, it is highly recommended that you check your centrifugal advance yourself, or better yet simply go ahead and overhaul it. If you aren't the type to get your hands dirty, it probably would be money well spent to have an independent shop confirm the first shop's conclusions.

John Napoli confirms this: "I know or deal with about a half-dozen repair shops. Some are run by friends (no chicanery ever) and the others, including my local Jag dealer, are pure business relationships. None of them ever heard anything about the chronic Jag problem of seized centrifugal weights. Not even the Jag dealer, although maybe they do know and don't tell. I'll go further and say that no Jag owner I've encountered has ever heard of it, either. You get these strange looks when you bring it up ("If I don't know, then it can't hurt me."). I find it hard to believe, but it looks like a lot of the information regarding the idiosyncrasies of these cars never reaches the people who can use it most. Perhaps this is part of the reason why so many Jag owners have bad experiences with repair shops."

The usual indications of a seized advance mechanism are an XJ-S that lacks power at higher RPM and a nasty tendency to overheat. In some cases, when the throttle is backed off suddenly there is a brief power surge before decelerating. If your car doesn't have the performance at higher RPM that it should, check the advance mechanism immediately; a distributor seizure is easily fixed, but warped blocks, dropped valve seats and burned pistons are much more expensive and are the inevitable outcome of continued operation.

To confirm for yourself that your advance unit is seized, remove the distributor cap. Attempt to turn the rotor counterclockwise. If operating properly, you can easily turn it about 11° (H.E.) or about 13° (pre-H.E.) against a spring. Note that this thing should feel really loose and rattly, and when you twist it and let go it should snap back with a metallic clink; if at all sticky or gummy-feeling when turned, time to overhaul. The forces that move this thing are balanced against each other, so a very slight difference is supposed to make it move; while the springs may seem mighty strong when you're fiddling with them, even a slight amount of drag or stickiness is enough to keep it from moving as it should. It may be movable by hand but not as far as it should or not as freely as it should. Unfortunately, in a book such as this it is difficult to convey adequately how to tell that an advance is gummy until a person has felt a properly-operating advance for themselves. This might be an excellent topic for a monthly Jaguar club meeting -- to have someone who knows what the advance should feel like check every V12 that shows up. Of course, if totally seized, the problem is obvious; you cannot move it at all except for backlash in the drivetrain.

Another method of checking for a seized distributor is to compare the timing (with the vacuum line to the distributor disconnected and plugged) at 2000 RPM with the timing at idle (under 900 RPM). The two readings should differ by at least 12° (H.E.) or at least 22° (non-H.E.). If they are the same or very close, the centrifugal advance is seized. If the advance at 2000 RPM is more than a couple of degrees different when you come *up* to that RPM from idle than it is if you come *down* to that RPM from 4000, then the advance is sticky; overhaul it.

OK, SO IT'S SEIZED -- NOW WHAT? To prevent/correct a seized centrifugal advance mechanism, it's necessary to overhaul the distributor, clean out all of the original lubricant, clean up the parts, and reassemble with a reliable lubricant. Roger Bywater says, "Most of them probably run for years without the cap being lifted so by the time anyone does get round to it the spindle is likely to be running dry and getting built up with debris. Adding lube at that stage may well loosen the debris and aggravate the situation so really it needs complete stripping to ensure that it will not jam at some future time." Bywater, having worked for Jaguar, can be expected to blame the seizures on poor maintenance -- and perhaps he's correct. I personally suspect the original lubricant used at assembly was lousy, based on what the stuff looked like when I got my distributor apart! It really doesn't matter what the cause; either way, the distributor has to come apart.

Of course, you don't have time for overhauling. You will probably want to try the easy fix: Remove the distributor cap and rotor, and put some penetrating oil down the center and see if you can work it loose. If you are successful, it is recommended that you check its operation regularly -- or better yet, just go ahead and overhaul it when you get the chance. The results of operation with a seized centrifugal advance are simply too costly to ignore.

This is one place where getting a *new* part will probably not help. There is little wear in the distributor, and an overhauled and properly lubricated used part can be expected to last the life of the car. But a *new* distributor may have the same problem as the original distributor did. It is recommended that even a brand new in-the-box distributor be overhauled prior to installation (to get that lousy lubricant outta there).

The good news: The reported incidence of centrifugal advances seizing *after* they have been overhauled is nil. This may be because the original grease is the problem, and once it's removed the problem goes away. It may simply be because once the overhaul has been done the owner understands what's going on and lubricates it regularly. Whatever, once the distributor has been overhauled, there is apparently no reason to expect to ever have to do it again.

Randy K. Wilson points out that the problems with seized centrifugal advances on pre-H.E. engines may actually be different in nature. "From what I've seen the gummy advance problem is unique to the V12 H.E. distributor. Earlier distributors also had a problem with seizing, but these galled from a total lack of lubrication." Of course, this could mean that the H.E. only gets hot enough inside the distributor to turn the lubricant to varnish while the pre-H.E. got hot enough to burn the lubricant away entirely. Or, it could mean that Jaguar added grease to the assembly in response to the dry seizures, and the grease caused its own seizures.

DISTRIBUTOR REMOVAL: If the centrifugal advance is seized, or if you wish to prevent seizure in the future, the distributor should be removed and disassembled. It's not difficult, but it will help to read the following sections thoroughly *before* tackling the job.

Note: If you prefer, it is possible to rebuild the centrifugal advance mechanism with the distributor in place. It's easier to take it out and do it on the bench rather than leaning over the fender, though.

Before removal, care must be taken to ensure the distributor can be reinstalled with the gears meshed correctly so the rotor faces the same direction as before. If the crankshaft is not to be disturbed, this is very simple: Note the position of the rotor prior to removal, so you can be sure it is in the same position when reinstalled. It's a gear mesh and one tooth off would be obvious, so just note the position well enough you can make sure you are on the same tooth when reassembled.

Note: If you have the older Lucas OPUS ignition system, you are advised to position the engine at TDC on cylinder 1A, which is where the timing marks on the crank pulley line up *and* the rotor is pointing at the front left headlight. If the rotor is pointing at the right side door, you need to turn the engine around one full turn. The reason that this is important is that the OPUS has a wheel within the distributor that has three slotted holes that line up with the distributor mounting bolts in this position. Even if you can get it off without moving to TDC on 1A (by busting up the plastic wheel, for example) you're still gonna be in a pickle putting the rebuilt distributor back on without tearing it back apart or turning the crank while the distributor is out.

If you turn the crankshaft while the distributor is out, you face additional problems. The distributor turns once every

time the crankshaft turns twice, and therefore the distributor must not only be lined up facing 1A while the engine is at 10° Before Top Dead Center (BTDC) but it must be on the correct stroke. If not, the spark plugs will fire at the end of the exhaust stroke instead of the compression stroke, and the motor will not run.

To get the setting right, cylinder 1A must be on the compression stroke when the distributor is installed pointing to 1A on the cap. If you know in advance you may be turning the engine, it is easy enough to avoid problems. While the distributor cap is off and the rotor is pointing at 1A and the crankshaft is at 10° BTDC, remove the oil filler cap. Reach beyond the front edge of the chain and mark the camshaft gear itself (the camshaft gear turns at the same rate as the distributor). You can use a dab of paint, or stake it, or whatever will give you a clear indication.

You might also want to mark the position of the base of the distributor, since it mounts on slotted holes. Ideally, the base should be mounted so the correct timing is near the center of the range of the eccentric adjuster, but to begin with it will be easier to put it back where it came from. Peter Smith: "I find that using typist's white out to paint across components can be helpful. It can be applied over slightly greasy surfaces and if precise alignment is necessary I can draw on it with a biro."

You can insert an allen wrench through the openings in the distributor and undo three screws and remove the distributor as a unit. However, for the purposes of doing the marking mentioned above, it may be preferable to proceed with the disassembly described below with the distributor still on the engine until you've removed enough parts to be able to mark the bottom of the housing on the inside.

DISTRIBUTOR DISASSEMBLY: Remove the rotor arm; see page 126.

Remove the EFI trigger board or anti-flash shield (whichever). The biggest problem with removing the anti-flash shield will be dropping the tiny screws and washers, but the trigger board causes more trouble. It is mounted with four tiny plastic screws, and Jan Wikström reports that the screws get stuck to the metal; "On my own experience of three distributors, you can expect to get two out intact. If you're *very* careful." He also reports that he has used metal screws in a pinch with no apparent problems. When installing the plastic screws, maybe it would be a good idea to use anti-seize compound, even though it looks silly on tiny plastic screws.

Richard Dowling dealt with the trigger board screws differently: "I retapped the holes to M4 (about 2 times stronger) and fitted bigger nylon screws."

Next, remove whatever is used to trigger the ignition; on 1982-89 cars, you need to remove a C-clip, then slide off a wavy washer, then pry out a U-shaped pin. Finally, you need to slide off the iron star-shaped inductor rotor, being careful not to damage it or deform the points. Even more importantly, don't just pull upward on a sticky star rotor, because you may stretch the springs in the centrifugal advance mechanism underneath. Here's a method that seems to work: Lift gently on the star rotor a little bit and insert the claw of a claw hammer under the star rotor. Rest the head of the hammer on the edge of the distributor housing, but *do not pry*. While holding the star rotor in its slightly elevated position with the claw hammer, tap downward on the center of the rotor carrier shaft with a plastic-surfaced hammer. Once the end of the rotor carrier shaft is flush with the surface of the star rotor, if it still won't simply slide off you can position a small socket with an OD slightly smaller than the rotor carrier shaft on top and continue tapping.

On the pre-1982 cars, a plastic disk with 12 ferrite inserts was used; according to Jan Wikström, "Its hub is about an inch long (estimated; I've never seen an intact one) and all beneath the disk. It's a tight fit on the spindle and in its keyway. And the disk, which is all you have to apply force to, is about 3/16 in thick near the hub. On an old car like mine, the only way to get the disk out would be by breaking it up."

Fortunately, John Nuttall found a better way: "I discovered a technique for removing the circular plastic timing rotor which, according to Jan W in your book, often breaks under extraction. The idea is to undo the three screws which hold the movable part of the distributor body to the base. This can be done with the rotor in place. These screws have springs on them to allow the body to rotate when the vernier is turned. It is then possible to push upwards on the rotor with the body with the force being applied uniformly very close to the central shaft of the rotor - much better than pulling at the edge."

Unfortunately, Wikström counters: "It's better than fingers, although it still bears on the thin part of the disk outside the

hub. But sure, it's worth trying before you break the disk up. One hitch: If you don't have the distributor with the little screw inside the top of the shaft, lifting the micro housing (charming name, isn't it?) will pull the centrifugal advance mechanism apart without shifting the disk." And stretch your advance springs beyond recognition. If you can't rely on the retainer to hold the rotor carrier shaft still, you must press down on the center shaft with your thumbs while pulling up on the housing to get the disk off. Maybe some method involving tapping with a plastic-faced hammer will work here, too.

Whichever distributor you have, you must remove the three screws with springs and lift off the movable portion of the base to gain access to the centrifugal mechanism below. You could leave the pickup assembly in place, but on the 1982-89 it's in the way for getting to one of the screws with springs; since it's only two Pozidriv screws to remove the pickup assembly, that's the easy solution. Of course, it's a good idea to inspect the vacuum advance mechanism as well as the pickup module while you're there.

Note how the centrifugal weights and springs are installed. Being careful not to stretch them, disconnect the springs from the pivot posts for the centrifugal weights; Carlos Artal says, "Use a piece of strong, thin string (such as fishing line, etc. -- I used dental floss) to take away the springs without damaging them or overextending them. It works for mounting them too. Just get one extreme, and pull slightly outwards and up." You don't have to disconnect the springs from the posts on the rotor carrier base plate if you don't want to; you can just let them dangle. Yes, the two springs are different, but it doesn't matter which one goes on which weight.

Remove the felt from the top of the rotor carrier (if there is any) and observe the retainer underneath. This is a possible cause of trouble. The early cars had a screw there, but on later cars there's a nylon clip instead. The nylon clip is usually brittle and cracked, sometimes allowing the rotor carrier to rise on the distributor shaft and possibly causing interference damage down in the advance mechanism. If you don't have a screw, the procedure for removing the rotor carrier is to yank, which usually results in breaking the nylon clip.

Normally the rotor carrier shaft should slide off the distributor shaft at this point, but if it is seized some Liquid Wrench or other measures may be called for. Please try not to bend the distributor shaft -- it is remarkably thin within the rotor carrier. And don't grab the rotor carrier shaft with pliers or vice grips -- the metal isn't that hard, you'll booger up the surface, and then it will be difficult to get the plastic wheel or star wheel back on. Once apart, clean all the crud off the bearing surfaces. Decide for yourself whether Bywater or I am right, whether it seized due to lack of lubrication (dry) or a lousy lubricant (gummed or varnished).

There are photos of some of the parts within the distributor at:

<http://www.jag-lovers.org/xj-s/book/Distributor.html>

DISTRIBUTOR SERVICE KIT: A distributor service kit, part number DZB105, is available; it is often called an "anti-flash shield kit" since the anti-flash shield is the most obvious part in the bag. The kit contains parts usable on all pre-Marelli distributors. Stefan Schulz points out: "It's a Lucas part number rather than a Jaguar one. My friendly not-so-local Jaguar parts man couldn't find it on his system."

The mail order catalogs may not list what parts are supplied in this kit, so the list is provided here:

- Clear plastic anti-flash shield (used on 1982-89 only)
- Screws and washers for anti-flash shield (4 ea)
- Ignition pickup mounting screws (2 ea - used on 1982-89 only)
- Distributor cap gasket
- U-pin for reluctor positioning (used on 1982-89 only)
- Reluctor retaining clip and wavy spring washer
- Replacement carbon contact for distributor cap, with spring
- O-ring for distributor-to-engine joint
- Nylon rotor retaining clip (see note under DISTRIBUTOR DISASSEMBLY above)

It may not really be necessary to obtain this kit to perform a distributor overhaul. The O-ring can easily be purchased locally, and you'd be well advised to find a Viton one anyway. The rotor retaining clip, while not likely to survive

disassembly, can be replaced with a couple of small washers and a tiny O-ring -- see CENTRIFUGAL ADVANCE REASSEMBLY below. The existing anti-flash shield, screws, cap gasket, U-pin, retaining clip, wavy washer, and carbon contact may all be reusable -- and if not, screws and washers can be purchased separately, a gasket can be purchased separately from Jaguar (DAC4063) or cut from gasket stock, and a carbon contact can be pilfered from some other type of distributor cap.

In fact, the only part of this kit you're likely to really need is the anti-flash shield itself since the old one may be brittle and cracking. You could try buying it separately from Jaguar; it's part number AEU1722. Or you could try fabbing a flat disc from clear plastic and installing it with four long nylon screws and some nylon nuts to support it at the same level as the top of the original shield; you might drill the four holes in the housing out and tap them larger to permit using stouter nylon screws. You could try fabbing a shield from the bottom of a plastic container of some sort, again finding a way to hold it in place without creating an electrical path to ground. Finally, you could just omit the anti-flash shield entirely, since it's plausible that it's entire purpose in existence was to provide a purpose for the four screw holes that were originally intended to hold the trigger board on D Jetronic cars.

DISTRIBUTOR SHAFT SEAL: The Jaguar V12 distributor has had two common problems, centrifugal advance seizing and cracking distributor caps. Both of these problems have been attributed to crankcase vapors entering the distributor between the shaft and the housing. Supposedly the vapors condense into the type of varnish found inside engines, seizing the advance mechanism. Vapors collecting within the cap are ignited by the arcing of the distributor and cause an explosion which cracks the cap.

Both causes are in question. Hard deposits that seize the advance may very well be the original lubricant exposed to too much heat. And Jaguar's reported reason for venting the later distributor caps was to deal with high temperatures that caused the caps to crack, although clearly the vent system could also remove collecting vapors. It is noteworthy that the later, vented distributors are still prone to advance mechanism seizing, and the still later Marelli distributors are vented even though they have no advance mechanisms to seize. And the real source of the explosive vapors is the incompetent mechanic who has addressed a seized centrifugal advance by spraying WD-40 down the center of the shaft, which spun out and was ignited on startup and blew the cap apart.

There is a seal between the shaft and the distributor housing, but it gets hard and brittle, probably due to the heat in this area. If the distributor is being worked on, it might be a good idea to replace this seal. Note that removing the distributor drive gear retaining pin requires some grinding, and reinstalling the pin requires a tack weld to hold it in place. There's a bearing in there, too, you might wanna renew it while you're there.

RATTLY PARTS: Richard Chapman had another problem: "The pressed connection between the rotor shaft and plate where the springs connect was loose. I brazed it very carefully and that made the timing reading stable rather than flickering." This is not a rare occurrence; be sure to check your rotor carrier for looseness before reassembly.

THINGY: Highly technical term referring to a specially-shaped plastic thrust washer at the bottom of the rotor carrier shaft, just below the centrifugal advance weights. It has ears on it that appear to provide an inner stop for the centrifugal weights, apparently to reduce noise but effectively limiting how retarded the timing moves at idle. It's also a British non-metallic part, so it may be cracked or broken. Note: If you have the early distributor held together with a screw under the rotor instead of the nylon clip, you don't have a thingy and don't need one.

If you're lucky enough to have an intact thingy, you need to take care to reinstall it properly during reassembly. If you just look at it and line up the notches with the "wings" on the cam plate on the bottom of the rotor carrier shaft, there's a better than even chance you will have installed it wrong. There is a pair of pins on the thingy that hold it in position relative to the cam plate, and the correct position of these pins is shown in Figure 9. Note that for clarity the thingy itself is not shown, only its pins.

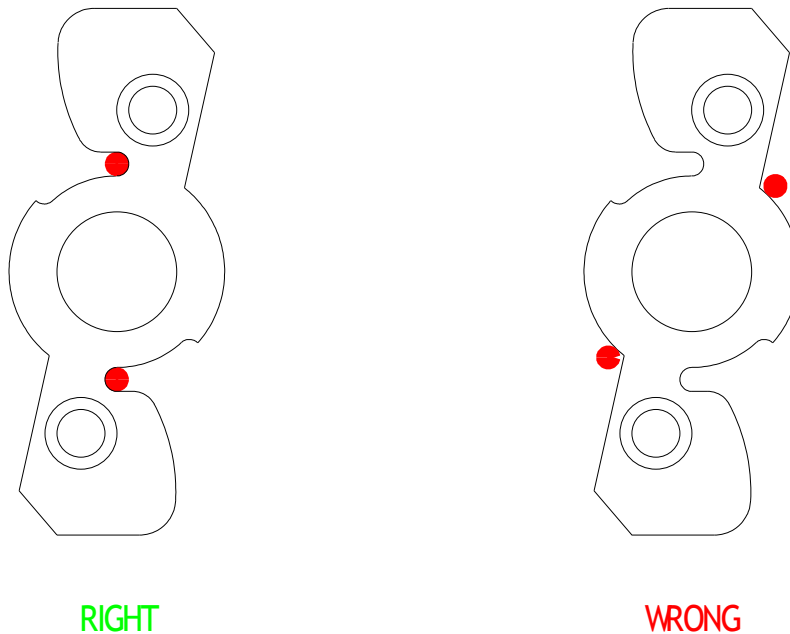


Figure 9 - Locating the Pins on the "Thingy"

If your thingy is toast, bad news: This part is apparently unobtainable. It's not included in the DZB105 kit. One frustrated owner reported: "I phoned Lucas Aftermarket Operations, Parts and Service (note: See page 705). Apparently, they have routine service parts which are readily available at most dealers, other service parts which they can provide part numbers for and which are often available, and then there are non-service parts which of course the thingy and the seal fall under. The parts did not show up on his drawings although he did have DZB105. He could see the shaft bearings in the drawing, but no seal and no plastic thingy. I asked what happens to parts that are not on their drawings anymore. I was advised that once it is not profitable to sell replacement parts, they are removed from the aftermarket listing and so, to Lucas Aftermarket the part numbers are no longer available. He told me that the part numbers could only be obtained from the factory drawings once they were declared non-service parts. He also advised that they factory would not talk to me about this because that is what Lucas Aftermarket is for. So, Lucas Aftermarket is apparently the only information source Lucas has for part numbers and they do not have these parts listed anymore."

You're screwed. The only option -- and it's a perfectly workable one -- is to install a generic 5/16" ID flat thrust washer in place of this thingy. Val Danilov adds "I wouldn't use any washer there larger than 0.5in OD, as it may interfere with the weights." The thrust washer also needs to be at least .060" thick, although if thinner you could merely stack two in there; the ideal thickness is around .078", but you could probably install anything up to about .120" without any problem. The loss of the inner stops for the centrifugal weights will evidently allow the timing to retard a fraction of a degree more at idle than before (timing is set at 3000 RPM, well out of the influence of this thingy, so timing anywhere except idle will be unaffected). There also might be some noise at idle with the weights hitting the metal shaft instead of the plastic stops, although how you would ever hear it above the general din of the engine idling is simply inconceivable.

Plastic, brass or bronze will work nicely; steel might gall against the other steel parts, and aluminum or copper may be too soft and wear quickly. Danilov doesn't like the idea of plastic, since this is the type of application where choosing the wrong plastic will result in a part that gets hard and cracks with age; he found a porous bronze thrust washer at an Ace hardware store with the 1/2" OD and was able to drill out the ID to the correct size. This sintered bronze bearing material is ideal, since the entire purpose of the material is for use as a bearing between steel parts. Another idea would be to buy a 5/16" ID - 1/2" OD bronze sleeve bushing and slice a suitable ring off one end of it (if you find a place that sells them, you might want to pick up a couple more such bushings; see the section on throttle

linkage bushing replacement on page 269).

CENTRIFUGAL ADVANCE REASSEMBLY: *Do not* grease the sleeve bearing area between the rotor carrier shaft and the distributor shaft before reassembly; this bearing should be lubricated with *full synthetic* engine oil *only*. Steve Holst shared his experience with the xj-s@jag-lovers.org discussion list: “I can vouch for having no grease put in the rebuild. I had my distributor rebuilt by my previous Jag mechanic before I knew of this list. About two years later it was seized up again. It didn't take long before that grease was gumming things up again. I have a feeling that most Jag mechanics assume that slathering on the stuff is the way to do this job. I cleaned it out myself that time and haven't had a problem since.”

It is recommended that the pivots for the weights be lubricated with dry graphite only. The ends of the springs and the contact surfaces all the way around the cam plate on the bottom of the rotor carrier shaft may be lubricated with a high temp light grease such as automotive contact grease, but make sure not to apply so much that there is any conceivable way you could cause a seizure if this grease hardens. An unnamed source on the MG discussion list says, “Dupont makes a line of synthetic greases under the Krytox brand name which use a PFPE (perfluoropolyether) oil thickened with PTFE (Teflon). It is rated for continuous use up to 260°C and down to forty below zero and is chemically inert, so it won't react with anything which may come into contact with it (gas, liquid or solid). I think the GPL-225 would probably meet your needs, but something thicker (GPL-226) might be good, too. You should be able to get a 'sample' tube of this stuff for about \$10 or less. Check out:

<http://www.lubricants.dupont.com/>

Finding a replacement nylon clip apparently requires buying the entire service kit (see page 141), which you might want to consider anyway. However, considering the clip's failure tendencies, you may decide not to use it. It has been found that an excellent method to retain the rotor carrier is to insert a couple of small metal washers that fit within the carrier but around the top of the shaft, followed by a tiny, chubby O-ring. Snap the O-ring into the groove on the top of the shaft so that it retains the washers in place, which in turn retain the carrier. David Johnson says, “I found a #61 O-Ring at Home Depot was a perfect fit in the groove. It has the following dimensions: 9/32” x 5/32” x 1/16””. The O-Ring has a slightly smaller diameter than the top of the shaft. When you get it on it seems to stretch until it is a perfect fit for the groove.” For owners in the UK, Carlos Artal says, “The O-ring can be found in the generic O-ring packet they sell at Halfords. There are 2 boxes, one with large rings and one with small ones ; in the small O-rings one, there's a perfect sized O-ring.” It might even be a good idea to try to find a Viton O-ring in this size, although since sealing isn't the issue and you'd be willing to buy a new O-ring whenever you take the distributor apart perhaps you don't care if it gets hard and brittle.

Another suggestion: Roger Bywater says, “Pulling the spindle apart invariably destroys the plastic retainer at the top but we find a small push on trim lock washer works just as well.”

The washers need to have an OD less than 13/32” (10.3mm) but larger than 5/16” (7.9mm), and the ID needs to be at least 3/16” (4.8mm). Brass washers would be ideal; you don't need yet another source of rust in this assembly. Johnson says that Home Depot's 5mm plain zinc washers fit perfectly. “They are in the pull out boxes and not hanging on peg hooks. 4 per bag.”

If these parts are installed properly the carrier should have a slight amount of up and down play, but if excessive there is the possibility the rotor carrier shaft might be able to slide up far enough to disengage the pins on the thingy down below. If the thingy moves while thus disengaged, the rotor carrier shaft might come back down and crunch it. This is unlikely to happen while running, but it might occur when somebody is trying to replace the rotor. To avoid the problem, install at least *two* washers under the O-ring. Better yet, do some trial fits while apart; first, try just the O-ring and washers on the distributor shaft to see how many will fit, then trial assemble the rotor carrier shaft, thingy, washers and O-ring without the centrifugal weights in the way and see if the pins on the thingy remain engaged when the rotor carrier shaft is lifted. When through with the trial, it should be possible to simply pull the rotor carrier shaft off, popping the O-ring without damage, but just in case it'd probably be a good idea to have a couple of spare O-rings on hand for such trials.

Once the rotor carrier shaft is in place and retained, you can connect up the centrifugal advance springs. On the heavy

one, it is recommended that the elongated end be positioned on the outward post that a weight pivots on rather than the inward post on the rotor carrier shaft baseplate. It might not make any difference, but it'll make sure the tip of the spring doesn't touch the side of the rotor carrier itself. It'll probably be easier to assemble this way, too.

If there is no felt plug in the top of the rotor carrier shaft, install one -- or just jam a cotton ball in there. Something needs to hold some oil.

DISTRIBUTOR OVERHAUL -- PAY SOMEONE ELSE VERSION: Jeff Elmore points out that British Car Service (page 706) will overhaul your distributor for you. "I called them and they said that they do the whole seals, bushings and new springs. They said that they have an assortment of springs and they keep trying until they get the right advance curve."

DISTRIBUTOR INSTALLATION: Since you read this book first and marked the parts correctly, installation is a snap. If the crankshaft has not been disturbed, reinstall the distributor with the rotor pointing in the same direction it was before removal (Note: Correcting a seized advance mechanism may make the rotor point *slightly* differently, but it's real close. You'll know if you miss by one tooth on the drive gear). If the crankshaft was turned, remove the oil filler cap, turn the engine until 10° BTDC and the mark you made on the sprocket is showing, and install the distributor with the rotor pointing towards the 1A contact on the cap.

If you didn't plan ahead and the engine has been turned, it is not so easy. If you just take a blind shot at this you only have a 50/50 chance of getting it right. There is a mark on the jackshaft, but the jackshaft turns at the same rate as the crankshaft, twice the rate of the distributor, so that mark is of no help.

To ensure correct positioning, the 1A spark plug can be removed and the engine turned over with a thumb over the hole; the compression stroke can easily be determined. However, getting the 1A plug out and a thumb over the hole is difficult on the H.E. (it's much easier on the pre-H.E.). You might try Bob Egerton's bubble trick described in the section on timing starting on page 126. There are also whistles sold that can screw into the plug hole to report when you're on the compression stroke.

Craig Sawyers says, "...look down the hole. If it is on exhaust, you can just see the exhaust valve if you shine a light down the hole. If it is on ignition, you won't see any valve (they'll both be shut)."

Mike Morrin says, "There is an easier way. Set the engine to TDC according to the mark on the crankshaft, get a short length of hose which will seal up against the spark plug hole, and blow into it. On the compression stroke, you should go red in the face."

Alternatively you can check cylinder 6A (right rear cylinder), which may be easier for any of the methods described above. This cylinder fires exactly one complete crankshaft rotation before and after 1A. Therefore, you can find the top of the compression stroke on 6A and then turn the crankshaft through one complete turn. Or, you can leave it there and install the distributor such that the rotor points to the 6A contact instead, exactly opposite the 1A contact.

To place the distributor housing in the right place on the slotted holes so the vernier adjustment has a usable range, merely align it with the marks you made before you took it out. You didn't mark it? Tsk, tsk. Read on.

Michael Neal claims, after working on these cars daily, that the optimum location of the distributor body on the three slotted holes is always the same. The correct position "is with the distributor body set at 3.5 degrees retarded at the adjuster. The centerline of the rotor will be 75% past the No. 1 line on the inner shield. The slots for the holddown allen bolts will be 2/3 past the allen heads. The tooth on the pickup will be roughly 5 degrees past the center of the pickup point. Note that the distributor turns anti-clockwise. This setting will give you near perfect timing almost every time with adjustments both ways. Other settings tend to give too much retard or advance with no adjustment."

PREVENTING THE DAMN THING FROM SEIZING AGAIN: After you've overhauled the distributor and fixed the seized advance, the rotor carrier/distributor shaft interface must be lubricated regularly; the Lubrication Chart in the

ROM says two or three drops of clean engine oil in the felt under the rotor every 6,000 miles (every oil change - no, Quickie Lube is *not* likely to be doing this!). This is not easy, as it requires removing the distributor cap, which in turn requires removing the cruise control unit and all the ignition wires. This lubrication procedure is obviously very important; it is recommended that owners do it themselves, or make very sure their mechanic isn't skipping this part of the maintenance. Jan Wikström suggests installing a new felt pad, then taking it in for service. If the pad is dry when checked afterward, cease doing business with that shop. Perhaps good advice, but has a significant probability of eliminating every shop in the area from consideration!

Note that many XJ-S distributors don't seem to have any felt. Considering the known problems here, it'd probably be a good idea to put some in. Or, just a wad of cotton.

Since the seizing appears to be caused by the lubricant getting baked, normal "clean engine oil" might not be the best idea. I recommend that a synthetic engine oil be used, since it won't tend to varnish or sludge and withstands higher temperatures without breaking down. Soak the felt or cotton thoroughly every time you're in there, and make sure you're in there often enough. It might not need to be as often as every 6,000 miles -- especially if you're using synthetic motor oil -- but it's better to be safe than sorry here, so make sure you do it often until you personally have confidence that you can go longer between oilings without the thing drying out or gumming up.

It is suggested that spray lubricants of the flammable variety be avoided within the distributor. When running, there are sparks between the rotor and the electrodes in the cap; vapors will be ignited upon starting, ruining your day.

DISTRIBUTOR CAP REPLACEMENT: Randy Wilson has a low opinion of the aftermarket products, and recommends buying only the genuine Lucas parts: "The last time I checked, there was only one aftermarket cap available. I ordered in a lot of them... and every single one was defective in one way or another. Missing center buttons, missing vent tubes, pre-cracked, molded oval... Flimsy pieces. They're about 1/3 the price of the Lucas pieces... and not worth it." Note that the author has also purchased one of these aftermarket items, and in fact had trouble with the vent tubes simply falling off. Rendering it usable required careful application of JB Weld.

Jason Korke says, "I have found when I installed a replacement cap & rotor from "Standard" brand, they worked OK but the vent tubes broke off. I reinstalled the Lucas cap, and found no spark! Eventually I found the Standard cap & rotor will work and the Lucas cap & rotor will work, but do not mix the two brands."

DISTRIBUTOR CAP VENTING: The 82-89 distributor cap has two fittings for a positive ventilation system. Air is drawn through a small filter, through the distributor, and into the engine side of the air filter housing. The filter is normally found laying against the left wing at the crossbrace attachment, and sometimes concerns owners because it appears to have been disconnected from somewhere.

Reportedly this system was incorporated because the earlier distributor caps were cracking due to excessive heat, although some suspect removal of flammable vapors was the real reason -- see comments under DISTRIBUTOR SHAFT SEAL on page 142.

The connection to the air filter housing is not actually to the housing directly, but rather to a hose between the housing and the auxiliary air valve (see page 265). This is therefore a special molded hose with provision for a tiny fitting. The fitting itself is a plastic elbow, and is often found to be broken. It is not to difficult to find a suitable replacement, though, and you might even find a brass one. Or, you can forget the whole thing and install a generic piece of hose between the air filter housing and the auxiliary air valve, and install a small fitting right onto the inner side of the air filter housing for connecting the vent line from the distributor.

The filter itself is no more complicated than it looks. Any generic fuel filter will serve as a replacement. Unfortunately, some people actually have trouble finding one; David Littlefield says, "These used to be widely available as a generic fuel filter. However, when I looked for one recently they were nowhere to be found. I finally ran across one at my local auto parts store, but not with the automobile fuel filters -- it was in the lawnmower parts!" Others suggest asking for a fuel filter for a VW. Peter Havas got carried away and made a filter from a plastic film container stuffed with generic filter material (cotton, some types of vacuum cleaner filters, a coffee filter, or the crankcase ventilation filters sold in auto

parts stores will serve). He cut lots of little holes in one end, and cut a hole in the other end just a hair smaller than the OD of the hose and stuffed the hose into it. This arrangement allows him to service the filter by opening it up and cleaning or replacing the “element”.

Obviously, optimizing airflow and cooling would be a good idea, so replacing this filter before it gets significantly plugged up is recommended. If you drive in dusty conditions, take note.

If you would like to help this system out, reroute the intake filter to somewhere in front of the radiator. This will draw cooler air, and will also draw more air since this is a high pressure area. The cooler air should also help the electronic ignition pickup last longer.

It’s possible that this ventilation scheme was retrofitted to earlier cars. It may also be possible to drill the older cap and fashion suitable fittings, one in the side for an inlet and one out the top for an outlet. A few pieces of hose, a fuel filter, and a connection to the engine side of an air filter housing and it’s done.

Lucas OPUS Mark 2 (pre-1982)

LUCAS “OPUS” MARK 2 IGNITION -- DESCRIPTION: This is a brief description of how the pre-1982 ignition system works, based on the more detailed description in SAE paper 720163 on the development of the engine.

The pickup within the distributor consists of an E-shaped transformer with one input coil and two output coils. The input coil is on the center leg of the E and is fed a 600KHz input signal from the amplifier. The two output coils are on the outer legs of the E and are wired in series so that their outputs cancel -- provided the two sides of the transformer are equal.

When one of the ferrite inserts built into the plastic rotor in the distributor aligns itself with one side of this transformer, it magnetically completes the circle on one side of the E. Since the output coil on this side is now more closely coupled with the input coil than the other output coil, its output is greater -- and the two no longer cancel each other. A transistor in the amp is toggled by the resultant output signal, triggering a spark.

TROUBLESHOOTING: Jan Wikström sends this procedure for testing the OPUS ignition system:

1. Pull the lead from coil to distributor out of the distributor and jam it under a fuel pipe so there’s a gap of about 1 mm (.04in) between the brass and the nearest engine part.
2. Crank the engine. Do you get fat, blue sparks in the gap? Then the ignition is OK and you need to troubleshoot the injection system. If not, continue:
3. Pull the spade connector off the coil terminal marked (+). Turn the ignition on, then test the power with a spare light bulb between the connector and engine bare metal (this is better than a voltmeter, because it will reveal a poor contact with insufficient current carrying capacity). Is the lamp bright? Then continue; if there’s no voltage, check the ignition switch and all its wiring including the ballast resistor.
4. Touch the connector quickly several times to the terminal. Do you get a spark now? Then the pickup coil in the distributor or its wiring, or (less likely) the amplifier, may be faulty. If there’s no spark, turn the ignition off and continue:
5. Get a test lead with alligator clips. Clip one end to bare metal on the engine, pull the tubular connector off the (-) terminal of the coil and clip the other end to that terminal.
6. Repeat test 4. If you get a spark now, the amplifier or its wiring is faulty. If you get no spark, the coil is dead.”

OPUS IGNITION AMPLIFIER RELOCATION: The OPUS ignition amplifier is a finned aluminum block that was originally mounted down within the galley between the cam covers. It gets cooked, primarily after the engine is shut off and all that heat from the block rises. Dick Russell says that intermittent failures characterized by the tach reading zero even when the engine is still turning are a sure sign the amp has failed.

Jaguar makes a kit to relocate this amplifier to the plate across the top of the radiator so it stays cooler. The kit includes a new amplifier and a new pickup for inside the distributor, and costs over \$300.

It is possible Jaguar includes the amplifier and pickup simply because the only time their mechanics get a call to relocate the unit is after the original unit has fried. On the other hand, perhaps the reason the unit was originally located in such a sorry place was because the wiring needed to be as short as possible, and the replacement amp and pickup have updated circuitry necessary for the longer wires. According to Jan Wikström, the plugs and wires used on the replacement kit are different than the original, indicating you're supposed to replace the amp and pickup together. However, he simply spliced wires and used his old pickup, and it worked fine. He notes, however, that the wire color codes changed; it is necessary to open the amp and verify where the wires go to ensure they are connected correctly.

Clearly, crosstalk between the 600 KHz input signal and the output wire back to the amp would be detrimental to operation, and such crosstalk could be easily caused by the wires merely being located too close to each other for too great a distance. Also, the output wire picking up any *other* signals -- such as interference from the ignition wires -- would be ungood.

Reportedly, some owners have relocated their original amps by simply lengthening the wires, and have been successful. Others have *not* been successful. At least one owner reports that the official Jaguar relocation kit caused the wires to pick up so much interference from the spark plug wires that the car wouldn't run, and he couldn't get the system to work until he *shortened* the wires back to the length of the original.

Russell recommends that ribbon wire with five or more conductors be used to relocate the amp. By using every other conductor, the unused conductors in between provide adequate spacing between the active conductors to prevent crosstalk and interference.

Russell also recommends relocating the amp to the firewall rather than the top of the radiator. In his car, the amp was affected by water and crud thrown up from cars in front of him. Fortunately, he was able to repair it by resoldering some connections inside.

Perhaps another solution is to leave the amp in the valley and attempt to keep it cool there. Fashioning a heat shield from sheet aluminum for underneath it will help. Also, see the suggestion on page 125 about cutting a hole in the A/C compressor mounting plate.

British Auto/USA (see page 692) claims to have "reinvented" this amp using modern electronics. The amp they offer, part number JLM368/R, looks exactly like the original and is supposedly durable enough that it may be located within the V; apparently some concours judges will subtract points if the amp isn't in its original location.

Of course, if you don't care about concours points, the best relocation idea is to relocate that OPUS system to a dumpster and replace it with an aftermarket ignition system. See page 150.

If you have a 1982-89 car with a black plastic amplifier mounted on top of the left intake manifold, you have the Lucas CEI ignition rather than the Lucas OPUS. There is no need to worry about relocating the amp.

IGNITION AMPLIFIER -- REPAIR: Referring to the OPUS finned aluminum ignition amp, Jan Wikström says: "As for the amplifier itself, there is precious little pottery involved. I opened up the suspect one (four small hex-head screws underneath) and found that while there's a silicon blob at the cable entry and a silicon slurp for a seal around the lid, the inside is empty and there is complete access to PC board and power transistor. No need to spend up on a new one if it goes belly up; this unit is eminently repairable."

Phil Stuart says, "There are four transistors in the early Lucas Opus ignition amplifier, one is a big one in a TO-3 casing for amplifying and 3 smaller ones for switching. I burnt up the smaller switching transistor. It's fixed and running now; the transistor we finally put in was a ECG128, NPN type. Cost \$2.95 CND. The original one was Germanium NPN;

the replacement is silicon NPN.”

PICKUP WIRING: Wikström warns: “One problem I’ve had on both cars is an intermittent break in one of the three ignition trigger wires coming out the front of the distributor, right in the moulded grommet. This seems inherent to the design, as the big, heavy three-pin connector flops around on loose wires and should cause metal fatigue as the wire bends back and forth. I have replaced the wires (solder joints inside the distributor) and applied spade connectors instead of the three-pin job.”

COIL LOCATION: If you can’t find it, you’re in trouble. If you have the Haynes manual, the caption on the photograph labelled 10.2 on page 118 says it’s “at the rear of the throttle pedestal” but it lies, it’s at the front.

BALLAST RESISTOR PACK: The ballast resistor pack is shown as item 164 on the Jaguar wiring schematics. On earlier schematics, it is illustrated as a simple rectangular box with six wires connected to it, but on later schematics they show three resistors inside. It would probably have been better if they hadn’t done that, because the simplistic 3-resistor illustration is incorrect and misleading.

Section 86.35.29/3 of the ©1975 ROM is titled “Ballast resistor check”, and provides a simplistic continuity test. It provides a more detailed illustration of the ballast resistor pack -- also incorrect. Section 86.35.29/4, “Coil voltage check”, Step #4 includes values for the resistors in the ballast resistor pack, but they’re numbered “Resistor 1” through “Resistor 3” and “Connection 4” and “Connection 5” with no clue whatsoever what connections they’re talking about. In section 86.35.29/10, in the latter half of Step #4, inexplicably buried in the midst of a coil/amplifier check procedure, the resistance values are repeated and the illustration is provided again -- this time with Connection 4 and 5 labelled, but you’re still left to guess at the resistor numbers. The Haynes manual doesn’t have any illustrations of the ballast resistor pack innards, just photos of the outside. Is it any wonder that this book has grown to over 730 pages? Anyhow, the easiest thing to do is to simply provide a new illustration, so please refer to the figure here instead of *any* of the illustrations in the manuals.

It should also be noted that some of the diagrams in the Haynes book have differing color codes on the wires; for example, Fig. 4.1 shows a UW wire where the XJ-S has a W/U, and a WU wire where the XJ-S has a W/SU.

Mike Morrin explains the tach connection: The power from the center left terminal through the 7.6-9.2Ω resistor to the upper right terminal on the ballast pack diagram (which connects to the W/U wire) “...is the drive current for the output switching transistor. So, the tachometer gets its drive direct from the amplifier, not from the coil circuit.”

“According to the parts books I have here, there was an early version, used 1971-72 which apparently did not have the tachometer connection, and the later version, which was used 1972-80.” Morrin provides part numbers:

- E-type C35883 until engine 7S7559
- E-type C37759 from engine 7S7560
- XJ-S C37759 all

“C37759 is apparently Lucas 47229.”

There is some discrepancy about the resistor serving the tach. The XJ-S ROM reports it as 100Ω, but the SIII E-Type

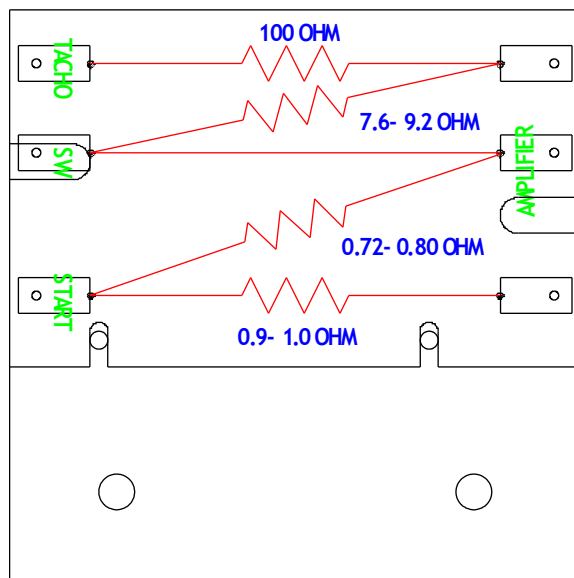


Figure 10 - OPUS Ballast Resistor Pack

ROM reports it as a straight-through connection, no resistor. This actually probably wouldn't make any difference to an electronic tachometer; the resistor merely limits current in the event of a short circuit or something. Could the part number change with engine 7S7560 reflect the resistor? Morrin: "Either way there is a mistake, it says:

"Connection 5 - Tachometer terminal and straight through internal connection (incorporated in later units marked 47227)."

That 47227 part is apparently a typo in the E-Type manual; it should say 47229, which is what is actually marked on the ballast packs.

"On reflection, I think the early unit probably had the straight through connection and the later unit the 100 ohm resistor. There does not appear to be any change in the vehicle wiring coinciding with the change in ballast."

Note that 86.35.33 describes how to remove the resistor pack. Evidently rocket science, don't tackle this job unless you are a very experienced mechanic. At least Jaguar didn't put any serious errors in this procedure.

If your ballast resistor pack has failed, it shouldn't be terribly difficult to put together a collection of generic resistors to replace it. After some discussion about a ballast resistor pack in which that 7.6-9.2Ω resistor had blown, Gary Johnson suggested "Radio Shack (Tandy). They sell a 10 or 20 watt 8 ohm non-inductive resistor that sounds perfect for this application." For the main resistor serving the coil, there are a wide variety of ballast resistors available at any parts store since just about all cars used them up until the 80's; it should be easy to find one that will work.

TACHOMETER PROBLEMS: Both John Holmes and Jan Wikström had tachometers that didn't work, and both arrived at the same corrective action: they disconnected the tach signal wire from the ballast pack and connected it to the - terminal on the coil, where it's connected on every other car ever made. Holmes: "I just know how this is wired in other cars and did the simplest circuit possible to see if the tach worked. When it did, why change it again?"

LUCAS OPUS IGNITION SYSTEM UPGRADE: As mentioned above, British Auto/USA (see page 692) offers a replacement amplifier for the OPUS ignition system that supposedly is more reliable than the original. Supposedly, Steve S reports, "I had of those BA updated amps bought from SNG in UK fitted to my V12 E. The original OPUS amp did 20 years and 90k miles in the V and was still working when I took it out after hearing that it was unreliable. I thought I was going to "decrease chance of a breakdown". The SNG updated unit lasted about 3 years and 7K miles before failing in the classic opus failure mode - dies suddenly when hot. Fortunately because this was a USA inspired device it came with a lifetime guarantee (as against a UK guarantee of guaranteed until it breaks)."

LUCAS OPUS IGNITION SYSTEM REPLACEMENT: If you have any trouble with the original Lucas OPUS ignition system, it is recommended that you simply replace the entire system with a modern aftermarket ignition system. There are several available, and most of them can be purchased in entirety for less than replacing any defective *part* of the OPUS system. And the owners who have opted for such upgrades have universally reported better performance from their cars. Note: this recommendation does *not* carry over to cars with the Lucas CEI ignition; that is an excellent system and there is rarely any cause to ditch it.

Lucas designed the plastic wheel within the OPUS distributor with three slotted holes that enable the mechanic to insert an Allen wrench, loosen the three screws at the very bottom, and remove the distributor as a unit. If you install some sort of aftermarket system, you might want to consider whether or not you will be able to get that Allen wrench past or through whatever is used to trigger the pickup. Of course, it might not be your highest priority; you could always simply disassemble the distributor in place far enough to remove the wheel to gain access to the screws.

None of the common aftermarket systems will replace the EFI trigger board. The EFI is a separate system that just happens to have its trigger board inside the distributor. After you've removed all the OPUS junk and installed an optical wheel and pickup or whatever, you will need to put that trigger board right back in. If your trigger board is toast and you've priced a new one, that is definitely bad news. However, Jaguar's upgrade trigger board -- which uses Hall effect transistors instead of the reed switches used in the original -- seems to be reliable, so usually you only need to buy it

once.

LUCAS OPUS IGNITION SYSTEM REPLACEMENT -- ALLISON/CRANE XR700: Allison was acquired by Crane. By whichever name, their XR700 is a popular replacement for the OPUS. Derek Hibbs reports: "My ign amp died as a result of convected heat last year. A reliable replacement unit was not available so the workshop installed a Crane Cams unit. The unit itself is located on the RHS air cleaner and it came with replacement pieces for the distributor because it uses an optical pickup."

Andrew Holley says, "I removed the Lucas (Prince of Darkness) system and fitted the Crane XR700-0300 system, took all of about 2 hrs. The car starts first time every time, and seems to run a bit more crisply. It has improved fuel consumption slightly, but the major benefit is that it now starts instantly, no matter the conditions."

Steve Douglass says, "After fighting problems (mostly heat related) with the original OPUS system on my car, I replaced it with a Crane Fireball system that I got from Terry's for \$124.00. The kit came with everything I needed to do the job along with good instructions. The system has an optical pickup that goes in the distributor and an amplifier that mounts on the firewall. Pretty much like what it replaces. I was able to install the thing in about 2 hrs and the car fired right up."

Paul Clarkson had a hell of a time with pickup mounting brackets inside the distributor and ended up having to fab and modify stuff, but he's apparently the only one; everyone else claims the system is a simple bolt-in. Emin Morali replied: "Try to assemble the optical pick-up unit without using any bracket. You use only two screws and it will fit perfectly in the place of original pick-up unit."

There is some confusion about which coil to use with the XR700. Clarkson reported, "I invested in a Crane Cams XR700 amp and PS91 coil. Here is a reply I received from the tech. dept. at Crane Cams in reply to my query about lengthening the pick-up leads (so I could locate it in a cool place):

"The XR700 is to be used with our PS20 or PS40 coil with the supplied ballast resistor that comes with them. The PS91 coil has such a low resistance that two ballast resistors are needed to keep the XR700 from overheating. This also kills off some of the spark power to the point of being worse than it would be if the proper coils were used. If you wish to keep the killer coil you will need to use the XR3000 amp that is designed to use the higher output coil. Please fix this before proceeding. You hook it up just as you see in the instructions and everything should be fine. You can also add to the length of the wires on the amp if they are of the same gauge and type of wire. Hope this helps. Tech support, Steve 4208..."

Again, Emin Morali responds: "When I fit Crane XR700, the car was hesitating to exceed 5000-5200 rpm with misfire at the engine. So I changed the PS20 with PS91 keeping the same OEM ballast resistor pack of my car, but adding a serial resistor of 1.4 ohm to protect XR700. No result, the same problem continued. This time I throw the 1.4 ohm resistor away and used PS91 with OEM resistor pack. My problem finished. However the possibility of damaging the amplifier pushed me to replace PS91 with a Bosch blue coil (also low primary resistance) by adding a serial resistor and no problem at all."

Clarkson says the XR700/PS91 setup was recommended by (now defunct) GT Jaguar. Paul Squire: "Quoting their website: "Gran Turismo worked very closely with Crane on these systems. The tech questions they receive about their systems for Jaguars are referred to us because they know we have more knowledge in this area than even they do.""

Terry's Jaguar (page 696) offers the Crane system, or you can also get it directly from Crane.

The Crane system comes with a disk with suitable slotted holes for access to the screws in the bottom of the distributor.

LUCAS OPUS IGNITION SYSTEM REPLACEMENT -- ALLISON/CRANE XR3000: Emin Morali says, "I had called a Crane dealer in Florida to ask him if I can use XR3000 with PS91. After he discussed the subject with a Crane tech., he told me that it won't work. I did not understand the reason why, however I had seen before in Crane web site

that XR3000 may have compatibility problem with OPUS systems and was not recommended.” Gee, it seems the Crane tech support keeps telling us not to do things that work fine; Bernard Embden installed the XR3000 and it seems to have worked out, although he put a lot of effort into locating the amp inside the car and making a bracket he liked for the optical pickup inside the distributor. You can view his installation at

<http://bernardembden.com/xjs/ingamp/index.htm>

LUCAS OPUS IGNITION SYSTEM REPLACEMENT -- LUMENITION: Welsh Enterprises (page 697) offers at least two different models of Lumenition electronic ignition system for the XJ-S, each featuring an optical pickup and compatible with their engine rev limiters.

LUCAS OPUS IGNITION SYSTEM REPLACEMENT -- LUCAS CEI: The later Lucas CEI system makes an excellent upgrade for the Lucas OPUS. Buying the Jaguar parts new would be more expensive than just going with one of the aftermarket systems above, but if you can find what you need in a junkyard you might get off pretty cheap. If you can't find the CEI ignition amp for a reasonable price, you can build one with a GM HEI module, a couple of resistors, a capacitor, a zener diode, and a suitable box to mount them in. You can use the Lucas CEI distributor, but you must install the vacuum and centrifugal mechanisms from the original distributor in it to maintain the correct advance curves for the pre-H.E. engine. You'll also need to omit the anti-flash shield used in the CEI distributor to mount the D Jetronic EFI trigger board, but they use the same mounting holes so that's easy. Make sure to use the earlier "green stripe" rotor as it has the magnet in it that drives the EFI trigger board.

Alternatively, you can reuse your OPUS distributor. You will probably need to modify it to install the CEI pickup, though. On the CEI cars, the pickup mounts on a metal plate that can rotate with the vacuum advance; on the OPUS cars, there's a fragile micarta part that rotates and holds the pickup. The body of the OPUS distributor includes a center section that this micarta part rotates around, and on the CEI distributor body this center section is gone.

According to John Testrake, SNG Barratt (page 696) developed a way to upgrade to the Lucas CEI while maintaining the appearance of the OPUS under the hood. "They have marketed it for Ser III E-types which are, of course, carburetted. I called them last year and asked if they could do it for an EFI engine. They said yes and that they were just bringing that to market. I think mine was the first one.

"They completely rebuilt the dist. from my car with all new parts and refitted it with the CEI reluctor and pickup. Then they swapped the internal parts of my amp with CEI parts and built in a heat resistant mounting. It's all designed to operate with the D-jet EFI and has all the original advance curves, trigger board and what not.

"And it uses one coil. It's a Lucas coil with bare aluminum case about 6" long and a white cap where the leads connect that says LUCAS. It mounts to the front of the throttle pedestal like the original. Pretty standard issue, I think and it comes as part of the kit.

"Everything looks like OPUS. Nobody can tell it has CEI inside. I'm hoping for a JCNA North American class 11 Championship with this car. So that's why all the fuss over originality."

Steve S, who reported above that he had purchased the British Auto/USA-upgraded OPUS amp from SNG Barratt and it failed on him: "SNG being good people exchanged it for one of the CEI units in the OPUS case - although the lifetime guarantee is not available with this new one. I gather the original unit was withdrawn because it was unreliable. With the kit you also get a new aluminium U-shaped resistor pack identical to the original and decent fitting instructions. You have to send your old distributor back in part exchange. The coil, OPUS style alloy box, and resistor pack have stickers on them in inconspicuous places warning that this is an updated system with a reference number for maintenance in future so standard parts do not get swapped back in."

LUCAS OPUS IGNITION SYSTEM REPLACEMENT -- \$\$\$: You could just go hog wild and install a fancy-schmancy modern high-tech ignition system. See the ideas for upgrading the Marelli on page 172; any of those systems can be used to upgrade the OPUS as well.

Lucas Constant Energy Ignition (1982-89)

LUCAS CEI IGNITION -- DESCRIPTION: The triggering mechanism for the Lucas CEI ignition system consists of a “star wheel”, a wheel with 12 points on it, mounted on the distributor shaft with a “pickup” adjacent to it. There is a magnet and a coil in the pickup. A magnetic field is established in which the flux passes from one pole of the magnet through the coil, through the star wheel, and back to the opposite pole of the magnet. When a point on the star wheel aligns with the core of the coil, this magnetic flux has a nearly continuous path of iron and is therefore at its strongest. When the point is far away from the core of the coil, the magnetic flux is at its weakest because there is so much air space in its path.

Since a voltage is generated in a coil with a *changing* magnetic flux through its core, a voltage is generated in the pickup by the increasing strength of the magnetic flux as a point on the star wheel approaches the tip of the core. A voltage is likewise generated by the decreasing strength of the magnetic flux as a point on the star wheel moves away from the tip of the core -- but this voltage will be opposite in polarity from the first one. The pickup will therefore produce a voltage that suddenly reverses polarity as a point on the star wheel passes the tip of the core. The electronics within the amplifier module sense this voltage reversal to break the ground connection to the coil, triggering a spark.

But that’s not all this system does. It waits a varying amount of time before reestablishing the ground connection to begin charging the coil for the next spark, getting the charging started ASAP at high RPM but waiting a bit longer to get started under idle conditions so as to minimize coil heating. It also monitors the current flow to the coil to make sure that it does not exceed a set limit, which might happen at low RPM when there is more than adequate time to build up a charge in the coil. If the current rises too much, the amp begins to cut back on the voltage applied, holding the current constant and preventing the coil from overheating.

Prior to systems with such features, coils had to be designed to handle high-current conditions at low RPM and had ballast resistors to limit the current. With the current control features, coils can be designed more compact and without the oil inside that was needed to keep them cool. They could also be designed with very low impedance in the primary coil without worrying about current overload problems, allowing much faster charging on 12 volts. Unfortunately, such coils weren’t available when the Lucas CEI was introduced, so two conventional coils were wired together to accomplish the task. Later, after suitable coils became commonplace, Jaguar would replace the dual-coil setup with a single modern coil whenever a coil needed service.

During most operation, the ignition amp is merely switching the current on and off and is dissipating very little heat. However, at low RPM when it’s having to cut back the voltage to limit the current in the coil, it’s having to dissipate that extra power. It gets hot under such conditions. The amplifier is bolted to the aluminum intake manifold to try to dissipate some of this heat to the manifold and to the cool air passing within.

Roger Bywater: “The 12.5:1 compression of the H.E. was too much for OPUS to fire and in any case it was getting to be a bit primitive by that time as it had no means of current control other than via the ballast resistor.”

TROUBLESHOOTING: Randy Wilson sends this procedure: “With the engine cranking, check for:

- Power to the ballast source
- Power to the coil + post
- Ground switching on coil - post (if so, you should have spark)
- Ground to amplifier case

“If everything passes except the ground switching on the coil, then it’s in the amplifier or its wiring.

“A scope put on the pickup leads should give a modified sine wave pattern typical of magnetic induction sensor. At crank speed, I *think* it’s around 1.5V peak-to-peak. No scope pattern is a bad pickup.”

“I’ve never personally seen the pickup go bad, but have run into cracked wires in the pickup harness. Quite often jiggling the harness will cause the problem to “correct” itself; sometimes for many years. Everything working fine after doing the scope check is bad pickup wires.”

If your car runs well when cold but gets uppity when hot and you suspect the ignition amp, you might try pouring some water on it to cool it off. If the car runs well again, you have definitely narrowed the search for a cause down to *something* in that little black box!

IGNITION AMPLIFIER -- REPAIR: The Lucas Constant Energy ignition amplifier is a black plastic box mounted on top of the left intake manifold. This unit is clearly labeled “Lucas” and “Made in UK”. The mail-order catalogs call for a part number DAB106, and want serious \$\$\$ for it.

If you unbolt this unit from the intake manifold, turn it over, remove four tiny screws and remove the cover, you will see four components inside. The predominant component is a GM High Energy Ignition (HEI) module. This unit is so common that you can find it on a bubble card hanging from a hook in any department store with an automotive section -- for around \$20. Usually this amplifier can be repaired by simply replacing the GM HEI module for considerably less than the cost of replacing the whole unit.

Simple? Maybe not. Dave Johnson says, “The amp on my ’84 died on me several years ago. I replaced the module with the equivalent GM module and it lasted 3 months. I replaced the zener and the capacitor with equivalents. I again replaced the module. This one lasted 1 month. I gave them one more chance (lifetime warranty) and it’s worked for 4 years now. The moral of the story? I believe the modules available from discounters are marginal and you have to keep trying to get a good one. Since I didn’t even consider buying a new amp from the dealer I can’t rate their failure rate but a GM mechanic friend of mine kept after me that the modules I was getting were junk. He was right and I now have a working one. No more intermittent problems. Try another one.”

Tom Drakos concurs: “After buying 3 different control modules all made by Wells, DR100, I got 3 different types of results, all of which were terrible, to the point of undrivable. I knew the original was made by GM, so I searched the internet looking for a similar application. I ended up with a control module made by AC Delco, part # D1906, even has the GM stamp on top like the original. Price was a little more, \$41.00 from Discount Auto, but well worth it. The car runs like new, smooth as silk at all engine speeds and idle.

“My advice to anyone experiencing a problem with a control module would be *not* to use WELLS D100...these things are *crap!*”

Terry Pegler apparently disagrees about the part number. “The replacement modules that I am using are AC Delco # 10482820 from the GM Dealer. It is made in singapore...” Doug Dwyer adds that there were earlier part numbers for the module, starting with 1875990 in early years, but the 10482820 replaced them.

Just because you spend the big bucks on the Delco doesn’t guarantee you’ll get a good unit. Owners have reported bad ones of those, too. Just keep trying.

Shafi Keisler claims that the standard GM HEI module is rated for 6 amps but the one in the Jaguar V12 is a special unit rated at 8 amps. Nobody has been able to confirm that claim, though. The standard HEI works great, once you get a good one.

Reportedly some modules come with a packet of heat sink compound. Tom Bennett says, “I just bought a GM module from AC Delco, came with a pack of silicone heat transfer goo. I am familiar with the usual white heat sink paste; this stuff is very different, it’s labeled silicone grease and contains 90% polysiloxane 10% silica.” Hmmm. Might not be heat transfer goo; might just be goo. Dunno why they’d provide a packet of goo, though.

Heat sink compound might not be a bad idea; applying it between the module and the ign amp housing might help the module run cooler. Even if the module you get doesn’t come with the stuff, you can get it at electronics shops. The best way to apply heat sink compound is with a single bead, so that when you bring the parts together you squeeze the compound so it spreads out. This way you avoid air pockets in it.

John Robison says, “Advance Auto has an electronic gizmo they can plug the GM unit into. It simulates loading at both

low and high rpm (somehow) and then gives a pass/fail indication for both conditions.” While it may hardly seem worthwhile to check a \$20 part rather than simply replacing it, such a test may go a long way toward confirming diagnoses. You might even consider testing the new one you just bought before you leave the store.

Joe Bialy adds: “There are 5 connections on the GM HEI module. The fifth terminal is the ground for the module which is actually one of the mounting holes on the module itself. All of the coil current passes through this connection. If the ground terminal on the module itself is not secure, ignition problems will occur.” Peter Havas adds, “The HEI's on GM engines sit atop the distributor cap, and the replacements must have a second ground wire or they burn up. I don't know why, but having had many GM trucks which suffered spontaneous HEI failure, it was revealed by the local GM garage that you must run a straight ground as well as the little flat strip to the HEI to keep it from burning up. This applies only to replacement units, and I have no idea why. It works though.” There don't seem to be similar problems in the Jaguar V12 application -- perhaps since the module is securely bolted to the aluminum intake manifold rather than to the distributor cap -- but it couldn't hurt to make sure the ground is solid while you're in there replacing a module.

Becky Amason says, “Anyone having repeat failures of your ignition modules should check the wires from the stator in the distributor for damaged insulation. This is a known problem with GM HEI ignitions. The wires flex as the vacuum advance moves back and forth, eventually breaking the insulation and shorting out the ignition module.”

The other components inside the amp housing are a 1 microfarad condenser, a couple of resistors buried in a white rubber blob, and a zener diode mounted in the top of the case so the upper surface is actually visible from outside. The condenser may actually be a common source of trouble; there are at least two reports of it shorting out when warm, so the engine runs OK when cold but has trouble when warm. Since the condenser is connected to 12V, it shorting out causes it to get even hotter. Pouring cold water over the amp fixes the problem for a few seconds.

The condenser is apparently only a noise reducer, being connected to the +12V side of the coil. As such, just about any condenser would probably work. If you're looking for a replacement condenser, you might consider the one intended for use with the GM HEI ignition system. Auto parts stores sell a part labelled a “capacitor”, but it's more than that. This part is a little harness that has a 2-terminal connector on one end that plugs onto the HEI module, a 3-terminal connector at the other end that plugs into the GM distributor, and a capacitor attached to the 2-terminal connector. One such part is made by Standard, part number RC-4. Joe Bialy says, “More than likely, the cap in the connector will work as well as the Lucas cap if it is wired identically. Noise suppression caps are not the most critical components in a system. Typically, -20/+80% tolerance items. I'd even bet an old "points" type would work just as well too.” Peyton Gill says, “I replaced the condenser (capacitor) in the ignition amp about a year back. I used a condenser from a Chevy inline six distributor. As memory serves, it required removal of the mounting bracket which was soldered to the condenser body. It is a little longer but the diameter was about the same.”

About the resistors, Walter Petermann says, “The white piece of rubber has 2 resistors in it. One is 10k, the other 6.8k. They are connected together at one end to terminal C of the GM module. This same terminal goes to the coil minus and the large diode. The other end of the resistors go to tach and fuel ECU (white/gray wires)” The 10K resistor connects to the tach and the 6.8K connects to the EFI ECU. On the ignition amp, both wires are the same color but the tach wire has a male terminal and the ECU wire has a female terminal; the wires they connect to are clearly distinguishable, since the ECU lead is a shielded cable and the tach wire is a plain W/S/U wire. Craig Sawyers points out that the 6.8K resistor is actually shown on the fuel injection system wiring diagrams. You can easily test the resistors without even unbolting the amp from the manifold; just disconnect the W/B wire from the ignition coil and the leads to the ECU and tach and measure from the W/B wire to each. If the resistor feeding the tach fails the only symptom would be a nonfunctional tach, but a failure of the resistor feeding the ECU will stop the car with conviction.

The trick to testing the zener diode is in recognizing that it only exists to protect the amp against overvoltage, which normally occurs only when the system is operated with a spark plug wire disconnected. Under normal conditions, it does nothing. So, to find out if it is causing trouble, merely disconnect it. If nothing changes, the diode is probably not the problem. If the problems go away, you can consider finding a replacement zener diode or simply leave it disconnected; if you choose the latter option, you might want to be careful not to operate the ignition with any spark plug wires disconnected from then on.

FIDDLING WITH THE GM HEI IGNITION MODULE: This author found a warning *inside* a Lucas CEI ignition amp that read:

CONTAINS
BERYLLIA
DO NOT OPEN

Judging from the fact that this label was attached to the surface of the GM HEI module itself, the beryllia referred to is probably inside that module; there is nothing else within the Lucas ignition amplifier that appears to be this type of substance.

Beryllia is the oxide of Beryllium, and is used in a type of ceramic used to mount or encase electronic parts. This ceramic conducts heat very well, helping keep the part cool, while being an electrical insulator -- an unusual combination. Unfortunately, beryllium is really as dangerous as indicated. If you are inside the box repairing your amp, just remove and replace components. Don't go sawing open the GM module, the dust created can **kill** you.

Mike Morrin adds, "There is actually very little of it used in anything built in the last 20 years except high power transmitters and some specialised power modules. I am not sure about the GM ignition module, but if there is any, it is likely to be a pad under the power device about 2mm square and .5mm thick. Beryllium Oxide is very expensive, so the semiconductor manufacturers avoid it where possible, the safety aspects not withstanding."

MORE TECHNICAL INFO ON THE GM HEI: Motorola once offered a publication MC3334/D which provided "analog IC device data" on a chip they made, MC3334 (and a couple of variations) which was described as a "High Energy Ignition Circuit" and was apparently used within the GM HEI module. This document was very informative, not only on the circuit itself but on the entire ignition system it's used in. Unfortunately, such info is apparently NLA; perhaps Motorola no longer makes that chip, leaving it to the aftermarket businesses.

ELECTRONIC IGNITION PICKUP: The electronic pickup used in the Lucas CEI distributor involves a magnet that is mounted with two screws. Be careful tightening these screws; the ceramic magnet is much more brittle than metal items, and can easily crack. If already cracked (notably around one of the screw holes), do not be concerned, it will not affect operation. However, be sure not to leave any chips in there that could come loose and move around within the distributor. It is better to discard small bits of the magnet that have broken away.

The pickup itself is apparently quite reliable, but there are a couple of indications that it may develop intermittent problems. Don Lawson of Northeastern Classics had a customer with a car that would run fine and then suddenly quit, and after a considerable amount of frustration they finally simply replaced the distributor in entirety -- and never had the problem again. The original distributor was sent to this author for analysis, but nothing could be found wrong with it. The pickup was monitored while immersed in water being brought to a boil, and it showed no problems. It's possible the problem was elsewhere in the V and it was accidentally corrected while changing distributors.

Martin Walker had similar problems. "Mine would run fine if I kept moving, but let it idle for 30 minutes, or run it in slow traffic for a long time in hot weather and it would suddenly die. It would then not start for about 2 hours, and would then fire up OK and run well again. This cost me much time, money and aggravation, as it eventually did this some distance from home. The AA trailered it to the nearest Jag main dealer, who spent lots of my money in man-hours trying - and failing - to find the problem. I paid to have it trailered back to my garage, and replaced the ignition amp before turning to the pickup. I took it out and mounted it on a soldering iron - and at a consistent temperature (80-odd degrees, I recall) it would simply go open-circuit."

Keith Morris concurs: "I believe that the epoxy in the pickup heats up and breaks a close tolerance gap. I have experienced this problem on an MGB and a Jaguar. A simple replacement of the part solved the problem."

If you have decided that the pickup is a problem, don't replace the entire distributor; the pickup itself is available at most auto parts stores, made by several different aftermarket brands. It's not cheap -- over a hundred bucks -- but it's cheaper than a new distributor.

Considering how many different cars use the same GM HEI ignition amp, it may be possible to find a cheap pickup that fits some other car and make it fit the Jag distributor. The ones that fit Chevy V8's of the same era look totally different, but there are other pickups in the catalogs that do look fairly similar.

PICKUP GAP ADJUSTMENT: David Littlefield says, "The Haynes manual calls for readjusting the gap between the magnetic pickup and the iron star wheel with a plastic or non-ferrous feeler gauge. Believe it or not, these are readily available. I found some at Pep Boys hanging on a card beside other feeler gauges, I think they were made of brass." Note: brass corrodes easily, and polishing removes a little metal so your feeler gauges would get progressively less accurate. It is recommended that you spray a little WD-40 or something similar on each blade before tossing it back in the tool box, or take some other measures to prevent corrosion.

"Also, the Haynes manual says to turn the crank until one of the points on the star is next to the pickup so you can check the gap. *Unnecessary!!* Just remove the U-shaped thingy holding the star wheel in place and it will turn on the rotor carrier so you can get a point of the star in the proper position."

CONNECTORS: Mark Whitnell reports, "For the last several months the only way I could get it started was to use starting fluid. I checked out the spark since that was an area recommended by Kirby. The spark was very small and I suspect that the small spark could not ignite the gas but could ignite the ether (lower vapor pressure).

"I checked the distributor pick-up coil for the proper resistance according to Haynes (2.2K to 4.8K). I checked at the connector attaching to the ig amp first...very high megohms. Then I pulled the connector apart at the distributor. Checked the continuity of the wiring to the ig amp...checked ok. Then measured the resistance at the connector to the distributor...high resistance. Looking at the two prong connector...visually it looked fine. I went ahead and cut off the connector and measured resistance of the two wires to the distributor pick-up. Measured resistance... 3000 ohms within the range described in Haynes. Replaced the connector. Voilà, starting problem solved.. good spark, etc."

COILS: The Lucas CEI system uses two conventional ignition coils wired in parallel. The high-tension lead of the secondary coil is sealed off, and only the lead from the main coil is connected to the distributor. Between firings, energy is built up in both coils. When the 12V supply is broken ("the points open" in the lingo of the pre-electronic age), the energy stored in the secondary coil cannot escape through the high tension lead because it is sealed off, so the energy comes back through the 12V leads instead. The primary coil then not only has to release the energy it has stored itself, but also the energy coming back from the secondary coil. These two energies add to produce a powerful output at the high tension lead on the primary coil.

The secondary coil, located in front of the radiator, is *not* a spare or a backup; it is designed into the system for producing a good spark. If the secondary coil goes bad or gets disconnected, the performance will suffer; typically, the engine will top out at around 4500 RPM and won't go any faster. The secondary coil is not special, however, and can be replaced with a conventional coil provided the high tension connection is covered so that it cannot arc to ground.

Since mid-1989, XJ-S's have gone to a Marelli ignition system that also uses two coils. However, the Marelli coils are not wired together; each one fires only six cylinders.

According to Alan Jenks, "Jaguar now recommends replacing both coils with a single "solid" (not oil filled) coil (#DAC 6093) that fits in place of the main coil. The aux coil and wiring is removed." Roger Bywater says, "The best coil to use on Lucas HE V12s is DAC 6093 (Ducelier coil - 0.62 ohms primary); only one needed and works well in place of earlier twin coil set up. If you can find another coil with primary winding resistance of 0.5 - 0.6 ohms maybe it is worth a try. If the resistance is any more than that it will not be able to build up enough coil energy to fire a spark at the higher end of the rev range when the coil "on time" is very short (about 1.4 milliseconds at 6000 revs). It might also struggle around the peak torque point. Although the V12 constant energy ignition module is fairly tolerant (it runs OK with the blanked second coil removed - albeit with a loss of spark energy) I have encountered some that behave very oddly if the coil is not the correct load match. The DAC 6093 might be a bit expensive but it does the job..."

He adds that the original parallel coil arrangement was “conceived when coils of sufficiently low resistance were not available.” That's no longer true; it's not too difficult to find coils with a 0.6 ohm primary impedance today.

From an unidentified owner: "It looks to be apparent that a single coil either epoxy or oil filled will do the trick. I found the coils listed along with several other brands in a copy of the Performance Corner parts catalog. On the catalog cover is a web address of

<http://www.performancecorner.com>

In the catalog are listed the MSD 8207 coils which have been suggested by others. The brand name of the coils I've been asking about is PerTronix. Their Flame-Thrower coils are rated at 45,000 volts (45001 is 0.6 ohm Chrome oil filled, 45011 is 0.6 ohm black oil filled and the epoxy 0.6 ohm one in black only is 45111). The Xtreme coil 0.6 ohm is the one rated at 60,000 volts in chrome is 60060 and 60061 for black."

John Goodman defends the earlier parallel coil setup: “The only difference (between the two coils) is the HT socket is sealed on the aux coil, and is no longer stocked by Lucas. The primary coil is still available from a Lucas distributor and is cheaper than the universal coil Jaguar sells to replace the two V12 coils. I am experiencing coil/ignition related problems on my car and have tried a few of these Ducelier coils (original equip on the XJR-S). I am convinced it is the coil causing intermittent starting and cutting out problems, thinking of resorting to the early twin Lucas coil system which never gave any trouble on previous cars.”

The choice is yours. You can switch to a single coil of 0.6 ohm primary impedance or you can go with two coils of 1.2 ohm primary impedance each. Both setups work equally well, which is excellently. You don't need genuine Jaguar or Lucas coils for either scheme; any coil with the correct impedance will work. The two 1.2 ohm coils are likely to be cheaper than the single 0.6 ohm coil, since we're talking about conventional oil-filled bottle-shaped coils that are available in any parts store for just a few bucks each.

Ignore the claims of how many thousands of volts the coils are "rated" for. This is a completely meaningless claim; the voltage generating the spark is a function of the spark plug gap and combustion chamber pressure and has nothing to do with the coil.

Jim Isbell: “BTW, if you measure the primary, be careful because when you remove the meter the secondary sparks and it can really make you jump; also, when the field collapses you can feel the bite on the primary as well.”

LUCAS CEI IGNITION SYSTEM REPLACEMENT: There is rarely any good reason to replace the Lucas CEI ignition system. The performance is excellent, and replacing with aftermarket rarely results in any improvement. The centrifugal advance mechanism is prone to seizing, but that's easily avoided with regular maintenance. The vacuum advance module fails after a few years in the heat in the vee, but it's not that expensive to replace; besides, most reasonably-priced aftermarket ignition systems continue to rely on the original centrifugal and vacuum advances anyway. Repairing a failed amplifier costs \$20 with parts available everywhere. The two coils are reasonably-priced and easily obtainable (or you can spend bigger bucks for a modern single coil). The only parts that are even remotely expensive to replace are those in the distributor, the star wheel and the magnetic pickup, but they rarely cause any trouble. The pickup itself is available at regular (non-Jaguar) auto parts stores for around \$100.

Terry Pegler: “I ordered the Crane XR/700, part number 700-0300 conversion system; it arrived the other day. The instructions on Page 1 state "If the distributor has a 3 terminal connector it is an OPUS system and you can proceed. If the distributor has a 2 terminal connector, it is not an OPUS system and you must use Crane HI-6R part number 6000-6400."” Unfortunately, Pegler was replacing his CEI system due to a severely mangled star wheel and therefore had to wait until he could obtain that additional Crane part to get his car running again.

Of course, if you're a performance enthusiast, you might wish to replace the Lucas CEI with something more sophisticated or flexible. Most owners would not be enthused about upgrading to the later Marelli system because it's too expensive and failure-prone, but there are modern aftermarket systems that have all sorts of features. See the discussions on upgrading the Marelli on page 172; any of those systems could replace the Lucas CEI as well.

Marelli Ignition

MARELLI IGNITION: In this age of electronic wizardry, many modern cars have done away with the mechanical centrifugal and vacuum advance mechanisms and do the whole job with microprocessors. In some cars, the distributor is done away with altogether, and separate ignition coils are used instead.

Since Jaguar incorporated the Marelli ignition system in 1989, this is essentially the type of system used. There is no centrifugal or vacuum advance mechanism; the timing is all done electronically. However, rather than using lots of separate coils, the distributor was kept, using two coils and directing the spark mechanically. This distributor is clearly lacking many of the internal parts of the earlier models, since it no longer handles the timing functions. The rotor is actually two rotors in one, and the cap is two six-cylinder caps in one, so each coil is operated as though it is running a six-cylinder engine. The computer that handles the timing is located near the passenger's feet, and has a vacuum line to it.

The source:

Magneti Marelli S.p.A.
Viale Aldo Borletti, 61/63
20011 Corbetta (Milan) - Italy
+39-2/972001 FAX: +39-2/97200355
<http://www.marelli.it/>

As of this writing, this WWW site doesn't have anything on the XJ-S ignition system; only general info on the company.

MARELLI OR NOT? If you don't know if you have a Marelli ignition system or not, measure the diameter of the cap. If it's around 4-1/4", it's a Marelli; the Lucas cap is about 5-1/2" in diameter. You can also check the height from the mounting surface of the cap to the top of any one of the 12 spark plug wire connectors around the edge; the Lucas will measure about 2-1/4" while the Marelli will measure about 3-1/8".

If these descriptions aren't good enough, you can try looking at pictures at:

<http://www.jag-lovers.org/xj-s/book/LucasMarelli.html>

EFI TRIGGERING: The Digital P fuel injection system, in use on the Jaguar V12 since 1980, is triggered by the ignition system. With the Lucas OPUS and later with the Lucas CEI, this signal was taken from the - terminal of the coil, with a resistor in the line to limit spikes to the electronics. The Marelli has two coils, each of which only see six cylinders of pulses, so the ignition ECU itself includes circuitry to provide a suitable signal to the EFI. Don Neff says, "This signal is carried by a small shielded wire from pin 24 of the ign ECU to pin 17 of the EFI ECU.

"The power amps above the radiator do not have any feedback, but the two ign coils each have one. The feedback from the A-bank coil goes to the tach and the feedback from the B-bank coil goes to the diagnostic socket. The engine continues to run if either ign amp is unplugged." As a result of the tach getting a signal from only one coil, a six-cylinder tach is used.

SIII XJ12: For some reason, the Marelli ignition system was not introduced in the XJ12 until the XJ40 version model came out in 1993. Roger Bywater adds, "What may not be so obvious is that the saloon standardised on the low compression engine at the same time that Marelli was introduced on the XJ-S. It is interesting that while the non-cat Marelli XJ-S used a completely different fuel map (DAC 6338) from other engines the non-cat saloon stayed with the same mapping (DAC 6336) that was used for the previous high compression engine. The cat saloon used the same ECU as had been used on the pre-Marelli / Lucas / cat low compression XJ-S (DAC 6335)."

CAP VENTING: The Marelli distributor is vented in the same manner as the Lucas distributor (see page 146), except that the vent connections are on the base rather than on the cap. Since there are no centrifugal or vacuum advance mechanisms, there are fewer reasons that Jaguar would have decided to provide this system. Either the cap needs cooling to prevent cracking, or explosions can be the result of fumes building up.

TUNE-UP PARTS: There is supposed to be a gasket under the Marelli cap, but the new cap doesn't come with one. Part # JLM-1910. Reportedly atrociously expensive, just like the cap itself.

IGNITION AMPLIFIERS: Everything about the Marelli ignition system is expensive, including the two amplifiers, DAC11520. However, reasonably-priced substitutes are available. Pete Bainbridge-Clayton says, "I was surprised to find that both my amps were different, and neither seemed to be the 'correct' one. One is a Unipart GIM5002, the other one is a Bosch 0 227 100 139. Discovered that there was an Intermotor 15000-c which was an equivalent. The Bosch was running fine, and I managed to find a stockist of the Intermotor part - in fact they are available off EBay, the seller is cashfromthechaos and they charge a whopping GBP10!! Yes, ten pounds plus postage - quite a difference from the Jaguar part! All I can say is that it is running fine, the amp doesn't get hot, and I am very happy with it!"

TIMING: You don't really wanna adjust the timing on this thing, do you? Randy Wilson describes the XJ40, which is similar: "Spark timing is not easily adjustable. This car has a crank triggered digital ignition system. Timing changes would require moving the pickup and/or modifying the ECU."

On the other hand, there are two different timing maps built into the ignition ECU. Michael Neal says: "There is a nifty little jumper on the harness at the back side of the left intake manifold. Pull this sucker and your timing retards, perfect for those trips to Mexico. Usually the connector is red."

Mike Wilson quotes from a Jaguar manual: "Map Link Selector- This link permits the selection of either of (2) ignition maps contained in memory. If the link is in place the ignition map suitable for 95 Octane fuel is selected, and if the link is removed the ignition map suitable for 91 Octane fuel is selected."

Mike Wilson continues, "To find this 'link' look behind the lefthand intake manifold. This link (barrel shaped and with two wires coming out of it. One is yellow, the other black) is usually wire tied to the Diagnostic Socket."

DISTRIBUTOR POSITION ADJUSTMENT: Randy Wilson, still talking about the AJ6 engine: "Jaguar has a special jig for doing this, but it's not really needed. The whole purpose is to make sure the rotor is pointing to a wire lug no matter what the current computer-chosen timing is. On normal dizzies, the centrifugal advance moves the timing up... but it also advances the rotor by the same amount, as they are attached. No such luxury with the crankfire system.

"First mark the dizzy body directly in line with the #1 and #6 plug wires (note: 1A and 6A on the V12). Then remove the cap. Bring the engine up to TDC, noting which way the rotor turns. When you reach TDC, the rotor should be pointing at one of the two marks. It doesn't matter which one (why we marked both). Now turn the dizzy body until the mark is just past the trailing edge of the rotor contact. Just past it, not more than a degree or two. In this position, the rotor contact will line up with the wire lug in cap in the timing range of about 5 to 40 degrees before TDC; the operative timing range of the engine.

"If the adjustment is off very far, the results will be subtle. The most likely thing is the rotor and cap will tend to burn a little uneven...biased against the direction of misadjustment. The cap and rotor will "wear out" a little faster. If the misadjustment is extreme... and I'm not sure it's possible on the AJ6, there will be a misfire at the extreme end of the timing curve as the spark has to jump a pretty large gap inside.

"Next time, mark the position before you remove the distributor. This is one of those rare cases where "close" is good enough."

Regarding the Marelli on the XJ-S: "Yep, 'tis the same ideas and principles. I've never actually had to pull a Marelli

distributor, so I can not comment on the *exact* position. You would mark 1A and 6A... and set things so the rotor sweep-by happened in the 10 to 30+ before range.”

MARELLI-CAUSED DISASTERS: The combination of Marelli ignition and catalytic convertors can, and often will, result in the destruction of the catalytic convertors and possibly the whole car. This is *not* a section of this book to be glossed over lightly! If you have a car with Marelli ignition and catalytic convertors, you need to take a proactive role in making sure your car doesn't become a burned-out hulk in a junkyard somewhere.

CATALYTIC CONVERTOR MELTDOWN/FIRE (ONE-BANK FAILURE): While any misfire is a cause for concern with catalytic convertors (see page 318), the Marelli ignition system provides a unique and especially threatening possibility: running on six cylinders. While the various Lucas ignition systems were single 12-cylinder ignition systems, the Marelli is actually two separate 6-cylinder ignition systems. Hence, it is possible -- probable, even -- that sooner or later one of these ignition systems will fail while the other continues working. Since each half of the ignition system operates one bank of the engine, one entire half of the engine, along with its dedicated catalytic convertors and oxygen sensor, may see no spark all of a sudden while the other bank continues to run normally.

The V12 can be accurately described as two six-cylinder engines; each bank has the same firing order and the same natural balance as an inline six-cylinder engine (note: conversely, a V8 is *not* two four-cylinder inline engines). Hence, the V12 actually runs smoothly on six cylinders, and drivers who have not read this section may make the fatal mistake of trying to press on to the next exit or the next gas station. According to LaRue Boyce, symptoms to look for include: “Loss of power, more gas smell but no noise, just the no power feeling. Oh, the loss of vacuum also causes the transmission not to want to shift. You will know when it happens, there is *no* power, just enough to get you to 45mph on flat ground.” Julian Mullaney says, “When my car started running on 6 it was *very* noticeable. I thought that the tranny was slipping at first because I had to give it so much throttle to get it moving.” Note that, with the typical failure mode described below, this happens all at once; there is no intermittent operation where it runs well most of the time and drops to low power on occasion. Once a bank shuts off, it's gone for good.

Running a non-cat V12 with no spark on one bank fills the inop side of the exhaust system with fuel -- a disaster looking for a place to happen. Since the XJ-S exhaust system loops up and over the rear suspension, it should be able to hold several gallons of fuel before it starts pouring out the tailpipe! Since there is no spark in that bank at all, the owner might just get away with it -- but he'd better hope his ignition system doesn't mysteriously start working again! The same goes for a cat-equipped car that had an ignition failure when started from cold; the cats won't work when cold, so the fuel in the exhaust system on that side may never be ignited.

If the car is equipped with catalytic convertors and they were at operating temperature when the ignition failure occurred, the cats will burn the fuel as it arrives, and things will get considerably hotter in a big hurry. What's worse, if the car continues to be driven, more throttle will be applied to get any speed out of it, so even *more* fuel and air will be dumped into these cats. The inevitable result will be a cat meltdown within seconds. What's worse, often the cherry red-hot catalytic convertors will ignite something, perhaps by melting through the fuel hoses that are above and not too far away. The car is immolated so fast you'll barely have time to pull over and get out.

You don't want to be driving on six cylinders, not even for a minute.

If you were dozing when you read those last few paragraphs, pinch yourself, clear your head, and go back and read them again.

DISTRIBUTOR ROTOR PROBLEM: Unfortunately, a one-bank ignition failure turns out to be a common occurrence on Marelli-equipped V12 Jags. Although anything that kills one side of the Marelli ignition system can cause the car to run on six cylinders and threaten a cat fire, there is one possible cause that clearly outweighs all others in terms of frequency of occurrence. Randy Wilson: “The most common failure, the one that *kills* the A bank, is the center post of the rotor burns through, allowing a ground path from the rotor contact straight to the distributor shaft.” This characteristically results in a fire or meltdown in the right side cats only, since it is always the A bank ignition system

affected. For a photo of a cut-away rotor that suffered this failure, see

http://www.jag-lovers.org/xj-s/book/Marelli_pix.html

WHAT TO DO: If you have a Jaguar V12 with Marelli ignition, take the following action immediately: Remove the distributor cap. Remove the distributor rotor, which is held in place with two screws. Looking at the top of the distributor shaft where the rotor attaches, you will see the flat plate that the two screws thread into, and you'll see the hexagonal stub of the shaft itself sticking up above the center of this plate. Cut or grind that stub off, down to nearly flush with the plate. Obviously, you will want to make sure to collect all metal particles generated. This hexagonal stub helps center the rotor while you install the screws, but that's not really necessary. You can, if you wish, leave just a bit of it above the plate to help center the rotor, but really it's better if you just hack it completely off and let the screws locate the rotor.

That was Step 1. For Step 2, hold the rotor upside down and notice the opening in the bottom; it's shaped something like an asterisk. Fill this opening completely with clear silicone sealant, the stuff used to seal windows. Try to make sure there are no air bubbles down in the recesses. Then, while the sealant is still wet, install the rotor and secure it with the two screws. If done properly, you will have a bit of sealant squeeze out the edges as you're tightening the screws down. Simply wipe away the excess. Of course, allow the sealant to set up before driving the car.

As of this writing, I have received *no* reports of a Marelli ignition system suffering a one-bank failure due to shorting through the rotor after having done this "silicone squirt". It appears to be a 100% effective fix. It was even tried once on a rotor that had already failed just to demonstrate how effective it is, and it did in fact render the rotor functional again -- but obviously using the method to resurrect failed rotors is not recommended, it should only be used to protect against failures in the first place.

Just do it. And remember to do it again each time you install a new rotor.

The "silicone squirt" was originally suggested by Julian Mullaney. Marelli owners everywhere will forever be indebted to him.

CHEAP AFTERMARKET PARTS? The frequency of the rotor failure has been blamed on aftermarket rotors. It is true that some of the aftermarket rotors are *highly* susceptible to failure, and have been known to fail within minutes of installation. Note, however, that similar rotor failures have been reported in genuine Marelli parts as well -- it just takes longer. No matter which rotor you obtain, you need to perform the silicone squirt.

It is a simple matter to tell if you have genuine Marelli parts: they say "Marelli" right on the part. Being marked "Made in Italy", coming from a Jaguar dealer in a Jaguar box with a Jaguar part number, or costing a king's ransom are *not* indications of the genuine article, because many of the knockoffs are made in Italy (the genuine Marelli items may actually be made in the UK!), Jaguar apparently offers any and all of them under their part number, and they are *all* expensive.

Rumors have been circulating for years that Marelli has ceased making the genuine articles and once the stock is used up only the aftermarkets will be available. These are apparently false rumors as of 2002. It's bound to happen eventually, though; even if Marelli is still making caps and rotors now, they will cease making them sooner or later -- the V12 has been out of production for years.

SPARK PLUG GAPS: The correct spark plug gap on a Jaguar V12 with Marelli ignition is 0.025". Period. Use of larger gaps causes higher electrical stresses on the rotor and everything else in the ignition system. And remember that the gaps tend to grow with wear.

There are two problems here. First, there are spark plug catalogs that claim that the gap should be 0.035". Donald Anthony says, "I've been checking around for parts for the last few days and all (100%) of the spark plug sellers (napa, oriellys, pep boys, and all the local foreign parts guys) told me the proper gap is .035". I even saw it on their computer

screens for all brands of spark plugs.” Ignore them, they are wrong, and they are wrong in a very big way.

The other problem is the fact that new spark plugs for the Jaguar V12, just like most other new spark plugs, come out of the box with a 0.035” gaps. They *must* be regapped prior to installation. Interrogate your mechanic, making sure to use the word “lawsuit” when asking if he made sure the gaps were 0.025” before he installed them.

See page 121.

AFTERMARKET DISTRIBUTOR CAP PROBLEM: Besides the problems with the rotor, there are also problems with Marelli distributor caps. However, these problems appear to only occur with aftermarket caps, and only certain ones; some care when purchasing should avoid trouble, as discussed below.

The problems with the cap soon become obvious: the cap chars and melts from the inside out around the base of the center post where the A bank coil wire plugs in. To see some photos of such problems, see

http://www.jag-lovers.org/xj-s/book/Marelli_pix.html

On the cheaper aftermarket cap, the carbon brush fits into an opening in the plastic of the cap at the top on the inside. There is a spring behind this carbon brush to hold it against the top center of the rotor. Inside the hole, there is an aluminum terminal built into the plastic that the spring pushes against and the wire snaps into on the topside. So, the spark from the coil comes through the wire, into the aluminum, through the spring, into the carbon, and on into the rotor, all by direct contact. The only arcing going on in the vicinity is out at the tip of the rotor.

The primary problem with the aftermarket cap is that the spring behind the carbon brush on the center electrode isn't long enough. If this brush is pushed all the way up into the cap, it barely comes back down to flush with the surrounding plastic. As a result, the carbon won't actually contact the top of the rotor, and the ignition pulses will be arcing from the carbon to the rotor -- perhaps aggravating the already weak rotor.

But the worse problem results if the carbon brush is *not* pushed up into the cap. Since the spring is too short, it doesn't make it all the way to the aluminum terminal. Instead, a wide spot in the spring fits snugly against the ID of the hole in the plastic, and acts like it is securely installed. Although it looks good to the mechanic, the ignition pulses will now have to arc inside the hole between the aluminum terminal and the upper end of the spring. This will chew up the spring in a hurry, making the gap get larger and larger -- and the arcs will heat things up in that little chamber, eventually melting the plastic and burning through the cap.

Obviously, as a minimum fix, the carbon brush and spring should be pulled out of the cap, separated, and the spring stretched. The spring is a loose fit in the hole at both ends, but there is a wide portion in the middle that fits snugly in the hole. You will find that twisting the spring counterclockwise makes it easier to remove and reinstall in the hole; a counterclockwise twist pulls the coils a little smaller. To get the carbon brush to snap in and out of the spring, turn it clockwise; a clockwise twist makes the spring coils larger. When done, the carbon should protrude at least 1/4” from the plastic each time it is pushed back and released. If you have a VOM, check the ohmage between the carbon itself (without compressing it back into the cap) and the electrode up on top. It should be well under 1Ω, but it won't be zero because carbon isn't really that good a conductor. If it's an open circuit (infinite ohms), you didn't get that spring seated against the electrode; pull it apart and try again.

While the spring stretch might render the cheap aftermarket cap workable, there is a far better fix: making sure the hole for the brush features a metal sleeve rather than simply being a hole in the plastic. Thus, the spring will make a good contact with the terminal whether it reaches the bottom of the hole or not; the wide portion contacting the sides of the hole serve as electrical contact. It also protects the plastic from heat, wear, etc. And the spring seems to be easier to install properly, since the wide portion is sliding on smooth machined metal rather than molded plastic.

This is an easy fix on the part of the manufacturers; they merely have to redesign the aluminum terminal to include a sleeve that extends all the way to the inside surface of the cap. And, believe it or not, they have made this fix. Andy Klopfenstein reports that “Apparently the manufacturer discovered the apparent flaw we have seen in the cap. This new cap has a different inner aluminum cross section. The new inner aluminum shank now comes all the way to the bottom of the center post (inside cap). You can see it when you look at the contact button. The contact button now slides up

and down in the aluminum shank.” Hey, even the aftermarket caps aren’t cheap; since you’re spending good money, make sure you can see aluminum around the carbon brush within the cap as Klopfenstein describes before paying for a new cap.

If you are unable to find an upgraded cap or have a relatively new pre-upgrade cap and don’t wanna throw it away just yet, the following fix to the pre-upgrade aftermarket cap is easy: Remove the carbon brush and spring. Fit a 9/32” bit into the drill, preferably a variable-speed critter so it can be run slowly. A drill press might also be helpful here. Drill right down the center hole inside the cap until you get to aluminum. Keep drilling until you are drilling the *bottom* of the hole, not just the sides. Then take a piece of 1/4” ID brass tubing (available at better hobby shops) and bevel one end’s OD edge with a file. Poke this end into the hole, set the cap down on a firm surface, and tap the other end of the tube with a hammer until it seats securely in the bottom of the hole. If it fits tight, great; if it fits too loosely, pull it back out and apply a little JB Weld around the outside of the tube about 1/2” from the end (not at the very end!) so that it is smeared into the edge of the plastic as the tube is driven home. Let it dry. Then, using a Dremel with a cutoff wheel in it, cut the tubing off flush with the surface of the plastic. Clean up the edges a bit, then reinstall the spring and brush.

Regardless of what type cap you end up with -- even a genuine Marelli -- it wouldn’t hurt to stretch the spring as described above, just in case.

THAT’S NOT ALL: George Schulte says, “I came out of a store after 15 min of shopping to see smoke billowing out of my hood. When I opened it the flames were pretty well involved. Luckily a fire extinguisher was close at hand. The fire began from the center of the distributor cap. The lighter cap besides being cheaper and lighter is also flammable. I noticed some arcing around the center hi voltage lead but didn’t think too much at the time because the car was running fine. The plastic is not hi temp and the entire cap caught fire which spread to the rest of the wires in the area which spread out and melted the fuel hoses.”

REPLACING THE DISTRIBUTOR: Perhaps the easiest and cheapest way to avoid the problems with the Marelli cap and rotor is to replace the entire Marelli distributor while keeping the rest of the Marelli ignition system, which has no significant problems. Any 12-cylinder distributor (or even two 6-cylinder distributors, if you can figure out how to mount them) will take the spark from a coil and distribute it to 12 cylinders; you’re not worried about timing advance curves because the Marelli electronics will still be handling that.

The distributor of choice is obvious: the Lucas distributor! It’ll bolt right in.

There is one problem, however: connecting the outputs of two separate ignition coils to the single center post on the Lucas distributor cap. You can’t just splice them together; a spark generated in one coil would backfeed into the other coil rather than jumping the gap at a spark plug. Charlie Welkie points out that there’s a product on the market for this job: an MSD Automatic Coil Selector, part number 8210. It’s a diode pack with two inlets and one outlet for connecting two ignition systems to one distributor cap. Its original intention is to allow racers to install main and backup ignition systems in their race cars, and when the main one fails simply switch on the backup system and keep going. Jeff Strom of MSD reports: “There are 8 diodes in each unit, 4 per side.” Each diode is rated at 12KV, so it will block a 48KV spark -- which is plenty for ensuring the spark goes to the plug instead of to the other coil.

Even though it’s not involved in timing, you should maintain the centrifugal advance mechanism in the Lucas distributor. It’s helpful to have the centrifugal mechanism keeping the rotor tip aligned with the terminals in the cap throughout the advance range. You can discard the vacuum advance hardware and plug the opening. You can discard the Lucas CEI pickup and star wheel. If you happen to use an early model distributor, you can discard the OPUS pickup and plastic rotor. You can discard the trigger board if there is one. Of course, rather than simply discarding all this stuff, you can sell it on EBay.

Before removing the Marelli distributor, position the crank at TDC on 1A, which is indicated by a mark on the front damper lining up with the sensor at the bottom. Pull the cap off and make sure the lower tip on the rotor points towards the notch in the housing; if it points the opposite way, turn the crank one full turn.

You need to position the Lucas distributor correctly, and you won’t be able to use a timing light to do it. With the crank

at TDC on 1A, position the distributor so that the trailing corner of the rotor tip lines up with the 1A terminal in the cap. It doesn't require great precision since it's not determining actual ignition timing; it's just making sure the rotor is positioned close enough that the spark can jump the gap.

Note that the spark plug wires do *not* go in the same places on the Lucas cap as on the Marelli cap. On the Lucas cap, the 12 wires go in firing order. They do not on the Marelli; they are switching back and forth across the cap. #1A is marked on the Lucas cap, and the firing order is counterclockwise looking down on it:

1A-6B-5A-2B-3A-4B-6A-1B-2A-5B-4A-3B

The distributor ventilation scheme connects to the base of the Marelli distributor, but connects to the cap on a Lucas. Reconnect accordingly.

After you've driven the car a while, pop the distributor cap back off and check where the arcing is etching the tip of the rotor. If it's distributed along the tip of the rotor, just put the cap back on. If the arcing is concentrated on one corner, turn the distributor a bit to try to get it towards the center of the tip. Clean the tip up a bit so you can check it again later. It may take a couple of tries to get the position right, but once you do you should be able to forget it for the life of the car.

"Slover Jr" performed this mod on his car with great success: "Yes, I'm using the exact twin coil separator mentioned in your book which btw has been so helpful in my years of ownership! I purchased one off E-Bay from a racer and it's been working flawlessly. The swapping to a Lucas dist only required a small modification to the coil(s) mounting to make room for the larger cap and new wires as the original marked ones did not reach their respective plugs (you could maybe make them work but I needed new ones anyway) and you need to find/make some short ones with 90° boots on one side, straight boots on the other for the extra coil/cap connections to the separator but other than that it was no problem.

"Also using the method you described in lining up the Lucas unit after replacing the dist and running the car for a bit I looked inside the cap and the rotor was making contact right on spot, not bad for a w/e hack like me. It's such an easy mod I don't know why I didn't do it sooner as I drove with fears of pyromania for too long!"

Not only will this "retro retrofit" avoid the Marelli rotor and cap problems, but it's also likely to save the owner some money! A used Lucas distributor plus the MSD Automatic Coil Selector probably won't cost much more than a new Marelli cap and rotor, so it can be done instead of the next scheduled tune-up. And the *next* tune-up will be a bunch cheaper -- and you can even postpone it a long time, since the Lucas cap and rotor lasts nearly forever.

Slover Jr says, "...my shopping list was as follows:

- Used Lucas dist with cap & rotor (very nice condition ready to run) \$75
- Used coil separator (could have went new for \$60) \$25
- New V12 wires set (used some of my old ones to make the short leads for the coil separator) \$70

"Once I had it all done and verified it was running perfectly I sold the Marelli unit for \$50 (It had 70K on it, was in real nice shape, and I had no plans to ever go back) so my total cost was \$120.

"Even if I want to sell the car I will not worry about being able to put it back to original; most people would not even be able to notice and someone who knows these cars that well would have to agree it was a clever thing to do!"

DETECTING IGNITION FAILURES: As soon as the Marelli failure mode was discussed and understood on the online xj-s discussion list, several members proposed methods to detect such a failure and thereby avoid disaster. Andrew Corkan promptly designed a dirt-cheap circuit for detecting whether or not there are sparks going to each bank and providing a warning indication if they are not -- see Figure 11.

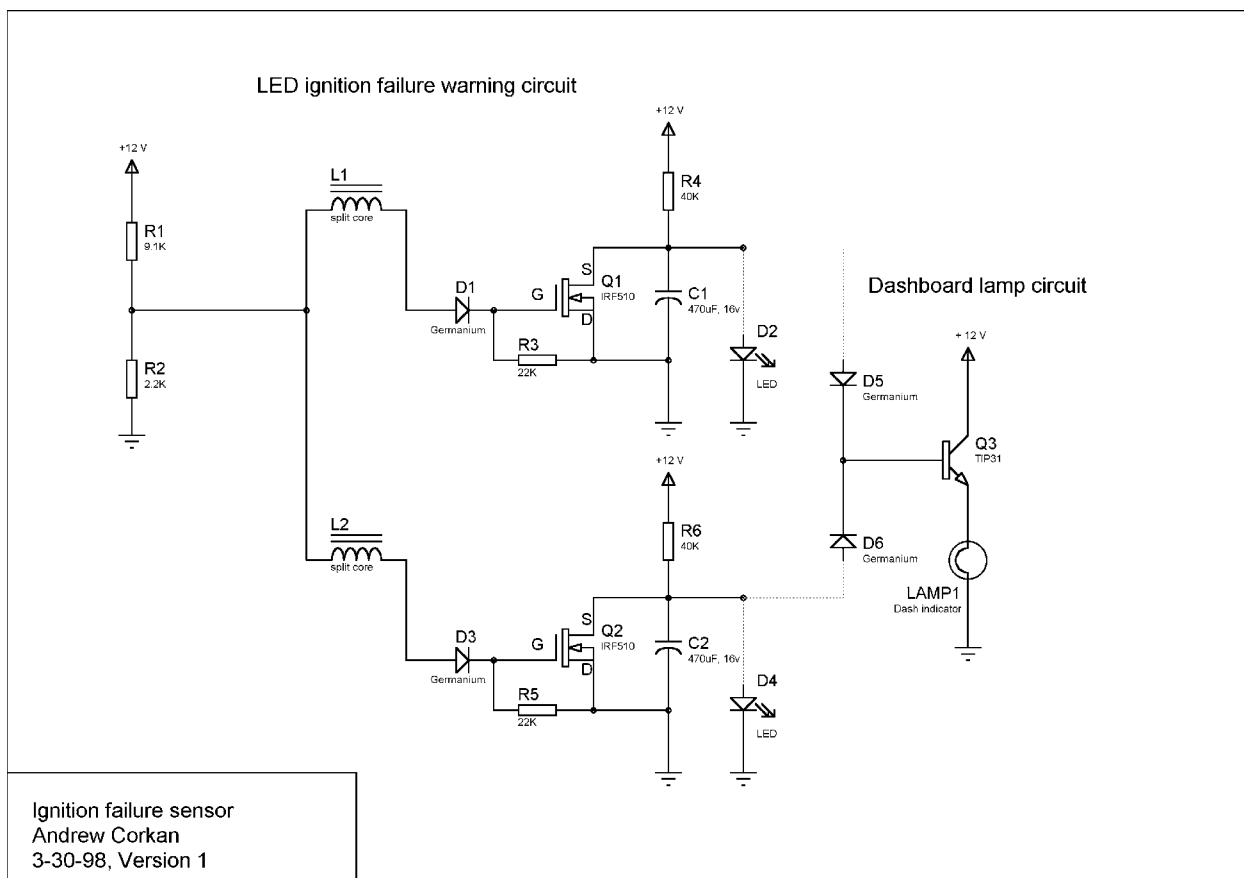


Figure 11 - Ignition Failure Sensor

Corkan describes his creation: “The circuit detects a spark in either bank by means of an induction pickup placed on a plug wire, similar to the ones used by tune-up timing lights. When a spark pulse is detected it shorts out an RC circuit that would otherwise cause an LED to light up.”

“You have to make your own inductive pickup using a so-called RF choke (really just a two-part inductor core) and magnet wire. Open the core and remove half of it from the plastic holder. Wrap 50 loops of magnet wire around the half of the core still in the plastic holder. You do not want the magnet wire exposed in the engine so solder regular wire to it and pot that half of the pickup sensor, magnet wire and solder joint in RTV. The wires you solder on should be long enough to reach into the car where you will place the circuit. Replace the rest of the choke when you install it around the plug wire. The choke will fit around the plug wire, no need to remove the plug wire.

“There are two options for hooking up indicator lights (see dotted lines in circuit schematic). The first option is to use LED's. Just wire them as D2 and D4 and bring the wires into the interior. Kirbert⁴ suggested a second option of using the 'trailer' bulb in the dash as an indicator light. For this option you can wire up D5 and D6 to the base of Q3, which will in turn power up a 12 volt lamp.” Note that in this latter case, a spark failure in either bank will light the same light; arguably, the driver doesn't really care *which* bank just failed, as long as the light tells him a bank just failed (with the Marelli rotor failures, it's always the A bank that fails). The owner may choose to use the trailer warning light, the seat belt warning light, or any other 12V light he wishes, and he may want to relabel the indicator accordingly, color it red, etc.

“All references in the schematic to "+12V" are to a switched (accessory) power source. When you hook things up you

⁴ “Kirbert” is Kirby Palm’s online pseudonym.

should see the lights come on when you move the key to 'accessories' but they should turn off as soon as you start the engine.” Hence, no need to provide a separate bulb check circuit.

“All the parts for this circuit are available from Radio Shack (but our overseas friends should have no trouble finding these parts). In addition to what is listed here you will need wire to run from the sensors to the box you put the stuff in, and wires to run the LED's or the signal light into the dash (if you use that option). You will also want to get a small circuit board or breadboard and a little plastic box to put the circuit into; a 3 in. x 4 in. box is just fine.”

<u>Part #</u>	<u>Value/type</u>	<u>Radio Shack #</u>
R1	9.1K	
R2	2.2K	
R3,R5	22K	
R4,R6	40K	
C1,C2	470uF, 16v	272-957
Q1,Q2	IRF510, N-Channel MOSFET	276-2072
Q3	TIP31 NPN Transistor (option B)	276-2017
D1,D3,D5,D6	Germanium Diodes	276-1123
D2,D4	LED, any kind will do (option A)	
L1,L2	RF choke (two part inductor cores)	273-104
LAMP1	Lamp on the dash (option B)	
Magnet wire	any kind will do	278-1345
Wire	any kind will do	
Box and board	any kind will do	

“It is easy to build, all you need is a soldering iron. It will monitor both banks and turn on a light if there is a Marelli boo-boo.”

Different colored D2 and D4 LED's may be used for the indicator lights to indicate which bank, or red could be used for both to indicate trouble. As shown, the circuit monitors one plug wire (chosen at random) on each bank. One plug wire on each bank would be enough to detect the common Marelli failure (really, you might as well save your money on circuit components and just build one circuit to monitor the A bank), although you could get carried away and build 12 circuits instead of the 2 shown and install a complete set of 12 LED's if you wanna really be sure you detect any possible problem.

Corkan goes into more detail for those interested: “The circuit uses two identical channels for each bank. Pulses from the inductive pickups trigger the MOSFET transistors (Q1, Q2), which are sensitive to voltage. They are pretty standard N-channel MOSFETS that will trigger at about 3.0 - 3.5 volts. To make sure they work reliably with the faint pulses coming from the sensors, R1 and R2 provide an offset voltage of about 2.5 V. (If you can not locate the right MOSFET you may have to change the values of R1 and R2, they should be selected so they bias the sensor pickups to 1.0 V less than the MOSFET needs to trigger.)

The diodes (D1, D3) are very important. The diodes keep the voltage pulses from going back down the sensor wire, forcing it to drain more slowly through R3 or R5. Germanium diodes have a small voltage drop, unlike standard diodes. If you do not use Germanium then you will need to increase the bias voltage on the sensors by about 0.5 V to make up for the additional voltage loss.

Each time the MOSFET's fire they short out the RC circuit formed by R4 and C1 (also R6 and C2). This RC circuit takes about two seconds to charge, and when it does voltage then flows into D2, lighting it up and warning the driver (or flowing through D5 to the NPN transistor which lights the lamp, etc...). When a pulse hits Q1 (or Q2) it drains C1 (or C2) preventing the indicator circuit from ever getting enough voltage to light. As long as there is a steady supply of pulses the RC circuit never charges and the light never lights.”

The polarity of the pickups on the plug wires makes no difference, since the pickup will put out a voltage pulse in one direction when the spark starts and a very similar pulse in the opposite direction when the spark stops. Corkan: “...and thus the reason for the first diode. In fact the circuit is sensitive enough that polarity will not make a difference, even though you can see a small difference in the signal on an oscilloscope.”

An alternative warning system idea would be to detect the overheating of the cat itself, as discussed on page 318. This has the advantage of indicating a problem no matter what the cause.

AUTOMATIC SHUTDOWN: Once you have some sort of failure detection system that will tell you that the Marelli has quit firing one bank, there is still the question of what to do with the indication. You could provide an idiot light, but anyone that drives despite a sudden lack of horsepower may likewise drive despite a warning light; some XJ-S owners allow others to drive their cars and don't want to have to lecture them on the importance of a particular idiot light each time. Another possibility is to have the sensor shut down the car. If Corkan's ignition monitoring circuit can light one of the dash indicators, it could just as well be used to operate a relay to shut off power to the ignition -- but you'd have to install the relay so that it doesn't cut off the ignition when the ignition switch is in the "start" position or you'll never get the car started. The OEM starter relay has a contact that will work perfectly, left over from the days when a ballast resistor was used with a coil but was bypassed during starting; just use the same contact to bypass the cutout relay.

A better idea, though, is to use the relay to shut off power to the EFI system or to the injectors themselves. That way starting won't be a problem; as soon as the starter turns the engine over and the system detects some ignition pulses, the EFI will be enabled and the car will start.

LIMP-HOME MODE: Automatically shutting off the engine in the event of six-cylinder operation protects the car but aggravates the driver, especially if it happens in traffic or in a bad neighborhood. A better idea is to shut off fuel to the bank that has lost spark, thereby making it *safe* to drive the car on six cylinders. That same relay idea should work for this, using Corkan's circuit with two separate Q3's (you can omit diodes D5 and D6 if each subcircuit controls its own Q3) to control separate fuel injector shutoff relays for each bank. Starting should take care of itself; as soon as sparks are detected in each bank, that bank's fuelling will be enabled and the engine will start.

The idea of shutting off fuel to one bank and continuing to run does have one important benefit: it is likely to provide a better cooldown of the overheated parts. Several owners, having already been made aware of the Marelli problems, nevertheless reported that the right side cats were cherry red hot by the time they figured out what was happening, shut it off, and got the hood open. When the engine is simply shut off under such conditions, the residual heat within the cat may nevertheless fry nearby rubber parts, sensors, wires, etc. If the fuel is shut off and the engine continues to run, cooling air continues to flow through the engine compartment, and air continues to flow through the cylinders of the inop bank and out through the exhaust system. A running cooldown is better on the engine and ancillaries than a hot shutdown. Perhaps even if a sensor provided only a warning light indication, a switch could be provided to manually shut off fuel to the inop bank to allow the car to continue moving.

CATALYTIC CONVERTORS -- MELTDOWN/FIRE (SENSOR-CAUSED): Greg Maddison lamented a large loss to his wallet: "The front two had melted into a solid mass and the debris ruined the back two." Obviously, this symptom differs from the typical Marelli six-cylinder operation described above, since the Marelli failure will toast the cats on one side only.

"It seems there is yet another reason the Marelli system can cause a misfire that brings the cats up to kiln temperatures. This would be problems with the TDC sensor/magnets. There are 3 equally-spaced bar magnets around the crank damper and a sensor that "looks" at the magnets and sends a pulse directly to the Marelli computer. There is a specific air gap between the magnets and sensor that must be maintained for the system to work properly.

The Jag dealer replaced the damper/magnet assembly on my car saying the rubber had split. This caused the air gap to be too wide between one of the magnets and the sensor. They first tried to grind down the other two magnets and move the sensor closer (sounds like the damper deformed and became eccentric), only lasted 600miles so I had to have damper replaced. The dealer's mechanic explained to me that each magnet produces a timing pulse for 4 cylinders. If one of the pulses are missing, 4 cylinders don't get spark and send unburned fuel through the cats. The mechanic said that a different damper is fitted to cars with the 100-amp alternator (like mine) and fails more often than the older cars." Note:

the 100-amp alternator requires a grooved belt instead of a V-belt, and the alternator belt is driven by the damper itself rather than the bolt-on pulley, so the 100-amp alternator does require a different damper. Perhaps it fails more often because of the increased torque load of the alternator being applied to the rubber.

“After removing the crank pulley they found the woodruff key sheared and cone split, pulley had rotated 6 degrees on the shaft. Mechanic says the Marelli computer can vary the timing up to +/- 28 degrees. So, at this point I don't know if they misdiagnosed the sheared key problem as a damper problem (they are claiming both are toast) all along. I can certainly understand how having the pulley rotate on the shaft can introduce timing errors on a Marelli car.”

There are a few problems in the explanation offered by Maddison's mechanic. First off, the tabs on the pulley are attached to the center portion, not to the outer portion held in place by the rubber -- but they might still be damaged by the rubber shearing. Chris Carley explains: “The timing tabs are a ring with 3 tabs sticking out every 120 degrees bolted to the back of the pulley attached to the solid middle section and then the tabs are bent over the edge of the pulley. There is a 1/2 inch of pulley behind the alternator belt (ribbed), where these are bent over. If the rubber sandwich breaks down then the outside ring of the pulley will slop around and bash the tabs out, which could then hit the sensor (.028 to .042 gap). Whether that problem sheared the key - who knows?” Whatever, make sure your pulley is in good shape and securely torqued down (see page 90); somehow, problems here can evidently toast your cats.

CATALYTIC CONVERTORS -- MELTDOWN (SECONDARY DAMAGE): Greg Maddison says, “Also check the engine speed sensor located on the flywheel housing. It is a \$40 part located very near one of the catalyts. Mine melted when the catalyst overheated. After that the speed sensor became temperature sensitive, car ran well when it was cold. After it warmed up the car wouldn't develop any power and couldn't go over 40 MPH.”

Tim Jones had another secondary problem. After having the cats replaced and the car put right, it started issuing white smoke from the right exhaust pipe. This is an indication of a blown diaphragm in the vacuum modulator on the GM400 transmission; the vacuum line sucks transmission fluid out of the transmission and into the right manifold, causing the smoke in the right bank only. Apparently the catalytic convertor meltdown generated enough heat to roast the vacuum modulator.

INTERMITTENT FAILURES: Greg Maddison suffered from electrical connections: “Occasionally when warm/hot the engine just stops. It will usually restart after a few tries or if left for a couple of minutes. It turned out to be the crankshaft sensor connector. I could jiggle the crank sensor and car would start again. If you have the Marelli digital ignition system you will have a crankshaft sensor and a flywheel sensor; engine will not run if the signal is interrupted from either. Look for a two-wire connector on the left front top of the engine; wires should be in a hard plastic wire protector running down the front of the engine to the back side of the crankshaft pulley. I found the contacts in this connector to be green and nasty. Cleaning with spray-on relay and contact cleaner cured the problem. Run the engine and wiggle this connector and see if it stops. Also check the flywheel sensor connector, it's on the rear top left of the engine, looks like the crank sensor connector and hard to get to.”

Steve Sarmanian had the same problem, only different. “In the 2-wire upper connector of the front crank sensor (1 white wire, 1 blue), about 8 inches back into the top harness the white wire connects to the wire braid that surrounds the sheathing around the blue wire by a solder connection. That connection is protected by a clear plastic sheath (rubbery plastic tubing about an inch long). The connection is bad, and bad from the factory. It fooled me the first time around because underneath the clear tubing the wiring looked good. But this time I split open the tubing with a razor blade and the white wire fell off the braid. There's no good mechanical connection there; when the loom is built they apparently just strip the end of the the white wire, lay it on top of the braid and melt on the solder. The tubing holds the joint together. I confirmed that that was the cause of my problem: touch the wires, the car will start; separate them and the engine dies.

“The fix is to twist the sheath into a secure mechanical connection with the white wire, crimp it with a slip connector and then resolder. Problem disappeared.

“I unwrapped the rear sensor to check the braid connection on that one (near the firewall) and saw that someone had

been in there before me with a mechanical fix, but no solder. I fixed it.”

John J. Lynch had similar symptoms, but the cause turned out to be the crank sensor itself. “The problem went something like this:

- 1) Car started fine
- 2) Ran normally for 15 minutes
- 3) Died completely due to spark failure
- 4) Engine cooled down for 1-4 hours
- 5) Repeat step 1

“Turns out the Engine Speed Sensor was the *real* culprit. The specs say that the sensor should read about 700 ohms but when I measured it after the engine died I noticed it was only reading about 260 ohms. Since I had previously tested the sensor with an O-Scope and saw that it was producing the square wave I was expecting, I thought everything was fine. I was wrong. For some reason when the engine warms up the sensors resistance is dropping below 700 ohms causing the voltages that are delivered to the ignition computer to be way out of spec. Consequently the computer was shutting down the ignition amps. For kicks I decided to put a 500 ohm resistor in series with the sensor to validate my new conclusion and sure enough the car ran fine. As soon as I removed the resistor, the car died again. Problem solved!!!”

LACK OF OOOMPH: Jim Householder reports on “a problem I had with my 1991 XJS; cost me a lot of money and stumped all the Jag mechs. At 4500 RPM the engine would just flatten out and go no more, but ran quite well up to this speed. The story is long and sad about trying to get it fixed but decided I would try it myself. Turns out that the number 2 coil was bad, not a big deal but seems none of the Jag pros had run into this problem.” Interestingly, running out of juice at 4500 RPM is exactly what you would expect from a secondary coil failure on the earlier cars with Lucas CEI ignition, but it’s not obvious how it can occur with the Marelli.

1992-ON: Richard Mansell quotes from a Jaguar Publication on the changes for the 1992 model year:

“The Marelli digital ignition ECU has been software upgraded.”

REPLACING THE MARELLI IGNITION SYSTEM: Since the Marelli has some serious problems that can cause fires, obviously there is incentive to replace this system as a preventative measure. Those fires sometimes destroy considerable portions of the Marelli system itself, though, and Marelli hardware is quite expensive, so owners having already suffered such fires also seriously consider a change of system -- not only to avoid a repeat but because they have a budget for such a replacement.

If your objective is to avoid even the slightest possibility of a fire, you’re out of luck; any car with any ignition system can have a fire if things go too far wrong. If your objective is to eliminate even the slightest possibility of having a one-bank failure of the type the Marelli system is infamous for, the only way is to replace the Marelli system entirely; as long as there’s effectively two six-cylinder ignition systems, there will always be the possibility that one will fail while the other keeps working. Before you latch onto that for a solution, though, you might wish to review the first fact and realize that the Marelli, if you can fix the rotor and cap problems, may actually be relatively safe. This author suggests your money might be better spent on an overtemp sensor for the catalytic convertors.

If you have decided that two six-cylinder ignition systems are totally unacceptable, there are two other types of system that will work on a V12: a single 12-cylinder system or a distributorless system.

REPLACING THE MARELLI IGNITION SYSTEM PART I: The only replacement ignition systems that will eliminate the problems with the Marelli distributor are ones that eliminate the Marelli distributor. One idea is a distributorless system -- six double-ended coils, each connected directly to two spark plugs.

One source is Electromotive; see page 716. The installation manual for their HPV-1 includes instructions on how to

install two six-cylinder systems on a V12. You are once again back to two six-cylinder systems, one of which can fail! But at least you won't have the Marelli rotor to worry about any more.

Another source is...Jaguar. As discussed below, the final few months of XJ12 production came with a Nippondenso distributorless ignition system. Yeah, that'll be a cheap retrofit. Judging from Roger Bywater's and Rick Wilder's descriptions of this system, it's two six-cylinder systems again!

A distributorless system can have a failure in one part of the system; for example, one of the six double-ended coils could fail, killing two cylinders in one bank. But that would cause a lumpy-running engine, hopefully getting the driver's notice. It wouldn't keep running smoothly as the Marelli one-bank failure does unless the three coils serving one bank happened to fail together, which is highly unlikely. But if the distributorless system actually consists of two six-cylinder systems -- as apparently many of them are -- you obviously could lose one control circuit and have a one-bank failure, just what you feared with the Marelli.

If the system you install happens to be a "total engine management" system (ignition and EFI together), you may be in luck. It's still likely to be two six-cylinder systems, but the ignition pulses from each six trigger the injectors for each six. So, if the ignition for one bank fails, it *might* cause the injectors for that bank to quit operating -- providing a safe limp-home mode.

REPLACING THE MARELLI IGNITION SYSTEM PART II: Another idea is to retrofit the earlier Lucas CEI system into the later cars. It's kind of a shame to replace the high-tech electronically-controlled Marelli with the comparatively archaic Lucas with its mechanical advance controls, but it will definitely eliminate the possibility of one-bank ignition failures. If anything in the Lucas ignition system quits working, the car stops; one-bank failures are simply not possible.

Note that the centrifugal advance mechanism in the Lucas distributor should be attended to prior to installation, as described beginning on page 137. This mechanism then requires periodic maintenance (oiling) to make sure it doesn't seize, but this isn't really a problem unless you don't do it.

This retrofit has the additional benefit of saving money on future tune-ups. The Lucas caps and rotors aren't cheap, but they're cheaper than the Marelli items.

Whit Coleman at British Parts International (page 692) reportedly has assisted several owners with installing Lucas ignition systems in Marelli-equipped cars -- *after* the fire. The motive was cost, pure and simple; after the car has suffered an engine compartment fire, it's cheaper to convert to a Lucas system than it is to buy the Marelli parts needed to get it going again -- possibly because the Lucas stuff is more readily available at junkyards. Coleman claims that people usually obtain an entire donor car to do this job.

Coleman asserts that the change requires replacing the EFI ECU and the associated wiring harness with the items used with Lucas ignition systems. He's not entirely sure why, but if you're using a donor car you've got those items on hand anyway. He also points out that you can then turn around and sell the EFI ECU that worked with the Marelli, possibly recouping a considerable portion of the cost of the donor car.

This author is not convinced that retrofitting the Lucas ignition system requires changing the EFI ECU and the harness. If I didn't have the replacement ECU and harness handy, I'd try running a shielded wire from the Lucas CEI ignition amp to the footwell where the Marelli ECU was and connect to the suitable pin in the harness for sending the trigger signal to the EFI system and see if it works.

If that works, it'll also be possible to use the early OPUS distributor along with an aftermarket ignition pickup and amp like those suggested on page 150 -- but you'll want to recurve the distributor advance mechanisms to the curves used with the H.E. engine. If the ignition system doesn't provide a dedicated trigger signal lead, connect a wire to the - terminal on the coil and run it through a 600Ω resistor for a trigger signal.

Coleman also points out that this conversion will require changing out the tachometer, since a six-cylinder tachometer is used with the Marelli ignition. Again, if you have the donor car, this is no problem -- unless you have the later style dash and the earlier tach won't fit.

REPLACING THE MARELLI IGNITION SYSTEM PART III: As mentioned below, the XJR-S came fitted with a Zytec engine control system which utilizes a gutted Lucas distributor. The XJR-S is not a common model and the Zytec system controls both EFI and ignition, so installing this system in a regular XJ-S is likely to be costly. The Zytec system is supposedly programmable -- you'll probably need to reprogram it to work with a non-XJR-S engine -- but it's reportedly difficult to get the programming software from Zytec. All in all, this retrofit is probably not a reasonable option from a cost standpoint unless you happen to need a new EFI system as well, and even then it's not likely to be the cheapest alternative. Of course, if you happen to have a junked XJR-S laying around...

UPGRADING THE MARELLI IGNITION SYSTEM: Aside from fire avoidance and/or fire repair, some might opt to replace the Marelli system (or the Lucas systems, for that matter) simply to improve performance. There are several features that might be worth seeking. Some of the better aftermarket ignition systems have electronically-controlled advance, making them ostensibly similar to the Marelli -- but they almost invariably are programmable in order to be adaptable to different cars. This programmability might be of considerable value, especially if the engine is being modified. Some systems include knock sensors which will allow better optimization of the advance curves as well as automatic compensation for differing tankfuls of fuel. Some systems use six double-ended coils, thereby eliminating the need for a distributor.

The ultimate, perhaps, is the "total engine management" system. Such systems replace both the ignition system and the EFI ECU with an integrated, programmable control system. Some even integrate electronic control of an automatic transmission -- but obviously you'd need to upgrade the transmission to take advantage of that.

XJR-S Ignition

John Goodman reports that the XJR-S uses a Zytec ignition/fuel injection system -- see pages 307 and 721. "Basically it is a modified Lucas distributor; even the rotor arm is standard. However the vacuum and mechanical advance mechanisms have been removed (ECU-controlled vacuum sensor and programmed advance).

"It has a magnetic "Hall effect" engine speed sensor and a similar timing sensor. The 'Hall' effect thing has an inner and outer wheel. The inner one has one notch and is the timing signal/ speed sensor, similar to the Marelli crank sensor, the outer star like wheel has twelve notches/spikes to control injectors.

"It appears that to set the timing exactly you really need the dealer to plug in the "JaguarSport magic laptop". In the set up screen there is a function <reference ignition timing>. This is where you set the distributor to the 10 degrees BDC at idle for the ECU to get its base line input. After exiting the screen the ignition timing reverts to the control of the ECU.

"So, under the ECU control, at idle you should be seeing 3.5 degrees and at 3000 rpm it should be around 18 degrees if the timing is right. It is a damn inconvenience not being able to check or set the ignition timing without the software."

The Zytec system continued to use the altered Lucas distributor even when the baseline XJ-S was fitted with the Marelli ignition.

Distributorless Ignition

The Jaguar V12 was fitted with a distributorless ignition system for a short time just before it was discontinued, but didn't make it into the XJ-S; Roger Bywater of AJ6 Engineering (page 713) says, "It was on the 300 range saloon and we have a dealer technical guide telling all about it. There were two amplifier modules driving two coil modules each containing 3 double ended coils for a bank of 6 cylinders. All driven by a Nippondenso Engine Management system."

Rick Wilder, who owns a '95 XJ12, says, "I had the impression that the distributorless ignition was only added in the 1996 MY. That erroneous impression was reinforced by alldata.com, which shows the Marelli ignition on my MY. I just took the valley cover off to see what's up and found the 2 coil packs, each with 6 spark plug wires attached, and no distributor."

COOLING SYSTEM

COOLING SYSTEM DESIGN: In most "water-cooled" cars, the cooling system consists of a circuit wherein a fluid is pumped into the portion of the block surrounding the cylinders, then up into the heads, then on to a thermostat, and from there through the radiator and back to the pump. The thermostat and housing are usually designed so that, when the thermostat is closed, the fluid is not deadheaded but rather bypassed to allow the fluid to circulate around between the engine and pump without going to the radiator.

The Jaguar V12, of course, is different. It has two thermostat housings, one at the front of each bank. The XJ-S radiator is a side-flow radiator divided into a top third and a bottom two-thirds; the end tank on the left end of the radiator either has an internal baffle one third of the way down, or actually consists of two separate end tanks. The coolant coming from the left bank, via the left side thermostat, enters at the top left and flows left-to-right through the top third of the core. Then the coolant from the right bank comes in, mixing with this already-cooled fluid. The mixture then flows right-to-left through the bottom two thirds of the core and on to the pump. Each thermostat also controls a bypass directly back to the pump inlet via a "cross pipe"; as the thermostats open to allow coolant to the radiator, these bypasses are closed off by a disk on the bottom of each thermostat.

It is unknown why Jaguar contrived a dual-thermostat system, but it was probably just to reduce plumbing -- not having to get the fluid from both banks back to a single thermostat housing.

Because the mixed fluid goes through the pump and to both banks, both banks are always seeing the same incoming coolant temperature. When the thermostats are closed and the fluid is bypassing into the cross pipe, both banks will also see the same flow rate, and therefore will warm up at the same rate. When the thermostats are fully open and the bypasses are closed, however, the left (B) bank will *always* see a lower flow rate than the right (A) bank, and therefore will run warmer. This is due to the radiator design; the fluid from the left thermostat outlet has to pass through the upper third of the radiator core to get to the exact same place the fluid from the right thermostat outlet goes to directly. As a result, the backpressure at the left radiator inlet will always be higher than the backpressure at the right radiator inlet. Since the flow to both banks is from the same pump and it is not a positive displacement pump but a centrifugal, most of the flow will naturally take the easier route through the A bank.

The action of the thermostats may accentuate the differential flow at operating temperatures. When the thermostats are only partially open, the bypass leads directly back to the pump inlet while the route through the radiator has a higher backpressure. As the higher backpressure begins to slow the flow in the left bank, the coolant arriving at the left thermostat begins to get warmer. As a result, it closes off the bypass some more, *further* reducing the flow in the left bank! Some have advocated installing a colder thermostat in the left side to compensate for the warmer running bank, but this would seem to be the exact wrong thing to do; it could arguably be better to put a *warmer* thermostat in the left side so the bypass stays open and flow is maintained through the bank. Flow will be reduced in the radiator, though, possibly causing the entire engine to run hotter.

As long as the cooling system is clean and operating properly, the differential cooling flow between banks doesn't seem to cause any problem. However, there are three implications the XJ-S owner should be aware of:

1) The coolant temperature sensor for the EFI system is on the left thermostat housing. Since this side is running warmer than the right and the EFI system will be adjusting the fuel mixture for the entire engine accordingly, the right bank is likely to be running a little leaner than the left. Of course, on cars with Digital P EFI and oxygen sensors, the system will automatically correct the mixture on individual banks -- as long as you're in closed-loop mode. When you put your foot in it, you go into open-loop mode -- and when your foot is in it is precisely when you *don't* want to be running lean! You can only hope that the open-loop scheduling includes enough enrichment to overcome the effects of the temperature differential between banks. Again, as long as the system is clean and operating properly, there doesn't seem to be a problem.

2) The coolant temperature sensor for the gauge on the dash is on the right thermostat housing. This means that the left bank can have zero flow and be overheating severely, and the driver would have no indication from the dash as long as the right side still had good flow.

3) While the system works fine when clean and operating properly, the double-pass radiator scheme seems designed to accentuate any problems that develop. While the coolant flow is always lower through the left bank, the radiator getting obstructed internally seems to increase the difference in flow -- possibly because the flow from that bank has to go through twice as many passes of the obstructed radiator, or perhaps just because the thermostats are closing off the bypass fully. Whatever, the incidence of dropped valve seats or other overheating damage is much higher for the left bank.

Roger Bywater has a different theory about why the left bank seems to drop more valve seats: "If the V12 overheats for any reason B bank is likely to suffer more than A bank and I believe this is because A bank is fed from the low side of the water pump whilst B bank is fed from the top. Therefore any condition which might promote cavitation at the pump will have a more damaging effect on B bank." There are even those who suggest that the left bank suffers more than the right because the big belt-driven fan is blowing air over the right bank, although this is a minor factor at best. Rather than trying to decide *which* theory is correct, note that *all* these theories might have some validity! The B bank is definitely the one at risk.

Bywater relates "...an observation from when I first started doing Japanese Heat Damage Tests, which involved an extremely arduous simulated incline run. The test was carried out on a chassis dynamometer in a temperature controlled environment with airflow coupled to road speed. The punishing part was a simulated gradient lasting (going from memory) 20 minutes at high load and moderate speed in which the airflow through the radiator is barely adequate to cool the engine.

"Before we added supplementary fans to live with the test most cars would overheat badly towards the end and I remember that a V12 dropped a few valve seats on one occasion. The dropped seats were in the left hand head. This was a test fleet car in sound condition so all those theories like radiator or heater blocking are not relevant. I do not accept that airflow around the engine is a significant factor.

"I think just about any car would have overheated in the circumstances. A pair of electric fans mounted in front of the radiator kept the problem under control (I cannot be sure if that was done on the V12 but it certainly was on the 4.2) so maybe that should be suggested to anyone whose driving pattern gets into similar territory. Personally I was dubious about the fans making much difference but the engineer in charge of cooling systems assured me it would work and he was right. The setup was used in production on XJ6s for the Japanese market only (it is shown on the parts slide) but I don't think the V12s ever had it."

RECOMMENDATIONS: Despite the proven shortcomings of the cooling system design, many experienced XJ-S owners insist you can avoid trouble by scrupulously maintaining your cooling system. This author does *not* agree. If you put any stock in what I say, you will make four changes to your cooling system *immediately*:

1) Install coolant filters in the upper radiator hoses. I recommend the Tefba's, although the Ganos also work fine. See page 190. Note that you might also want to install a convenient coolant drain to aid in servicing these filters.

- 2) Modify the banjo bolt in the air bleed port at the top right corner of the radiator so that it actually allows air through. See page 44.
- 3) Install a “flushing tee” in the highest point in the heater hose, and use it whenever you’re changing coolant. See page 180.
- 4) Install foam weatherstripping in every nook and cranny where air might get around the radiator rather than going through it. See page 226.

Those are all easy. They'll only cost you a few bucks and won't take more than a couple of hours. In addition to those four items, there are two things that should be done when the opportunity presents itself:

- 1) If the radiator ever must come out for any reason, convert the system to single-pass. If that radiator is going back in, have the radiator shop modify it first. If a new radiator is going in, make sure it's a single-pass radiator. See page 198.
- 2) If you ever have any trouble with that belt-driven fan, chuck the whole thing and install an electric fan in its place. See page 219.

HOW HOT IS TOO HOT? Just about the first question everyone asks is just how high the needle can get before it's time to start worrying. Unfortunately, all too often owners ask people who *should* know, including supposedly certified Jaguar mechanics, about their gauges reading halfway between N and H, and are told, “That’s OK, they read there all the time, don’t worry about it.” These people are *liars*, and you can tell ‘em Kirby Palm said so. Many, if not most, of the maintenance headaches occurring on Jaguar V12’s can be traced to overheating -- not just one-time overheating, but long, persistent, chronic overheating, the type that can only happen when the owner is ignoring the gauge -- usually because someone told him it was OK. If anyone tells you your temp readings are OK, ask him if he will guarantee that and agree to pay for engine repairs when the valve seats drop.

Trying to get a handle on just what constitutes a reason to panic on the XJ-S temperature gauge has long been difficult, since reports from owners seemed inconsistent or contradictory. The gauge being an example of British electrics has only added to the uncertainty. However, by noting many such reports on the internet discussion list and following several of them while the owners checked things and made corrections, this author has been able to derive the following guidelines. Note that these descriptions apply to the vertical or “barrel” coolant temperature gauge found in the pre-'91 XJ-S; those with later cars with round gauges will most certainly see similar behavior in general, but I can only offer a few reports on where the needle sits when the car is running properly -- see below.

Some vertical gauges reportedly have temperature scales in degrees, while others have merely a C at the bottom, an N dead center of the scale, and an H at the top. This description will refer to the C-N-H scale but both type gauges are apparently identical except for the paint.

There are basically four situations that the vertical gauge will indicate:

- 1) If your car has a properly-operating cooling system fitted with 190°F (88°C) thermostats, the needle will always be sitting on the N when the car is warmed up. Perhaps just a hair to the high side of the centerline of the scale, but always within the width of the letter itself, never above it.
- 2) If your car has a properly-operating cooling system fitted with 180°F (82°C) thermostats, the needle will always be sitting about 1/4” below the N when warmed up.
- 3) If your needle seems to wander around a lot, you have air in your cooling system. See the section on filling and bleeding on page 179.
- 4) If your needle is above the N, your car is overheating. If your needle is halfway between the N and the H, your car is *severely* overheating. And don't worry about the needle being on the H; it will never get that far.

Note that these guidelines apply to the XJ-S as configured from the factory -- with the gauge sender located in the right

side thermostat housing. As mentioned above, it's the left side that is likely to have overheating problems -- which may explain why trouble occurs when the gauge reads just above the N where any reasonable person would presume it's still within normal operating range. If the sender were moved to the left thermostat housing as proposed below, perhaps the gauge would have to be reading closer to the H to indicate serious trouble.

Believe it or not, it appears that the vertical gauge is actually quite reliable. In many (but not all!) of the reported cases of the needle being above the N due to problems with the gauge or sender, it was plainly obvious that there were gauge problems -- often with all four gauges, and sometimes pegging them against the upper end of the gauge seconds after cold start. More subtle faults in the electrics, such as corroded connections, always seem to cause the needle to read low (often all four gauges at once -- see page 591) or to not read at all, staying at the C end. A high temp reading that appears even remotely plausible is usually a cause for concern.

A lot of owners describe the situation when talking about their temp readings, such as how hard they've been driving down the freeway or how hot it is outside today. Unfortunately, such qualifiers are usually an indicator of trouble. Engine coolant temperature is controlled by the thermostats, and should not vary beyond their control range *regardless* of conditions. And their control range (from fully closed to fully open) is pretty tight indeed; it has been described as "three needle widths" of travel on the gauge. Since the cooling system should always have some margin (excess cooling capacity) so the thermostats can control the coolant temp, the indication should always be within this control range. If the gauge ever indicates more than a couple of needle widths above the regular operating temperature with whatever thermostats are installed -- including reading *on* the N with 180°F thermostats -- it means that the thermostats are no longer in control, they are wide open, and it's absolutely everything the cooling system can do to hold the temperature indicated. Obviously, if things get just a hair worse -- the outdoor temperature rises a couple of degrees, one more tube inside your radiator gets plugged up, you sit in traffic a few more minutes, whatever -- the temp is going to rise some more. Overheating damage is imminent, you need to be taking corrective action *now*.

The only way "corrective action" would include replacing thermostats is if the thermostats are bad. Merely switching to colder thermostats is not corrective action; if the cooling system can't hold 190°F, it won't be able to hold 180°F either. Replacing 190°F thermostats with colder thermostats won't fix anything unless the 190°F thermostats were defective.

HOW HOT IS TOO HOT? - LATER XJ-S ROUND GAUGE: James Teston says, "I have a '92 with the round temperature gauge. (Not the barrel gauge)! It looks like this:

C \ N / H
 ^
 |

And this is where the needle stays (Between the N and the right hash mark)."

Steve Gallant says, "My 93 XJR-s with 6.0L engine runs the same regarding temperature -- middle of the N to just slightly to the right. It has been this way since I purchased the car with 5k miles on it."

Howard Gladman concurs: "My 95- 6.0L exhibits same reading. Once the the needle reaches about a needle width to the right of N the Aux fan switches on and the needle stabilizes. 56,000 on the clock and running strong."

It's a pretty safe bet that all three of the above cars are running 190°F thermostats. If you're running colder thermostats, expect readings farther left than these -- and if you don't see them, fix your cooling system.

COOLANT TEMPERATURE SENSOR RELOCATION: As mentioned in the description of the cooling system above, the coolant temperature sensor for the EFI system is on the left thermostat housing while the coolant temperature sender for the gauge is on the right thermostat housing -- and both are on the wrong side. It would be better if the EFI coolant temperature sensor was on the right side and the gauge sender was on the left side, for two different reasons. As a result, an owner could rationally decide to move the EFI sensor from left to right, or the gauge sender from right to left, or to move both, essentially exchanging the two. All moves are covered here; make your own choice.

It'd be really nice if both sensors were the same thread so you could just swap them. Unfortunately, the gauge sender is

Smiths with a 5/8" UNF, 18 threads per inch, while the EFI sensor is Bosch, metric, 12mm x 1.5mm thread.

To move the gauge sender to the left thermostat housing, you're gonna have to drill and tap a 5/8"-18 hole. This will require two tools you probably don't have: a 9/16" drill bit, and a 5/8"-18 tap. 9/16" drill bits are not too difficult to find, but note that they are only available to fit 1/2" or larger drills! They make 1/2" drill bits with reduced shanks all the way down to 1/4", but the idea of a drill bit any larger than 1/2" reduced to 3/8" shank seems to have completely eluded the market. A 14mm drill bit might also work, but they aren't available to fit a 3/8" drill either.

One possibility is obviously to rent a 1/2" drill. Another idea: you can carefully grind six flats on the bottom 1/2" of the shank of the bit. Then you can chuck up a socket driver in your 1/4" or 3/8" drill, snap a socket onto the socket driver, and insert the hex on the bottom end of the drill bit into the socket. It might be a little wobbly, but if you drill the hole as large as possible with conventional drill bits beforehand (1/2"), this hokey arrangement should do an acceptable job of enlarging the hole.

This author bought a 9/16" bit with a 1/2" shank and three long flats to help it fit securely in a chuck. By grinding three short flats in between the existing flats, a 12mm socket fit quite well -- and doesn't hurt the bit one iota, since the original flats are intact and would still fit properly in a 1/2" drill.

Another option, of course, would be to replace the OEM gauge sender with a generic sender with similar electrical characteristics but threads that fit the existing EFI sensor port on the left thermostat housing. Good luck. If you wish to try this, note the OEM sender registers 412Ω at 40°C.

You can install the gauge sender anywhere in the left thermostat housing that will see coolant flow from the heads. It should not go in either the bypass passage or the passage to the radiator, since either may be closed off at one time or another. On a pre-8S44060 engine, the obvious place to put it is on a flat that was clearly intended for such a boss but never drilled, right on top and near the rear end of the housing. From engine 8S44060 on, there's already a hole here with a sensor in it, so this location isn't an option.

There's another flat surface apparently intended for a boss just rearward of the EFI sensor, but this port location connects to the bypass passage. Also, the boss is too small for drilling and tapping a 5/8" hole.

Another option, of course, is to just drill out the EFI coolant temperature sensor boss and retap it for the gauge sender. That leads to the next problem: you now need somewhere to put the EFI coolant temperature sensor. And over on the right side is ideal.

There are at least two existing ports on the right side; the one where the gauge sender goes, and the one where the thermotime switch goes. On the author's '83, there is no thermotime switch; there is a plug in the hole. Doesn't help, unfortunately; both holes are too large for the EFI coolant temperature sensor. So, you have two options: either drill and tap one of the existing holes out to a significantly larger size, install a plug, and drill and tap the plug to fit the EFI sensor; or just install a suitable plug in the old gauge sender hole and drill and tap an entirely new hole in the coolant manifold for the EFI sensor. There are a couple of locations that will serve. Note that the EFI sensor could just as easily go on the *rear* coolant manifolds.

For a plug for the old gauge sender port, I'd suggest: another sender. In fact, just leave the original sender there and buy a new sender DAC2583 for the left side. The senders are less than ten bucks each.

In fact, as long as you have two gauge senders, just install another wire and a switch somewhere so you can switch from one to the other to monitor *both* sides of the engine with the same gauge. If you go this route, you might want to replace an original C40106 sender with another DAC2583 just to make sure any difference in indicated temp is due to a real difference in temperature rather than a difference in sender.

If you have just read through this section and have decided to make this mod, note that unless you can figure out how to use taps and drills down in some fairly tight places, you will need to remove the thermostat housings to do the drilling and tapping. Probably the easiest way to do that will be to remove the air filter housings and then unbolt the entire manifold assembly -- thermostat housing, coolant connecting pipe, and rear coolant manifold -- and move the entire assembly rearward far enough to disengage the hose connecting the thermostat housing to the crossover pipe. So, while you're preparing for this job, go ahead and buy a total of eight coolant manifold gaskets EBC 9634, two air filter housing gaskets EBC 9635, and both thermostat cover gaskets EBC 8330 and EBC 8331. You may also want to get

four “top hat” seals C37990 for the coolant connecting pipe, and maybe an AAV gasket C42165 or whatever a newer gasket number is. And you will want to get a new copper washer for reinstalling the EFI sensor, C2296/3, although you can probably find a suitable sealing washer locally. Reportedly a new gauge sender comes with a washer, so if you don’t remove the existing sender you won’t need to buy one separately.

BLOWING COOLANT: In general, if you are blowing coolant, your car is running too hot. If you have a pre-H.E., pressure relief at the radiator cap on the header tank on the left wheel well will blow coolant or steam out the little tube into the wheel well. Note that, if you fill the system right up to the cap, it will blow a little coolant the first time you run simply due to expansion. You should be able to tell when it’s actually overheating, since it will blow much more energetically.

If you have an H.E., pressure relief at the radiator cap on the header tank on the left wheel well will cause coolant or steam to blow into the plastic “atmospheric catchment tank” within the compartment behind the left front wheel. This tank, in turn, overflows via a tiny tube out the bottom of the car at the very rear of the left front wheel well. If the tank is empty or nearly empty, you may not be able to tell that the cap is relieving pressure; steam may condense within the plastic tank, and nothing visible comes out the tube. If the overflow tank is totally full -- which it can get to if the owner continues to top up the system on a regular basis -- any pressure relief can push liquid out of this tube, even if it’s steam that’s coming out of the header tank. And, again, if the system is topped up, it may push a little liquid out the first time it’s run without overheating.

Finally, as noted on page 186, the overflow tube coming out of the atmospheric catchment tank is a classic example of poor design, so more than likely any flow out of this tank will be all over the inside of that compartment and come leaking out of nooks and crannies, such as out the joint between the rocker panel and the fender.

OVERHEATING DAMAGE: In any aluminum-block engine, severe overheating can result in a warped block or warped heads, which in turn normally call for an engine replacement. In the Jaguar V12, a more common symptom of an overheated engine is a dropped valve seat. Since the heads are aluminum, the valve seats are sintered iron rings that are pressed into the aluminum. Since iron and aluminum have different coefficients of thermal expansion, overheating will cause a loose fit and the seat can just fall out. After that, it holds the valve part way open and bangs around in there. Amazingly, reports of broken valves are rare; more often the owner who continues driving despite the annoying ticking under the hood allows the valve to beat the seat to pieces, which in turn bang up the piston, the other valve, and the head.

Do not continue to drive when the car is overheating. If no other options are available, drive it short distances at a time, shutting it off and allowing it to cool before starting again. And don’t continue to drive if it sounds like a Chevy with bad lifters, either -- you’ve already dropped a seat, but you might as well quit before you do even more damage.

If at all possible, don’t shut off the engine when the car is overheating; many have reported that’s when the valve seats drop -- when the engine is stopped. Instead, find a water hose and leave the engine running as you hose down the radiator through the front grille. Once the temp gauge comes down, then shut it down -- and call a tow truck, do not start it again until you have addressed its overheating problems.

OVERHEATING -- H.E. vs. PRE-H.E.: Roger Bywater indicates that the pre-H.E. cars had some tendency to overheat: “With regard to the marginal cooling at sustained high speeds the H.E. had a slight advantage in that the higher compression ratio raised the thermal efficiency and reduced the heat losses to the coolant. It was also noticeably over-fuelled at high revs which must have helped further and the problem, slight though it was, seemed to be solved. Distributor build quality was also better by this time.”

OVERHEATING -- CAUSES: Believe it or not, the XJ-S H.E. does not overheat when it’s running right -- and this from an owner who lives in Florida! If yours tends to overheat, don’t ignore it. Check the following, all of which are

described further in this book:

- 1) The cooling system must be properly filled with no air in it.
 - a) The system must be filled with the proper coolant mixture and bled correctly to begin with, which requires disconnecting a hose at the heater valve (not mentioned in the manuals).
 - b) The automatic air purge system must be working properly to *keep* air out.
 - i) The banjo fitting on top of the radiator is probably plugged if it hasn't been modified.
 - ii) The line to the atmospheric catchment tank may be obstructed or kinked.
- 2) The radiator must be clear, no blockage or sludge; unfortunately, this is difficult to check conclusively on the XJ-S without removing it from the car and removing the end tanks. Crud in the radiator will cause overheating under all conditions, but usually more at speed than at idle. Experience indicates that any radiator maintained following the owner's handbook guidelines for more than ten years is likely to be plugged.
- 3) Suspend the thermostats in a pan of water on the stove and bring them to a boil. Do not let them contact the bottom of the pan. If the thermostats are not visibly wide open by the time the water boils, replace them. Their usual failure mode is to open only slightly.
- 4) Retarded timing will cause overheating under all operating conditions. See the sections on ignition timing beginning on page 126.
 - a) A seized centrifugal advance mechanism may be seized at any position from idle to max advance. Usually, it will be correct at one particular RPM, retarded everywhere above that RPM, and overadvanced everywhere below. Conditions with retarded timing will cause overheating. Conditions with overadvanced timing can also cause overheating but usually not as severe; the more obvious problem is knocking. See page 137.
 - b) A blown vacuum advance module will cause timing to be retarded at low throttle while correct at full throttle, so the car will overheat more when driving gently.
- 5) There may be debris obstructing airflow through the radiator, such as dirt and leaves -- either plugging the fins themselves or within the space between the A/C condenser and the radiator. See page 202.
- 6) A bad fan clutch causes overheating *only* in stop-and-go traffic or other conditions where motion of the car doesn't provide enough air flow. See page 215.
- 7) The fan shroud needs to be properly installed and sealed up against the back side of the radiator. See page 226.
- 8) The fan shroud flaps should be intact and free to flap as intended. If they are missing, overheating when stopped and idling is likely.
- 9) There needs to be foam surrounding the radiator to prevent air from bypassing it. See page 226.
- 10) Front spoiler -- it must be there, and it must be properly mounted. See page 227.
- 11) Automatic transmission problems can be putting too much extra heat into the radiator. See page 324.

While all of the above items point to common faults, it must be said that far and away the most common cause of overheating on XJ-S's that are ten years old or more is a plugged radiator. If you are having cooling problems, address the easy items first, but you might as well go ahead and plan to remove the radiator and have it rodded, recored, or replaced.

FILLING THE COOLANT SYSTEM: The ROM and the Haynes both provide a detailed coolant fill procedure and give dire warnings about engine damage caused by hot spots if the procedure is not followed. Allow me to add: they ain't kidding. Reportedly, one indication that the system has not been properly filled and bled is that the coolant level light comes on every now and then while driving. Another is a temp gauge that seems to wander around.

Of course, you could just take your car to the Jag dealer and let the experts change the coolant so you don't have to

worry about it, right? Get real. Stefan Schulz: “In my experience (in the bad old days, that is, when I still let garage mechanics near my car), they never seemed to follow this procedure because the coolant level light would behave as you describe after they messed with the cooling system. When I started doing my own maintenance and followed the procedure *to the letter except for the leak sealer* I never got the low coolant light on when the engine was running.”

Steve Gallant: “Same for me here. My car was serviced by a very reputable main dealer as part of a pre-purchase service. After receiving the car, I noticed the low coolant light came on on my first drive. I performed the factory procedure for filling/bleeding, and the light was extinguished. I must have added close to a quart of coolant. So even dealers don't take the necessary time to perform this operation 100% successfully.”

Wally Magathan: “My car was also serviced by a reputable dealer, but I didn't know it was routine for them to ignore the bleed procedure until now. I've now bled the system, put in almost a gallon, and hate to think what's been going on in the engine in the month since they "fixed" my radiator hose.”

Jim Isbell provides a great tip on filling the coolant system: “Getting the water into the system has always been a problem on the XJS because of the two fill points. I always tried to do it on level ground before and spent many minutes shaking the car to get all the air out of the system. Today, just by accident, I was parked in the driveway with the nose of the car elevated and I didn't feel like moving it. So I pulled the cap on the header tank and filled the car (about two quarts) then I pulled the cap on the crossover pipe and added another quart. The air bubbled out quickly and the car was completely full in no time. I recapped both vents and it's finished. From now on I will park the car with the nose uphill when I fill the radiator.”

The engine is deliberately designed for the coolant to flow upward with no air pockets, but when parked on level ground it just barely flows upward. Tilting the nose up should make the air clear out a *lot* better. Offhand, it's probable that you can't have the nose *too* far up until the air bleed port on the top left of the radiator is *higher* than the fill opening on the crossover pipe.

Be sure to bleed the air out of the heater circuit while filling the cooling system. See below.

AIR BLEED VALVE: At the top left corner of the radiator is a small fitting used to allow air out while filling. Mike Morrin says, “The first few XJ-S (1975 model year) left the factory with a threaded plug.” Then they switched to a little winged valve for most pre-H.E. cars -- but for H.E.'s, they went back to the plug. Morrin: “The owner's handbook and manual give instructions for both types of fitting.” Both items were the same thread, 1/8" BSPP -- so if you're here in the US, don't lose that plug! If you'd prefer the convenience of the valve, C45587, it will fit where the plug fits; the valve sits a little higher and therefore closer to the hood, but this doesn't seem to be a problem.

AIR BLEED AT THE HEATER VALVE: There is none, but there should be. Since the line comes out of the right side coolant manifold, goes upward until it gets to the heater valve and then downward until it connects to the bottom left corner of the radiator, it forms a big bubble when filling the coolant system. Therefore, you need to disconnect a hose at the heater valve to let the air out when filling. A disconnected hose creates two openings, one on the end of the hose and the other on the end of the fitting it was attached to. As you fill, coolant will start to pour out of one of the openings first; put a thumb over that opening and continue to fill until coolant starts to pour out of the other opening, then reconnect the hose.

Of course, it'd be more convenient if there were actually a bleed port. Douglas Dahl says, “2 clamps and a \$0.99 5/8" connector at any auto parts store. It is the same as the T's used in the flushing kits out there and comes with a screw top.” These black plastic “flushing tees” are commonly available in 1/2", 5/8", and 3/4" size, and you'll need the 5/8" for this job. The straight section of the tee has hose barbs of the specified size while the connection off the side is a male garden hose fitting, and it comes with a blank-off cap with a rubber washer inside. It really could not be any simpler to install or use. If your local auto parts store doesn't sell these flushing tees individually, it may sell the flushing kits which contain three tees -- one of each size -- plus one cap and a few other items, all for less than five bucks so it still won't break you. Note: you might want to check the passages inside the tee for plastic mold flashing before installing.

Please note that installation and use of an air bleed in the heater circuit does *not* mean you don't need to follow the

prescribed procedure for filling and bleeding the cooling system. You will still get air in the system when filling; we just hope that you will trap *less* air in the system by bleeding air from the heater circuit.

When filling the cooling system, it is suggested that you run the car for a few minutes with the climate control system off. With it off, the heater valve will remain open, so the cooling system will have a chance to push the air pockets out of the heater circuit. With the system on, it may just close that heater valve as soon as the engine is started unless it's cold enough inside the car for the system to call for heat.

ANTIFREEZE: Don't operate the Jag or any car without antifreeze in the cooling system. The name "antifreeze" is an unfortunate misnomer, and pure water is a totally unacceptable coolant -- even in Hawaii. Antifreeze not only prevents freezing, it also retards corrosion and crud buildup, helps prevent boilover, and serves as a water pump seal conditioner. Running pure water will result in early water pump seal failure. Also, replace the antifreeze annually, because the inhibitors in it wear out and it becomes corrosive.

Scott Fisher sends the following wisdom: "In the context of the automotive cooling system ethylene glycol is not an anti-corrosive agent; it is in fact corrosive. To offset this fact, manufacturers add anti-corrosives (inhibitors) to the glycol. These preparations, while in good condition, perform well in both minimizing corrosion and preventing freezing of the coolant. However, over the life of the coolant the anti-corrosion properties of the inhibitors are depleted.

"Water aids corrosion in three main ways: 1) bringing free oxygen in close contact with the metals so that corrosion (oxidation) can occur. 2) Water is conductive. Once water has been flowing in your cooling system for some time, its conductivity will rise as it picks up metal ions. The water may serve to promote electrical activity which may erode metals by galvanic action. 3) Some of the metal ions in the water may also react directly with the metal surfaces.

"Apart from supporting the above three processes, ethylene glycol has the added unfortunate property that it oxidizes through several stages to oxalic acid. The products of ethylene glycol oxidation by oxygen and subsequent reactions include: aldehydes, carboxylic acid, nitric acid, glycolic acid, glyoxylic acid, oxalic acid, formaldehyde and formic acid. Most of the series of oxidation products to and including oxalic acid are directly corrosive to metals. Added to this, oxalic acid is highly toxic.

"To combat the above acids and other corrosion activity, antioxidants and alkaline formulations are added to the glycol mix. These include many compounds which are used in cooling systems where antifreeze properties are not required and include primary, secondary and tertiary amines; organic and inorganic phosphates, silicates cresols and other phenolic substances; a wide variety of sulfur compounds; soaps; alkali metal salts; and borates.

"These inhibitors slow down the corrosion process caused by the glycol and the water. They may coat the metal surfaces and prevent corrosion by passivation. Passivation is the process where the a protective film forms on the metal which prevents further contact with the solution. Unfortunately, in all coolant preparations (with or without glycol) the inhibitor system (during engine operation) is being continuously depleted in the performance of these actions. For this reason, proper cooling system maintenance is critical.

"One aspect of cooling system maintenance that we can all easily follow is to minimize "aeration" of your coolant. Aerating accelerates the uptake of free oxygen from the atmosphere. As free oxygen is one of the essential ingredients for corrosion, the importance of minimizing it's uptake is clear. To this end you should make sure all your hoses are in good condition and clamped tightly. "Closed systems", where an expansion tank and recovery system closed to the atmosphere is used, also help in this regard.

"If you overheat (boil) glycol-based coolants they must be replaced immediately as this accelerates the oxidization process of the glycol to acids."

LONG LIFE COOLANT: Peter Cohen says, "I noticed that the manual called out "phosphate free" coolant. The statement I am referring to is on Page 26-03 of Volume 2 of the XJS Service Manual (JJM 10 04 06) under the heading "ANTIFREEZE". The V12 HE motor is essentially unchanged since long before the existence of non-phosphate coolant. Ergo, the Jaguar V12 has been doing fine on normal coolant for all these years, so why ask for non-phosphate

now?"

"After much searching, the only non-phosphate stuff I could find at the time was Prestone 460 Long Life coolant. The Prestone 460 has the distinct disadvantage of being brown, so now coolant leaks are the same color as oil leaks (and the same color as rusty old coolant). I have since found Texaco Havoline Long Life, which is orange."

Jim Belkoff answers, "Beyond the phosphate-free issue and the long-life issue, Texaco DEX-COOL (and I assume the Prestone equivalent) contains no silicates. From what I understand, silicates are abrasive and gradually eat away at water pump seals. Texaco and GM have done tests to prove this new coolant results in fewer water pump replacements.

"The reason the new coolant lasts so long is the carboxylate inhibitor system that's added to the base ethylene glycol. I would suggest taking a look at Texaco's website (www.texaco.com).

How important is phosphate-free coolant? Apparently we should ask the folks at Saturn. Cohen: "In their first year of production, Saturn recalled and destroyed all of the first cars they sold because "they were shipped with the wrong coolant, which could destroy the engine block". Given that they could simply have issued new motors, this was an impressive waste of money."

Peter Cohen says, "DEX-COOL apparently eats silicone sealants. If you are replacing your water pump, do not use silicone sealant on the gasket. Either use no additional sealant, or use Permatex."

LONG LIFE COOLANT -- MAYBE NOT: That orange long life coolant sure sounds good, but eventually enough negative reports appeared to convince many owners to stick with the traditional green stuff. In fact, enough negative reports appeared to convince many auto mechanics to avoid the orange stuff like the plague. Gary Penovich says, "Chevrolets and other late model GM cars have been affected by brown sludge. It seems that extreme driving conditions and/or low coolant situations lead to a gelatin-like thickening of the stuff."

Wally Plumley, on the Porsche 928 discussion list, discussed coolants with Texaco reps and learned that long life coolants are not suitable for "open" cooling systems in which air is present in the cooling system. In other words, it's not suitable for systems that don't have a coolant overflow tank -- such as the pre-H.E. XJ-S. It's also not suitable for systems that leak. "Silicates in conventional coolants will "plate out" or coat metal surfaces inside the cooling system. If the cooling system gets low on coolant, the plated silicates will give some corrosion protection to the metal that is then exposed to hot, moisture-saturated air. DEX-COOL has no silicates, so if the coolant level gets low, the metal exposed to hot, moisture-saturated air has no corrosion protection, and will corrode relatively quickly." Of course, this wouldn't matter to anyone whose car never got low on coolant.

Bernard Embden argues that DEX-COOL is not only inappropriate for systems that don't have an overflow tank, but for system with unpressurized overflow tanks -- which would include *all* Jaguar XJ-S's. "On my 88 Grand Prix with its non-pressurized expansion tank, (tank does not have a "pressurized radiator cap") a nasty sludge built up around the expansion tank filler cap with DEX-COOL installed. The crap was hard and not easily removed. Based on my experience, it appears that DEX-COOL reacts with the atmosphere to form this sludge. GM agrees that low coolant resulting in radiator contamination is the death bell of DEX-COOL. A "low coolant" condition creates an "air pocket" within the radiator that allows a deposit accumulation unique to DEX-COOL. Once this deposit attaches itself to the radiator cap, the cap loses its sealing ability and a vicious cycle of low coolant/more deposits starts.

"Without a pressurized radiator cap, the cooling system has a large and variable "air pocket" in the non-pressurized expansion tank. This allows DEX-COOL deposits to start to build up immediately in the expansion tank and is ultimately drawn to the radiator cap. Once on the radiator cap sealing surface it prevents proper sealing. From this point on your radiator is on borrowed time."

RETROFITTING OLDER CARS WITH LONG LIFE COOLANT: Jim Crider says, "A few years ago, someone thought a long-life coolant (original plan: life of vehicle) would be a Good Thing. This leads to Organic Acid Technology coolant (OAT), which is marketed as "DEX-COOL" by GM and has been factory-fill in their products (except C4 Corvette -- not sure about C5 Corvette) since 1995. It's the orange or orangy-red stuff. Someone along the

line decided the word "acid" was a Bad Thing to try to sell, so OAT was recursively changed to Organic Additive Technology. It can go 5 years/100K or 150K miles -- provided it's not mixed with other coolant. OAT has less cavitation resistance than silicate-based coolant, and can attack certain sealing materials, so it's not a good idea to convert a green-coolant car over to OAT unless the manufacturer says it's okay. OAT also has a tendency to stain translucent plastics in things like overflow bottles and pressurized de-gas bottles with a funky brown crud. Oh, and OAT from one manufacturer isn't necessarily compatible with OAT from a different manufacturer. Texaco is GM's OEM supplier and is licensed to use GM's "DEX-COOL" trademark on their aftermarket packaging.

“Many European automakers use a hybrid of OAT -- HOAT (Hybrid Organic Additive Technology -- clever, huh?), which is the OAT package with a small amount of silicates added to increase the cavitation resistance and make it less aggressive against those seals and gaskets. This is often pale yellow in color. This stuff seems to offer pretty much the best of both worlds -- it's not quite as long-lived as straight OAT, but it is much better behaved in operation than OAT, much like conventional coolant.

“Note that these three different additive packages are not really cross-compatible. No, they won't eat the insides of your radiator if you mix a little of one in with another in a pinch, but you'll be better to get the system flushed out and a fresh mix of 50/50 whatever your car needs put back into it.

“If I owned a car that came with OAT or HOAT from the factory, I'd likely stay with it. The anti-corrosion additives, in particular, leave residues on the walls of the various coolant passages (that's how they work -- the residues coat the base metal and prevent corrosion), and it's tricky to convert an engine that's been run with one style of package to use another package and get the full benefit.

“Switching from conventional to OAT, for instance, requires a mild acid flush of the cooling system after removal of the conventional coolant and before pouring in the OAT if the long-life corrosion benefit of the OAT coolant is to be realized. Just pouring the OAT in after draining the conventional won't gain the full measure of added coolant life the OAT marketers (notably Texaco) like to use as selling points.”

Somewhere in the midst of all this, the labelling on the containers of DEX-COOL quietly changed, making far more modest claims for durability and combatibility.

Quoting from the [Popular Mechanics web site](#): “Now let's look at "retrofit" and "drain and fill" and explain what you can and can't do safely, and a bit of why. If a vehicle has a copper-and-brass radiator, forget a retrofit, says General Motors, because the organic acid (orange) antifreeze may not provide adequate protection for the lead solder in that radiator. The Chrysler orange hybrid combination of silicates and organic acids is meant to provide special protection for the water pump. Sorry, you can buy it only at a Chrysler-brand dealer.

“Prestone believes you can retrofit to its organic acid orange almost any vehicle with an aluminum radiator and cooling system that has been well-maintained and is in good condition, if you do it right. However, the antifreeze maker recognizes the possibility of a problem with Dodge truck 5.9-liter V8 water pumps, for which green or yellow/gold U.S. antifreeze is recommended—if you don't get Chrysler's specific orange.”

A 1998 magazine article quoting Applied Chemical Specialities Co. (a competitor of Havoline) put the retrofit issue more strongly: “DEX-COOL is an excellent antifreeze to be used in brand new cars in which traditional phosphate/silicate antifreeze has never been used. However, if any traditional antifreeze has ever been used in your car's cooling system, it is strongly advised to avoid using DEX-COOL. This is because, short of a dangerous strong acid cleaning or complete replacement of all parts within the cooling system, it is physically impossible to remove all residuals of phosphates and silicates - even with repeated flushing. If DEX-COOL is used in such a system, deposit formation will be almost instantaneous and will seriously affect your car's cooling system efficiency and performance. Because most corrosion occurs under such deposits, it will also affect the long-term corrosion prevention in such a system as well.”

In a more Jaguar-specific vein, Al Askevold reports some problems with DEX-COOL: “Besides the bad report about DEX-COOL from the radiator shop who did my recore, I could not remove my rad caps without damaging the rubber seals, and my Tefba filters - I had to remove them and clamp them in a vice to remove the tops. I tried several different kinds of lubricant on the parts with no effect. I finally flushed the DEX-COOL, I am now using a different brand, so far no problems.”

WATER: The antifreeze needs to be mixed approximately 50/50 with water, but if you care about your cooling system you might want to be careful about what water you use. The garden hose may be convenient, but it's not necessarily healthy for the car. The biggest problem to be concerned with is dissolved solids, that stuff that's left in a pot after you boil water away. Since boiling is often going on alongside the hottest parts of the engine (cylinder liners, head), this same stuff is left there. As a scale on the metal surfaces, it can insulate them from the coolant and make the cooling system less effective. When the scale flakes off in chunks, it can find its way into the radiator and plug up some of the tiny tubes. Finally, the scale is somewhat abrasive, and therefore is not particularly good for the seal in the water pump.

This problem might be considered minor. There are only about two gallons of water introduced to the system at each coolant change, and that amount of water only has a finite amount of dissolved solids in it. This appears to be the attitude the auto manufacturers take, since there are no radiator hose filters in a car from the factory (see page 190). However, if you change your coolant often or use really crummy water, you might be contributing to the plugging of your radiator. If your car loses coolant and you add water daily from a garden hose, you might as well go ahead and pull your radiator and have it rodded out.

To minimize problems with dissolved solids, you should use distilled water, deionized water (also known as demineralized water), or water that's been purified using a reverse osmosis process. All three types are generally available at the local grocery store for perhaps 75 cents a gallon; at some places, you can take your own jug and get it even cheaper from a dispensing machine. Deionized water is sometimes called "purified water", and is usually labelled that it "serves distilled water uses".

Grocery stores also sell various types of drinking water, including spring water. These may not be any better than the tap water, since they may contain lots of dissolved solids -- they just contain dissolved solids that taste good.

Other processes advertised include ozonated water, which is a process to kill germs, and carbon filtered water, which is a process to remove volatile compounds that affect the flavor. Neither process has any significant benefit for cooling system use. The first time the engine is warmed up to operating temperature, the germs will be dead and the volatile compounds will have boiled away and been removed from the system by the air purge system.

There are arguments about using rain water or condensate from an A/C system. The argument is that they are both "distilled"; however, the other side of the argument is that they apparently pick up quite a load of dissolved solids somewhere along the way, either from pollutants in the air or from dust or whatever. Look at the container that collects the water and judge for yourself if it's OK for the inside of your cooling system to have similar stuff in it.

Peter Smith reports from "...a series of brochures from Tectaloy. It says "the preferred water is demineralised. Do not use spring or bore water." The brochure illustrated that the corrosion effects on welded aluminium were serious, and that as little as 1 volt earthing through the cooling system could chew out an aluminium radiator in weeks (probably do the cylinder head a power of no good as well). It also notes that true distilled water is getting harder to obtain due to the cost of production and the energy required in the distillation process. Also "if you believe rain water is the answer just reflect for a second on the damage it does to gutters and tanks, and they're usually galvanised against corrosion. Spring water is totally unsuitable as it is full of minerals and salts". Summary was that distilled, demineralised or reverse osmosis water were the most suitable."

One thing you should definitely not use is "softened" water from one of those water softeners that is recharged with salt. Dave Lokensgard says, "*Never* use softened water in a cooling system containing aluminum. Water softeners are ion-exchange units, not de-ionizing units. The main bad actor coming from the water in aluminum corrosion is the chloride ion, and water softeners work by replacing all anions in the water (negatively-charged ions, like phosphate, sulfate, and so on) with chloride, and all positively-charged ions with sodium ion. This is why they are recharged with salt (sodium chloride). So softened water is the worst thing you can use in a cooling system."

Jason Korke: "The coolant I bought was designed to be mixed with water. It was made by Castrol which in Australia is I believe fairly well regarded. It wasn't cheap! The bottle said, "Mix with demineralized or soft water."" It is unknown why Castrol's directions would say such a thing; perhaps they meant naturally soft water (water with few minerals) as opposed to softened water (water in which the minerals have been exchanged for salt).

If you work in a science lab, an electric power plant, or some other type of industrial facility that uses clean water, you may actually be able to get ahold of some *really* pure water -- something chemically much closer to unadulterated H₂O than the distilled, deionized, or RO stuff you can buy locally. Believe it or not, this may not be good. Pure water is a solvent; it would actually be quite effective at corroding your aluminum, iron, and brass parts if it weren't for the protective additives in the antifreeze. So, although the total lack of dissolved solids is nice, perhaps it'd be better if you added some dissolved solids before using; drop a few chunks of scrap aluminum and copper into the jug and let it sit a while before using it in your cooling system.

If you want to learn more about water, there is a "WaterNet" forum on the Internet.

RADIATOR CAPS: The XJ-S H.E. has two radiator caps, but only the one on the header tank (left side of the engine compartment) is actually meant to operate as a conventional radiator cap; namely, to control the pressure in the system. The one on the cross pipe (at the top right of the engine) is really just a place to add coolant, using a standard radiator cap because they're available. If one or both of the caps go bad, they may be replaced with standard coolant-recovery radiator caps.

The early XJ-S H.E. originally came with two different caps that were chained in place to make absolutely sure you didn't mix them up. However, as Alex Dorne points out (and Jaguar eventually figured out), there is no opening out of the chamber between the lower seat and the upper seal in the fitting on the cross pipe. As a result, it doesn't really matter what pressure rating the cap is you install there; the upper seal will totally seal that opening, no pressure relief is possible. The cap on the header tank will always establish the pressure limit within the cooling system. So, Jaguar now offers two identical caps as a replacement so it doesn't matter if you mix them up.

Nowadays all radiator caps are coolant-recovery type, but I will point out the difference anyway. In non-recovery systems, any coolant that was relieved by the radiator cap merely blew overboard, and when the system cooled back down air would be drawn back in. Radiator caps made for non-recovery systems usually had a brass diaphragm under the top cover that primarily served as a spring to keep the cap from rattling; it didn't matter if it didn't seal, since coolant was just going overboard and air was being sucked in anyway.

In a recovery system, coolant released is collected in a reservoir and sucked back into the system on cooldown. While the configuration of the radiator opening hasn't changed, it now becomes more important that the top cover of the cap actually seal. When the engine is cooling down and drawing coolant back in, any leaks at this joint will cause it to draw air instead. So, modern coolant-recovery caps have a rubber seal in place of the brass diaphragm. Since this type cap works just fine on non-recovery systems, it is doubtful if anyone actually makes the older style anymore.

COOLANT RECOVERY SYSTEM: Hey, all cars have them nowadays, it's not rocket science. Each time an engine heats up, the expansion and pressure buildup blows air, gasses, and coolant past the radiator cap and into a recovery tank, where the air and gasses bubble to the top. When the engine cools down, the contraction draws coolant back from the bottom of the recovery tank. However, on the XJ-S the coolant return line from the pressure cap to the "atmospheric catchment tank" behind the left front wheel is unusually long. Since the expansion/contraction of an engine only moves a little water at a time, it requires several thermal cycles to purge the air out of the hose (unless you overheat and blow steam). Each time you open the pressure cap, you allow the water to drain into the atmospheric tank and the line to fill with air. If you keep opening the pressure cap to check the level, it will never get a chance to work properly.

Even the tiniest leak in the coolant circuit will screw up a coolant recovery system. You may not be concerned about a very slight loss of coolant, but you should be. The engine takes several hours to cool down, so the rate at which coolant is drawn back from the recovery tank is glacial indeed. With even a tiny leak in the system, this suction will draw in air from outdoors instead. Once you have pockets of air in the system, the next event in your life will be an engine rebuild. Steve Haley says, "I found that even being a cup and a half low on coolant makes a big difference in the location of my gauge needle."

ATMOSPHERIC CATCHMENT TANK: On the H.E., the atmospheric catchment tank is a plastic container located directly behind the left front wheel, within the bodywork. "Atmospheric" means that it's not pressurized; it's basically an open container to pour coolant into. To get to it, remove the left front wheel and remove the sheet metal panel at the rear of the wheel well.

The vent on the atmospheric catchment tank is somewhat unusual. On most cars, the coolant recovery container is within the engine compartment, and when it overflows (like, when your car is overheating big time), the fluid coming out the vent just dribbles out onto the ground. In the XJ-S, however, such leakage would result in antifreeze throughout the bodywork -- unacceptable. So, the container has a vent line that is routed out the bottom of the car. For this vent to work as intended, the container must be airtight. The design is really lousy, however, and it is likely to leak throughout the bodywork when overheating anyway.

To prevent such localized flooding, try this idea: install a pan underneath the atmospheric catchment tank to catch any coolant that spills out of it, and provide a drain from this pan out the bottom of the car.

According to Mike Morrin, the pre-H.E. doesn't have an atmospheric catchment tank; relief from the radiator cap on the header tank just drains into the wheel well. He suggests that an overflow tank might be a useful retrofit. Considering the problems with the OEM tank noted above, it might be wiser to simply purchase a generic "coolant recovery system" such as those offered by J.C. Whitney. Note, however, that such generic tanks may be designed to overflow all over the place rather than out a tube; either mount them somewhere that this isn't a problem, or provide a tray to catch the overflow and route it out the bottom of the car. Tank volume may also be a concern, so if given a choice get the largest container you can find.

ATMOSPHERIC CATCHMENT TANK FILLING: Ideally, you'd like to have a minimum of a couple of inches of coolant in the bottom of the atmospheric catchment tank. However, you'll notice there's no convenient way to put any coolant in it! Apparently, Jaguar expects you to just add coolant at the header tank, and eventually some of it will get into the catchment tank eventually. Or maybe you're supposed to disconnect the hose from under the cap on the header tank, put a funnel in the end and hold it high and fill it that way.

Steve Haley had a better idea. "I added a fill hose which I ran back out through the same hole as the others." This would give you a filler location in the left rear corner of the engine compartment. Note that the point where this hose enters the atmospheric catchment tank should be airtight, so if it overflows the excess coolant will come out the vent line behind the LF wheel rather than pouring all over everything.

Even with such a nifty filler scheme, you still don't have any good way to tell what the level is. If you arrange your filler hose to end about two inches above the bottom of the tank, you can find out by blowing into it. If you hear bubbling, the level is at or above the end of the hose, and you don't need to add coolant. If the blowing just whooshes into the tank freely, you need to add coolant. If you think you might have too much coolant in it, you might even connect a siphon and drain the excess through this hose; when it gets down to the two-inch level, it will suck air and automatically quit siphoning.

COOLANT RECOVERY HOSE: The line from under the radiator cap on the header tank to the atmospheric catchment tank is anything but simple -- or reliable. In the engine compartment, where you can see it with the hood open, it is a sturdy thick-walled 5/16" hose. When it gets into the compartment behind the LF wheel well, where you can't easily inspect it, it connects to an adapter that steps the size up to 3/8", which then connects to a length of thin-walled rubber tubing (which actually appears smaller than the 5/16" hose). This 3/8" hose then bends downward 90° and into the atmospheric catchment tank.

One common problem is that the thin-walled tubing may get kinked making that 90° bend -- sometimes because somebody has fiddled with the hose in the engine compartment and pushed more of it into the hidden compartment, tightening up the bend. Michael Aiken says, "My coolant recovery hose was kinked as it enters the atmospheric bottle. This made the recovery system totally inoperable and could lead to more severe damage anywhere in the cooling system, as this is the only way pressure is vented as the coolant expands.

“It can easily be tested by disconnecting the hose at the top of the neck of the expansion tank and blowing in the hose. It should offer little resistance to air flow and you should hear a gurgling sound behind the LF wheel. I applied 30 lbs of pressure and no flow. It was really kinked. It could also possibly be broken which is not as severe but could lead to slow coolant loss. The hose is a soft rubber and makes two 90° turns in 5 inches. The second turn (the one that kinked) has a radius of less than an inch. I cut the hose off just above the bottle cap, installed a 90° 3/8" heater elbow (plastic) and a non-crimping heater hose back to the original connector. Cost less than \$4.

“If I were reading this I would take the 2 minutes and check it out. Unlike most cars this recovery system is completely out of sight and problems are likely to go undetected. This hose is really flimsy (unlike the hose from the tank neck into the wheel well which seems very strong) and just fell apart as I took it off.”

Another problem is the little adapter, which is steel and therefore subject to corrosion. Craig Sawyers reports, “Mine was rusted solid inside, and so totally inoperative.” Steve Haley says, “The short metallic slightly conical connector was completely plugged with corrosion. The hose into the tank crumbled in my hands...and the metal brackets were rusted and in pieces.”

Yet another concern: The end of the rubber hose inside the atmospheric catchment tank obviously needs to be open, both to allow coolant out and to suck coolant back in. In some cases, the hose blows coolant just fine, but when sucking the tip of the hose gets sucked onto the bottom of the tank (or even onto the side, if someone is really unlucky). It then can't pull in any more fluid even though surrounded by fluid, so the system pulls in some air from somewhere else instead -- or starts sucking radiator hoses flat, which is also trouble.

The fix is easy: pull the hose out of the atmospheric catchment tank, and redesign the tip of the hose so it can't possibly get sucked onto a surface. One idea is to punch a 1/4" hole through the hose crossways about a half inch from the tip. This will prevent the hose from sucking up the bottom 1/2" of the fluid in the atmospheric catchment tank, but typically you'd rather not suck up the dregs anyway.

When fooling with the coolant recovery hose, remember that the hole where it enters the top of the atmospheric catchment tank is supposed to be airtight so that fluid won't overflow out that point if the tank gets full.

AIR PURGE SYSTEM: When coolant is added to a cooling system, there is always some air diffused in the liquid. Over time, this air will come out of solution and rise to the top of the liquid, forming air pockets. To avoid creating hot spots (since the air won't cool the metal adjacent to it as well as the liquid would), the idea is to design the system so the air will collect in a spot where it won't do any harm so the owner can deal with it at his leisure.

In old pickup trucks, the top of the radiator was the highest point in the cooling system. As a result, any air in the system would tend to collect right under the cap; all the owner had to do was top it up on occasion and the rest of the circuit would remain air-free. Unfortunately, when Jaguar designed the XJ-S, the hoodline of a 1950 Ford pickup was not considered acceptable; not only would the top of the radiator have to be so low that it would not be the highest point in the system, but it wouldn't have a cap on it either. Hence, more elaborate measures were necessary to continuously purge air out of the system.

These measures changed with the introduction of a second radiator cap on the bypass pipe with the introduction of the H.E. Mike Morrin says, “The Pre-H.E. XJ-S has only the cap on the header tank. The level of the cap is marginally below the radiator vent valve (with the car on level ground).” There was a small tube from the top right corner of the radiator over into the top of the header tank on the left wheel well. The bottom of the header tank was connected into the return line from the heater line, which is essentially the suction side of the pump. The pump operation would therefore draw a flow from the top of the radiator into the header tank. Within the header tank, the air would tend to rise out and collect under the radiator cap while liquid coolant went out the bottom back into the circuit. The owner simply tops up the system every now and then to keep air out.

With the H.E., it was decided to add a second fill cap on the bypass pipe. This formed another high spot where air would collect. So, the air purge tubing from the top of the radiator to the header tank was modified to include a hose connection for a line from a tap just under this second cap. Unfortunately, this complicated matters; the bypass pipe is connected to the suction side of the pump, so it's at low pressure. So, the coolant and air is likely to flow *into* the fill

connection rather than out toward the header tank. To make the air purge system work right, connections to the header tank were revised. Rather than simply relying upon the suction side of the pump to draw coolant, an ejector was incorporated into the air purge tubing to provide even more suction so as to pull air out of the cap fitting on the bypass pipe. To operate this ejector, a hose was provided from the left side thermostat housing (high pressure) and there's a special connection on the bypass pipe directly into the suction side of the pump to get the lowest pressure possible. The high flow resulting is routed through the ejector to provide as much suction as possible. The connection to the heater return line was eliminated; the heater line merely passes underneath the header tank on its way to the radiator outlet.

Correction: The ©1982 Supplement, page 26-1, Fig. 2 showing the cooling system schematically shows the ejector (item 18) incorrectly; the line from the radiator and the line from the left side thermostat housing are interchanged. Simply look at the tubing on your car to see the correct scheme. The same schematic with the same error is included in the Haynes manual, page 334, Fig. 13.6.

The XJ12 with carburetors has a second radiator cap on the bypass pipe, but lacks the ejector-based air purge scheme. Its air purge scheme operates similarly to the pre-H.E. except that it's connected to the coolant passages in the induction housings rather than to the top of the radiator.

On the H.E., in addition to the ejector scheme, a "water valve" EAC4168 was installed in the air purge connection to the bypass pipe. This is basically a check valve that allows air to flow out towards the header tank but won't allow coolant to flow from the top of the radiator into the bypass pipe. This water valve is built into the fitting on the bypass pipe itself. This requires a 3/8" fitting at that end, and since the air purge tubing is 1/4", Jaguar uses a special hose that's 1/4" on one end and 3/8" on the other. Of course, if you want to replace the hose, you can use a piece of 1/4" hose, a piece of 3/8" hose, and an adapter. Tony Bryant says, "I've brazed a 3/8" fitting onto the bleed pipe to be able to use "standard" 3/8" heater hose here."

If your water valve is toast and you can't find a replacement, you can use a generic in-hose check valve, but be sure that the unit you select opens *very* easily since the ejector will not provide enough suction to overcome a heavy spring. Bob Lovell points out that McMaster-Carr (<http://www.mcmaster.com/>) offers a wide selection of check valves; the best choice would probably be number 47245K23. However, better yet would probably be to make a check valve from three successive sizes of brass tubing and a steel ball. Most commercially-available check valves consider a positive closure of utmost importance, but in this case total cutoff is not as important as ease of opening. Don't install a spring in your assembly, just let the ball roll back and forth, and install it nearly horizontally.

If the air purge system doesn't seem to be keeping air out of the space under the cap on the bypass pipe, it may be a sign that the radiator is plugged. A plugged radiator will cause the pressure at the top right side of the radiator to be higher than it should be. As a result, coolant will be coming out the banjo fitting faster than it should, possibly overwhelming the air purge ejector and preventing any purge from the bypass pipe connection.

In either the pre-H.E. or H.E., the air purge system is attached to the radiator at a banjo fitting at the top right. This banjo fitting has a design defect in that the hole through the side of the bolt itself is too close to the head, so it doesn't line up with the annular groove in the fitting properly. This exact same flaw is found in the banjo bolts on the back end of the tappet blocks and is discussed at length beginning on page 44; the same modification should be done here to improve flow, reduce the tendency to get plugged up, and make sure the air purge system works as intended. The banjo fitting on the radiator is longer and has finer threads than those on the tappet blocks, but it is the same diameter.

If you don't want to modify that banjo bolt yourself, Ron Kelnhofer (page 718) offers a replacement banjo bolt of his own design. It is made of brass rather than steel, and it has the cross hole correctly located when used with the included copper washers. You can look at a pic of this bolt at

<http://neptune.spacebears.com/cars/engr/banjorad.html>

While the defective banjo bolts on the oil lines don't seem to cause obvious problems, this one tends to get plugged up and completely shut off the air purge system from the radiator. David M. Johnson says, "After Kirby's info on the banjo bolt being blocked, I took note and disassembled the bolt this weekend. Guess what, the holes in the bolt were blocked with crud. One of my cars was making a disgusting moaning sound for the first minute after start up; the moaning sound (trapped air) is now gone. Thanks Kirby, I would not have found that on my own."

Craig Tims had more serious problems. After having the radiator rodded and the thermostats replaced at the dealer, the car continued to overheat. He eventually found that the new thermostats had no jiggle pins and the banjo fitting was totally plugged. After clearing and modifying the banjo fitting and correcting the thermostats, his temp gauge stays where it should be. While such details may sound minor, Tims' example should illustrate just how important it is to have a working air purge system to keep air out of the coolant circuit.

Using thick sealing washers under the head makes the hole misalignment worse, so Jaguar provides really thin washers that tend to leak. Once the modification to the bolt is done, the thick copper washers commonly found in auto parts stores can be used for better sealing. This banjo fitting requires three seals, and the plug at the top left for venting the radiator when changing coolant requires one more of the same size. If your local auto parts store has a rack of red cards titled "Help!", it probably has a package of sealing washers that are perfect for these fittings: part number 66272, labelled "Brake Hose Bolt Washer". It says they are ID 25/64" and OD 5/8".

Depending on personal preference, you might consider fiber washers instead of copper. This might be especially advantageous on the plug at the top left of the radiator, since you may be opening that one more often and fiber washers can be reused if care is taken while copper washers must be replaced (or annealed) each time to seal properly. 3/8" fiber washers may be difficult to find in an auto parts store even though they carry lots of larger ones for oil drain plugs. Lowe's carries suitable fiber washers in its specialty fasteners section, part number 838050.

LEAK SEALERS: Mike Wilson says, "Here is what my 1990 XJ-S Drivers Handbook (publication number: JJM 18 02 03/00) states on page 176: "Two 135 ml bottles of Jaguar Radiator Leak Sealer or Barrs Leaks *must* also be mixed with fresh anti-freeze".

Folks, this horrible recommendation is probably the single biggest reason Jaguar didn't make it on its own and had to sell out to Ford. Many Jaguar mechanics owe their livelihood to this terrible advice, since a high percentage of their work is traced to this stuff plugging up the bottom half of the radiator and contributing to Jaguar's reputation for overheating problems. Please, do *not* use any leak-sealing substance within the V12 cooling system. If the system leaks, fix it.

To make sure no Barrs Leaks gets in there, you're gonna have to keep the car's cooling system away from Jag dealers. Craig Sawyers reports: "Here's a horrible thing. I bought Jag antifreeze, determined I wasn't going to run the risk of damaging my glitzy re-built V12 with the wrong stuff. Anyway, my dealer casually tossed in a Jaguar box marked "2xJLM 636". "What is this?" say I. "Oh - corrosion inhibitor". That sounds good I think, particularly given the recent thread on water types for radiator use, and electrolytic corrosion. Well, guess what is in the box? Two nicely packed bottles of (unmarked) Barrs Leaks. AAARGH! Will they *never* learn! Needless to say, they are still in the box, and will never even have sight of my rebuilt rad."

If the car is more than a few years old and having overheating problems, it's not a bad idea to just take the radiator to a shop and have it rodded to restore its effectiveness -- especially if you're not the original owner and the previous owner may have been using leak sealers. John Napoli reminds you to clean out "the engine block, heater core and don't forget to remove and flush the expansion tank -- these are commonly forgotten repositories of Barrs Leaks."

OTHER THINGS PLUGGING YOUR RADIATOR: Another major source of particles for plugging the tubes in the radiator is rust scale, which primarily comes from four items in the XJ-S cooling system: the header tank, the cross pipe, and a coolant connecting pipe on top of each head. Replacing some or all of these items with non-steel substitutes would reduce or eliminate this source of crud. See pages 204, 208, and 211.

GURGLE SOUNDS: Paul Burke says, "I had a gurgle which was coming from around the heater matrix. It started fairly quietly and only became audible when the car was stopped. I thought it was probably the air-conditioning system - ha. The sound became loader over time and more apparent under acceleration. The noise turned out to be virtually (well maybe not all, but more than normal) the full pump output going through the right hand bank of the engine, out the back, through the heater matrix, along the hose that runs along the left hand side of the engine, into the small "T" into the bottom hose and back to the pump thereby effectively bypassing the left hand side of the engine and the radiator.

My radiator had become partially blocked...”

FIXING A PLUGGED RADIATOR: Once you come to the realization that your radiator is plugged, there are generally five things you can opt to do about it. The first is to go down to the store and buy some product intended for “flushing” cooling systems and use it according to the directions. A quick survey of owners on the internet indicated that this *never* does any good. Paul Bachman says, “I was told by a good source (must have been good 'cause I can't remember who it was) that since the advent of aluminum engines and aluminum radiators there are no longer any radiator flushing products that do anything useful at all. It seems the chemicals that used to do a fairly good job of cleaning out a brass/copper radiator cause serious corrosion to aluminum. Soo... rather than face complaints (lawsuits?) from people who don't read directions, all such useful products just quietly disappeared from the shelves about 15 years ago. I believe he went on to state that the antifreeze additives that were capable of keeping a brass/copper radiator free from blockage were deleted at about the same time.... thus the reason why most of our radiators are blocked or becoming blocked. From my experience (from before 15 years ago), I have to say that this theory seems to have merit.”

Unfortunately, the next four options all involve removing the radiator. Deal with it.

The second option is to have the radiator “boiled”. This involves dunking the radiator in some kind of vat full of chemicals and cooking it for a while. Again, a survey of owners indicates that this only *rarely* works with the XJ-S radiator, possibly because of the types of junk that typically plug it. Considering how much effort it was to get it out and put it back in, you might want to rethink this option.

The third option is to have the radiator “rodded”. In this case, the radiator shop removes the covers on each end of the radiator and rams a rod through each tube from end to end, cleaning all the accumulated deposits out. He then solders the covers back on and pressure checks the assembly. This usually does the trick, although there have been a few reports when it didn't; it may depend on how skilled your local radiator shop is. Jim Isbell says, “Some shops don't know that to properly clean it *both* tanks have to be removed. If they only do one and you don't see any improvement it just might be because it wasn't cleaned properly.”

Keep in mind that rodding does *not* render your radiator as good as new; the passages are unplugged but not all deposits can be cleaned away, and some parts may be stressed or weakened during the procedure. Sometimes the shop will even report that the radiator is toast and cannot be rodded, and suggest option number four.

The fourth option is to have the radiator “recored”, which means they take the end covers off and solder them onto a new center section entirely. Apparently all brass radiators are made of comparable configuration cores, so the shop will be able to find a suitable core. You need to ensure the new core is at least as good -- and possibly better -- than the original was. Any upgrade generally involves the number of “rows” the core has. There is also a difference in fin spacing, but if given a choice you should probably opt for the bigger fin spacing; the amount of cooling capacity is a secondary concern compared to the likelihood of the fins getting plugged with debris, and it's difficult enough to hose out the radiator on this car.

The fifth option, of course, is to have the radiator replaced. You can opt for an OEM radiator -- but in this author's opinion, you'd be nuts to do so. As long as you're buying a radiator anyway, take the opportunity to convert to a single-pass arrangement as described on page 199.

If you're doing any of this work on your radiator, you should be installing coolant filters to make sure that it doesn't get plugged again -- probably within seconds of starting, as all the crud sitting in your block is promptly flushed into your freshly-cleaned radiator. Also consider the other items on the checklist on page 198.

COOLANT FILTERS: Everybody who has taken their XJ-S radiator to a shop and had it rodded out has been told that it was really plugged up. The Jaguar recommendation to use Barrs Leaks in this system is often blamed, but there are apparently other contributors as well. Rust scale coming off the inside of the header tank and cross pipe is a source of crud. Some mechanics use too much silicone sealant so it leaves a bead around the joint, and later on this bead peels off and starts looking for a passage to plug. And those who replace their coolant often but mix it with hard tap water are introducing a whole new supply of minerals with each change; when the engine heats up, all these minerals deposit on

hot engine parts as a scale, and then break off in chunks and reconvene in the radiator.

Why don't they make a "last chance" filter to install in the upper radiator hose to catch all this junk before it can get into the radiator and plug things up? There are no small passages in the engine, the chunks could just flow right through the block, but catching them before the radiator should greatly extend the time between roddings.

They do. In fact, it's a fairly popular idea among car enthusiasts, so there are several different model coolant filters available. Peter Smith identified one excellent brand: "The manufacturer is

Tefba
122/124 Silverdale road
Silverdale NSW Australia 2752
Phone: 02 4774 2022
Fax: 02 4774 2777

"It consists of a black nylon moulded body which resembles a jam jar approx. 2 inches (50mm) diameter by 2 inches high. It has a screw lid and the inlet and outlet pipes come in at base level such that the side elevation resembles an inverted "T". When you unscrew the lid you look down inside and see a stainless steel filter screen placed across the flow path of the coolant. The filter screen is bent to form a delta shape or arrow head pointing in the direction of the flow. This provides a filter element size effective of approx. 6 square inches. The filter mesh hole size is about twice the size of the tea strainer we have in the kitchen.

"I have installed two of these on my XJC and they look pretty neat. It is easy to check the screens by undoing the screw tops and there is a spigot which is attached to a disc which sits at the bottom of the pot. You use this spigot as a handle which lifts out the disc with the screen sitting on top plus the crap."

The Tefba housing is not transparent, so you can't inspect the element for accumulated crud without opening the top. However, by installing the Tefba filters in the highest horizontal portion of each upper radiator hose, owners have found that they can check the screens without draining any coolant first -- and so are able to check them regularly. The fact that the element is huge means it's not that important to check them very often anyway.

In the US, you can get Tefba filters from Fasterjags (page 716).

There have been at least three significant issues discovered with the Tefba filters. The first is that the element didn't come all the way up to the cap; when the cap was screwed on tight, there was a gap between the top of the screen and the bottom of the cap. Debris -- especially debris that floats -- could thus circumvent the screen and enter your radiator.

Ashcroft found an easy fix for the Tefba elements being too short: "the element does end about 3/16" below the cap, but the disc is about 5/16" below the in/outlet. I just put a 3/16" thick O-ring under the disc, raises the screen to the cap." Chip Wikan adds, "a trip to the local Advance Auto Parts found an O-ring, part # 64630.1, dimensions 30mm x 36mm x 3mm which elevates the "grudge" tray perfectly flush with the top of the filter."

This author went a bit farther and fashioned a thin strip of stainless steel sheet metal into a wavy shape and set it in the bottom of the housing before dropping in the tray with the screen on it. This bit acts as a spring that holds the element against the cap. One must be careful to shape the sheet metal so no edges dig into the plastic.

The second issue is that the screen is clearly shown to be formed into a V shape in the exploded view diagrams, but the one actually delivered in the filter is merely warped into a U shape. In operation, this U shape can be blown up against the outlet side of the housing. Ken Gray reports: "I decided to check mine after doing the equivalent of 6 or so Italian tuneups (testing the newly installed Crane system). I found a distinct dish in the filter elements exactly the same shape as the exit hole."

If this happens, the effective screen area is reduced from the entire screen down to just the portion covering the outlet itself -- and if there's any debris in there to speak of, flow is nearly entirely cut off, perhaps quite suddenly. This is bad. It is therefore imperative that all Tefba users carefully fold their screens into a crisp V shape as shown in the diagrams, which will prevent any such disasters.

The third issue is that the screen doesn't sit properly against the bottom of the tray, which can allow crud to slip under the screen and into the radiator. This problem may be made worse by folding the screen into the crisp V shape. The

recommended fix is to carefully cut notches in the edge of the plastic tray until the screen sits against the bottom as it should.

Despite these issues, the Tefba filter has proven to be the item of choice. All three problems are easily rectified once you know about them, and since you are reading this book, you know about them.

One other nice thing about Tefba filters: somebody out there must be listening, because many of the problems seem to be getting fixed. The later models reportedly come from the manufacturer with a stainless steel spring attached to the bottom of the tray to hold the screen up against the lid. And Richard Francis reports that the screen has been fixed, too: "Today's Tefba's are delivered with a stronger screen...shaped like a baseball field backstop...very difficult to bend and smaller holes."

The only remaining complaint about the Tefbas is that the cap sometimes becomes really difficult to get loose, which some owners blame on the lack of lubricity of long-life coolant. Applying a little water pump lubricant or some such to the threads might help some, but you might also consider this when installing and arrange the filter such that you can get a big pair of pliers or an oil filter wrench onto the cap. And, of course, don't overtighten the caps; Don Buresh suggests it's like installing an oil filter, "go 1/4 turn past seated and no more, otherwise it will be a real bear to get off." Dave Harvey says, "I apply Teflon grease to the threads and gasket surface, the same stuff plumbers use on gas fittings. This makes tightening and loosening the lids a much easier task. And I use a strap wrench. My strap wrench was originally intended for removing the oil filter on my (long gone) Ford Courier pickup. It works very well in a confined space since it has a 3/8" socket drive."

The Tefbas are so popular with XJ-S owners that can I even forward suggestions on what upper radiator hoses to buy. Al Askevold says, "I found two preformed hoses that can be used. On the right side I used a hose from Napa p/n 8303 from the t-stat housing to the filter, and a short piece of 1-1/4" hose on the other end. The 8303 Napa hose was used for clearance around my cold air intake mod, but should work for the OEM setup too.

"The OEM hose that I cut to fit for the b-bank is not the way to go! After clamping everything together both inside corners on the oem hose were bent just enough to cause a restriction, not much but not a good thing for the b-bank. So back to Napa, this time I came up with a Napa hose p/n 7737."

Brian Schultetus found another source of coolant filters:

Gano Filter Company
1205 Sandalwood Lane
Los Altos, California 94024
+1 (650) 968-7017

This company makes a filter that is essentially a conical screen in a tube. The basic model is a clear plastic tube so you can see the filter getting crudded up and know when to take it out and clean it, but some people don't like plastic so they offer a brass tube model as well. They also claim that the screen is made of the same copper alloy as the radiator itself, so it also serves as a monitor for corrosion. And they point out that merely having the clear tube can provide considerable information on what is going on in the cooling system; you can watch the little "window" while the engine is running.

The filter comes in three sizes, and of course they expect most customers to buy one per car. The V12 has two upper radiator hoses, though, so you will need two filters. The hoses are 1-1/4" ID, which corresponds to Gano's "small" size filter.

If you're worried about flow rates through those screens, Damrel suggests using the next size up Gano filter, the "medium" size filter. "I made up a couple of custom hoses and put the old hose over the radiator and thermostat housing nipples to make up the difference." This author uses the small Gano filters with no problem, but it certainly couldn't hurt to be using the next larger size.

Gano filters do a great job of keeping the radiator clean, but because the element is much smaller than the one in the Tefba they must be cleaned out periodically to keep from becoming obstructions themselves. Removal, cleaning, and reinstallation is a snap, except that it requires draining about one gallon of coolant and replacing it afterward. If you have the later XJ-S with no radiator drain, this could prove a pain. So, if you have the radiator out to be rodded (!) it's

suggested you have a drain port added. Another option might be to install a fitting in the lower radiator hose to facilitate easier draining. An even better idea might be to tee into the heater hose at the bottom left corner of the radiator, install a short hose out the bottom of the car and put a plug in the end.

Even if you have an earlier car with a drain valve, periodic cleaning could prove messy and wasteful of coolant. Hence, the idea presented in the section starting on page 195 of providing a fitting with a piece of hose with a plug at the end is recommended. This makes it very convenient to just drain a gallon into a clean jug, service the Gano filters, then put the gallon right back in.

Tony Glavovich points out that the clear Gano filters can be helpful in diagnosis: "If you have Gano filters, you might just tie some white string to the screen filter, then you can monitor when the stats are opening. That is how I discovered my problem. I was also able to see a difference in flow between the two sides by observing the string. The string thing is something that I would suggest to anyone with Gano see-through filters."

There are yet other sources of coolant filters. John Goodman says, "I noticed on the AC Delco website they have screw-on coolant filters (like oil filters). Paper filter with mesh so if they do clog up the paper busts leaving the slightly coarser mesh to still catch the big bits..."

There's another product made in Australia by:

Coolfilter Australia
151 Bushmead Road
Hazelmere WA 6055

Unfortunately, one customer had problems with the Coolfilter product. "It consists of a conical plastic material which has a series of steps. The idea is you cut it off at the appropriate shoulder to suit the ID of your hose. I fitted new hoses and there was no appropriate shoulder; one shoulder was too big and caused the filter to buckle and the next shoulder too small. The step sizes go from 1.1" to 1.3". The new hoses I have are 1.2" ID. The Coolfilter is very flimsy and cannot push the hose out to accommodate the 1.3" step and of course the 1.1" step is too loose.

"Also, I believe the holes are too large (tea leaves would go straight thru), it would only filter out large particles. The Coolfilter has slots which are 13mm long by 1.5mm wide tapering down to 1mm. The slots are in between each size step and running lengthwise. I have run the vehicle with the Coolfilters installed (as best as achievable) for about 50 kilometers and they have captured no crap at all. Either I have a clean system or they pass the crap thru the slots and gaps created by the buckling of the OD."

Tom Bennett says, "Make your own filters! I bought a couple of very fine mesh SS tea strainers, a little bit of cutting and shaping, ended up with 2 "chili" shaped strainers that fit into the top inlets of the rad. Work great! I open them up about once every 3 months, although the crud is getting less. First time I looked, there was about a teaspoonful of crap in each!"

You can look at some coolant filter installation photos at

<http://www.jag-lovers.org/xj-s/book/CoolantFilters.html>

One easy mistake to make is to service the radiator now and worry about installing coolant filters later. If you're having your radiator rodded or replaced, you should go ahead and put in coolant filters *now* to protect it from the junk that's still sitting in your engine waiting to get at it! Don't wait until after you reinstall the radiator and run the engine -- in the first five minutes of running, a whole pile of crud will get pumped into your nice clean radiator. Much of the crud in the cooling system is heavier than coolant, and so sits in low spots within the engine and won't move unless the flow is really high -- but your radiator is plugged, so the flow is *never* high enough to move it. Then you clean the radiator, and the first time the thermostats open there's more coolant flow through the system than it's seen in years! It stirs up all the crud laying around and pumps it right into the radiator.

Bob Gallivan: "I bought these some months ago & finally got around to putting them in & already I can see what looks like a gray crud through the filter. I'm sure that the *new rad* at this very moment is harboring this crap that has migrated there before I installed the filters."

Richard Damrel: "Had my radiator rodded out in May of this year, now it seems to need it again according to my

mechanic. The radiator shop says it's not uncommon for a massive build-up of scale or corrosion to be transferred from the block to the radiator. Seems to me that it should be much easier to change a few filters every now and then rather than pull the radiator twice a year."

Douglas Dahl: "I had to have my radiator rodded right after I got the car (about 6,000 miles ago). This last week, it was pulled again. No Barr's leak is allowed within 50 yards of the beast and I put the Gano filters on this time. I just ran it for less than five minutes and both filters seem to be completely clogged. Tomorrow, after it cools, I will clean them out and see how long it takes to clog them again, and so it will go until they need no further cleaning."

Chris Reed reports, "Several times since I had my radiator rodded and fitted TEFBAS, I have never found any debris in the filters. I cleaned my filters today (after a 400Km spirited run) and they were 75-80% covered in debris. I won't say 'blocked' as there was obviously water flow but the filter had a circle of particles the diameter of the hose, and I'll swear on a stack of bibles it was SAND! So regardless of how many times you check the filters and find them clean *do not* discard them - the crap I had in mine would not have been good news for the radiator!"

David Hodges says, "Rebuilt engine myself, *spotless* inside, hot tanked, etc. Reconditioned radiator, all new hoses etc. Flushed heater and crossover pipe, also header tank. Fitted Tefba's and still found crud within a week. After engine was carefully 'run in' and filters stopped showing crud, after the first real run down the track and the engine cooled there was more crud in the filters. I honestly do not know where it came from but can only assume the heat loosens scale or whatever from places mere humans cannot reach. I personally would not run without them."

A couple of owners have expressed concern that they will never be able to drive their cars for more than a few miles without having to clean coolant filters. When first installed, it's a good idea to check them *within the first five minutes* after the thermostats open, and continue to check them in relatively brief intervals until they look like they're willing to remain unplugged for a while. Rest assured, sooner or later you will get most of the crud out of the system and they will run clean for months at a time.

HEATER HOSE FILTER: Gano (see above) also offers a small filter assembly for installation in the line to the heater core, pointing out that the same crud that plugs radiators can also plug heater cores. Your immediate reaction might be "Who cares? If the heater core gets plugged, it doesn't damage the engine." However, you might want to rethink that reaction. The heater core getting plugged might not damage the engine, but it'd still be no picnic to fix.

Unfortunately, the Gano heater hose filter assembly is only available in brass -- no clear plastic version offered -- and therefore must be disassembled to check for pluggage.

On the plus side, you don't need to get this item from Gano; it's available in any hardware store! All it requires is a pair of fittings for a 5/8" garden hose, and one of those hose washers with the built-in conical screen intended for supply hoses for washing machines and dishwashers.

Garden hose fittings generally come in three flavors: The plastic junk, the slightly better "corroged" brass (made of brass sheet metal formed to shape), and high-quality fittings machined from solid brass. Besides being considerably more durable, the solid machined brass items also typically have flats around both male and female fittings, making it much easier to tighten and loosen. This being the US, most consumers are morons who buy the cheapest junk available and most retailers are also morons who cater to this stupidity rather than making the slightest effort towards educating their customers on why a better product is the wiser buy. So, the solid machined brass items can be a little hard to find.

Home Depot carries an excellent set. Made by Nelson, item N-1558 B, "5/8" Brass Hose Repair -- Extra Heavy Duty Rod Brass" contains a male fitting, a female fitting, two SS worm screw hose clamps, and one rubber washer -- in other words, everything you need except that you'll need to pitch the simple washer and install a screened washer instead. This set costs about \$5, and the screened washers are perhaps 3 for \$1. With a little shopping you can actually find screened washers in two or three different screen grid sizes; the ones with the biggest holes are suggested -- the fine ones are *really* fine. After screwing the two fittings together with this screened washer in the middle, just cut the heater hose between the engine and the heater valve and install this assembly with the clamps.

Wal-Mart also sells the top quality machined brass items, believe it or not. They offer the male and female fittings separately.

Despite the temptation to use big wrenches on the flats on the machined brass fittings, be careful not to overtighten. It's not too difficult to cut right through the rubber outer circumference of the screened washer. After all, the washer was designed for the fittings to be hand-tightened, so it's really soft rubber.

Cleaning this filter is easy, since you can easily install the fittings at the *very* highest point in the system and not even have to do any draining. Just unscrew the two hose fittings from each other, clean out the screened washer, and reassemble. In actual practice it often proves easier to loosen the hose clamps and remove the entire assembly for cleaning than to just unscrew the halves in place.

Will the screen in the line reduce flow to the heater core? Perhaps. Here in FL, we couldn't care less; any flow at all is enough, and most of the time we'd rather have *less* flow. But you guys who live in the less habitable climates might be concerned about installing this screen. I have this suggestion: Install the screen assembly, and then when winter approaches unscrew the fittings and replace the screened washer with a normal hose washer. That way, you get filtration in the summer, full flow in the winter. With any luck at all, the filtration in the summer will take enough of the crud out of the system that there won't be any pluggage during the winter.

Such a screen installed in the heater line might actually save your radiator! Since this essentially becomes a "bypass filter" arrangement, eventually this tiny screen should remove most of the crud circulating around the closed coolant circuit. The only problem will be the crud that jams tubes in the radiator before ever going through the heater hose, but if you're concerned you should be buying the radiator hose filters described above. The other shortcoming is that, since this screen is so small, it's likely you'll have to clean it out a lot of times right after installing it until you get the system pretty well cleared up.

RADIATOR DRAIN: Up until somewhere around 1988, the XJ-S was fitted with one of the most obnoxiously overdesigned radiator drain cocks in automotive history: a metal drain valve at the bottom right corner of the radiator, operated by a lever that extended up to just below the upper hose fitting. Evidently, the image of luxury is supposed to include being able to drain your coolant while standing erect beside the car in a tuxedo. For all this effort and expense, Jaguar couldn't bring themselves to provide an outlet out the bottom of the car, so opening the drain valve causes coolant to pour all over the structures in the area and dribble out wherever the catch pan isn't. The end of the valve is a spherical shape with a funny flange, making it rather difficult to attach a hose, but it's possible with enough determination.

Before you get too involved with that drain cock, let me provide a description of what you're getting into. The drain cock itself is a solid brass tapered plug valve that turns 90° from full open to full shut. There is a spring on the bottom that "loads" the tapered plug to keep it sealed; the seal is brass-to-brass, there are no elastomers inside the valve. There is also a little diamond-shaped washer that fits on a shoulder with two flats that limits motion to 90 degrees. This valve is probably repairable from most of its typical failure modes, which is an option you may want to keep open; read on before doing anything irreversible.

Unscrewing the valve from the radiator may be the first irreversible thing you do. It is not a tapered thread; it is sealed by a fiber washer. But when tightening down, the valve *must* end up oriented properly to align with the remote handle. To accomplish this interesting feat, Jaguar appears to have used two tactics: First, the fiber washer may in fact be two or more fiber washers, indicating the assembler may have added washers as required to get the proper alignment. Second, the fiber washers are thick and compressible, so there is some considerable range of tightness that will ensure a seal; the assembler can tighten until it lines up, and leave it. If you take it out, what do you suppose are the odds that it will line up properly *and* seal reliably when you reinstall it? Fortunately, the size washer needed is the same as those used on many oil drain plugs, so you should be able to obtain a good supply of fiber washers of various thicknesses from local auto supply houses.

If you decide to go ahead and unscrew it, here's a tip: the hex size is 19/32", but if you don't have a wrench that size a 15mm makes a good fit. It may be helpful to unbolt the fan shroud and back it away from the radiator a bit to permit use of an open-end wrench, since even a crowfoot won't work well in this space.

Before you reinstall the drain cock, here's another tip: The hole in the end of the valve is 5/16" to a depth of about a quarter inch, and then 1/4" the rest of the way through the valve. With a propane torch, it is a fairly simple matter to

solder a short length of 5/16" OD brass tubing into the end of the valve to provide something to attach a hose to. The hose can then be routed out the bottom of the car, making draining the coolant a lot neater and easier to collect and dispose of properly. Since there are no nonmetallic parts inside the valve, you don't even need to take it apart to solder on it, but you almost might as well -- it's only one cotter pin. Something to keep in mind: the radiator moves around a little on its rubber mounts, the oil lines move around a little with the engine moving on its rubber mounts, and the front subframe moves a bit on its rubber mounts. Make sure there is adequate clearance around the valve and attachments so they aren't subject to impacts or rubbing due to these various motions.

Let's say your radiator drain valve is toast and you have decided to replace it. Ed Sowell ordered one from Jaguar: "Problem is, it is not the same as the original, even though the part number is correct. Apparently Jaguar found a new source. The valve is different in several ways. In fact, the only similarity is that it is a 1/4" BSNB thread, about the same length. The plug is held with a nut rather than a spring and cotter pin. The important differences are:

- The diameter of the bore is 3/16", whereas the original is 5/16". Slower drain time, but would work. Also, with the original I can jamb a 5/16" plastic hose barb fitting into the outlet to allow coolant recovery (as opposed to washing down the front suspension and splashing on the floor). With the 3/16" bore, it appears impossible to attach a hose.
- There is a handle instead of the tongue on the stem. Consequently, the extension for above-car operation of the valve cannot be attached. Very bad. You have to get under the car to operate it, and there appears to be no way to avoid being drenched when you open it! Could be used, but nobody would want to. Might as well just slash the lower hose!
- Due to the height and length of the handle, it can not be installed in the radiator while it is in the car. No matter which way I set the handle, it bumps into something, e.g., the sub frame, or the oil cooler line. It might work if it was screwed in before dropping the radiator into the car.

"I find it hard to believe Jaguar would say this was a replacement for the original. They must be blind."

So, now you're in the market for something non-Jaguar to fit that hole. Go ahead and measure the threads; they are 13.16 mm OD and 19 threads/inch. As mentioned above, it is not a tapered pipe thread; it's a washer-sealed installation like an oil pan drain plug. Tony Bryant in NZ says this drain fitting is "1/4" BSP (British Standard Pipe). Very common in this part of the world. Cost me less than \$1 for a brass plug. Any competent hydraulic fitting supplier should be able to find one, or at least a thread adaptor. BSP is extremely common here, but NPT is a lot more difficult, but still possible." Well, here in the Bubba Belt in the good ol' USA, my local hydraulic fitting shop calls it BSPP (British Standard Pipe - Parallel, as opposed to a tapered version) and charged over \$5 for a fitting for connection to a 1/4" hose -- and only had that one type of fitting on hand to choose from. The hole through the middle is only about 1/8", so it would drain very slowly indeed; this fitting was clearly designed for hydraulics, not radiator drains.

The closest thing you're likely to find in auto parts stores in the US is a 1/4" NPT (tapered), but it will *not* fit properly -- it's 18 TPI.

Bryant also suggests that the coolant drain plug on the block (note: not the one on the radiator) of many Japanese cars is BSP, although the tapered version. Still, the tapered plug may be usable to plug the parallel fitting on the XJ-S radiator.

Another option: find a way to use the original valve as a plug. It's solid brass and very meaty (weighs about five pounds, I think) so it should be easy to work with. One possibility is to cut the valve portion off, just leaving the hex and threads, so it looks like a plug except it has a 1/4" hole through the middle. So, you can put a stainless steel or brass bolt through the middle and tighten a nut down on the other end, and use the assembly as a conventional plug -- just remove the whole thing when you want to drain the coolant. If you wanna get fancier, you can tap the hole in the center for a threaded plug instead of using a bolt.

Of course, using a simple threaded plug as a radiator drain is messy. For neater work, you can solder a piece of brass tubing into the hole in the plug, connect a piece of hose to it, route the hose out the bottom of the car, and plug the end of the hose with something. Then when you want to drain the coolant, you don't even need to open the hood -- just reach underneath and remove the plug from the end of the hose. You can stick with the 1/4" hole in the plug, but it might be a better idea to enlarge the hole to 5/16" and use larger tubing and hose; it'll drain quicker and larger chunks of crud can pass through.

A similar idea might be to drill and tap the hex portion and screw in a common fitting. It's too small to fit a 1/4" NPT fitting, but a 1/8" NPT will fit nicely. One might think that draining through a 1/8" NPT fitting would take forever, but believe it or not you can find fittings with 1/8" NPT on the outside and a clear hole through the middle that's larger than 1/4"! One such fitting is made by Brass-Tite!, part number 43275, and has a 1/8" male NPT on one end and a 3/8" hose fitting on the other; it is perfect for this task.

Yet another option would be to make the piece of the original valve into an adapter to fit a standard drain cock. This would involve drilling and tapping for the threads of whatever drain cock you buy. Most of the universal ones seem to fit a 1/4" NPT, but you'll need to choose a smaller drain cock with a 1/8" NPT. You also need to choose your drain cock carefully, since many of them have a moving plug at the inner end that would require more space inside the hole than you'll be able to provide within that chunk of the original valve.

If you have the radiator out, you can get more radical: toss the original drain cock in the trash and drill out the threads in the boss on the radiator and retap it for something readily available. The fitting on the radiator appears to be pretty meaty, so it could be drilled and tapped for something considerably larger than the stock drain cock.

WHAT RADIATOR DRAIN? Somewhere around 1988 -- possibly coinciding with the introduction of long-life phosphate-free coolant -- Jaguar went from the overdesigned drain cock to no drain cock at all. On later cars, it is necessary to disconnect the lower radiator hose to drain the coolant. Wearing a tux is not recommended. In fact, this author once suggested to an owner that he do this task *au naturel*, and just jump in the shower afterwards.

Joe Montgomery suggests another way to get most of the coolant out of later cars: "Having seen at the local shop the way coolant goes everywhere when the bottom radiator hose is pulled and since the storm drain that would collect it is a straight shoot to the bay, I found a better way. I got about 2 feet of 1/4" copper tube and 4 feet of plastic tube that would fit over the end from Home Depot. By inserting the copper tube through the bleed hole on the right hand side of the radiator I was able to syphon better than 3 1/2 gallons into a bucket for recycling."

Another suggestion: if you can locate a suitable tee, you can cut the bottom radiator hose and install the tee with two hose clamps and use the tee to drain the coolant. There is a similar tee used for adding a coolant heater in subfreezing climates; perhaps that tee could be used.

Something to note: the lower radiator hose does not connect to the bottom of the radiator in an XJ-S. It's perhaps four inches from the bottom at the left side. So, if the only way to drain and flush the coolant is by disconnecting this hose, you will *never* get the junk outta the bottom four inches of the radiator! And the connection is on the downstream side; anything larger than the tiny passages in the radiator core will pile up on the upstream side indefinitely. Hence, if you have the radiator out for service, you might consider having a drain fitting added at the bottom right corner.

RADIATOR REMOVAL: Both the official Jaguar manual and the Haynes manual state that removing the radiator requires discharging the air conditioner freon circuit. They lie. In fact, as Jim Isbell reports, "In the Haynes manual there are 21 steps under section #21 that describe the removal. Steps 1, 3, 5, 9, 10, and 11 are all unnecessary." Most are merely extra work, but discharging the freon is a waste of serious money.

Both manuals also provide the same illustration which shows the radiator sitting on top of the oil cooler. This may be the case for cars that weren't equipped with air conditioning, but for the rest of us the oil cooler is in front of the radiator, and the A/C condenser is on top of it.

Forget the manuals and just dive in. The radiator comes out vertically upward, leaving the A/C condenser and oil cooler in place. Drain the coolant and disconnect the hoses, remove the air purge system tubing from the top of the rail over the radiator, unbolt the A/C dryer from the rail and leave it hanging, unbolt the fan shroud, and remove the rail. Either remove the hood, or simply remove the grille, disconnect the struts, and tilt it forward until it rests on the bumper. Disconnect the hoses from the transmission cooler and the wire from the coolant level sensor (early models only) and whatever other little things are hanging on, and pull the radiator out straight up.

Now, if you have an early model such as Bernard Embden's '78, things are a bit more difficult. "The radiator has two

brackets welded to the bottom. The oil cooler is bolted to these brackets. To remove the radiator the oil cooler lines must be disconnected and the radiator and oil cooler removed as one unit. Once removed, the oil cooler can be unbolted from the radiator brackets.”

Embsen recommends changing things while you’re in there. “Why does the damn oil cooler have to be bolted to the radiator? After removing the radiator I decided I was not going thru this again. I went over to the radiator and sawed off the two tits (sorry, "oil mounting brackets") that the oil cooler bolts to. Now properly motivated, I fabbed two brackets out of 1/2 inch wide, 1/8 thick flat iron available at any hardware store. I offset the brackets (wider). Made two 1-1/4 inch straps. Bolted one end to the oil cooler mounting bracket, the other to the brackets that I fabbed up. This was so the brackets would fit below the still existing part of the bracket that remains on the bottom of the radiator. (I was concerned about clearance). Two bolts per side, drilled the holes thru the boxed lower radiator support. Brackets had to be angled slightly (hammer took care of that). Now the oil cooler and A/C condenser sit where they should be with the radiator *out*.”

RADIATOR WORK CHECKLIST: If you have to pull the radiator out for any reason, you should take advantage of the opportunity to do *all* of the following:

- 1) Rod, recore, or replace the radiator.
 - 1a) Consider converting to a single-pass system; see below.
 - 1b) If the coolant level sensor is located in the radiator, have the radiator shop plug the hole and relocate the sensor to the header tank -- see page 207.
- 2) Clean fins of A/C condenser and oil cooler.
- 3) Consider revision of radiator drain scheme -- see page 195.
- 4) Revise air bleed banjo fitting -- see page 187.
- 5) Install foam in all undesirable air paths -- see page 226.
- 6) Install coolant filters -- see page 190.

You might also consider the opportunity to replace the front oil seal on the engine or to check that the bolt holding the crank damper on is properly torqued (page 90).

IMPROVING THE ONE-AND-A-HALF-PASS RADIATOR SCHEME: As mentioned in the cooling system description beginning on page 173, the OEM radiator in the XJ-S will result in the left bank running warmer than the right. If you’d like both banks running at the same temperature, it will be necessary to revise the system so that both thermostat outlets see the same backpressure. Perhaps the simplest and most straightforward method to accomplish this would be to increase the backpressure on the right side thermostat outlet. Performance outfits like Summit Racing (page 720) offer flow restrictors for cooling systems, but their intentions are different and the parts may be difficult to adapt to the Jaguar V12. Perhaps the better tactic would be to simply adopt the idea, and provide a simple orifice in the upper right radiator hose or radiator inlet. We have no idea what size the orifice should be, unfortunately; if someone wants to take the effort to install pressure taps and experiment, the orifice should be just the right size that the pressure at both thermostat outlets is exactly the same -- but even with that criteria, the desired orifice size may vary with radiator condition and possibly even engine RPM.

This author installed a 1/2” stainless steel washer in the right side radiator hose as an orifice. The OD of a standard 1/2” flat washer proved to be exactly the same as the OD of a 1-1/4” Gano filter (see page 190), so a couple of tiny holes were drilled in the edge of the washer and it was screwed to the inlet end of the Gano filter with the existing screws that hold the Gano filter together. The ID of the 1/2” washer is 14mm. The car ran fine and stayed cool, as evidenced by the gauge sender in the right side thermostat housing; thus we can conclude that a 14mm orifice is large enough, although we really cannot decide if it is small enough without measuring the effect on the left bank temperature.

Note that the installation of such an orifice doesn't merely make the cooling of the right bank as bad as the left. It actually improves the cooling of the left bank. It accomplishes this by increasing the pressure loss in the right bank, which reduces the pressure in the right side end tank on the radiator. Since the flow through the upper 1/3 of the radiator is a function of the pressure difference between the left side inlet and the right side end tank, lowering the pressure in the right side end tank will increase the flow in the upper 1/3 of the radiator -- and hence in the left bank.

ELIMINATING THE ONE-AND-A-HALF-PASS RADIATOR SCHEME -- HOME VERSION: The optimum fix for the XJ-S cooling system would be to eliminate the one-and-a-half-pass scheme altogether and plumb this cooling system the way Jaguar should have in the first place. If you're handy with a propane torch or have a radiator shop willing to do some fiddling, you may be able to modify the OEM radiator to make it a single-pass. You will need to remove and cap the upper left inlet, and install a second inlet on the right side header tank just under the existing inlet. Remove and throw out that hokey radiator drain lever if your car has it (see page 195 for ideas on the radiator drain). Also, you need to make the left end of the radiator into a single tank the full height of the core. The radiator on this author's car has a single left end tank with a partition hidden inside, so you can remove the tank, remove the partition dividing the upper 1/3 from the lower 2/3, and reinstall the tank. Other owners have reported their radiators have two distinct tanks, an upper 1/3 and a lower 2/3. This latter type would obviously require more effort to convert into a single left side tank, such as perhaps adding a pipe between the two. Once you've got the radiator converted to a single-pass, see the plumbing issues below.

A testimonial from Joe Bialy: "With two electric fans and the original two pass scheme, the fans would run for a long time after shutdown. Sometimes cycling on and off a few times too. With my one pass scheme, only one fan runs for a minute or two after shutdown, never cycling on and off afterwards. This car absolutely runs cool as can be now, far and away the best it's ever been.

"Yank the radiator, slice out the baffle, solder it back up, buy a couple of 1" copper fittings and two radiator hoses, put it all back together and forget about it. This will be your best weekend investment under the hood ever and it'll only set you back \$50 or so."

Alternatively, you can convert to a single-pass system without modifying the radiator at all -- or even removing it from the car! Rather than removing the partition in the left tank, simply install a tee in the lower radiator hose and route a hose from the left inlet (which will now be a secondary outlet) down to it. Tee the two thermostat outlets together and feed them into the single 1-1/4" inlet on the right side; this inlet has been proven large enough to handle all the flow.

ELIMINATING THE ONE-AND-A-HALF-PASS SCHEME -- AFTERMARKET VERSION: The simplest way to fix the OEM cooling scheme would be to replace the one-and-a-half-pass radiator with a suitable single-pass radiator from some other application. It just so happens that one application springs to mind: the Jaguars that are converted to Chevy power. Chevy engines have only one thermostat outlet, so it makes no sense to try to use that one-and-a-half pass radiator with it. Besides, that would result in the Chevy overheating as readily as the V12 did! So, as one might expect, the outfits that offer Chevy conversion kits are a good place to go looking for a bolt-in single-pass radiator for the XJ-S. John's Cars (page 717) offers two such radiators, one intended for use with a small-block Chevy and a "super-duty" intended for use with a big block Chevy. Either one has plenty of capacity for a Jaguar V12. Both are quite reasonably priced -- meaning they are considerably cheaper than a new Jaguar radiator. John's Cars uses exactly the same radiators for either the XJ-S or the Series I/II/III XJ6/12 saloons, all years, indicating that the profusion of part numbers in the Jaguar parts books all involve minor detail distinctions.

Note that John's Cars may also offer radiators -- both regular and "super-duty" -- intended to be used with the Jaguar V12 engine, meaning they have the same 1-1/2-pass arrangement as the OEM radiator. You do *not* want one of these. Make it very clear that you want a radiator intended for use with a Chevy engine.

Another application also comes to mind: the Jaguars with 6-cyl engines. The 6-cyl Jaguars, whether they be XK, AJ6, or AJ16 engines, all use single-pass radiators. The radiator from a 6-cyl XJ-S is one obvious possibility, while a radiator from a pre-1988 XJ6 should also fit.

The only question mark is whether or not the 6-cyl radiator has enough capacity to keep a V12 cool -- and that's a serious question mark. The 6-cyl engines are a bit smaller and a bit less powerful than the V12, so in theory Jaguar could get by making their radiators with fewer rows or fewer fins or whatever. On the other hand, perhaps Jaguar just used the same cores for both type radiators and the only differences are in the end tanks and hose connections. Only someone who had both radiators in hand could tell whether the 6-cyl rad is lighter duty or whether it has comparable capacity to the V12 rad, and so far I have not gotten any reports.

Another idea would be to buy (or make) a single-pass radiator designed specifically for use in the V12 Jaguar XJ-S/XJ12. Chad Bolles and Bradley Smith have both blazed this trail, and their costs for a custom-made aluminum single-pass radiator actually compare favorably with buying a new OEM radiator from Jaguar!

Bolles and Smith had to discuss the radiator design at length with the people building it for them -- but you don't have to! Be Cool now offers aluminum radiators to fit the XJ-S; they are still "custom" in that they are designed specifically for the XJ-S and they are not actually made until you order one, but they already have the design on record -- you just order the part number of the radiator you need. Be Cool actually offers four part numbers, all of which end in 082 which is apparently Be Cool's indication that it fits an XJ-S. 62082 is the radiator that most XJ-S owners will need; it is a bare aluminum radiator for an XJ-S with an automatic transmission. 63082 is the same radiator, except that the aluminum is polished (Be Cool caters to the show car crowd, so all of their radiators are available with a polished finish). 60082 is a radiator for a manual transmission car, lacking the transmission cooler and therefore a few bucks cheaper. 61082 is the manual transmission radiator in polished form. All of these are single-pass radiators with a single large inlet at the top right, since Be Cool would have nothing to do with that silly one-and-a-half-pass idea.

I know what you're thinking: "The Jaguar parts books indicate that many different radiators were used over the years. Which one does the Be Cool radiator replace?" The answer: all of them. To illustrate, the following are the differences in the Jaguar OEM radiators:

- The very early cars had the oil cooler supported by the radiator. However, this is a really horrible arrangement to work on, and most owners who get in there find a way to convert the oil cooler mounting scheme to be more like the later cars; see page 197.
- The low coolant sensor was installed in the right front corner of the radiator up until sometime in the mid-80's, then was relocated to the header tank. Regardless of where yours presently is, it would be a good idea to relocate it to the header tank; see page 207.
- Up until the mid-80's, the transmission cooler had barbs protruding from the back side of the right header tank and the lines from the transmission were connected by sliding the hoses over the barbs and clamping. Later cars had threaded holes, and pipe thread fittings on the ends of the transmission lines were screwed in. The Be Cool radiators for automatic transmission cars come with threaded holes, which allows the owner of an older car with hoses and clamps two options: he can screw standard fittings into the holes and connect up the hoses with clamps, or he can replace his lines with the later lines with threaded fittings at the ends.
- Sometime in the late 80's, Jaguar eliminated the hokey drain cock and provided no drain at all! Be Cool took an interesting approach here; they provide a drain scheme based on the early radiators, complete with the cute little lever -- but they also provide a rationally-designed drain on the left end of the radiator.

It's probably possible to fit the Be Cool radiator to an XJ12, but that hasn't been confirmed.

Finally, note that there were apparently radiators with either three-, four- or five-row cores, and owners get very concerned about how many rows they end up with when recoring or replacing a radiator. Well, the Be Cool radiator is two-row -- but that only illustrates the shortcomings of this method of specifying a radiator. With brass radiators, each tube is perhaps a half inch wide by 1/8" thick, so a core that is two inches deep can fit four rows. However, Be Cool uses tubes that are a full inch wide and also a bit thicker than 1/8", so two rows provides at least as much surface area as four rows of the tiny brass tubes. Also, the brass tubes are so tiny and flat that you'd be lucky to fit a fingernail file into one, but the aluminum tubes have much larger passages so they are far more difficult to plug up.

Be Cool guarantees a 20-40° temperature drop over 4-5 row brass radiators. Just how you'd ever make such an evaluation is uncertain, but at least they appear willing to stand behind their product. By their estimation, this radiator

should be good for up to 600 cubic inches and 1000 hp.

As of this writing, Be Cool reportedly does not offer any help in connecting the two 1-1/4" thermostat outlets into a single radiator inlet; apparently you are on your own there, although it wouldn't be a great surprise if they start making a suitable accessory. See below for ideas on making a tee.

Be Cool's web site is at <http://www.becool.com>. Their products can be ordered through Summit Racing, page 720.

A few other comments about aluminum radiators: Aluminum conducts heat better than brass, although the walls of the aluminum tubes are thicker than the walls of brass tubes which negates some of that advantage. Brass radiators are soldered together, though, and solder doesn't conduct heat well at all. Aluminum radiators are welded together, so they are all-aluminum (the mass-production aluminum radiators on some cars have plastic end tanks, but that's not important here).

Some people also value the fact that an aluminum radiator weighs less than a brass radiator, but to make a fair comparison one would have to consider the volume of coolant inside as well as the weight of all the attachments and fittings involved; for most of us, this concern is not foremost in our minds at this point anyway.

Finally, note that an aluminum radiator apparently cannot be rodded or recored, so if you don't keep your cooling system clear of obstructions the next cleanout will involve replacing the radiator *again*.

The author will take this opportunity to express an opinion: it may not be worthwhile to run right out and purchase a single-pass radiator to replace a good condition OEM radiator, but if the original radiator is done for, anyone paying Jaguar prices for a new OEM radiator when new single-pass radiators are available for the same money or less ought to have his head examined. The annual sales of new OEM Jaguar radiators should be zero.

ELIMINATING THE ONE-AND-A-HALF-PASS SCHEME -- PLUMBING: Whichever single-pass radiator you choose, you will need to plumb it up. Obviously, you need to route the outlets from both thermostat housings over to the same side of the car. A simple pipe or hose supported along the back edge of the upper radiator support is one idea.

If your single-pass radiator has two 1-1/4" inlets, one right over the other, you simply need to route one hose from each thermostat outlet to them. When plumbing the two inlets, take care not to create air pockets; having the coolant going downhill to enter the radiator might trap air in the hose. It will probably work best to connect the nearest thermostat outlet to the lower of the two inlets. If you cannot devise a routing that will push air bubbles on into the radiator inlets, you will need to provide an air bleed port at the high point where a bubble might get hung up.

It's more likely your single-pass radiator will have one larger inlet rather than two 1-1/4" inlets. Hence, you will need to tee your two upper radiator hoses together. One idea would be to have a weld shop make up an aluminum tee. Another idea would be to make a tee out of brass or copper pipe fittings. And yet another idea is to just have a local radiator shop slap together a tee out of standard brass radiator fittings. Byrnal Haley did this: "All good rad shops stock inlet and outlet pipes for rad repair. I drew a diagram of what I needed and the rad guy fabricated it from stock parts. You just need to tell him which size pipes to use." The result simply couldn't have been prettier. You can take a look at:

<http://www.jag-lovers.org/xj-s/book/SinglePassRadiator.html>

An improvement on a tee would be to make it a wye for better flow characteristics. Another idea would be to actually make a manifold that reaches across the engine compartment, so you only need short pieces of hose to connect it up. And yet another idea would be to create a tank or container of some sort with two 1-1/4" lines in and one larger line out; a photo of a racing XJ-S in the May 2000 issue of Jaguar World shows such a tank, and it has a radiator cap on top -- and the radiator cap on the crossover pipe has been omitted.

Coolant filters are still recommended with a single-pass setup, but you now have the choice of one or two filters. Two filters, one connected to each thermostat outlet, has an advantage in diagnostics in that you can tell what crud came from which bank. Also, you may use the coolant filters as couplings to connect radiator hoses together to accomplish the routing required for this job. But using two filters also has the disadvantage that the B bank filter could get plugged without the temperature gauge sender in the A bank telling you about it. Hence, it's better to go with a single coolant filter plumbed in after the two lines are teed together if possible.

If you are using Gano filters, it's suggested that you either use two or use one that's 1-1/2" or larger and step the hose sizes up to meet it; a single 1-1/4" Gano would probably be too restrictive for the total coolant flow of this engine. This isn't an issue with the Tefba filters, though, since the filter elements are the same size, it's only the connections that vary.

If the new radiator's bottom outlet isn't in exactly the same place as it was on the OEM radiator, you'll need to abandon the OEM molded bottom hose in favor of a flex hose -- which is a better hose anyway.

You'll probably need to revise the air purge system across the top of the radiator. If the flow in your new single pass radiator is left-to-right, it can stay pretty much unchanged, but if the flow is right-to-left you'll probably want to reverse it and put the banjo fitting at the top left and the air bleed plug or valve at the top right. Simply exchange the banjo fitting with the air bleed port. You can cut the long metal tube and reconnect it with a piece of 1/4" hose and a pair of EFI clamps, making it a *lot* shorter than it was. You will also need to figure out how to route the connection from under the center radiator cap over to this location. It may be possible to cut the tube near the tee at the left side and flip the whole thing over and reinstall it, putting the banjo fitting at the left but leaving the long tube going across the top of the support rail and connecting to the hose from under the radiator cap in nearly its original position. The short tube that originally connected the hose from under the radiator cap to the banjo fitting can now be used to connect the banjo fitting back to the tee at the left side with a short piece of hose.

If you get rid of the one-and-a-half-pass scheme, you can forget about relocating the coolant temperature sensors as described on page 176. The only reasons to do that were due to the differential cooling, which you will have eliminated. Of course, if you've already done it, you can leave it alone; for similar reasons, there's no point in changing it back.

ELIMINATING THE ONE-AND-A-HALF-PASS SCHEME -- OTHER IDEAS: Another option would be to replace the one-and-a-half-pass sideflow radiator with a simple custom-made downflow radiator. This would result in an upper header tank all the way across, so the two inlets could be right where they are. The bottom outlet would probably have to change; it'd add complexity to try to get the outlet several inches up the left side where the OEM outlet is. It'd probably be easier and better to just provide an outlet at the bottom and use a generic flex hose to connect it to the pump inlet. Flex hoses are usually better in this location anyway.

Believe it or not, the Series III E-Type used a downflow radiator exactly as described. It's not known why Jaguar decided to cause all sorts of trouble by providing the XJ's with the one-and-a-half-pass sideflow radiator instead.

RADIATOR MOUNT BUSHINGS: The radiator is mounted on four rubber bushings, two at the bottom (C43577) and two at the top (C38333). If you wish, you may replace these by visiting your local discount auto parts store and looking through the selection of PCV valve grommets that are usually on a display rack in bubble packs. There is one intended for a Toyota that will serve quite nicely in both positions. It doesn't have as large a weight-bearing surface as the Jaguar originals, but it's not made of British rubber either.

By the way, there are several possible explanations for why the radiator is mounted on rubber bushings, including to allow for thermal expansion and to protect the fragile radiator from chassis flex and vibration. However, one plausible explanation is that it is to electrically isolate the radiator from chassis ground. Since the radiator is largely brass or copper while the engine block is aluminum, and the engine must be grounded, grounding the radiator would complete a circuit through the coolant causing electrolytic corrosion somewhere -- probably inside the block! Several owners have checked and confirmed that their radiators are not grounded; the rubber mounts, the rubber hoses, the foam packing, the fact that the fan shrouds are bolted to the rail instead of the radiator itself, all add up to complete electrical isolation. Unfortunately, the heater core -- also brass -- is quite effectively grounded.

RADIATOR OBSTRUCTIONS: One possible cause of overheating problems is that the outside of the coil or the spaces between the fins has been plugged with crud so air can't flow through. Since the fins in the A/C condenser coil and the oil cooler are coarse but the fins in the radiator itself are much finer, the blockage may be dirt jammed in the radiator fins while the condenser and oil cooler still look clean. One great way to avoid this problem would be to spray a garden hose through the radiator from the engine compartment forwards every time the car is washed to prevent any

buildup. Unfortunately, the design of the fan shrouds and the tightness of the engine compartment conspire to make this task all but impossible, so more likely it's going to have to be addressed by a periodic disassembly and service.

Worse yet, Jaguar does a poor job plugging the gaps around the condenser and oil cooler, so really big things like leaves get blown through the gaps and into the space between the condenser and radiator (see page 226). The result is often a massive collection of debris between the condenser and the radiator, where it's really miserable to get to.

John Bertsche provides a procedure: "Well, I really didn't feel like pulling the radiator this weekend. I came up with an alternate plan, which may or may not be useful to those of you with my problem.

- 1) Put the front of the car on ramps. Take off the spoiler, if you're lucky enough to have one. Take out the lower splash panel/lower center valence, or whatever you prefer to call it, if it hasn't rotted into swiss cheese from all the wet leaves that have collected between it and the oil cooler after all these years.
- 2) After liberal use of Liquid Wrench, use your sturdiest pair of vice grips to loosen the two large Phillips-head screws holding the oil cooler to the brackets attached to the frame. Once they're loose, you can try using an actual Phillips-head screwdriver to take them all the way out. (Ed. note: they're not Phillips, they're Pozidriv -- and using the correct tool may eliminate the need for the vice grips.)
- 3) Carefully pry (on the brackets, please, not the cooling fins!) the oil cooler away from the radiator just enough (about 1/4 inch) to get a straight piece of coat-hanger wire (a foot long or so) up in between the oil cooler and the radiator, and *gently gently* use the coat hanger wire to brush the debris out of the space. If your car is like mine, it will look like the tobacco inside a cigarette (about a carton's worth).
- 4) Use a blower, like your shop-vac, to blow forward through the radiator (like back-flushing the air flow) to loosen any crud that's trapped in the radiator fins. You can hold the oil cooler away from the radiator a little bit while you're doing this with sticks or whatever (again, levering only against brackets, not cooling fins!). You'll be surprised at the amount of junk that flies out. Thousands of insect wings, bits of leaves, styrofoam, paper, etc.
- 5) There's quite a bit of space between the A/C condenser and the radiator, but virtually none between the oil cooler and the radiator (at least on my car). So, as you clean out the bottom section, the debris from up above will fall down into the gap you're creating. Make sure you alternate between using the blower and the coat hanger a few times to get everything cleared out.
- 6) Put it back together and take the car out for a beer. You should notice a big improvement in cooling. I estimate my radiator was about 30-35% blocked.

"I'm pretty sure this took longer to write than it did to do (except for step 6). It may be worth a try (easy fixes first!)"

Instead of the coat hanger wire, Paul Gill says, "A plastic mini-blind slat is great for this."

Matt Dillon suggests another method: "Take the top holder off of the radiator so that you can spread it apart from the A/C condenser and clean out the junk that's in between them. I found a whole boatload of stuff in there." Removing the upper rail requires removing the air purge tubing, which in turn requires draining a little of the coolant. Think of it as an opportunity to modify the banjo fitting on the air purge system (see page 187) and install foam to prevent it getting plugged again (see page 226).

Before you decide that you're done, try to shine a light through the radiator. You might try laying a piece of paper on one side and see how much light shines on the paper. The task may still require a mirror and/or a tiny, bright light on the end of a long, bendable wire, or maybe you can shine enough light through the condenser and oil cooler. If you still can't get the enough of the crud out to see light everywhere, it may be necessary to drain all the coolant and pull the radiator out to clean the fins themselves. Think of this as an opportunity to have the radiator rodded (see page 189) and to revise the drain scheme (see page 195).

PREVENTING RADIATOR OBSTRUCTIONS: Colleen Melton suggests you install a screen in front of your condenser/oil cooler to keep crud from plugging things up. "A simple piece of fiberglass window screen (darker color

such as charcoal or black look less obtrusive) run in front of the heat exchangers works great at keeping leaves, bugs, etc., from clogging up the works. My car has such a screen installed, we've done it on all our vehicles for quite a few years. Ours is secured at the top by clamping under the A/C drier clamps, and at the bottom by pinching between the panel below the lower grille and the radiator lower support. Cost is next to nothing and we have more time to work on other things, rather than cleaning out crud to prevent the dreaded overtemp blues."

Of course, you could just opt for one of those bug screens that wraps around the nose of the car and clips onto the front wheel wells.

HEADER TANK: The header tank is susceptible to rust perforation. The good news is that the later and cheaper tank fits better. The filler is curved to clear the air cleaner that is set forward to clear the ABS unit. The newer tank is about half the price of the older one and has studs instead of bolts to mount it.

Unfortunately, it is still made of steel, which means it will eventually rust through again and the rust flakes will plug up your radiator. Better idea: Call Cathouse Spares in Sydney, Australia (page 693) and order their stainless steel version. This is one example where an international phone call and overseas shipping are definitely worthwhile.

Mike Morrin went another route: "I could not find a supplier of pre-H.E. expansion tanks. So I eventually had a local radiator shop make me one in brass, using the original fittings and brackets. He quoted (and I paid) US\$130, but I think he lost money on it because of the labour involved."

As Morrin notes, there are minor variations between header tanks. Most notably, the pre-H.E. has a fitting on the bottom for teeing into the line from the heater core to the radiator outlet, while the later cars have a upward-angled fitting at the bottom front corner for connecting to a fitting on the later crossover pipe right at the suction side of the pump. If you obtain the later type header tank, you can fit it to the earlier car by simply installing a generic tee in the heater hose and running a hose from the upward-angled fitting to it -- or you could spring for a new crossover pipe at the same time (also in SS from Cathouse Spares) and hook it up as in the later cars.

On later models, the coolant level sensor was located in the header tank instead of the earlier location at the front right corner of the radiator. If your new header tank doesn't have a hole for the sensor, drill one about 3" up from the bottom. If your car has the sensor in the old location in the radiator, relocate it. If you can't get around to doing the job properly just now, buy a new sensor and grommet and install them in the header tank and leave the old sensor where it is. Sooner or later, you'll probably have the radiator out for rodding and you can have the original sensor location sealed up at that time.

THERMOSTATS: The early OEM thermostats had "jiggle pins", a pin with a rubber ball on one end, loosely retained in a hole in the flange. They are supposed to be installed with the jiggle pins on the top side. These probably aid in either letting the air out while you're filling the system with coolant, or helping the air find its own way out during operation. Clearly, they're supposed to do more than provide a small leak; a hole would do that. The jiggle pins evidently act as a sort of check valve, allowing fluid or air through one way but sealing tight the other way. Mike Morrin provides a theory: "I always thought the jiggle pins were designed such that with the engine stopped, and no pressure differential across the (closed) thermostat, any air on the engine side of the thermostat could bleed out to the radiator, but with the engine running the pressure differential would push the pin (or ball) into the hole, blocking any flow of water until correct temperature is reached."

It has also been suggested that the pin, jiggling around in the hole, prevents the hole from being obstructed by a small air bubble. Or that the ball, being much heavier than air but only marginally heavier than water, will reliably fall open when surrounded by air but can be held shut by the slightest pressure differential when surrounded by water.

Morrin points out that the design got upgraded along the line: "I recently bought a pair of 88 degree thermostats for my 1986 V12 and they are Waxstats and came in genuine Jaguar packaging. The jiggle pin has however been replaced with a ball in a cage." Same thing only different, either design will work. Some aftermarket thermostats reportedly also feature this caged ball (no aftermarket thermostat apparently ever featured the jiggle pin). Jaguar isn't the only manufacturer to specify such features in their thermostats; you can find caged balls in several different thermostats on the

rack in the auto parts stores these days.

Try not to buy thermostats without jiggle pins or air bleed valves. If you tell the parts clerk the model year of your car and he returns with thermostats without such features, try giving him a later model year -- say, 1991. The design of the cooling system didn't change, but for some reason some of the computer listings in the parts stores list thermostats without air bleed valves for early cars and with air bleed valves for later cars. If you must buy aftermarket thermostats that have no wiggle pins, drill a 1/8" hole in the flange; the small leak might keep the engine from warming up quite as fast, but at least it won't drop valve seats due to air pockets. Michael Bucklew suggests "a small cotter pin can be used."

The Jag V12 also requires thermostats that have a post on the bottom with a spring-loaded disk for closing the bypass passage when the thermostat is open. Believe it or not, there are aftermarket thermostats purportedly intended for this car that don't have these attachments. Do *not* buy any such thermostats. There are acceptable aftermarket thermostats available; if you don't find them at first, try another store.

NOTE: Don't operate this engine without thermostats. The thermostats must be in place to prevent the coolant from taking a short circuit and bypassing the radiator. Incidentally, it's not really a good idea to operate *any* liquid-cooled engine without a thermostat.

If you're in the market for thermostats, make sure to check the computer or applications listing to get the correct type for the Jaguar; don't just pick up something that looks right. Julian Mullaney says, "First time around went to Pep boys and got some new t'stats that looked exactly like the originals. It wasn't until after putting them in water and looking at the amount of travel they open and the amount of spring compliance on the back close-off disc that I noticed they were different. They look identical, but they move differently. This is real important because that disc has to close off the crossover pipe properly. Went back and got some other t'stats that looked the same but had the right amount of travel. You can check it by taking it out of the package and just forcing it thru the motions to check travel length, etc."

This is not to say they must look identical to the originals. Bob Gallivan: "Just received a set of 88 deg C t-stats (Calorstat made by Vernet in France). These appear to be different than the 88 deg t-stats I replaced last year (Waxstat).

- 1: the vernet came with rubber ring gaskets that fits the outer edge of the disk.
- 2: overall length:
 - Vernet is 51 mm.
 - Waxstat is ~49.55 mm.
- 3: the valve (?) width
 - Vernet is ~23.25 mm
 - Waxstat ~17.8mm"

THERMOSTAT TEMPERATURES: The bulbs in thermostats work by taking advantage of the step increase in volume that accompanies a phase change, in this case when wax melts. Before the wax begins to melt, there is little plunger movement. As the wax melts, the volume of the wax increases, pushing the plunger out of the bulb and opening the poppet. Once the wax is completely melted, the plunger stops moving. The temperature at which the plunger moves is a function of the specific compound of wax used. The small changes in volume with changing temperature when the wax is entirely solid or liquid are insignificant, and since the bulb itself is changing volume at a comparable rate, they may not move the plunger at all.

The proper way to mark a thermostat is to indicate its "control range", the temperature at which it cracks open and the temperature at which it is fully open -- which, on the Jaguar V12 thermostats, is the point at which the bypass port is fully closed. However, the thermostat manufacturers generally don't do this; thermostats are commonly rated with a single temperature, with no indication whether this indicates the crack-open temperature, the fully-open temperature, or some temperature in between. The Jaguar literature (including the Haynes manual) does, however, specify "opening" and "fully open" temperatures for thermostats -- leaving the owner trying to figure out which thermostat in the store

corresponds to the specs. The general consensus seems to be that the “early cars” were originally fitted with 180°F (82°C) thermostats, while the “later cars” were fitted with 190°F (88°C) thermostats. The change may have coincided with the introduction of the H.E., but it may have changed at different times between North America and other markets.

The ambiguity in the rating scheme seems to allow for some funny stuff, though. The Robertshaw thermostats offered by Discount Auto Parts are available in 160°F (71°C), 180°F (82°C), or 195°F (91°C) ratings; their computer describes the 195°F items as being “closest to OEM specification”, and these are the ones generally kept in stock. Peter Cohen says, “195°F is the standard opening temp for American cars nowadays. Those responsible for spec-ing products at certain manufacturers are probably just going on automatic pilot.” More likely, they’re just making thermostats for the Jag using the same wax bulb used on their products for other cars rather than having to make a separate line of wax bulbs. Cohen continues: “Beck-Arnley, Motorcraft, and Motorad list 192 degree thermostats.” Perhaps the same idea, except these companies chose to split the difference between 190°F and 195°F for their wax bulbs!

James Teston says, “F.Y.I. A '92 has as standard (owners manual) 90°C (194°F) but you can get up to 205°F 'stats for this year. There are no listings this high for the '83.” I just love it when application listings give totally different data for an '83 than a '92, ignorant of the fact that the engine is totally unchanged.

You can apparently forget about relying on the thermostat manufacturer’s qualitative description of the temperature rating. A review of the offerings of several companies’ 180°F thermostats revealed that many of them described this as “standard temperature” or “O.E.” (which it is neither for most XJ-S’s), a few described it as “medium temperature”, while a great many described it as “high temperature” -- an interesting outlook, since it is the coldest thermostat that should ever be considered for this engine.

There is really little functional difference between 180°F (82°C), 190°F (88°C), 192°F(89°C), and 195°F (91°C) thermostats, although as noted on page 175 they will result in different gauge readings when the cooling system is working properly. In theory, the warmer thermostats should provide better fuel economy, and those who live where it snows report they will make the heater work quite a bit better.

There are also 160°F (71°C), 165°F (74°C), and 170°F (77°C) thermostats available, generally described by the manufacturers as “low temp”. None of these should be used in the Jaguar V12. They certainly won’t help anything in any car, but in this case they might actually cause problems; they may cause the engine to run cold enough that the EFI system is working on an enriched part of the fuelling map that it was never intended to use continuously, and you may get bad fuel economy, low power, spark plug fouling, etc. If it gets too far onto the cold fuelling map, it may actually run rich enough for excess fuel to rinse the oil off the cylinder walls, greatly reducing the engine life. Also note that the AAV (page 265) won’t fully close until 80°C, so you may also get an inconsistent idle trying to run colder.

The fact that the EFI coolant temp sensor and the AAV are both on the left bank and the left bank runs warmer than the right bank may confuse this issue a bit. Some people have installed low temp thermostats with no apparent ill effects, but this might be due to the fact that the left bank is running warm enough to put the EFI in a viable control mode and to fully close the AAV anyway. If the EFI sensor is moved to the right bank as discussed on page 176 or the cooling system is modified to eliminate the differential cooling between right and left bank as discussed on page 198, the EFI sensor and AAV may actually start seeing temperatures as cold as the thermostat spec -- and might start showing symptoms of running too cold. If this happens, the solution is obviously to replace the thermostats with units in the 180-195°F range.

THERMOSTAT SEATS: Jan Wikström reports that “The seat of the thermostat bypass (supposed to close when the thermostat opens) in the thermostat housings is subject to erosion. Inspect and fit a bronze seat if necessary.” It’s not known how common this erosion is, but if significant erosion is present it will definitely reduce cooling efficiency. Jan made a bronze seat by machining a pipe fitting and then machining a suitable recess in the thermostat housing to press it into. Other options would include building up with weld material and remachining or simply replacing the thermostat housings.

Rob Weiss-Malik says, “When I took the t-stats (which I had recently replaced) out again and inspected them I found that the somewhat spherical washer (valve?) at the back end of the t-stats (the one that seats against the coolant return opening when the t-stats open) had very faint off-center circular wear scratches on it. Upon checking the recessed

sockets that the t-stat flanges seat into I found that they contained gritty deposits of a grayish material that I could scrape off by using a small flat screwdriver.

“After seeing this I temporarily reinserted the t-stats back in the sockets and it immediately became apparent that they were not seating perpendicular to their sockets!!! This resulted in the back valves not seating the right way against the back opening when the t-stats opened and in turn causing the ring shaped seating marks (scratches). These conditions apparently lead to some of the flow not going to the radiator but going straight back to the engine with a concurrent rise in temperature. Please note that the amount of gritty material at the seats was very small, and yet it caused a large of amount of deflection in the alignment of the t-stats (sufficient to cause bypass of flow). I also religiously maintain the proper proportions of antifreeze in the cooling system, and the radiator was re-cored about 15K miles ago.

“The fix consisted of thoroughly scraping (without scratching) the recessed sockets with a flat screwdriver to remove all of the deposits. This was followed by light sanding with very fine (600 grit) sandpaper. Then the t-stats went back in. Now my gage sits below N and does not creep up into the gray-hair zone.

“By the way, the symptoms of this condition were that the gauge would first stabilize a quarter way below N and then would very slowly creep up past the N setting over a period of 15 to 30 minutes. The physical evidence for this condition were the deposits themselves (you can see them easily, assuming you can cram your head that low under the bonnet!!!) and the ring shaped seating marks on the back valve. This was an easy fix and I would recommend it as a routine maintenance procedure whether or not your cat is overheating.”

NOT-SO PRESS FITTINGS: Stefan Schulz found that the 1/4” connection on the top of the left side thermostat housing had come loose. This fitting is connected to a hose that goes to the air bleed piping on top of the radiator, and normally operates at cooling system pressure. Once it comes loose, it really comes loose: “The only thing that held it in place was the slight force exerted by the hose pressing on it from above!”

The ideal fix here would be to drill and tap the hole in the thermostat housing for a NPT and then screw in a suitable fitting, and throw that pressed-in thing away. Trouble is, it might be a bit difficult to do with the thermostat housing on the car. It's not horribly difficult to get the thermostat housing off the car, but it does complicate matters.

Unfortunately, Schulz is not the only owner to suffer this same failure. In fact, it appears to be fairly common. All in all, if you have that thermostat housing out for any reason, you might want to preemptively replace that pressed-in fitting with a screwed-in fitting just so you don't have to worry about it any more.

BADLY LOCATED FITTINGS: The right rear coolant manifold casting has locations for three bosses. On this author's '83, the manifold has a vacuum switch in the front boss and the hose supplying the heater is connected to a boss in the second; the third is blank, undrilled. On Jason Philbrook's '89, however, there are sensors in the first two bosses and the heater hose is connected to the third. This puts the hose fitting too close to the insulation on the structure of the car, and the engine moving on its mounts caused the corner of the insulation to wear a hole in the hose and cause a leak.

See COOLANT CONNECTING PIPE below for ideas on providing new taps along the pipe itself, allowing you to plug this one and not use it any more.

COOLANT LEVEL SENSOR: On early cars, it's at the front right side of the radiator, where it's very hard to find unless you have the hood off. Sometime in the early 80's, it was relocated to the header tank, where it's a lot easier to get to. If you have a car with the earlier sensor location, at a convenient opportunity you should relocate the sensor to the header tank. Simply drill a hole in the header tank about 3” above the bottom and insert the existing sensor with a new grommet, and find some way to seal the hole in the radiator.

This sensor is nothing more than a pin that makes electrical contact with the fluid itself. The resulting ohmage reading is processed by an electronic gadget, C42294, into an on/off signal to the dash indicator light. If this gadget fails, note that some GM cars use exactly the same type of level sensing system. Their sensor won't fit the Jag, but the electronic box should work.

FINDING LEAKS: Michael Bucklew says there's a product to help. "The item is for checking for coolant leaks on the whole system. A kit comes with a ultraviolet dye that is circulated through system. Shut down, and hand pump up the pressure. With a blacklite the coolant leaks look like neon lights. Typically, kits comes with the lite and dye. I think the price is around 60 bucks at "better auto stores"."

COOLANT CONNECTING PIPE: On top of each head there is a coolant pipe, C42595, that connects a manifold at the rear of the head to the thermostat housing at the front. It is a straight steel pipe with a small shoulder at each end to hold itself and the sealing bush in place.

Of course, being steel it is subject to rust and corrosion. The outside merely looks ratty; the inside, which usually rusts worse than the outside, dumps flakes of rust into the coolant circuit and helps plug up your radiator.

There is an easy way to make a nice replacement. Drop by an air conditioning repair shop or supply house, and pick up a length of 5/8" ID (3/4" OD) copper tubing as well as a fitting or two. Note: air conditioning systems typically use the odd eighths sizes of tubing to differentiate them from water piping.

Cut the tubing the same length as the original. Cut the fittings to make rings and use a propane torch to solder them onto the tubing to form shoulders. If you take the effort to polish it up a little, having the copper tube across the top of each head looks really snazzy. Since this tube is mounted in rubber at both ends and has no direct contact with aluminum parts, galvanic corrosion is no more of a concern than in the copper radiator.

If you need additional openings into the cooling circuit for adding or relocating sensors or taps, one possibility would be to assemble copper coolant connecting pipes as described. Then, carefully noting where there is room for such things, you can install a tee in one of these pipes. A simple "sweat" tee would make an excellent connection for the heater hose, leaving the threaded openings in the manifold itself available for sensors. Or, you could solder in a cast bronze tee with a threaded connection. And, of course, you can install more than one tee if it would be helpful.

Al Askevold has another idea: Make pipes from Schedule 40 pipe. But wait a minute! In copper piping we needed 5/8", but Schedule 40 only comes in 1/2" and 3/4". Fortunately, 1/2" Schedule 40 has no dimensions anywhere near 1/2". Askevold: "Schedule 40 is OD 0.840, ID 0.622, with a wall thickness of 0.109." So, cut 1/2" pipe to length and then machine the OD down to 3/4" at the ends to fit the seals.

But Schedule 40 is ugly! Yeah, it's typically galvanized cast iron, and the black iron is just as ugly. But if you shop around, you can find it in solid brass or stainless steel. The stainless steel Schedule 40 is not very pretty since it is unfinished, but as long as you're machining it anyway you could give it a skim cut over its entire length to polish it up. Askevold points out that stainless steel pipe is available from McMaster-Carr (page 711), but the shipping will probably bankrupt you; better to buy locally if you can find it.

COOLANT CONNECTING PIPE SEALS: Part number C37990, commonly referred to as a "top hat seal", is actually the same seal used on the electric fan control thermal switch on the early XJ-S, and may even be used on other types of British cars. This seal can be used only once -- it says so right on the seal itself. When installed and the engine is run, this seal seems to bond itself to the pipe and makes a very effective seal. Unfortunately the steel pipe will then rust, eventually breaking this seal. So, every time you're working in this area, you'll probably be well advised to replace these seals while there, cleaning up the OD of the pipe before reinstallation.

Unless you go with the copper pipe replacement described above. In this case, the seal bonds itself very well to the copper, it never rusts, and it can be a real pain to try to pull apart during the next overhaul. Solution: don't ever take it apart again! Since it will never leak if undisturbed, every time the engine is worked on simply remove the entire water rail assembly -- thermostat housing, pipe, and rear manifold -- as a single unit and set it aside for reinstallation later.

The top hat seals are expensive if purchased from Jaguar. There are aftermarket versions available for only a couple of bucks each, though; they reportedly don't have the writing on them. It's not known if there is any functional difference in the rubber compound, but the cheap items are likely to work fine here -- this is not a difficult connection to seal once

the rusty pipe issue is dealt with.

COOLANT CONNECTING PIPE SEAL REPLACEMENT: Odysseus Marcopolus passes along this idea: “Many thanks to Phil Prince's tip about not having to remove either of the manifolds to get the pipe out. All I needed to do was:

1. Drain coolant.
2. Remove air filter housing.
3. Grab pipe w/vicegrips and shove it into the back manifold until the front end was free; then pull forward and out. (I needed to whack the vicegrips a couple of times w/ a hammer to get the pipe moving.)
4. Remove seals from manifolds.
5. Cleanup pipe with grinder/wire wheel (just didn't have time to fab something new).
6. Place new seals in position.
7. I coated the pipe ends with gasket dressing.
8. Push pipe into rear manifold until there's enough room to get the front end in and position the pipe.
9. Refill coolant and replace air filter housing.”

Of course, this is not likely to work as well with the copper pipe described above as it does with the OEM steel pipe; not only will you bugger up the copper pipe with the vicegrips, but the soldered-on shoulders will make it quite difficult to push the pipe into the rear housing to remove. You could, of course, simply leave the shoulders off, since the pipe should remain in place just fine without them and then you could replace the seals using this method. Mark the pipe with a marker so you can tell when it's positioned properly at installation.

This replacement method should work with the stainless steel pipe if you machine the OD of the stainless steel pipe to the same dimensions as the OEM steel pipe. You could even taper the step in diameter to make it work even easier.

Of course, when all is said and done, it's not really all that difficult to remove the thermostat housing. And having either the copper or stainless steel pipe in place is likely to avoid the need to replace those top hat seals nearly as often.

RADIATOR HOSES: The hoses in the Jag are not significantly different than any other car. For locations where the shape of the hose is not too critical, go to the local parts shop and ask to look over their selection of molded hoses. Find one with the right diameter, and with a section that will fit where you want it to. It is helpful to have the car there, and a shop that will let you take the hoses out to the car and look at them. Buy the hose and cut it to the length and shape you need and discard the rest. This method is usually cheaper than either buying the Jag hoses or using flex hose, and is very aesthetically pleasing. Note: You will probably not find a hose with the exact same shape as the original. All that is important is that the two ends will connect properly, and that the hose doesn't run into anything in between. Also keep in mind that the engine moves around a little on its mounts, while the radiator stands still; a little room for flexibility in the radiator hoses is helpful.

Peter Smith: “the top left hose is the same shape as (in Australia) a Holden 186 or Mazda 929 late 80's.”

Peter Cohen says that the Goodyear catalog lists “a single XJS radiator hose, the one for the upper left. Goodyear part number 61267, cost \$6.39. It has a slightly tighter S bend than the original, and appears to be about an inch too long at the front end (so was the Mackay). Same wall thickness as the original. The Goodyear catalog also had a note that this item is also available in "Hi-Miler".”

Cohen also provides Beck-Arnley hose numbers:

Upper Left	142-4555
Upper Right	142-4548

Cohen also ran across an Australian brand. "I didn't like them much. The upper left developed a hole, and the lower was not shaped quite right, so it rubbed on a bolt on the motor, and began wearing a hole in itself. It had to be tie wrapped out of the way."

Auto parts stores offer a wide selection of molded heater hoses too. The question-mark-shaped section of hose that connects the heater return pipe to the outlet of the radiator, CAC 5125, can be neatly replaced by a hose number 303675.

Regarding the lower hose, Richard Dixon shopped around. He found one place that offered him P/N C41102 for a reasonable price, and another place that offered him P/N CCC6993 for an unreasonable price. He was given conflicting information on whether the later P/N fit only the 6.0 cars or superseded the earlier numbers. "Called a local import parts store and she said \$US 14.96 and I can have it tomorrow. When it comes in, guess what part number it has on it? Both C41102 and CCC6993. And it fit perfectly. Go figure!!!"

By the way, one big issue on lower radiator hoses is collapse. It's on the suction side of the water pump, and under some conditions (such as a plugged radiator -- and it's not like that never happens on a Jaguar XJ-S!) the suction can suck the hose flat -- which is really bad for coolant flow! The time-honored fix here is to install what looks like a big coil spring inside the hose; many lower radiator hoses come with such coils. The problem there is that they aren't stainless and eventually rust, which not only allows the hose to collapse but also puts chunks of spring steel into the coolant loop. If this type of thing is in your car, it is suggested that you replace this hose on a maintenance schedule rather than waiting for trouble.

Another solution seems to be to make the walls of the lower hose itself really tough. The problem here is that, eventually, hoses soften up, and may eventually start collapsing -- and you have a really tough time figuring out what's wrong with your car, since it's clearly having cooling problems but you can't find the fault. The hose looks fine when the engine's shut off. Again, replace the hose on schedule rather than waiting for trouble.

Marty Sullivan came up with the unthinkable solution: a flex hose. Flex hoses are widely considered unacceptable for some reason, but for a lower radiator hose they have some definite benefits. There is a coil of wire built into the casing of the hose itself, where it isn't in contact with the coolant, won't rust, and won't get chunks into the coolant circuit. Some people seem to feel they don't flow well, but there's little basis for this contention; certainly Sullivan didn't have any problems with flow. The biggest issue is that, when really old, sometimes a flex hose will delaminate, leaving the outside casing and the enclosed wire coil looking fine while the inner lining pulls away from it, collapses internally, and plugs the passage -- but this probably doesn't happen any sooner than the problems with molded hoses described above.

Sullivan claimed the flex hose he found fit beautifully and was much easier to get into place than a molded hose would have been.

If you want the best possible setup, though, the thing to do would probably be to get a good quality molded hose and make a stainless steel wire coil to go in it (whether it originally had a coil or not). You wouldn't have to worry about that hose until it actually sprung a leak.

If you have an engine heater in the lower hose, all of the above still applies except we're talking two short hoses instead of one long one. See page 685.

GENERAL WATER HOSES: Harry Trafford suggests better-than-stock cooling system hoses: "Gates makes a cool flexible, wire-inserted hose for bends that would kink regular hose. I think the old name was "Red Stripe", but don't know if the name has changed. The other type I'm using is is Gates "Vulco". No wire, but extremely strong."

WATER PUMP REMOVAL/CROSS PIPE INSTALLATION: What the Jag manual calls the "cross pipe" is the pipe that connects the two thermostat housings to the water pump inlet, and has the fill cap on top. It is variously called a crossover pipe, a bypass pipe, and several unprintable names. Note that the air balance pipe at the top rear of the engine connecting the two intake manifolds is also called a crossover pipe; try not to get confused.

The repair manuals indicate that the crank pulley must be removed to remove the water pump, but the cross pipe can stay where it is. However, according to Jim Isbell, “The water pump will come out and go back in without removing the crank pulley. But the pump will not go back on with the crossover pipe connected if the pulley is still on as you have to snake it in over the pulley and the crossover pipe would be a big impediment.

“So having said that and realizing that you are now going to replace the crossover pipe with the water pump already installed, there is only one way:

“Lubricate all three of the pipe connections (on the two thermostat housings and the water pump) liberally with 3M water hose sealer. Then lubricate the three matching pipe ends on the crossover pipe with the 3M stuff. Now slip the new, cut to the proper length, hoses onto the crossover pipe. Put two clamps onto each of the three hoses, not tight, just enough so they don’t slide off. The two clamps on the right side should be placed so the screw is on top when installed and slightly back. The clamp on the thermostat housing on the left side should be so that it is on the bottom and slightly back so there is enough room for a screwdriver angled down below the header tank. The two clamps on the water pump hose should be on the left side of the hose slightly back so the screwdriver is angled to the left side of the car. If you set the clamps up this way you will save a lot of grief later on.

“Now push the hoses up onto the crossover pipe as far as they will go. Next place the center (water pump), hose onto the water pump tilting it and the crossover into position. It will take a little pushing and prying with a screwdriver, but it’s not too bad and the hardest part is done.

“Now, pull all the three hoses into approximately the correct position and lightly tighten the clamps. Now make sure the small pipe on the top of the crossover is clear of the big bolt on the block so that the hose to the overflow tank can be put on without being in a position to rub a hole in it. Tighten all six clamps and you are done.”

Lenny Berk did this job, and had the following suggestion: “Removing the engine breather filter housing (two bolts) made my life a little easier to get the crossover pipe in.” The breather housing is the thing on the front of the left head, just forward of the oil filler.

Berk also was less than satisfied with the lubricating qualities of hose sealer when fitting the cross pipe. Suggestions for alternatives include water pump lubricant, intended as an additive to coolant. Care must be taken when selecting a lubricant, since the wrong stuff may attack the hose material or otherwise screw up the cooling system.

This author found another way to install this pipe: remove the engine breather housing, and unbolt the A/C compressor and shift it rearward a couple inches. Then, fit the left end of the cross pipe to the hose on the B bank thermostat housing with the right end of the cross pipe up in the air. Then swing the pipe down, inserting the fitting into the hose on the water pump as you do. Finally, connect up the right end, which is easy. Tighten the clamps and reinstall the breather housing and the A/C compressor.

When installing this cross pipe, try not to insert it too far into the hose connecting it to the water pump. Positioning the cross pipe a hair too low makes it considerably more difficult to get a socket on the bolts holding the front support plate for the A/C compressor. With the cross pipe properly located, the bolts holding the bottom of the support plate to the engine are easily accessible below the pipe, and the bolts holding the compressor to the support plate are easily accessible above it.

A/C V-BELT RUB: If the V-belt rubs against the cross pipe, it’s because the cross pipe wasn’t installed correctly. There are no brackets to hold this cross pipe in position; it is held only by the hoses connected to it. If it rubs the V-belt, the ends of the cross pipe were not inserted far enough into the hoses connecting to the thermostat housings. Usually, the clamps can simply be loosened and the pipe pushed into the proper position, and the clamps retightened. Note Jim Isbell’s warning above to take care not to install it too far rearward causing the small hose to the header tank to rub on the crankcase breather mount bolt.

CROSS PIPE REPLACEMENT: If you’ve had the cross pipe out, you’ve probably been alarmed at its condition. It’s cheap steel, and usually is so pitted and corroded that it’s amazing it doesn’t leak like a showerhead. It also is

reportedly atrociously expensive from Jaguar, and you really don't want to be searching the junkyards because the ones you find there are likely to be just as corroded. Mark Jackson suggests an alternative: "Cathouse Spares offers a third-party solution. Cathouse can provide stainless steel rails acquired from an anonymous source for about \$AUS135 (~\$US95) plus the usual costs of mail & handling. I've seen one and it looked pretty good - had all the bells and whistles - just a little "choppy". The angles from memory were mostly welded instead of smoothly bent, but it looked pretty spiffy anyway." Cathouse Spares is listed on page 693.

Of course, it's just plumbing. You could conceivably make your own. One possibility is to find suitable copper piping and fittings and solder or braze the whole mess together. The fill cap might be a bit of a challenge, but there's no good reason it has to be a conventional radiator cap; any opening with a suitable watertight cap should work. Or perhaps you could rip a radiator cap connection off the top of a brass radiator and solder it on. The trickiest part may be at the pump inlet itself, where the connection from the header tank seems to protrude down the center of the pump inlet connection. It's not known how critical this is, since all lines lead to the pump inlet sooner or later; perhaps a simple cross fitting would work.

You might even be able to replace the entire cross pipe assembly with straight sections of tubing, tees, and suitable hoses and clamps. Note that this is the suction side of the pump, so it might be a good idea to use hoses as short as possible and insert metal coils to prevent collapse.

CROSS PIPE HOSES: John Napoli decided to cut pieces from commonly available hoses to connect the cross pipe. "I did find Dayton hose numbers D71458 (smaller ID hose [to heads]) and D71316 (large ID hose [to water pump]). These were fairly inexpensive. They may not be the cheapest or the best donor hoses to use, but they seem ok. The smaller hose has enough material to cut at least four hoses, and the other two, so I will have a complete set of spares." All of the cross pipe hoses are short, straight sections, so it's probable there are dozens of readily-available hoses that can be cannibalized similarly.

WATER PUMP LUBRICATION: On the top of the water pump is a setscrew with a locknut on it. This setscrew is to prevent the outer race from rotating in the housing, and either inserts into a hole in the bearing or tightens onto a flat. If it inserts into a hole, you can remove the setscrew and screw in a zerk fitting (available at any hardware or auto parts store -- yes, it's even the right thread), and then you can grease the bearings with a grease gun. Be sure to reinstall the setscrew when you're done.

WATER PUMP SEAL FAILURE: In the water pump housing there is a small drain hole that leads from the space between the seal and the bearing out the bottom of the pump. As a result, when the seal fails the coolant comes out the bottom rather than *through* the bearing. This is actually fairly standard practice in water pump design.

WATER PUMP REBUILD PARTS: If you are visualizing a water pump seal as similar to, say, the simple crankshaft lip seal on the front of the engine, allow me to improve your mind. A water pump seal is *considerably* more involved. It consists of a non-rotating face that is spring-loaded in the axial direction (parallel to and surrounding the shaft) to hold it against a rotating seat. These two parts run against each other with spring pressure holding them in contact, so they are made of materials that should provide long wear as well as a good seal: a carbon face against a stainless steel seat in good ones, a plastic face against a brass seat in cheap ones. And, of course, the level of polish of both surfaces is important, so the rotating seat is replaceable and is sold as part of the seal.

There is an elastomer involved, but only to connect the spring-loaded face to the seal housing so that it is free to move axially to contact the seat but fluid won't leak around behind it. The elastomer is therefore not really a wear item, although it certainly can be the item that deteriorates!

The housing material is sometimes specified, commonly either brass or stainless steel. It's hard to care; the housing isn't going to be the part that fails. I suppose it may be important in industrial applications with corrosive fluids.

The Jag water pump seal is an industrial standard; it can be found in any industrial equipment supply store, such as Grainger, as a type 68 shaft seal. In fact, Grainger offers two seals that will fit: Catalog #1R306, which has a black plastic seal face and a Buna diaphragm and is rated -40° to 225°F, and #1R324, which has a carbon seal face, a Viton diaphragm, and is rated -20° to 350°F. The Viton one costs ten bucks more than the Buna. Both of these Grainger seals have stainless steel rotating seats. After buying a rebuild kit to get the bearing, Sean Straw described the seal included as having "...the characteristic *plastic* seal ring material, meaning these are likely the Buna version. The seal face is *very* different in quality vs. the Viton one I purchased. If you're a stickler for precision, get the Viton one -- the differences are *not* just in the seal rubber - the face of both the seal and the seal washer are *much* better in precision on the Viton - it's *polished*, whereas the Buna is a bit more coarse looking (it doesn't look super porous, but it is obviously not polished). How much of a difference it'll *really* make in this application is questionable, but for the cost of parts, I think it is worth it."

Straw goes on to report that the seal has an industrial standard designation: RS 80613. "That's the Buna version -- append a V for the Viton one."

When the author's pump needed rebuilding, it was because that diaphragm in the seal had failed; it's unknown just how prevalent this failure mode is, but why not go with the Viton seal and not worry about it any more? 225°F isn't all that far from the operating temperature of this engine, not even considering its tendencies to exceed that operating temperature. Meanwhile, if you ever exceed the -20° limit on the Viton seal, you'd better have a good antifreeze mix.

The bearing is also a fairly standard item, similar to those used in many common water pumps. In case you're not familiar with water pump bearings, the outer race is a long cylinder as though there are at least two rows of balls or rollers inside. The shaft itself is part of the bearing, and presumably the inner race is machined directly onto this shaft. Straw provided the critical dimensions for the Jaguar part: the bearing outer race is 1.500" OD and 2.1280" in length. The shaft is 4.9025" long overall, with 1.7745" of this protruding from the rear of the bearing. The portion of the shaft protruding from the rear has an OD of 0.6300" to fit the seal and to press fit into the impeller. 1" of the shaft protrudes from the front of the bearing, and this portion has an OD of 0.7500" to press fit into the pulley flange.

Finding a bearing supplier may be difficult, however. The easiest way to get one may be to purchase a rebuilt water pump for another type car from a discount auto parts store and remove the new bearing (and perhaps the seal as well) from it. After rebuilding your water pump, return the disassembled pump along with your old bearing for the core refund.

When used in a Chevy or some such, this bearing would be press fit into a cast iron housing. On the Jaguar V12 water pump, however, apparently a press fit into aluminum wasn't considered reliable, so in addition to the tight fit a small threaded stud is screwed into the side of the housing and into a recess in the side of the bearing outer race to positively hold it in place. All such bearings seem to have a hole or notch that will work, possibly originally intended to line up with grease fittings in other applications; if you happen to find one that's totally smooth, you could easily grind a small flat on it.

Rebuild kits for this pump are available at reasonable prices. Straw reported that the kit he received from XK's Unlimited (page 697) included the bearing, seal, impeller (cast iron), two gaskets, and a replacement stud and nut for holding the bearing in the housing. The author purchased a kit elsewhere and received only the bearing and seal, so take note and ask what is included before ordering.

Despite all the above availability, Dan Jensen suggests you forget about rebuilding the pump yourself and simply buy a rebuilt pump. It isn't that much more money, and unless you have things like presses around it's easy to screw up a DIY rebuild job. Don't even ask Jaguar for a new pump, though -- you can't afford it.

WATER PUMP REBUILDING: Some, but apparently not all, water pumps have a single countersunk Pozidriv screw. According to Thomas Alberts, it is a common mistake to overtighten this screw, resulting in a fracture of the aluminum casting surrounding it. Apparently the casting was designed for a non-countersunk bolt, and adding the countersinking makes the metal too thin for serious tightening. If you wanna make sure the pump doesn't leak, use a good sealing compound; don't overtighten this screw.

WATER PUMP CORROSION: There is apparently some history of the water pump housing getting corroded; nobody seems to know if it is as a result of pump cavitation, bad antifreeze mixture, or what. Randy K. Wilson says, "The place at which they corrode away is at the lower part of the water pump cavity. This is behind the impeller area, but not the working side of the impeller. The area should be a fairly low flow area on the high pressure side of the pump. But it's close enough to the output side of the impeller that turbulence could be present."

"Whatever the cause, I do see the corrosion pitting often enough. There may be a clue in that it's not very often when merely changing water pumps; I see it on engines being rebuilt. Engines get rebuilt because they have done some high mileage, or have been abused/neglected."

FAN TIP RUB: If the tips of the blades on your fan show signs of rubbing, the problem may be in the transmission mount -- see page 342. If you have a metal fan, you can hear it happen: you nail it from a standing start, and get a deafening screech from under the hood like all hell broke loose. A bad, or an incorrectly assembled, transmission mount allows the engine to pivot around on the engine mounts, causing the fan to rub.

A fan tip rub may also be caused by a failure of the left side motor mount. When stomping it in low gear, a lot of torque is applied to the drive shaft. According to Newton, this means that the same amount of torque is applied to the engine/transmission assembly in the opposite direction. The engine tries to tilt to the right, applying tension to the left motor mount that was really designed for compression only. If this rubber mount is torn, the entire engine will lift right up off its mount, causing the fan to rub.

PLASTIC FAN CRACKING: Issue 68 (June 1996) of Australian Jaguar Magazine: "Graham Cummins has recently found that the main plastic fan on the H.E. is prone to cracking and breaking up which can cause immense damage under the bonnet." Any guesses as to how Mr. Cummins discovered this problem? Are *you* gonna find it the same way?

Mark D. Stoner did. "My yellow fan decided to explode one day when shifting at full throttle from 1st to 2nd gear. Put a nice dent in the top of the hood along with shredding the steel fan shroud and blowing a *huge* hole in the radiator."

Lee Opausky wrote: "Yes, the yellow plastic fan is cracked at the front. When questioned, the shop foreman of one prominent Jag dealership told me not to worry, the crack on his XJ-S is 1/2" wide!" More proof that you can't trust the dealers for good advice.

Jim Isbell ordered a replacement fan, and reports that the fan he was shipped did not look like the original. "It is black and has a flat center metal piece. The old one was white (now yellow) and the center piece was dished. The old one had a lower aspect ratio (short and fat) to the blades while the new one has the higher aspect ratio (long and skinny). The black flat one makes up for the "dishing" by offsetting the plastic instead." With any luck at all, this means that Jaguar has recognized the problem and redesigned the fan, and this new one won't have cracking problems. By the way, some of us believe the original fan was yellow to begin with, not white.

The black plastic fan may be an improvement, but to be safer still it may be preferable to just go ahead and replace the belt-driven fan with electric fans as described beginning on page 219.

FAN CLUTCH TYPE -- EARLY VS. LATE: The early XJ-S fan clutch mounts with one bolt, the later with four. Mike Morrin points out that his ROM (Ed 4) appeared to have the two confused. "On page 26-3, section 26.35.21 appears twice, once titled "FAN AND TORQUATROL UNIT (Early Cars)" and then titled "FAN AND TORQUATROL UNIT (Later Cars)". The diagrams and text for these sections appear to be transposed, as the section for "later cars" matches my 1975 car (as well as the illustration in the 1980 edition of the parts catalogue)."

On second thought, maybe not. Morrin continues: "I am now sure that the version with the 4 bolts holding the clutch on to the pulley is the early version used on the carburetted XJ12 (and never on the XJ-S), as I now have one of these (XJ12) engines with fan clutch. My "spare" 1973 XJ12 engine has a fan clutch with 4 bolts holding the clutch to the

pulley. The clutch has “HOLSET HUDDERSFIELD” cast on the front of it. The illustrations both clearly show metal fans.”

So, apparently, this is what we have: The early XJ12 had a 4-bolt fan clutch with a metal fan. When the XJ-S was introduced, it came with a 1-bolt fan clutch and a metal fan. In 1979, this was replaced with a 4-bolt fan clutch with a plastic fan.

There are photos of the guts of a 1-bolt fan clutch at:

<http://www.jag-lovers.org/xj-s/book/FanClutch1.html>

And there are photos of the guts of a 4-bolt fan clutch at:

<http://www.jag-lovers.org/xj-s/book/FanClutch.html>

OPERATION -- 1-BOLT CLUTCH: The 1-bolt fan clutch is a study in simplicity; the hub that is bolted to the pulley is a simple disk inside an aluminum housing filled with thick goo. There aren't even any bearings; the disk itself serves as a goo-lubricated bearing.

FAN CLUTCH CHECKING -- 1-BOLT CLUTCH: It would appear that the only plausible failure mode would be for one of the seals to fail and the goo to escape, and there are reports of such failures; the goo leaves a track on the outside of the clutch and perhaps spattered around the engine compartment. Such a failure should be apparent when turning the fan by hand; either the resistance is “jerky” or inconsistent, indicating some of the goo is gone, or it spins effortlessly, indicating all of the goo is gone.

It's plausible, though, that the goo make break down with time or mileage. Typically, a highly viscous fluid has long molecular chains, and subjecting such a fluid to shear gradually breaks those chains and makes the fluid less viscous; this is one of the reasons you change your oil regularly. If the same thing happens to the goo in a fan clutch, it may lose its effectiveness as mileage is added up even if the seals remain intact. Ed Sowell says, “I am a great fan (no pun intended!) of changing the clutch. It had a very good effect for me, even though there was no external evidence of mine being worn out. It is my opinion that the commonly cited fan clutch tests are meaningless.”

OPERATION -- 4-BOLT CLUTCH: The later 4-bolt fan clutch is a thermostatic type, meaning it engages more firmly to blow more air when the air coming through the radiator is hot. As opposed to the simple 1-bolt fan clutch, this thing is remarkably complicated. It functions by having a chamber at the front, divided from the driving impeller by a panel. When the engine is cold, two thermostatic elements -- one obvious coil on the front and a simple bimetal strip inside -- conspire with centrifugal force to move the goo out of the impeller area and into this chamber, thereby largely disengaging the clutch. When it gets hot, the thermostatic elements allow the goo to move back into the impeller area, providing a firmer engagement and faster fan speed.

FAN CLUTCH CHECKING -- 4-BOLT CLUTCH: If the problem isn't obvious (totally seized, freewheeling, etc.) it's very difficult to tell when a thermostatic fan clutch is bad. How it feels when turned by hand depends largely on how hot the clutch was when the engine was last turned off, since the goo won't move from chamber to chamber when the engine isn't running. Just playing with it when cold can move some of the goo around, causing it to change feel while you're studying it. Reportedly the best indication the clutch is bad is that the car is running hot in stop-and-go traffic -- although, obviously, that might be caused by any of several other problems. Typically it's when the owner can't find the problem and replaces the clutch in desperation and the car quits overheating that we learn that the clutch was bad.

The thermostatic clutch may be complex, but it still involves thick goo -- and therefore the goo may be subject to the same molecular breakdown as that described for the 1-bolt clutch above. Hence, it may make sense to replace it every x miles (perhaps every 60K miles or 100Km) whether it looks bad or not.

Of course, if the clutch is completely locked up, it's shot. This is often the result of a bearing failure; the 4-bolt clutch has a single ball bearing in it. Some people are tempted to continue driving with a seized fan clutch, because it moves so much air and keeps the engine cool. However, it is not recommended for three reasons. First, it makes a lot of noise. Second, it uses a lot of energy, enough that you will be able to notice a drop in fuel economy if you're following the numbers closely. And third, if it's the plastic fan, it's likely to come apart since the fan will be turning a lot faster than it is intended to. When a couple of plastic blades bounce off the bottom of your hood and leave a nice dent, you'll wish you had sprung for a new fan clutch.

There is, believe it or not, at least one more failure mode of this fan clutch. Marty Sullivan had the bearing fail in his fan clutch so it didn't hold the fan centered properly. At highway speeds the unbalance vibrated the entire car. This was tricky to diagnose since it looked OK when the engine was off and felt OK when turned by hand; it was only by watching it wobble at idle you could figure it out. Of course, this problem is likely to damage the fan support bearing if not corrected quickly.

The difficulty in determining whether a fan clutch is operating properly is just one reason why replacing the belt-driven fan with an electric fan as described on page 219 makes sense. You can easily tell when an electric fan is operating properly.

FAN CLUTCH REPLACEMENT: If it is determined that the fan clutch is a problem, there are several possible courses of action: the fan clutch can be replaced with a new one; it can be replaced with a substitute; or the entire belt-driven fan scheme can be chucked and electric fans installed. Your local parts shop is unlikely to carry a Jaguar fan clutch, so you will have to consult a Jaguar parts supplier (and spend some serious cash) to exercise that option. Substitutes are discussed below. Replacing the belt-driven fan with an electric fan is discussed starting on page 219.

Of course, you could bolt on a fixed or flex-blade fan and eliminate the fan clutch altogether. However, this results in slightly worse fuel economy and a considerable amount of noise (whine). Most would consider the noise unacceptable in a car such as the XJ-S.

The electric fan is probably the best overall solution, and will result in better fuel economy and more power. There may be slightly more noise at idle (depending on the fan you use), but much less noise at higher RPM. It is unknown why Jaguar doesn't use this system to begin with; perhaps they don't like the sound an electric fan makes. Or, perhaps they wanted to minimize the use of Lucas and Bosch components.

FAN CLUTCH INSTALLATION -- ONE-BOLT TYPE: Graeme Adamson says, "I replaced the fan clutch several months ago. Having done it one before, I figured I was an expert. Only problem is, second time round, I didn't fasten the nose bolt tightly enough, nor did I use Loctite on the thread. As a result, I was driving home one day when I heard a "clatter clatter" sound. Switch off real fast, but the damage was done - the bolt had come out and fallen down the shroud, and the fan and clutch had spun off into the radiator.

"As it happened, the clutch was fine, I happened to have a spare fan, and I had to pay to have the radiator replaced."

FAN CLUTCH INSTALLATION -- FOUR-BOLT TYPE: Dan Jensen suggests that, when reinstalling the fan clutch, "Use nyloc nuts on the fan-to-pulley studs. It is a real pain to install both a lock washer and nut on the end of the four studs with *very* little clearance. Having just a nut to worry about dramatically lessens the problem. I have never had them come loose in any of my three Jags."

FAN CLUTCH SUBSTITUTION -- ONE-BOLT TYPE: The early XJ-S, from introduction through 8/79, was fitted with a fan clutch, part no. T55C, with a single bolt on the front to hold it on. These also used a metal fan blade, C39831.

Mike Morrin notes: "The early XJS fan clutch appears to be identical to the unit used on a Rover 3500 SDI. This might

not be very helpful in the USA, but they are relatively common in the UK and some other countries. When the fan clutch on my XJ-S was found to be seized, I bolted on the Rover part (no modifications) and have had no problems. The Rover plastic fan is different to the Jaguar's."

It *might* be possible to retrofit the later type clutch EAC4751 and plastic fan EAC3265 (or the substitutes suggested below) to the earlier XJ-S by purchasing the pulley EAC3438 and the bearing EAC3437. You might also need bushing EAC4382. The question is whether or not the bearing housing is the same, or will at least position the fan properly.

FAN CLUTCH SUBSTITUTION -- FOUR-BOLT TYPE: Later XJ-S's used a fan clutch that mounts with four bolts to the front of the drive pulley. This is the prevalent style on US automobiles, leading one to consider the possibility of low-cost substitutes. However, the fan clutch market is full of niggling little details, so one must check several dimensions carefully to make sure a substitute will fit:

- A) The pilot hole in the center of the shaft must fit snugly around the stub in the center of the mounting flange. A hole too small won't go on, and a hole too big won't center the shaft properly.
- B) The mounting bolt pattern must be workable. This generally isn't too critical, because they all seem to use four bolts and the aftermarket clutches provide radial slots to fit nearly any pattern.
- C) The shaft must be of comparable length. Too long will press the fan into the back of the radiator. This dimension doesn't need to be exact, merely close enough to prevent interferences and keep the fan within the shroud for maximum efficiency.
- D) The bolt pattern for mounting the fan to the clutch must match.
- E) If the fan has a recess for the clutch housing, the clutch housing must fit within the opening.

The auto parts houses normally have a cross-reference chart that lists the above dimensions for the fan clutches available. If you compare the clutch from your car to their chart, you can determine what can be used.

If you find a clutch that is suitable except the pilot hole is too big, it would be a simple matter for a machine shop to fabricate a bushing to adapt. Some Jaguars come with such a bushing, EAC4382; perhaps this bushing can be used to adapt an aftermarket clutch. Its ID is 5/8", OD is 3/4". Michael Neal suggests you be sure the bushing is correct and necessary before pressing it into the clutch, since it can be difficult to remove.

David M. Johnson found a substitute, a Hayden 2747. "This is a Ford/GM heavy duty clutch, all the dimensions match except it is a little longer, i.e. the clutch bolts on directly with *no* modifications. The existing fan will bolt directly to the clutch. The advantage of this clutch is that it will turn at 90% of the pulley RPM. The standard duty units only turn at 75% of the pulley RPM."

Now, if you have replaced your yellow fan with the later design black plastic fan -- or wisely plan to (see the section on fan cracking on page 214) -- Johnson has bad news: "The two fans (yellow and black) are interchangeable if you have the original Jag fan coupling. The GM fan coupling I stated was a replacement only works with the yellow fan because the centre boss is a larger diameter (approx 7.5 inches). The black fan is OK with the jag clutch coupling, but will not fit the GM fan clutch substitute, because the black fan centre boss is only 6.5 inches diameter, i.e. the GM fan clutch fouls with the fan blades. I went out this weekend in search of a clutch coupling for the black fan, but cannot get an exact match with the Jag original, because all the ones that fit the bolt holes and centre boss are more than 6.5 inches in diameter." Understandably, the original style fan is no longer available, so obtaining a new one of the crack-prone design is not an option.

Of course, another option would be to find a fan from some other car and make it fit the clutch and the car. One possibility: the XJ6 fan! This fan looks just like the original white XJ-S fan, complete with the hub that provides enough space for a substitute clutch, but the OD is larger -- 17-3/4" as opposed to the 17" fan used on the XJ-S. So, you'll have to trim 3/8" off the tip of each blade and then rebalance it.

Another possibility may be to modify the later design black plastic fan. The design of this fan involves a plastic cylinder with the blades protruding outward, but the blades also protrude inward perhaps a half inch. It's these inward-

protruding stubs that cause the interference with the larger generic fan clutches. Emile Desroches reports that carefully marking and trimming these stubs will permit fitting the Hayden 2747 clutch described above: "I used a Dremel "MotoTool" which is a small hand held grinder designed for hobby work and a small circular saw blade, but it can be done with a sharp knife or a file if you're patient. This procedure takes about an hour. I feel the results (needle well below N) are more than worth the grief of the installation."

Another alternative for using a non-OEM fan clutch: You can usually find a way to use whatever fan was originally designed to mate to the clutch you are using -- which means you don't have to restrict yourself to clutches with the same fan bolt pattern. A procedure is described below.

1. Go to your local junkyard and buy a fan that fits the clutch, basic Ford or Chevy; preferably with unequally-spaced blades (reduces whine) and preferably with aluminum blades (easier to cut).
2. Trim the tips of the new fan until it is the same diameter as the original. After cutting, round the corners and file the edges for safety.
3. Bolt the sucker together and check for interferences. Noted possible interferences include the water pump pulley and an oil line across the bottom. The oil line may be bent and repositioned, or both interferences may be corrected by trimming or notching the blades. Obviously, trim all blades exactly the same way. It's helpful to cut out a cardboard template the shape of one blade and use it to mark each blade for trimming.
4. Remove the fan from the clutch. Set the fan on razor blades centered on opposing bolt holes to check the balance. Trim a little metal from the blades on the heavy side until it balances. Rotate 90° and balance the other way. Make sure it balances both ways when completed.

A fan clutch that has the same pilot hole diameter, a slightly longer shaft length, and a different fan bolt pattern was found at AutoZone. It is made by Imperial, part number 215038. Since the offset of the mounting flange of the junkyard-purchased fan was less, the fan blades themselves end up in exactly the same place. The longer shaft also makes it a lot easier to get the mounting bolts in. It is believed this clutch, with a modified fan from a junkyard, will fit all the XJ-S's from 8/79 on.

Since the aftermarket clutch was designed to turn a 19" fan while the original turned a 17", the aftermarket clutch engages more forcefully than the original. This assembly will therefore make more noise (whoosh) than the original. But it will *reliably* keep the engine cool.

Some aftermarket fan clutches come with a lifetime warranty. But even if yours doesn't, you still can replace it much more easily next time, since you will already have a suitable fan and/or bushing.

FAN BEARING: The fan on an XJ-S is mounted on a dedicated bearing instead of on the water pump as in most front-engined RWD cars. The bearing appears to be similar to those found in several types of water pump, except the shaft on one end is too short to mount anything on. Perhaps a suitable water pump bearing can be found and the unused portion of shaft cut off (be careful not to get the shaft too hot and damage the seals!). Since finding the bearing itself may be hard, perhaps the most expedient procurement method would be to buy a suitable rebuilt pump, remove the bearing, throw the remains of the new pump along with the shot Jag bearing back in the box and return it for the core refund. Some rebuilt pumps available in auto parts shops are *really* cheap.

A better alternative is to chuck the engine-driven fan and install an electric fan as described below.

IDLER PULLEY BEARING: The repair manuals indicate that the idler pulley for the fan drive belt is attached to its support arm with a nut within a recess on the back side. On the author's '83, the assembly looks just like the pictures except there is no nut; the end of the shaft is flush with the surface within the recess. Apparently the bearing itself is not intended to be replaceable; the parts suppliers offer only the entire arm/pulley assembly, EAC8097.

Bernie Embden reports that the early arms were made of aluminum; later idler arms are iron. Bernie's car is a '78 (and

has a nut), so apparently the early design was used at least that late. Mike Morrin has two early cars and one has a nut and the other does not, but both have aluminum arms, so there are apparently at least three configurations: Aluminum with nut, aluminum without nut, and iron without nut. "The 1980 XJ-S parts catalogue shows the part number of the assembly as being C39875, with no separate part numbers for the pulley or arm (and no nut)." This might be the aluminum without nut part number, with the EAC8097 reflecting the change to iron.

Daniel Pontes had a shot bearing in the idler pulley, and rebuilt the water pump thinking that's where the noise came from. "This pulley mounts on the water pump so a stethoscope is useless. Disconnecting belts and running the engine is also a waste of time. The only way to track the source is a manual shake with your hands on each and every pulley.

"A few phone calls later I find out that this pulley is very costly and very hard to come by. Since it is only the bearing that goes I thought it should be no problem to put a new one in. Yea right!! My fix-

1. find a new FAG bearing # W52315-1.
2. Have your machine shop press out the old bearing out of the pulley, mark which side faces the front.
3. The shaft is only peened onto the arm, it comes out easy enough.
4. The new bearing has a long and short shaft on either side of the outer race. This is a water pump bearing and the shaft is the inner race.
5. Have the machinist chuck the long end into a lathe and dress the short shaft to fit into the idler arm.
6. Press the pulley back on with the front side facing the front.
7. The goal is to get the pulley as close as possible to the arm without rubbing.
8. Press the pulley with the new bearing into the idler arm.
9. *Do not peen this bearing onto the arm. It will break.* TIG weld it into place-- it can always be drilled out if it fails again.
10. Cut the long end of the bearing shaft as close as possible to the outer race of the bearing and dress it .
11. Install your new idler."

Of course, welding is not likely to be good for the seals and lubricants within that bearing or the temper of the shaft -- and would be especially difficult if the arm is aluminum. Perhaps while the machinist is working on dressing that shaft, he can provide a retention scheme -- like threading it for a nut.

Note that the fan clears the front of this assembly by only a small amount, so it may be advisable to check the clearance of the new assembly by spinning the fan around by hand *before* starting the engine.

Michael Aines wrote: "I have had 2 of these go out in 115,000 miles. My last replacement came from Welch Enterprises. It is not the original part, and requires some fiddling to install. However, it has a replaceable bearing, unlike the original, so not only is it cheaper to buy, it can be repaired even more cheaply in the future."

This may start sounding like a broken record, but rather than repair the idler bearing, you might consider tossing the entire engine-driven fan scheme and installing an electric fan as described below.

ELECTRIC FAN SUBSTITUTION FOR BELT-DRIVEN FAN: The best solution for fan clutch problems, cracked fan blade problems, and idler pulley problems is to install a large electric fan (or two large electric fans) and remove the fan, clutch, mounting assembly (shaft & bearings), belt, and idler pulley altogether -- and perhaps the little stock electric fan as well. The Jag V12 is a hot beast, so the biggest electric fans that will fit should be used; a single 16", dual 14", etc. One benefit: we have all heard stories about how much power the belt-driven fan uses or even how much the belt itself uses, but the 16" electric fans typically draw about 10 amps -- meaning they use only about 1/8 horsepower when

they are on. And if you control them properly, they're not on when not needed.

There are lots of places to purchase electric fans. Most local auto parts stores carry them, as well as J. C. Whitney (page 694). Some of the best selections are from Jeg's (page 717) or Summit Racing (page 720). Harry Trafford points out there are at least two retailers on the www that specialize in electric fans:

Fluidyne: <http://www.fluidyne.com/>

Scotts Cooling Fans: <http://scottscoolingfans.com/> 1-800-272-3267

If you are shopping for a new fan, note that the Imperial brand electric fans are reportedly unreliable; you'd be well advised to avoid that make. Ed Hyatt: "I have had two Imperials fail and the problem was the glue that they use to hold the magnets to the case. The glue fails and the magnet attaches itself to the rotor, shorting out everything and blowing the fuse."

Also note that Hayden 16" fans come in two models, one with considerably higher airflow than the other. The high airflow model has comparable airflow to most other aftermarket 16" fans, but is more expensive than most. The lower airflow model is comparably priced with the others, but its airflow is pathetic by comparison. Haydens are reportedly very quiet, though, perhaps due to their sickle-shaped blades. One more concern here is that the two different models are visually almost identical, and on store shelves it's entirely possible that someone has switched fans around in the boxes in order to get the high airflow fan for the lower price -- leaving you to pay the higher price for the low airflow model without even knowing you're getting gypped.

One thing to look for in electric fans: a grille to keep your fingers out of it. Some have it, some don't. If you're the kind of person that worries about such things, you might want the grille. The rest of us most definitely do *not* want the grille, since it reduces the airflow by a considerable amount.

Peter Cohen offers another possibility: "Went shopping in the wrecking yard the other day. I came home with a 16" electric fan from an '83 Buick Regal (\$20). This fan has a ring on the outer edge that is attached to the fan blades, and rotates with it. It is secured by three metal rods that go from the motor housing to two points on the lower radiator support brace, and one to the upper support brace. Interestingly, it also uses a ballast resistor, and 3 wires. One wire is ground, one goes through the ballast resistor, and one bypasses the ballast resistor, presumably to make a two speed fan." This author visited his local junkyard and found similar fans in a Delta 88, a LeSabre, and a Toronado, except that they had plastic support structures instead of the metal tripod. All had the same resistor arrangement for two speeds. The key is apparently to look for large FWD GM cars with a transverse-mounted V6, but note that the exact same fan can also be found on the V6 Pontiac Fiero. Smaller FWD GM cars have a 14" electric fan, and RWD GM cars use belt-driven fans. The GM electric fans are not very compact; the total depth is around 5 inches, as compared to about 3 inches for a typical aftermarket electric fan, but once the stock belt-driven fan and support are removed there is plenty of room in the XJ-S. Tip: take a 10mm socket and ratchet with you to the junkyard. Note: the GM fans do not have a grille to keep fingers out.

When you buy an electric fan from a reputable junkyard, they will typically mark it. That way, you can take it home, test it and see if it works properly, and bring it back if it doesn't and exchange it for another. This is actually a better policy than some stores that sell *new* parts, since many places have a no-return policy on electrical stuff. Needless to say, you are advised to test any and all electric fans as soon as you can, perhaps using jumper cables; you don't want to fabricate shrouds, bracketry and wiring and *then* find out the fan doesn't work.

Electric fans can sometimes be mounted on the front of the radiator (if you can deal with the diagonal strut on the XJ-S), opening up considerable working room in the engine compartment. Many aftermarket fans are designed to be installed on either side of the radiator; to mount in front, typically the blade must be removed, turned around, and reinstalled, and the wiring must be reversed to run the motor in the "blow" direction rather than the "suck" direction. Note that a fan on the front side and blowing should have a minimal shroud so as not to block air flowing into the radiator due to vehicle motion, but a fan on the back side and sucking needs a larger shroud to draw air from a large area of the radiator. The shroud that's integral with an aftermarket electric fan is usually inadequate for use on the back side; what's really needed is a rectangular shroud to cover the entire radiator -- or, if multiple electric fans are used, an entire section of the radiator.

Installation of electric fans requires more thought than simply slapping a fan in there. For example, consider the space between the A/C condenser and the radiator: with a blower fan in front, the air might come through the condenser, go sideways within this space, and come back out forwards through a different part of the condenser -- providing excellent A/C but leaving the engine uncooled. Similarly, a sucking fan can pull air from the engine compartment through the radiator backwards, across the space, and back through the radiator to the fan -- leaving the A/C condenser without airflow, and eventually overheating the engine from recirculating the same air over and over. If the space between the condenser and radiator is open to outside, things get even worse. In the XJ-S, one tempting possibility is to mount one 16" electric fan in the existing shroud on the right side of the radiator (replacing the stock belt-driven fan), and a second 16" fan on the left front of the radiator blowing through the A/C condenser; this would make sure that both coils get airflow. Another possibility is to just replace the belt-driven fan with an electric and leave the small electric fan and the entire shroud assembly as stock.

John Napoli went this latter route, and reports on the process: "Removing all the stock stuff is a bit of a pain -- there is not much room to work, the process is iterative -- but it all comes out. You'll have to replace a couple of the water pump bolts that went through the idler pulley bracket with shorter bolts. Remove the radiator while you are at it to clean out the leaves in between the rad and the condenser -- I seem to recall that if you pull the rad first it is easier to get out the stock fan.

"I kept the stock electric fan and added the second inside the shroud of the old mechanical fan. The fan shroud is split from the factory (little fan and big fan) so this is real easy. I used an 'S' bladed fan from a Hot Rod supplier - 1-800-str-rod or some such - it is the largest one they had (17" or 18"). Any fan of similar size should be fine; you can get them from Pep Boys or JCWhitney. Be sure to run the fan before installing it. Some are out of balance. Mine was, and you would not believe how annoying it is! I had to balance the blade (wrapped solder around the light spots and used weatherstrip adhesive to lock it in place) but it would have been better to start with a perfect unit.

"I made brackets to hang it off of the stock shroud. It fits in there nicely and the underhood appearance and access is improved. *Do not* under any circumstances attach the fan to the radiator core with those silly little plastic thingies! The Jag radiator is softly mounted to absorb vibration. Use those shortcuts, and the new fan will quickly work loose.

"Performance has been fine as measured on accurate mechanical water temperature gauges. I like overkill, though, and may some day add one or two little pushers in front of the condenser." Note: a better way to evaluate fan adequacy would be to measure the temperature of the *air* coming through. A marginal capacity fan may keep the coolant within limits but the air coming through the radiator will be really hot, while an excessive amount of airflow will reduce how much the air heats up. Of course, comparisons would have to be done on similar days with the engine running under similar conditions.

This author also installed a 16" electric fan in place of the belt-driven fan, but went a slightly different route than Napoli. Rather than adapting an electric fan to the opening in the existing shroud, a new section of shroud was fabricated. This is remarkably easy, since the XJ-S shroud is actually two sections, with the left 1/3 containing the small electric fan and a set of flaps while the right 2/3 has the hole for the belt-driven fan. By keeping the left 1/3 but making a new right 2/3, it was possible to provide a hole the correct diameter to fit the electric fan. The right 2/3 piece of the shroud was made at a sheet metal shop by merely folding three sides of a flat piece of sheet metal, and cost \$20. There are photos of this installation on the www at

<http://www.jag-lovers.org/xj-s/book/ElecFan.html>

Duncan Williamson: "I dumped the fan clutch / fan from my car and used a pair of electric fans from a Honda (I think it was an Integra). They came complete with the plastic mounting frame which is the same size as an XJ-S radiator. The whole assembly is attached to the radiator frame with 6 large nylon ties. I also picked up the thermostatic switch and soldered it into the bottom of the radiator (near the bottom hose). I now have really good cooling in traffic and the whole fitting exercise took about half a day. The fan motors are very flat so fitting/clearances were not a problem. They cost next to nothing, look very tidy and may well be a viable option."

If you are removing the stock mechanical fan bearing support, you will need two studs 4-1/4" long with 5/16"-18 (coarse) threads on one end to continue to hold the water pump properly. The other end of each stud can be either coarse or fine thread, since it gets a nut and you can use whatever nut matches. Good luck finding such studs!

Alternatively, you can use threaded rod cut to length, or you can cut the original stud shorter and thread it. Or, you can just stack washers on the existing stud if you don't need clearance in the area for the motor on your electric fan. You will also need two 5/16"-18 bolts 1" long, but those are easy to find.

Even though the addition of an electric fan may reduce the total hp drain on the engine, it will definitely add to the load on the alternator. If you have a Lucas alternator with 66 or 75 amp capacity, this mod may push the total electrical load over the alternator capacity; when the A/C compressor kicks on and brings on both electric radiator fans with it, the system voltage drops and the lights dim. Hence, it might prove necessary to replace the Lucas alternator with the later 115-amp Bosch (see page 574) or a 100+ amp GM (see page 576) to maintain voltage under all operating conditions.

CONTROLLING ELECTRIC FANS: Electric fans can be controlled by either of several mechanisms. The simplest method is to wire the fans to run whenever the ignition is on. This is wasteful, however, since the fans are only needed when the car is standing still or moving slowly. It also may cause the engine to run cold, or take too long to warm up, in cold weather.

The electric fans could also be connected to the existing electric fan control system, which automatically operates when the engine is hot or when the air conditioner compressor is operating. Note that replacing the single tiny fan with a couple big ones requires more electrical work than simply installing a larger fuse in the #1 position in the headlight fusebox; the stock wiring, even if it doesn't burn up, will provide too much resistance and the fans won't run as fast as they should. Some suitably heavy wiring should be run from the bus on the firewall to the new fans, using a separate relay for each fan. Napoli: "I wired the new fan simply: I added a relay that is picked up by the stock (ie, little) fan coming on. The power for the new fan is routed through the relay from one of the 12 volt feeder wires located near the relays at the upper rear corner of the right fender. You can get fancy and route alternative feeds from the A/C compressor or a dashboard switch, but if you do you may need a diode to prevent backfeeding something else."

Yet another possibility is to add another fan switch into the coolant system. Jaguar makes a suitable housing for a switch for the Mk III E-type, C34005, that fits into a radiator hose, or maybe you could get lucky and find a switch that will fit one of the unused ports in the water rails on top of the heads. Or, there are switches sold for electric fans that just strap to the outside of a pipe, so you could just attach it to one of the coolant pipes -- or oil pipes, for that matter. With any such switch, one of two fans can be connected to the stock wiring and the other to a separate switch. This would result in the two fans operating separately, and only one running when only a small amount of airflow is needed (since one fan will always come on before the other). The dual circuit also provides a measure of redundancy, since one of the fans would provide some cooling in the event of the failure of the other circuit.

The fans could also be controlled via an air temperature sensor in the air coming through the radiator. This method is often used by the aftermarket fans, providing a switch that mounts right on the fan housing. Note that if the fans are mounted in front of the radiator, the sensor must be moved to behind the radiator to work properly. This method scares me, since I always wonder what would happen if there is no air coming through the radiator -- like, the car is stuck in traffic and there's a slight breeze from behind.

Yet another control system would be to provide a "paddle" switch that shuts the fans off when the airflow due to car motion is adequate. There don't appear to be any such items commercially available, but making one would not be difficult. A pivot with a paddle on one side and a tiny counterweight on the other, balanced to eliminate inertia effects, could be installed in the area behind the front grille. The arrangement could be rigged to operate a conventional microswitch with contact ratings sufficient to operate the fans directly, or a relay could be incorporated. Using an ohmmeter or a light bulb, the car can be tested and the switch adjusted until it operates at a suitable speed, about 30-40 mph. This system would still operate the fans when the engine was cold, but would function properly with the air conditioner; the air conditioner requires airflow when running even when the engine is cold, but the motion of the car above 30 mph will be adequate; turning the fans off is OK.

Finally, remember that you can use a *combination* of the above schemes; for example, you could use a paddle switch along with a temperature sensor to prevent the fan from operating when moving fast *or* when the engine is cold.

If the control scheme used allows any possibility that the fans will be off when the car is idling, be sure to incorporate circuitry to run at least one fan (preferably *all* fans) whenever the air conditioner compressor is operating (similar to the

present wiring for the small stock electric fan). On some later XJ-S's, the small stock electric fan does *not* come on with the compressor, but remember that this is assuming a belt-driven fan that is always turning; regardless of the stock wiring, if the belt-driven fan is removed you *must* provide fan operation when the A/C compressor is engaged, regardless of engine temperature or outdoor temperature.

One final note: another nice feature of electric fans is their ability to run after the engine is shut off. The biggest heat problem in the XJ-S is heat soak after shutdown. The small electric fan already can provide some relief if the coolant is hot enough for it to be on when the car is shut down, but having multiple electric fans and multiple control schemes provides more possibilities for addressing this issue. It might even make sense to provide an air temperature sensor at the upper rear of the engine compartment to control post-shutdown fan operation. Or, maybe using a hot-start sensor in the fuel rail to control a fan would help with hot starts *more* than the way it's normally used (to alter fuelling).

ELECTRIC COOLING FAN: Here we're talking about the small OEM electric fan, not the replacements for the belt driven fan described above. Yes, the original Bosch fan is atrociously expensive. But it doesn't do anything any other 12V, 11" diameter electric fan won't do; substitutions are in order. Ideally, you'd like to include a system of rubber mounts, similar to the Jag originals, to minimize noise.

One possibility is to buy the 11" electric fan from J. C. Whitney, 38xx3020A, remove the fan/motor from the shroud it comes in and figure out how to mount it. Depth won't be a problem, it's really flat. But you don't really have a good opportunity to look at it before you buy it to decide if you can make it fit.

John Himes says, "I am using a Hayden pancake style fan & motor. Their 12" model fits inside of the current shroud for the 11" Bosch fan. There are four mounting points on the Hayden that I had to remove. I used a few self-tapping screws to secure the fan inside of the shroud. It has been in use for three years or so with no problems."

If you'd rather shop at the junkyard, a Subaru fan will work with minor blade trimming and a homemade mounting adapter plate. In fact, there are probably dozens of electric fans from small cars that can be used here. Many small Japanese cars come with two small electric fans, one that's standard for the car and another that comes with the air conditioning option -- and these two fans are different, giving you two options from the same car.

Alex Dorne fit an electric fan from a Saab 900 Turbo and says it "replaced, and even looked better, than the original when in place. The diameter was perfect, giving about 1/4 of an inch air around the propeller. And after removing a metal protective ring around the prop I could use what was left of the mount and bolt the fan to the shroud using the upper rh and lower holes. I also think this fan flows more than the original since it's designed to cool a Turbo engine all by itself."

"The Turbo fan motor is flatter than on the non-Turbo because the lack of space between the radiator and the engine... the flatter design leaves even more space between the fan and the engine in the Jag than the original fan did."

The author used a fan from a Mercedes sedan of some sort. This was a "puller" style fan, but in the Mercedes it had been installed in a "pusher" location, in front of the radiator. It was the only fan cooling the Mercedes; small but extremely powerful, far more powerful than the OEM Jaguar fan. It was also very ruggedly constructed. It did require some bracket fabrication to hold it in place.

Duncan Smith says, "UK list subscribers may be interested to know that the fan from an MGB will fit with only a couple of minor mods (the shaft needs shortening and a hole drilling through it). The substitute fan was £40.

"One (big?) drawback is that the rear of the motor housing is open, unlike that on the Jag motor (not that its being sealed protected mine from corroding and finally seizing!). My mechanic sealed it up with tape which he swore would be good for the life of the car (maybe he's dropping a hint ;-). I am not entirely convinced, but given the price of the Jag part and the age of my car I am not too bothered..."

John Goodman reports that the XJR-S has a different 11" fan than the basic XJ-S: "Seven blades high CFM part no. EBC 4553. No part no. listed for the fan shroud so would imagine it could be retrofitted." You can draw your own conclusions about why Jaguar would go to the effort of providing a different fan.

ELECTRIC RADIATOR FAN SWITCH: There are apparently at least three different switches that have been used in the XJ-S. Up through VIN 101854 (mid-'79), switch EAC1322 pressed into a rubber grommet in the water pump inlet. I think this type of switch is called an "otter switch". From VIN 101855 to VIN 151087, switch EAC2510 threaded into roughly the same location on the pump inlet, so clearly the pump inlet was changed to provide a threaded hole. After VIN 151087, switch DBC2145 was used. It is unknown what the difference between the last two switches is, since they both fit into a threaded hole; perhaps they turn the fan on at different temperatures. Peter Cohen says, "The thermal fan switch from my '89 XJ-S says 85° C. It also says 909-6 and EAC2510."

The difference between EAC2510 and DBC2145 might also be in the connector styles. Cohen reports: "Beck-Arnley lists the same part number for the 85-91 XJ-S V12 as for the 88-90 XJ40. This part is actually an XJ40 part. It has two wires that are potted into the switch itself, leading to a cylindrical plastic connector (2 inches long by 1 inch diameter). This part can be used in the XJ-S V12 by cutting off the connector, and attaching blade connectors to the switch wiring. This part *may* also be correct for the 92-96 4.0L XJS 6 cyl.

"The Jaguar dealer quoted \$122.50 for the XJ-S switch. The Beck-Arnley part is just under \$30. Here are the catalog listings for some other sources for XJ40 fan switches that should be in the same price range:

Beck-Arnley	
XJ40 and 85-91 V12	201-1151

Four Seasons (Division of Standard Motor Parts)	
XJ40	36538

NAPA	
88-90 XJ40	FS-222

Note that the original switch has connectors right on it -- which is a real pain to get the spade connectors on and off of. Since this XJ40 switch has wires that you put spade connectors on the end of, it should be easier to connect the harness to.

Would the XJ40 switch replace both the DBC2145 and the EAC2510? Unknown. However, Cohen claims the elbow itself, EAC3195, apparently didn't change, so it should thread in.

If you have an early car, do you really want to put in a new otter switch? Well, if it were my car, I wouldn't. Instead, I'd consider buying a new pump inlet EAC3195 (or threading the hole in the original inlet where the rubber grommet went) and fitting the later switch. Failing that, it may be possible to wrap a piece of bailing wire around the inlet elbow to securely hold the otter switch in place, but make sure that the bailing wire doesn't short out the connectors on the switch.

ELECTRIC RADIATOR FAN RELAY: As mentioned on page 563, the electric radiator fan relay is an SPDT relay (red to indicate it's different), meaning it has a central fifth terminal labelled 87a - a NC contact. In this particular application the 87 contact is 12V power and the 87a contact is connected directly to ground. As a result, if a relay with two 87 terminals or one 87 and one 87b terminal is plugged in, a direct short will result and fuse #1 in the headlamp fusebox will blow immediately.

The NC contact shorts the fan motor to ground when not operating. It's not known why Jaguar did this. If a 4-terminal relay that has no center spade terminal is installed, the system seems to work fine; the fan operates normally when on, and the fact that the fan is not grounded when off doesn't seem to make any noticeable difference. However, it seems unlikely that Jaguar would have gone to the effort of supplying the grounding circuit without a good reason.

ELECTRIC FAN DIODE PACK: The blue item mounted on the top left side of the engine compartment just rearward of the diagonal strut looks like a relay, and has the same spade terminal layout as a relay, but it's not a relay at all; it's the diode pack for the electric fan. The terminals are numbered simply 1, 2, 3, 4, and 5. You can easily pry the box open

with a small screwdriver and inspect the layout inside.

Diodes merely allow current in one direction only. When testing this pack, you should be able to get current to flow from terminal 3 to terminal 1 but not the other way around. You should also be able to get current to flow from terminal 5 to terminal 4 and from terminal 2 to terminal 4, but not the other way on either. This description uses the accepted definition of current as flowing “from” a + terminal to a - terminal. Note that some meters may not incite a diode to flow in *either* direction when set to a standard ohmmeter setting; if the meter does not have a setting for testing diodes, it might be better to use a battery and a light bulb to test.

In case you haven't developed a healthy disrespect for Lucas engineering yet, here's another example of their handiwork: the wires that connect to terminals 1 and 3 are both GN, but they are different and you'd better not mix them up! Likewise, the wires that connect to terminals 2 and 4 are both LG, but don't mix those up either!

If you've already disconnected them and gotten confused: on the author's '83, the GN wire that connects to terminal 1 is actually two wires attached to the same spade connector, while the GN that connects to terminal 3 is a single wire. Likewise, the LG wire that connects to terminal 2 is actually a pair of wires, while the LG that connects to terminal 4 is a single wire. Here's hoping other cars are the same!

I will describe more elaborate tests, in case the above proves inadequate. If you apply 12V to a GN wire and the electric radiator fan starts running, that wire connects to terminal 1. If the clutch on the A/C compressor engages, it connects to terminal 3. If the engine is cold and you turn the ignition on and read 12V at a LG wire, it connects to terminal 2; if not, either a fuse is blown or it connects to terminal 4.

Just when you thought you had these things figured out, Jaguar goes and does something totally unexplainable. Michel Carpentier reports on the diode pack in his Daimler Double Six: “The blue box is clearly the same as described in your book: one diode with anode in 3 and cathode in 1; two diodes with anodes in 2 and 5, common cathode in 4. But it provides the logic for the headlamp wash/wipe system. 2 is connected to a blue/red wire (high beam), 5 to a blue/white wire (low beam), 4 goes to terminal 85 of the wash/wipe relay via a blue/red wire. 1 has a green/blue wire going to one of the washer pump terminals. 3 has two green wires, live when ignition is on. Terminal 86 of the headlamp wash/wipe relay is connected to the other terminal of the washer pump (common to windshield and headlights) and to the windshield washer switch. When you push the windshield washer switch, terminal 86 of the headlamp wash/wipe relay is grounded and the pump operates via diode 1/3. If the headlights are off you get normal windshield washer operation. If they are on (either low beam or high beam) 4 is live so the relay is energized: the headlamp wiper motors kick in and valves open, squirting fluid on the outer headlights. Much ado for a perfectly useless gadget!

“Back to the cooling fan. Against the radiator is a small harness which comprises the following: A green/brown wire running from a connector on the RHS of the radiator (said connector linked to A/C compressor clutch) to terminal 86 of the red fan relay. Somewhere in between, this wire is cut and a small PCB (about 30x8mm) holding a diode soldered in, with the cathode towards the relay. Terminal 86 of the red fan relay is also connected to the thermostatic switch by a green/white wire. A black wire connects terminals 85 and 87A to ground. A brown/green wire comes from the main harness on the LHS (live at all times) and goes to terminal 87. Another small PCB (exactly 32x10mm) is also buried inside the harness. It holds two diodes with a common cathode connected to the thermostatic switch by a green/orange wire. One anode has a red wire going to terminal 30/51 and thence to the fan motor. The other anode is connected to the main harness by a green wire (live when ignition is on). This harness is held together by the usual weaving: outwardly there is no way you can tell that it is so electronically sophisticated as to contain 3 diodes!”

Craig Sawyers says, “Curiously, it seems that some detail went into the choice of diodes in the fan control and headlamp wiper circuits (the blue box with four terminals). The diodes are all soft recovery devices, which are specifically designed to eliminate fast voltage spikes when they switch off (caused by junction capacitance in the diode itself). I took the lid off just out of curiosity some time ago, and they are all quite distinctive (BUV something or other). When I looked them up they are quite specifically soft recovery diodes each with different ratings, designed to reduce the transient interference when they switch off. I was quite surprised at the obvious care that had been taken in the choice of components.”

Peter Cohen talks about the later cars: “The facelift model cars have a different setup to the 1991 and earlier cars. The later cars have a completely different diode pack. It will be in approximately the same location. Most relays are

manufactured by Hella or Bosch. If you see a component made by someone other than Hella or Bosch in that general vicinity, it is worth a look. It will have one BG and two LG wires.”

LATE MODEL ELECTRIC FAN OPERATION: Bruce Segal reports: “I believe Jaguar changed the design in 89 so that the fans no longer come on with the A/C compressor.” Wise? Many owners don’t think so, and rewire the fan the way the earlier cars were wired so the small electric fan comes on with the compressor. You can read all about the benefits of optimum airflow through the A/C condenser on page 516.

FAN SHROUDS: The fan shrouds ensure that air drawn by the fans comes through the radiator rather than other places. If the fan shroud is not installed properly and held securely against the back of the radiator, then air from the engine compartment can be drawn in by the fans. This short-circuits the airflow and reduces the amount of air coming through the radiator.

Anytime there are two fans and one may be on while the other is off, it is also important that the fan shrouds provide a separation between the two so that air draw by the running one doesn’t simply come backwards through the non-running one.

FAN SHROUD FLAPS: At the lower left corner of the XJ-S fan shroud are a couple of rubber flaps. These are designed to allow air to flow rearward through the openings in the shroud but not forward. At speed, the air coming in the front of the car and through the radiator merely blows these flaps open. At a standstill, when the fans are trying to draw air through the radiator, these flaps shut to prevent the fans from drawing air from the engine compartment instead.

They’re as simple as they look. If they are damaged or missing, it is easy enough to make replacement flaps from an old inner tube, or even old shoe leather.

FOAM IN AIR PATHS: In order to ensure that air coming in the front of the car goes *through* the radiator, any passages *around* the radiator must be plugged; air would much rather take an easy route, so even a small gap will allow a large portion of the airflow to bypass the actual heat transfer area. Also note that the space between the radiator and the A/C condenser/oil cooler must be sealed all around, so that the fans draw air through the A/C coil and oil cooler rather than in through a leak path. And, of course, air coming in the front of the car should be compelled to go through the A/C condenser/oil cooler rather than sneaking past it as well.

There is a second reason to apply the foam in the nooks and crannies around the A/C condenser and oil cooler. As mentioned on page 202, the space in between the condenser/oil cooler and the radiator itself is often found to be plugged up with debris. While the difference in coarseness between the condenser/oil cooler and the radiator may permit a particular range of grit sizes to get in there, the fact is that this space is usually found to be full of leaves -- far too large to have passed *through* the condenser coils. They can only be getting in there by sneaking through openings that should have been plugged with foam.

Jaguar used foam to plug some of these openings -- a British nonmetallic material. If your radiator seems to have no such foam anymore, Thomas Alberts says, “Most of the mail order places do not carry these "gaskets" (as they are called in the parts book), however they can be purchased from Jaguar dealers for a few bucks. The part numbers (for my 1987 XJ-S) were CAC2321 for the side and CAC3821 top & bottom.”

Alternatively, go to the building supply store and purchase one package of 2-1/4” x 2-1/4” x 42” foam intended for sealing window air conditioners and at least one package (maybe two) of 1/2” thick 3/4” wide weatherstripping foam tape. For the tape, you may have a choice between “open-cell poly” and “closed-cell vinyl”; either will probably work fine. You may also buy a couple other thicknesses of foam weatherstripping while you’re there, just in case.

Doing a proper sealing job is easier if you have a lot of stuff apart in this area. For example, having the fan shrouds removed helps, and having the radiator upper support rail off is also a big help. Ideally, do this job while you have the

radiator itself out. But if you're not doing that kind of work today, don't postpone sealing the openings until you do; do your best with what you can, and if necessary buy some more foam later when you have things apart.

If you have the radiator out, start by applying the foam tape to seal the bottom of the radiator between the rubber support grommets and outboard of the grommets to prevent air from sneaking by under the radiator.

Cutting the 2-1/4" foam with a razor knife, install a piece on either side of the radiator to fill the huge gaps there. Install the foam in front of the radiator itself, beside the A/C condenser/oil cooler. If positioned properly, it will seal against both by fitting snugly against the ends of the A/C condenser and against the front of the header on each end of the radiator. Make sure the pieces stand high enough that the upper radiator support rail sits down on them when installed. The foam can be fit behind the supports for the front bumper crash absorbers all right, but you'll have to end it where the pipes connect to the oil cooler. Then cut a couple more chunks from the remainder of the 2-1/4" foam to fill in the openings *under* the pipes to the oil cooler.

From the remainder of the 2-1/4" foam, cut a piece about 6" long and then cut it lengthwise at a slight angle to create two wedge-shaped pieces of foam. Use these to fill in the space on each side near the top where the 2-1/4" foam wasn't fat enough to completely fill in the space. If you have wiring or hoses passing through here, you can arrange them to go between the pieces of foam so they are nicely supported. You can cut suitable recesses in the pieces of foam to make way for the freon line coming around the top right end of the radiator.

Looking through the lower grille in front of the car, you will notice that there are two more gaps created by the fact that the oil cooler is not as long as the A/C condenser. Cut two blocks of foam and insert them by reaching right through the grille.

There is also a gap between the bottom of the A/C condenser and the top of the oil cooler. This gap should be plugged, even though it never was originally. This seems counterintuitive, since it's directly in front of the radiator and it would seem that plugging this gap would reduce airflow through the radiator. That's not the problem, though; the problem, besides allowing air to bypass the A/C condenser and the oil cooler, is that this gap allows leaves and other debris to pass through and get lodged in the space between the radiator and the oil cooler. This has proven to be a *far* more serious concern for XJ-S owners than any reduction in airflow that might result from sealing this gap. Fortunately, sealing the gap is really easy; just cut a piece of weatherstripping to a suitable length and cram it in there. If you use weatherstripping that's perhaps twice the width of the gap, it'll stay in place just by friction; there's no need for the adhesive on the weatherstripping to stick to anything.

If the upper radiator support rail is off, make sure to seal it against the top of the radiator, against the top of the A/C condenser, and against the top of the fan shroud before reinstalling it. The top of the A/C condenser in particular may have such a huge opening that it doesn't even appear sealable; you may need to stack 1/2" foam tape two or three layers high to fill the hole.

FRONT SPOILER: It's important to have the front spoiler in place. Engine cooling relies on air coming in through the radiator, and it must have a place to go. The XJ-S does not have vents through the hood or out the sides, so all this air must go out the bottom. The front spoiler is designed to direct air either into the radiator or around the sides of the car, and to restrict air from going under the nose of the car as much as possible. This results in low pressure under the car, so the air going through the engine compartment can easily flow out that way.

However, if the spoiler is missing, air can flow right under the nose of the car unimpeded. This increases the pressure under the front of the car, which in turn resists the outflow from the engine compartment. The air coming in through the radiator cannot escape as easily, and builds up pressure in the engine compartment. The resulting backpressure prevents as much air flowing through the radiator. It also tends to cause significant lift on the front end (try multiplying a very small pressure over the entire area of the front half of the car; the total lift can be very large indeed) and can cause the car to "wander" at high speed.

HEATER CONTROL VALVE: See page 495.

Post-Shutdown Cooling

It is commonly acknowledged that the worst cooling problem the XJ-S has is not when running but after shutdown. The small electric fan runs after shutdown if the thermal switch has it running when the engine is shut off, but once the switch cuts out -- which it does all too soon, since it is reading coolant temperature at radiator outlet -- it will not come on again. 700 pounds of hot engine plus hot exhaust manifolds and hot catalytic converters tend to raise the underhood temperatures after shutdown considerably higher than they ever were while running, and there are indications that parts of the engine itself get hotter after shutdown as well.

There are three problems generally associated with post-shutdown heating: Dropped valve seats, hot start difficulties, and heat-stressed engine compartment components. The exact mechanism of dropped valve seats is unclear, but several owners have suffered dropped seats *after* a hot shutdown rather than while running. The other two problems are clearer, and result from the high temperature of the air surrounding the engine -- and all the extraneous components that are heated by the air. Since there is no longer fuel flow in the rail, the fuel sitting in it gets hotter and hotter, causing serious hot start problems that Jaguar has addressed with a couple different types of fuel rail temp sensor providing fuel enrichment. The post-shutdown underhood temperatures are clearly a key cause of deteriorated hoses, brittle wiring, short-lived electrical components, and a host of other traditional Jaguar afflictions.

This section includes several ideas for dealing with the post-shutdown temperatures. Most address primarily the temperature of the *air* within the engine compartment, which may or may not have a significant effect on the temperature of the heads themselves in the vicinity of the valve seats.

HOOD VENTS: Just the ticket for letting the heat rise naturally out of the hood after shutdown. It's a body modification, so it's discussed further on page 473.

ELECTRIC COOLING FAN BOOTSTRAP CIRCUIT: The electric fan includes a "bootstrap" circuit, so that if the coolant is hot enough for the fan to be running when the engine is shut off, the fan will continue to run until the coolant temperature switch shuts it off. Once off, the bootstrap circuit drops out and the fan cannot start again, no matter what.

Other cars -- notably Japanese and other FWD 4-bangers -- have cooling fans that cycle on and off for quite a while after the engine is shut off. Clearly, they are wired so that the fan will run if the thermostat calls for it, regardless of whether the ignition is on or not. It is also evident that they *come* on -- indicating that once they shut off the first time, they may still be needed again. Probably the engine heat soaking through the compartment.

Why did Jaguar provide this bootstrap circuit, rather than just wiring the fan to run when needed like the Japanese cars? There would be two possible results if the bootstrap weren't in there: 1) The fan would never come on after shutting off the first time -- meaning that the bootstrap circuit was unnecessary; or 2) the fan *would* come on after shutting down, which means it *needs* to come on and the bootstrap circuit is contributing to the cooking of the engine parts!

The only plausible explanations: A) Jaguar was afraid the Lucas thermostat would fail in the on position and kill the battery; B) they didn't feel that a fan kicking on and off in the parking lot was in keeping with the proper Jaguar image; or C) they were worried about liability from someone having their fingers in there when a fan came on unexpectedly. Stuart Barnes adds D) "Many car alarms are voltage sensing and although they can cope with a voltage rise (to allow an electric fan to run and then stop) a lot of the aftermarket varieties can't cope with the voltage drop that would occur when the fan came back on."

For those of us who are more concerned with the life of our machines, keep our fingers out of moving machinery as a force of habit, and don't have such alarm system concerns, it might be a good idea to rewire that circuit to run the fan whenever necessary. It's easy to do: On the left side of the engine compartment is a small blue box that looks like a relay, but it's the diode pack (see page 224). Pull the LG wire off of terminal 4 and connect it to a 12V power supply.

There is a 12V supply available at the solid brown wires at the headlight fusebox just a few inches forward of the diode pack.

Note that, if you have headlight washers and wipers, the blue box might not be the fan diode pack. See page 224.

ENGINE COMPARTMENT AIR TEMP SENSOR: Another way to get the electric cooling fan to run longer after shutdown might involve adding an air temperature thermostat within the engine compartment -- preferably high and rearward, where the post-shutdown cooking problems are the worst. This thermostat could be set at a much lower temperature than the one in the coolant and still wouldn't come into play while the car is moving or the engine-driven fan is circulating air. But if the air starts getting hotter after shutdown, it can come on -- even if the coolant in the water pump isn't that hot -- and flow some cool air through the engine compartment.

Imperial makes a dandy little "Adjustable Thermostat for Electric Cooling Fans", number 226203, available at Discount Auto Parts. It's really an air temp thermostat. It has a remote bulb sensor and includes instructions for mounting right on the back side of the radiator core, but you could mount it anywhere -- even on the underside of the hood! The thermostat is adjustable from 248°F to 32°F, and the contacts are heavy enough to control fans directly without relays.

ELECTRIC COOLING FAN POST-SHUTDOWN TIMER: Michael Aiken's plan: forget relying on temp sensors and simply provide a timer that runs the fan for a fixed amount of time after shutdown. Aiken used one of the existing 10-minute seat heater timers to provide this fan operation, and provided the wiring scheme shown in Figure 12 which automatically starts the fan running on the timer whenever the engine is fully warmed up and shut off. Aiken points out that this is not an unheard-of idea; the Nissan 300ZX uses a similar scheme with a 17-minute timer.

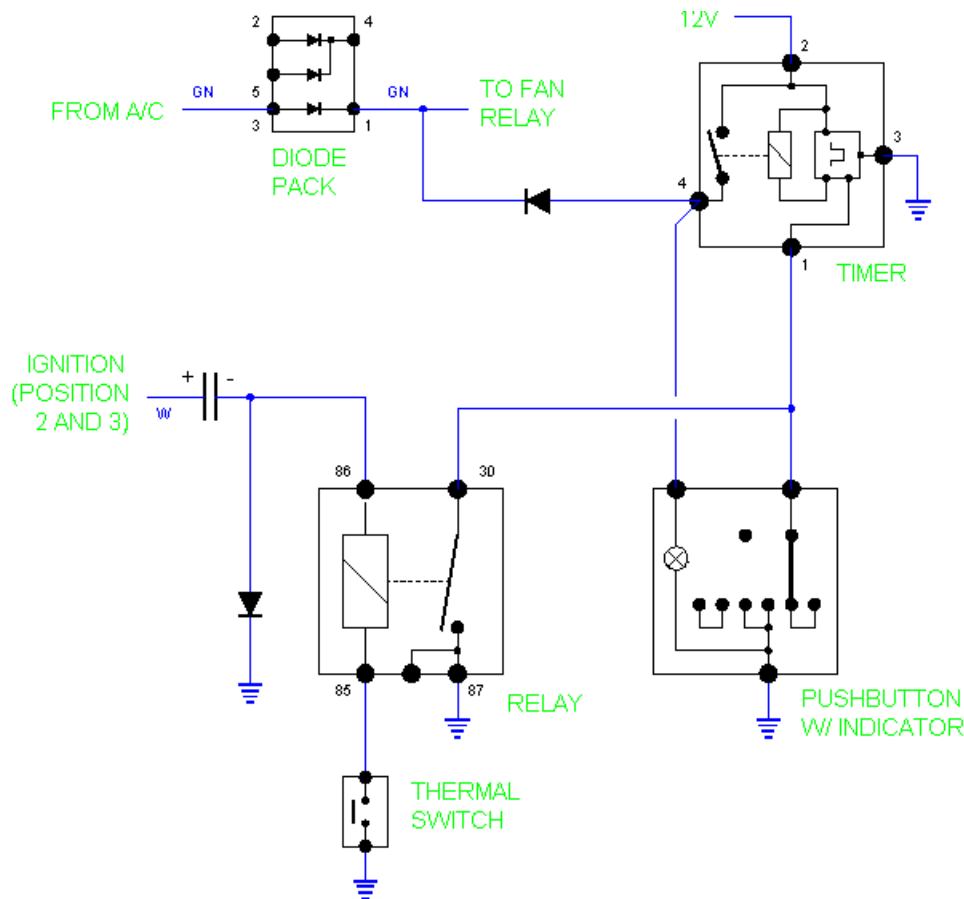


Figure 12 - Post-Shutdown Cooling Fan Timer

Aiken describes this scheme: “The timer is activated by grounding pin 1 and then releasing it. It will not activate if pin 1 is held to ground. I left the manual switch (on the side of the console) wired in so the light would show when the fan is on, but that is optional.” Having the pushbutton may have an additional benefit: you can push the button to force 10 minutes of fan operation whenever you wish. This might be handy if, for example, you get stuck in downtown traffic; you can simply tell the fan to run continuously for 10 minutes rather than cycle on and off with the thermostatic switch operation.

“The capacitor is a 2000 μ fd electrolyte and the diode is 3 amp. The capacitor attaches to ignition key 12V output in position 2 and 3. This is important to keep the fan from coming on during startup (position 3).” Ed. note: the wires that meet this criteria are white, as has been indicated on the schematic. They are connected to terminal 3 on the ignition switch.

“When 12V is applied to the capacitor it charges through the diode. When the ignition is turned off the capacitor discharges back through the relay momentarily (about .5 seconds) activating it and starting the timer relay. The fan runs for 10 minutes and then shuts off. The thermostat in the ground leg prevents the capacitor discharge if the engine is not yet warmed up. The capacitor does hold the charge and will discharge later if the temp reaches the set temp -- even several minutes after shutdown. I set my temp at 180°F.”

The schematic shows the output of the timer (pin 4) connected through a diode to the wire from terminal 1 on the diode pack to the fan relay, so it will directly close the relay and operate the fan. Radio Shack catalog number 276-1661 will serve nicely for this diode as well as the other one used in this scheme. In this application on the timer output, the diode only serves to make the indicator light show that the timer is engaged. If this diode is omitted, the system will still work just dandy but the light will be on whenever the fan is running, even if it is the A/C compressor control or the stock

coolant switch operating it.

If you happen to have one of the later cars where the A/C compressor does not bring on the electric fan (as Aiken has), you don't have to buy a new diode for this task; there's an unused one in the diode pack. Just connect pin 4 of the timer directly to terminal 3 of the diode pack.

Aiken also points out that this scheme doesn't have to control the small stock electric fan; it could be used just as well to control an aftermarket electric fan, or anything else electrical you'd like to run for 10 minutes after shutdown. The use of a marine bilge vent fan has even been suggested. It's probably not a good idea to operate a large fan or multiple fans; it shouldn't take much airflow to keep the underhood temperatures within reason, and you don't want to strain the battery. The fact is, the stock Jag small fan is probably perfect for this job.

Since Aiken used the seat heater controls, the schematic shows the timer and the pushbutton with indicator light as they appear in the Jaguar seat heater schematics. Of course, if you'd rather leave your seat heaters wired as originally intended -- or if you have an earlier car that doesn't even have seat heaters -- you can simply buy a new timer from Jaguar, or perhaps a generic timer (or maybe the one from a Nissan!). You can simply leave the pushbutton and indicator light (and the related diode) out of the circuitry altogether if you wish and connect terminal 30 of the relay directly to pin 1 on the timer. Or, you can buy any generic momentary pushbutton switch; don't let the excessively complicated Jaguar illustration fool you, that heater switch is just a normal momentary single contact switch with a built-in indicator light. If it's only the indicator light you want, you can skip the switch altogether and simply buy any generic 12V indicator and connect it to pin 4 on the timer and to ground and mount it anywhere convenient -- or you could wire it to one of the unneeded warning lights in the dash.

Aiken apparently left his timer where it was originally mounted behind the dash, but if you're installing a new timer you can pretty well choose anywhere to install it. Other than 12V power -- any brown wire -- the only thing you really need is access to a suitable white ignition wire, and they are all over the car -- even going to the EFI power relay in the trunk. There is also one to the ignition system on the engine, so it's possible to install all of this stuff someplace near the fan itself -- perhaps in front of the radiator, or in the compartment behind a headlight -- and not have to run any wires into the passenger compartment, provided you don't want a pushbutton or indicator light.

FUEL SYSTEM

The D-Jetronic XJ-S fuel system involves a fuel tank with a drain that feeds a small surge tank. A screened pickup in the surge tank leads to a soft-mounted fuel pump just below and to the right of the spare tire. The line leads to a fuel filter and then to two separate fuel rails on the engine, one for the left bank and one for the right. A pressure regulator on each rail directs excess flow through a fuel cooler and then back to the tank.

The Digital P uses a similar system except that the two separate fuel rails were replaced with a single rail. There are still two pressure regulators, but in this case one is a supply regulator and one is a return regulator. Supposedly the return regulator, the one on the LF corner of the engine, is the only one that actually does anything. While the D-Jetronic regulators held rail pressure constant, the Digital P regulators vary rail pressure with intake manifold vacuum and therefore have vacuum lines connected to them.

The earliest saloons are fitted with carburetors, which use much lower fuel pressure than EFI. The EFI saloons have fuel systems resembling those in the XJ-S. The most notable difference in the saloon fuel system, though, is that the Jaguar saloons have two fuel tanks and a switchover system so the driver can choose which tank to use.

In 1992 the XJ-S fuel system changed markedly. The external fuel pump was replaced with a submersible pump inside the tank. The fuel rails were redesigned to connect to the injectors with O-rings instead of short hoses. The worthless supply regulator was omitted.

Fuel Fires

Besides the usual general concerns about fuel fires -- fuel lines left in place too long until they rot, etc. -- there are also a couple of specific worries:

EARLY D-JETRONIC FUEL RAIL: The early Digital P XJ-S's (early 80's) had a problem with engine fires. There was a recall to address the problem in which the fuel rail on the engine was replaced; the newer design is indicated by rectangular tubing, while the pre-recall rail was made of round tubing. All Digital P XJ-S's were subject to this recall, but indications are the recall was not as conscientiously applied outside the US. Unfortunately, word is that the recall is "closed" and dealers will no longer perform it. If you have a Digital P with round tubing in the fuel rail, you probably should consult your favorite junkyard and collect all the parts that look different and perform the recall yourself. Note that the D Jetronic still uses fuel rails with round tubing.

Leaking fuel in an engine compartment is remarkably difficult to ignite. Usually there have been obvious odors and visible leakage for some time. Please do not ignore fuel odors; the XJ-S shouldn't have any.

MARELLI IGNITION WIRES: The later XJ-S with Marelli ignition also has a reputation for engine fires. Peyton Gill reports on "an XJ-S that had a little pyrotechnics under bonnet. I asked the guy about it and he said that the fire was put out within 30 sec (owner had a fire extinguisher) and the estimate to repair was \$2000.00. There was not that much damage. The cause of the fire was the ignition coil wire was about 1/4 inch from one of the fuel injection lines (between rail and injector). The ignition wire had been arcing to the line and eventually worked its way through. I guess the physical damage and ozone created by the arc eventually broke down the line."

Julian Mullaney adds, "There was a recall for cracked injector hoses and injector bodies. Ozone from the distributor leads causes the perished plastic. The recall replaces the lead with a shorter one, and replaces the injector. They looked up my car (vin no.) in their database and the fix had already been done a long time ago, however the problem persisted.

“The problem was ozone deteriorating the injector hose on the right bank second cyl. from the firewall. It produces a cracked surface of the rubber hose. You should look carefully for this, it's not easy to spot.

“The dealer said that they were instructed to look for visual damage to the hose and replace injector if needed. "If" is the key word here. However, if it looked good, they could get away with only changing the HT lead to a shorter one (thus not close to the injector) and leave the original injector hose. This leaves the chance that damage could have occurred to the hose but it's not visible yet, leading to the following chain of events:

- upon initial recall they only replace the HT lead
- then the hose continues to deteriorate from initial ozone embrittlement;
- then you see the damage to the hose a year or two later;
- pyrophobia sets in;
- then you call the dealer;
- then they tell you sorry, the fix has already been done;
- then you find that the recall was done sloppily;
- then you get pissed off;
 - a) then you think about fixing the problem yourself
 - b) you call the dealer again and insist they fix it again properly
 - then dealer calls Jaguar to authorize 2nd repair
 - they say OK
 - you get it fixed for free

“Option b) worked fine with me, my local dealer was very good about it.”

Ron White adds, “I checked the recall database and the recall only affects 1989-91 XJ-S models; this is a result of: "The high tension lead from the ignition coil can move from the production location closer to the #4A fuel injector hose. Vehicle description: coupes and convertibles with Marelli ignition systems.””

MTBE: Stephen Wood says, “We starting in Spring 1996 having a substance called MTBE -- methyl tutol-buytol ethanol, something like that -- blended with our gas to help reduce emissions. Hopefully they will be taking it out soon, as there has been a major hubbub about it here. You see, it also melts things, like fuel lines, carburetor gaskets, (especially the old rubber/cork type), fuel tanks, brazing material solder, etc.

“Last summer car fires were up significantly all over the state, including my brother’s ’69 Camaro (it was restored). MTBE melted through the carb gaskets on his vintage Holley and *poof*.”

“At that point it got serious, and I checked my fuel lines, and sure enough, they were going way squishy from the inside out. In other cars we have seen it also has melted injector seals.

“If you ask the insurance companies they have had a slight increase but nothing to worry about. No problem, right? *Wrong!* Most of the cars affected are cars that the insurance industry won’t provide fire, theft and vandalism coverage on anyway. If you ask the CHP and the firemen, they know that last summer was a major problem.”

So, you need a new type of fuel hose, right? “The problem with the hose issue is that the rubber manufacturers are not going to gear up for a California-only issue. However, some of the new cars have fuel lines made out of a tygon derivative, a newer plastic that is more resistant to these blended fuels (New LT1- LT4- and LS1 GM motors). I don't think there is a crossover app. as of yet, tygon is a bitch to work with and has the characteristics of polypropylene tubing, i.e., firm and not clampable. You have to use special fittings with it.

“There is supposed to be some new silicone-based flexible "rubber like" fuel line coming out soon from Gates or

Goodyear but I haven't seen it. So for now, I have been keeping an eye on the situation and checking all pressurized fuel lines every month, and replacing them every 6 months (I have done this three times now). Vent lines are ok from when I replaced them 6 months ago. I have been changing fuel filters every 45-60 days (preventative mania), making sure to cut open the old filter to see if anything weird develops like little bits of rubber hose.

"I will have to take my gas tank out this summer, and have it boiled and welded or just put in a new one. The corrosion around the outlet is growing and I think it is melting through the solder. I may just JB Weld it or something."

FIRE EXTINGUISHERS: After reading this book, you have probably come down with a healthy dose of paranoia regarding fires in the XJ-S. A fire extinguisher is cheap, and may come in handy.

Ron White had a fire in his car, and thanks to having a fire extinguisher in the trunk and knowing how to use it, his car survived with almost no damage. "I have seen engine fires in other cars and have seen people make the mistake of flinging their hoods (these were American cars) open, only to have the fire flare up 5 or 6 feet because of the added oxygen. I opened the bonnet just enough to get the nozzle of the extinguisher in, and gave it a good squirt. I then cautiously opened the bonnet up and seeing no flames opened it up all of the way and gave it a *real good squirt!*" White's extinguisher happened to be a Halon type which works wonderfully and leaves no crud on the engine but is bad for the ozone layer and is in the process of being outlawed. Experts seem to feel that a common powder type fire extinguisher would probably work just as well, the only disadvantage being that you'd have a job getting all the powder out of the engine compartment afterward.

One more note: White's car is an '86, meaning it's late enough to have had all the updates to correct the early fuel rail problems and too early to be covered by the recall for the later cars with the Marelli ignition. "It appears that the cause was a cracked body on an injector, and it was squirting fuel directly on the distributor!" That fire extinguisher is sounding like a better idea all the time, isn't it?

John Napoli suggests a built-in system like those found on race cars: "It should be a lot easier to extinguish a fire within the closed confines of the engine compartment with the bonnet closed, and you could certainly react a lot quicker than, say, opening the bonnet, saying "Oh, sh\$t", running for the boot, trying to find the fire extinguisher that is underneath all your luggage, meanwhile the bonnet is open and the flames are getting higher..." Of course, keeping the extinguisher on the floor in front of the front seat may help.

Emile A. DesRoches says, "If anybody is really interested in a real "racing car" fire control system (sanctioning bodies require a system plumbed in to spray at the engine, fuel cell and driver's lap area), they can be obtained from such organizations as Racer's Wholesale in Atlanta. From experience as an SCCA tech inspector, I can say that they may make a mess, but they work and clean up is inevitably less expensive than replacing a fried V12 motor."

Fuel Odors

FUEL ODORS: To state what should be obvious: Jaguars are not supposed to smell like fuel.

One excellent suggestion is to trot the car right down to your local Jaguar dealer, or anyone else with the equipment to test automotive emissions. The testing equipment includes a probe that is inserted in the tailpipe to detect unburned hydrocarbons (fuel). This probe is real handy for finding fuel leaks anywhere in the car.

There is a relay in the trunk through which the EFI controls the fuel pump; it's the one without a red paint mark on it. You can remove the relay and jump connectors 30 and 87 in the socket to run the fuel pump. This is useful for searching for fuel leaks without having to leave the engine running. Of course, you'll kill your battery if you do it for too long.

FUEL ODORS IN TRUNK: The trunk smelling of fuel is a common problem with many common causes:

- fuel-soaked carpet padding (see page 235)
- leaking hoses either in the trunk or over the IRS (see page 235)
- leaking compression fittings (see page 236)
- someone installed the wrong type hose in your fuel system (see page 238)
- there may be a bad O-ring in the fuel filler connection (see page 244)
- a plugged or disconnected drain from the fuel filler compartment (see page 245).
- a tank that develops a hole by rubbing on a steenkin' rivet (see page 245)
- a tank that has developed stress cracks (see page 245)
- a tank that has simply rusted through (see page 245)

Note that you can greatly reduce the possibility of fuel leaks or odors by addressing all of these concerns at once! Take the tank out, coat it outside and in, replace all fuel and vent hoses with new, and reassemble. It would take a few days, largely because lining and coating the tank require several steps of cleaning and coating and letting them dry overnight. If you're not willing to try lining the inside of the tank yourself, doing all the other tasks would still be worthwhile.

Don't overlook the possibility that fuel odors in the trunk aren't originating in the trunk. The author had a leak in a line under the car, and couldn't smell it outside the car but it stank somethin' awful inside the trunk. I couldn't even imagine how the fumes got *into* the trunk. Likewise, a malfunctioning vapor recovery system (see page 259) that's releasing fumes into the bodywork up at the front of the car may result in the fumes migrating into the trunk. In fact, even a cylinder misfiring and releasing unburned fuel out a tailpipe has been known to cause fumes to collect inside the trunk.

People who correct problems with the vapor recovery system often report that it cures odor problems in the trunk. If the problem was a stuck-open (or missing) Rochester valve overloading the carbon canister and as a result odors were coming from the carbon canister up front and were working their way through the bodywork to the trunk, they may be truly cured. Likewise, if the problem was a leak from the vapor recovery system somewhere, it may be truly cured. But if the problem was a plugged vapor recovery system causing excessive pressure in the tank, the problems are *not* cured, they're just no longer as apparent. The vapor recovery system is supposed to prevent excessive pressures within the tank, and if it fails the pressures may reach levels that force fuel through leaking fittings or even crack the tank. If the vapor recovery system is fixed and the pressures are no longer excessive, there may be far less fuel coming through the leaks -- but the leaks are still there. And any cracks that may have started in the tank are still there, too. If you could smell fuel, that fuel was getting out *somewhere*, and it would behoove you to find out where.

SMELLY CARPET PADDING: The fuel filter is the size of a Coke can and is located behind the spare tire in the trunk. When this filter is replaced, it is all too easy to spill its contents within the trunk. The nature of the foam padding under the carpet is such that once this happens, your trunk will smell of fuel for all eternity. The only suggested fix is to replace the carpeting and padding. It is recommended that before the filter is replaced, and before any repairs to the fuel system in the trunk are carried out, the carpet be removed.

When changing that filter, unscrew the mounting bracket from the floor first. Then you can hold the filter over a catch pan when disconnecting the hoses.

LEAKY FUEL LINES: As described on page 243, there are several fuel lines that include a piece of hose in the middle of a metal tubing assembly. When old, these hoses often weep fuel rather than burst outright. In fact, they may leak so slowly that they never appear wet; the fuel evaporates faster than it leaks. Just about the only indication of trouble is the odor.

Two of the hoses that need attention are not in the trunk, but rather under the car and over the rear suspension. The line

over the right rear axle is the pressure line to the engine, and the line over the left rear axle is the return line to the tank. If the hose section of either line develops leaks, it seems to cause odor in the trunk more than anywhere else for some reason.

Check all of these lines with the pump running, and replace any hose you even suspect of being the cause of odors. Better yet, just replace the hose sections if they are older than ten years or so.

Both hose sections over the IRS are actually fairly easy to replace. Both lines connect at threaded fittings at the forward corners of the trunk floor, and both have couplings just forward of the IRS. Before removing the right side one, depressurize the fuel system, and before working on either, pinch the appropriate fuel lines in the trunk and in the engine compartment (if the tank hasn't been removed and the system totally emptied).

This author found the one on the right side a bit easier to do than the one on the left, because there were more other things in the way on the left side -- but some of these things, like the handbrake cable, may switch sides on a RHD car so others may have different challenges. On the author's '83, the fuel line assembly on the right side came out as a unit, so it could be rebuilt and reinstalled easily enough.

The line on the left side takes a little more thought. First, there is a plastic clip up at the top of the arch holding it in place. If it's not broken to begin with, it's easy enough to break it; it is only too apparent that it's not necessary to hold it in place. Second, the short section of metal tubing on the rear end is hook-shaped, so it isn't likely to feed out over the IRS. Instead, after disconnecting both ends of the line, pull it rearward a bit and use a razor knife to slice through the hose itself. Then remove the rear section rearward and the front section forward.

To rebuild and reinstall it, start by cutting a piece of new hose a couple of inches longer than the original hose. In fact, note how much of the straight section of the hook-shaped metal portion is exposed beyond the end of the hose, and cut the new hose longer enough to cover almost the entire straight section. Install this new hose on the front metal section of the line with an EFI clamp, making sure that the screw portion of the clamp is positioned downward and a little inward because the top and outer side will be against the inside of the bodywork. Stick a plug in the end of the hose, then feed the hose into position from the front until the end of the hose comes out on the back side of the IRS where you can get ahold of it. Clean the entire straight portion of the hook-shaped section in preparation for having a hose slid onto it. Put an EFI clamp over the tube, remove the plug in the end of the hose, then push the tube into the hose and continue to push until things begin to line up. Loosely assemble the coupling at the forward end. When the tube has been pushed into the hose far enough that the threaded end lines up properly with the fitting on the trunk floor, position the clamp near the end of the hose and tighten it down. By using a longer piece of hose here, the clamp is located such that it can easily be tightened below the corner of the chassis and the screwdriver can be held within the wheel well.

When you tighten the threaded end into the fitting on the trunk floor, you will need to have an assistant hold the end of the line on the inside of the trunk in the correct position. Failure to hold the lines in position while tightening will result in distortion of either the hose over the IRS or the hose in the trunk or both.

COMPRESSION FITTINGS: In the author's '83, there are seven places in the rear end of the car where a metal fuel line is attached via a brass nut and a brass compression seal. Three of these are on the main fuel tank itself: the main line to the surge tank, the vent line from the surge tank, and the return line from the front of the car. The other four are in two elaborate bulkhead fittings where the supply line and the return line run through the floor of the trunk.

These fittings are assembled by sliding the nut onto the tube, then sliding the brass compression seal onto the tube, then inserting the tube into the fitting and tightening down the nut. As the nut is tightened, the brass ring is compressed onto the steel tube, forming a reliable seal and also securely holding the tube in place. Typically, the thin-walled steel tube is soft enough that the compression of the seal necks the tube, although this isn't strictly necessary for sealing or retention.

The bad news is that these type connections are meant to be assembled once and left alone. If you unscrew the nut, you can remove the nut/tube/seal assembly out of the fitting, but you cannot get the seal off the tube -- and you'll only get the nut off if it can slide off the other end. If you simply slide the thing back together and tighten it down, there's only a moderate chance it will seal; the tube and the compression ring apparently work-harden, and there's no further compression available to allow it to reseal. Applying sealing substances is a waste of time, and can result in chunks of

sealant plugging up your fuel system. To ensure a proper seal, both the brass ring and the steel tube must be replaced whenever such a fitting is disassembled.

The good news is that the brass compression seals themselves are common in the US and are available at any hardware store or industrial supply house. They are also often available in auto parts stores, in the bins with brass fittings. Note, however, that there is a similar type of compression seal intended for use with copper or plastic tubing, and the compression ring itself is a bit different; it has a collar around the middle. It might work here, but obviously you might be well advised to seek out the same type as was originally used to ensure it seals properly in these fittings.

Suitable steel tubing is also available in sizes up to 3/8", sold in auto parts stores in straight lengths with flared ends and nuts in place; just cut the flares off and chuck the nuts, they won't work here, all you want is the straight length of tubing.

You can purchase a tool in any auto parts store that will help you bend metal tubing without crimping it. Note that cheap tubing benders often don't work very well; it is recommended that you spring for a *good* one. Also note that you'll want to put the bends in your tubing *before* you cut it to length.

You can make a barb for attaching a hose to the steel tube using a tool sold at most auto parts stores. It's called a "double flaring tool", and its purpose is to make those flared ends that you just cut off the tubes you bought. The intended use of the double flaring tool involves two steps. The first step forms a little bulb on the end of the metal tube, and the second step folds the outer end of this bulb back inwards to form the double flare. Forget the second step, just perform the first step, and it leaves a neat, professional-looking barb on the end of the tube for attaching a hose. One example of this tool is the AmPro T73360.

Anyplace that sells the compression seals probably also sells the nuts that are used with them -- but that won't help you. This is a Jaguar, so the fittings are some oddball thread. In the US, you'd go nuts (!) trying to find a new nut of the same thread; if you need a new nut, just go ahead buy an entire new hose assembly from Jaguar. Fortunately, the old nuts are usually reusable; just cut the old tube in half to recover them.

When you assemble a compression fitting with a new section of tubing and a new compression seal, you'll know what they are supposed to feel like. You can feel a smooth crush as the seal is compressed onto the tube.

Now that you're an expert in rebuilding those compression fittings, let's discuss some special cases. First, the Rube Goldberg bulkhead fittings going through the floor of the trunk: if these things are leaking, don't even *think* of trying to reassemble them with new compression fittings and new tubing. Instead, yank the entire contraption out of there and install a simple rubber plug to fill the hole in the trunk floor. Cut a hole through this plug the size of the steel tubing involved. Bend a piece of steel tubing to a suitable shape and insert it through this hole, and connect the hoses to each end of it with suitable clamps. Presto, a simple, logical fuel line assembly with minimal opportunities for leakage.

"If it ain't broke, don't fix it" is a good credo, but you could actually justify removing those bulkhead assemblies on the basis of the weight savings alone.

I'd suggest you throw those bulkhead fittings as far as you can, but remember to save the nuts from them first; they might actually fit two of the connections on the tank itself -- although that'd be an unreasonable expectation from the British, they probably deliberately made them different to make sure you couldn't connect the wrong line to the wrong place!

If your problem is that you've boogered up one of the smaller nuts threaded into the tank itself, you might be able to save yourself the trouble of trying to find such an oddball nut by simply performing this bulkhead fitting replacement and getting the nuts from there.

Finally, the big problem: the main line from the main tank to the surge tank. On the author's '83, this is a hook-shaped 1/2" tube that screws into a 90° fitting on the tank. I certainly hope they changed this design on later cars. The incompetence of the designer was so awe-inspiring that you can't even get a wrench on that nut without removing the tank from the car! Anybody exhibiting this level of skill should be operating a broom rather than a pencil -- and only if you're not too picky about how clean the floor is.

This fitting is the most likely one to be leaking because of the hook-shaped tube. Getting a hose connected to that tube,

maneuvering the other hoses in the area, even replacing the battery or getting the spare tire in and out is liable to apply some stress to the end of the hook, all of which is likely to bend the tube right at the fitting and cause the compression seal to start leaking.

So, once you finally figure out this is where your trunk odors are coming from, you need to get that fitting apart. Drain the tank (see page 245). Disconnect the straps holding the tank in place. Insert some sort of broad pry bar between the gas tank and the deck it's sitting on and see if you can lift the tank up a bit. If you can't, use a machete to slice through the foam under the tank so you can. Once the tank is liftable, it's actually possible to get a box end wrench on the nut by sliding it on from the other end of the hook-shaped tube and holding the tank lifted as you maneuver the wrench to the nut and turn it. Hence, you can fix your leak without totally removing the tank, disconnecting all those other lines, removing the battery tray, etc.

1/2" brass compression seals are actually not too difficult to find, but 1/2" thinwall steel tubing is. The auto parts stores only carry steel lines up to 3/8". You might try a place that carries parts for large trucks. Other places that may carry 1/2" steel tubing, including hydraulic shops, typically have thicker-walled tubing -- which will work fine in the compression fitting but is difficult to bend or to form a barb on for connecting the hose.

The solutions here come together. First, you don't want to install another hook-shaped tube. Instead, what you want to do is install a very short straight tube, providing a hose barb right there at the fitting on the tank. Then you can use a longer piece of 1/2" fuel hose to connect it to the surge tank. Hence, you probably already have the tubing you need -- in the old tube. Just cut off the old compression seal and cut off the hook end, leaving a straight section of steel tubing about 3" long. Apply the old nut and new compression seal and install. Be sure to clean up the outside of the section of tubing with some fine sandpaper so it forms a good seal.

Of course, if you try to use the double flaring tool to provide a hose barb on a tube this large, you may mess it up -- and you have no backup tubing. Solution: don't bother providing a barb here. The maximum pressure this hose will ever see is about 3 psi, nowhere near enough to push a clamped hose off a smooth tube.

If your hook-shaped tube is too messed up to obtain a clean straight section from, you can use thicker-walled tubing since you're not bending it and you're not forming a barb. The thicker-walled stuff might even be advantageous in providing a more secure attachment with more resistance to bending or deformation.

STINKY FUEL LINES: Believe it or not, one reported cause of fuel odors in the trunk is apparently the use of the wrong type fuel hoses. They're not leaking; the odor seeps through the material of the hose itself. You can tell this is the problem by wiping your finger on the surface of the hose, walking a few feet away, then smelling your finger. If it smells like fuel, that's the problem.

Fuel Lines

FUEL HOSE MAINTENANCE: If you have any doubts about the condition of the fuel hoses in your car, replace them. Based on experience from the online discussion list, it would be an excellent idea to replace *all* of the fuel hoses in the car at least once every ten years; you can do it every five years to be on the safe side.

In some locations, there is a fuel line assembly that consists of hose crimped onto metal lines; in such cases you can just buy new Jaguar fuel line assemblies, but it's cheaper to buy generic hose and install it in the existing lines with suitable clamps (see below). The hardest part would be getting the original crimped fittings off, but the second time you do the job it'll be easier since you'll only need to loosen clamps. Don't overlook the sections of hose in the lines looping over the rear suspension on each side of the car.

In other places, you will be replacing pieces of hose with clamps on the ends. In yet other locations, you may need to replace hoses that don't seem to be attached at all -- they are merely pressed onto the fitting. Please read the following

sections to understand how these work before tackling the job.

FUEL HOSE SIZES - D-JETRONIC: Bernard Embden found that the nipples on the D-Jetronic fuel rail are measurably smaller than standard 5/16" nipples. "Putting 5/16" hose on the Pre-H.E. fuel rail resulted in a less than satisfactory connection. The clamps had to be tightened excessively and bunched the 5/16" hose just to prevent leakage at the required 30 lbs. fuel pressure. Even in this unsatisfactory condition, the 5/16" hose could be rotated easily on the rail. I fitted the 9/32" hose. This was the only size hose that fit the nipple correctly."

FUEL HOSE SIZES - DIGITAL P: The D Jetronic fuel rail and injectors truly need 9/16" hose, a fairly unusual size. The original hoses on the Digital P fuel injectors appear to be 7mm or 9/32" as well -- but in this case it's the wrong size. The injectors themselves are made by Bosch -- and have barbs designed to fit an 8mm hose, a very common size. The barbs on the square-tubing rail and on some of the lines to and from the rail are also designed to fit an 8mm hose. When you have the old hose off, it is a simple matter to measure the diameter of the straight-sided portion of the barb between the ridges to confirm what size hose is needed. 5/16" is 7.93mm and will fit an 8mm barb just fine.

The problems begin when the novice mechanic finds out how easy it is to push the new hoses onto these barbs. They just slide right on. That just doesn't seem right, and smaller hose is purchased and crammed onto the barbs with great effort and sometimes even boiling the hose prior to installation or other extreme measures that are only too likely to damage the hose or shorten its life.

Resist such thinking. The hoses are *supposed* to slip on easily. Why would Bosch design an attachment scheme that requires lots of effort on an assembly line? When 5/16" or 8mm hose is used on the clampless connections on the XJ-S, they simply do not leak. There is no problem there; the fuel leaks the car is plagued with come right *through* the hose when it dries up and cracks.

Some people have found 8.5mm hose -- sometimes at a Jaguar dealer. Don't use it on the XJ-S; there are no fittings on this car that call for this oddball size.

FUEL HOSE TYPE: The XJ-S features Electronic Fuel Injection, and EFI systems operate at higher fuel pressures than carburetors did: 30-50 psi vs. 5 psi. Ordinary "fuel hose" was designed for 5 psi -- do not use it anywhere in this fuel system. Most auto parts stores now carry "EFI hose". It is more expensive, but a fuel fire is no fun. The basic generic EFI hose *looks* like standard hose; you will need to read the printing on the rubber surface to know you've got the right stuff. Look for either "EFI" or "Fuel Injection" or some such clear indication of its suitability for fuel injection systems, or for a working pressure rating higher than 100 psi.

If you have clampless hose connections (see below), generic EFI hose will work fine -- but there is yet a better idea. If you find an industrial hose distributor or hydraulic hose shop, they can sell you what they refer to as "push-on hose", hose that was designed specifically for these type connections. Push-on hose is available in two different styles: smooth rubber surface or cloth surface. They both have basically the same specs; in fact, nobody seems to know why anyone would choose one over the other. It probably has something to do with abrasion resistance or some such.

The rubber surface push-on hose usually has a bunch of markings on it, including a pressure rating in the order of 350 psi, but it probably does *not* use the term "EFI". There is a spec number on there, and you're supposed to look it up in reference books to determine suitability for particular applications. It *is* suitable for automotive EFI systems.

The cloth surface hose this author found has far less text on it. Duh! It's harder to write on cloth! The letters are really big to be readable, and all it says is "WEATHERHEAD 5/16 H10005 D 09/14/98". The pressure rating on this hose is actually lower than the rubber surface hose (250 psi) even though it looks a lot tougher than the rubber surface hose. You cannot squeeze this hose flat with your fingers. Weatherhead H100 series hose has a nitrile inner liner suitable for use with non-oxygenated automotive fuels.

Note that there are a few places on the XJ-S where one end of a hose is a push-on connection and the other end requires a clamp. The push-on hose is suitable for these applications; it can be reliably clamped on suitable barbs.

The Weatherhead cloth surface hose is more expensive than the rubber surface: \$2/foot. Don't be intimidated by the fact that Jaguar wants many times that much for their "original" hose; it's no better, and it's arguably not as good. Weatherhead is one of the most respected names in the industrial hose business.

Another good reason to be shopping at the industrial hose supplier is that you can buy this Weatherhead H100 hose in 1/2" size. There are a couple of 1/2" fuel hoses in the trunk of the XJ-S, but there aren't many auto parts stores that carry 1/2" fuel hose.

Of course, you can buy fancier hose. Bill Fernandez says, "There is a lot of stuff available out there, aero hoses, rubber, etc. High quality cloth braided German fuel injection rubber hose is what I ended up using. This is the same equipment used in BMW and Mercedes, they don't go bad period. I have a 1975 CSi (BMW) with the original cloth braided hoses with 325k original miles and not a single leak or hint of gas yet.

"The H.E. Bosch injectors are designed to use slip-on rubber injector hoses. The aero style will require lots of modification to both the injectors and the fuel rail to get them to work. The aero stuff is very pricey and just not worth it aside from looks."

Hose to avoid: Based on *several* reports from owners, *do not use* Goodyear blue lined hose. Vans says, "My Goodyear fuel injection hoses 5/16" (blue lined) have failed in just 2 years. They would only leak when side pressure was applied to the fuel rail or hoses, they would squirt out a small amount of fuel. No leaks while running without side pressure.

"Just replaced all injector hoses with Dayco 7.9mm (5/16) from my local parts supplier. While removing the Goodyear hoses some were able to just pull off. When installing the Goodyear 2 years ago they were very tight and could not be pulled off. This is not a job I want to do every couple of years. My advise is to avoid Goodyear for these engines at all costs."

Ed Sowell adds: "I had the same problem with Goodyear hose. I redid the rail with Gates hose, which most auto parts stores no longer carry. NAPA does."

FUEL HOSE CLAMPS: Some fuel line connections, especially on earlier cars, came with crimped collars that compressed the hose against the barb. If you remove a hose with a crimped collar, you can replace it with new hose with a clamp -- provided you use the correct type clamp. If you live in the US and walk into an auto parts store and ask for a hose clamp, you will be handed a stainless steel band with a series of angled slots through it and a worm screw attached to one end. These "aircraft type" clamps are excellent -- for lines about 3/4" in diameter and larger. Although they do sell small clamps in this style, they do not work well on hoses as small as the fuel lines on the XJ-S. There are simply too many "corners" within that circle as it is snugged up, and although it may seal at first while you're looking it may leave local areas that aren't securely compressed against the fitting and will start leaking later when you're not looking.

If you live in the UK and ask for a hose clamp, you might get a "Jubilee" clamp or something similar. These are also stainless steel worm screw clamps, but instead of angled slots in the band it has little raised lips for the screw to engage. These are better than the US aircraft type clamps on small diameters, but still not good.

To assure a good, reliable seal, you're going to need some clamps that securely compress the hose onto the fitting uniformly all the way around. While the worm screw types are not recommended, there are several other types that will work fine. Many auto parts stores sell "EFI hose clamps", which consist of a steel band with a small screw and nut that draws it tight. They come in various sizes, and you need to carefully select the size you want; these type clamps will only fit the size hose intended, you cannot just keep screwing them down smaller like a worm screw clamp. Unfortunately, you're not likely to find these type clamps in stainless steel, so it is advisable to carefully apply anti-seize compound to the threads on that tiny screw if you ever want to get it loose later.

Sometimes EFI clamps are offered in a package with the hose; make sure you have suitable clamps on hand or can buy them separately before buying EFI hose *without* the clamps. Jim Taylor says, "I replaced the originals on my (then) 16-year-old '76 XJ12C. I obtained two Volvo FI hose replacement "kits" (part number 273680-9). Each kit contained the appropriate number of short rubber hoses and neat little black painted hose clamps (not worm gear type) for a Volvo six cylinder car. This fix didn't cost very much. My receipt (dated 3/4/92) shows I was charged the grand sum of \$6.11 per

kit.” Of course, similar kits may be available from other car makes as well.

John Ashcroft, who lives in Australia, says, “If you have screw (worm drive) clamps and have an engine fire, the insurance company *will not pay*. You have to have EFI clamps on fuel lines.”

There is also a type of clamp that works similarly to the EFI clamp described above, except that it has two loops of wire in place of the steel band. These seal pretty well, but they’re not very pretty and they really mangle the hose. They don’t seem to come in stainless steel either.

Greg Price says, “The Series III XJ6 has some nice fuel injection hose clamps, and my local Jag tech recommends Mercedes fuel injection hose clamps.”

Stefan Schulz says, “Here in the UK, Farnell offer stainless steel hi-torque hose clamps which are The Biz. Highly recommended. Farnell Industrial are on telephone [+44] 113-2636311.” Schulz adds that he does *not* recommend the fuel injection clamps from a Volvo.

Tom Mackie says, “I find most conventional "clamps" to be a little unsightly. So.. There is a clamp used in the repair of shop air hoses as well as on oxy/acetylene hoses (if that's not a high fire hazard application, I don't know what is). These clamps do not have a screw/nut on them. They are a single usage item. They are a formed metal band, with an outward flare/dimple/nipple (I have no idea what to call it) on each side. These simply slide over the hose, are placed into position, then using pliers, these nipples are squeezed, compressing them, which in turn tightens the clamp. No screw/nut sticking out, getting in the way, cluttering appearances etc. Definitely not self loosening. Removal is with side cutters.. Just snip off one side and bend it open. These are cheap.. so making them disposable is not a big deal. This I would use on the injector end.

“I was considering another crimp style, but for the fuel rail end. There is what I'll describe as a "cup" shaped unit, which I believe is sorta an aeroquip fitting. I have to confirm this yet, but I believe you could use any hose with the appropriate size "cup" and have it crimped into place. The minor catch is that you either need the special tool which applies pressure to about 6 locations at the same time, or you have the fittings shop do it by taking them the fuel rail. These are semi-permanent, and removal is with a hack saw, which destroys the hose. This is why I'm thinking of using these on the fuel rail side, and the removables on the injector side. Again, no screws sticking out, etc. Nice-n-neat.”

Note that the problem of worm screw clamps causing leaks is not unique to the EFI fuel system. One should also take note of the types of clamps used on the fuel tank vent system, the power steering hoses, the transmission cooler hoses, and just about anywhere else that small diameter hoses are clamped. Leaks at some of these locations may be less disastrous than a fuel system leak, but you’d still rather not have any leaks.

CLAMPLESS HOSE CONNECTIONS: The section above describes what clamps to use on fuel hoses. Now let’s discuss not using them! There are two types of hose barb used in the fuel systems on the XJ-S, and one of them *must* be clamped while the other should *not* be clamped.



Figure 13 - Fuel Hose Barbs

With the barb shown at left, the hose is installed by merely pushing it onto the barb. It works kinda like a Chinese finger trap; the hose slides on easily, but if you try to pull it off it grips onto the barb and won’t let go. These fittings typically come with a dished washer or cup that must be slid into place before pushing the hose on, but these items do nothing

more than hide the cut end of the hose to make the installation look neat. Hydraulic hose shops have push-on fittings with flimsy plastic dished washers.

Proper use of a hose clamp requires the smooth cylinder of the type shown at right for the clamp to compress the hose against. If a clamp is applied to the barb shown at left, it will compress the hose against the points on the ridges and possibly damage the inner liner of the hose. There are clampable barbs that have a series of small ridges in this clamping area, presumably to help ensure a reliable seal, but they are usually rounded and easily distinguishable from the large, toothy grips of the clampless barb.

Believe it or not, the non-clamped type provides a much more reliable seal. This is apparently because it allows the rubber hose to flex and seals more securely as it does, whereas the clamped connection will often start to leak as soon as any pulling or twisting is involved.

Typically, you will know which type you're dealing with before removing the old hose by looking at what's on there from the factory. If there's no clamp, it's the type that doesn't use a clamp. If it's the type that needs a clamp, there will be some form of clamp -- or a cup-shaped piece of metal that is "swaged" or "crimped" onto the end of the hose to compress it onto the barb. The decorative cups on the non-clamped barbs sometimes look similar, but it is obvious that they are not swaged; in fact, you can spin them around with your fingers.

The problem, of course, with relying on the existing situation as an indication of barb type is that someone may have gotten in there before you and added clamps where there shouldn't be any.

Note that you may have a mix of clamped and clampless fittings. The early D-Jetronic cars use clamps everywhere. John Ashcroft says that his '80 needs clamps on the rail but not on the injectors. On the author's '83, the entire injector/rail assembly uses clampless fittings, but the connections at the fuel cooler still require clamps.

Regarding pressure ratings and the security of push-on connections: A shop frequented by this author has a tester, and in their spare time they test things to failure just for grins. The 5/16" cloth-surface push-on hose described above was tested, installed as intended on a push-on fitting. It held to 1200 psi, and then the hose ruptured near the end of the barb. The push-on connection never leaked or came apart.

INJECTOR HOSE REPLACEMENT -- D JETRONIC: Injector hose replacement on the D Jetronic is pretty self-explanatory: Loosen clamps, disassemble, reassemble with new hose, tighten clamps. If there are crimped metal collars (you have original crimped collars after all these years?), you will need to cut through one side of each collar and spread it a little to get it off; replace the collars with EFI clamps when reassembling. Ed Sowell adds, "It is not sufficient to tighten the hose joints just once. I am absolutely sure they were all tight and non-leaking when I rebuilt the injection system last summer. Yet, in April of this year they were nearly all loose. I believe this is due to the hoses deforming under clamp pressure and setting in the compressed state due to high temperature. Then they will be loose when the engine is cool."

INJECTOR HOSE REPLACEMENT -- DIGITAL P: This job is not self-explanatory since there are no clamps, but it's still pretty easy. The guidelines below are for replacing the hose without even pulling the injectors, but you might want to remove them as a set to save your back and also to replace the injector seals at the same time. Either way, you will need to depressurize the fuel system. You will be spilling a little fuel, so take suitable precautions. Disconnect the inlet and outlet lines to the rail, and remove anything that goes *over* the rail.

Cut all twelve old hoses through the middle. Any fuel remaining in the rail itself will dump out, so you might want to choose a suitable hose to cut first and quickly aim it into a jar. You might then try cutting a hose at the other end of the rail and blowing through it to clear out as much fuel as possible. After cutting the hoses, lift off the rail, leaving the injectors in place.

Remove the pieces of the old hose from both rail and injectors. Don't lose the dished washers. Try to do as little damage to the barbs themselves as possible. The basic idea is to use a razor knife of some sort -- a boxcutter blade or utility blade, X-Acto knife, whatever -- to "shave" down one side of the hose, cutting just deep enough to slice through

the reinforcing cord inside the hose but being careful not to cut so deep as to penetrate the inner lining of the hose and contact the metal barb inside. Cut too shallow the first couple of times just for practice; you can always cut deeper, but once you've cut too deep you're faced with barb damage. Once the reinforcing cord is severed -- possibly two or more places around the barb -- the hose can be pulled off.

The problem, of course, is the dished washers get in the way. You can only slice so far down the side of the hose before the blade hits the washer, leaving the last 1/8" of the cord uncut. It's trying to get that last part cut, using a corner of the blade or whatever, where frustration sets in, and the frustration can result in damaged barbs. Richard Fields says, "I used an X-Acto knife (available at any hobby shop) to remove the hoses, after fighting them with a razor knife. The X-Acto blade I used was shaped like a cats-Jaguar?-claw and could get in behind the washers very easily. It made cutting the hoses off a snap!"

Note that while the clampless barbs all are similar in configuration, the ones on the injectors are made of much softer metal than the ones on the rail. You might want to work on the ones on the rail first so you get the hang of it before tackling the much-easier-to-damage ones on the injectors.

If the barbs get a little dinged up, believe it or not they can usually be repaired quite effectively. The trick is to make sure there are no "notches" in the edge of each ridge, so that the edge of the ridge contacts the inside of the hose all the way around to form a leakproof seal. If there's a notch, you can grip the barb gently with a standard pair of pliers while you rotate the injector (you probably need to remove the injector from the engine to do this properly) so that the teeth on the pliers scrape off the edge of the ridge all the way around until the notch is cleaned up. You *still* don't want to use a clamp on this hose connection unless you had to clean the ridges completely off to get rid of notches -- in which case you probably should spring for a new injector.

Others suggest not using a razor knife at all. John Ashcroft says, "Used a electric soldering iron to burn the old hoses off of injectors with no damage to barbs." Ken Gray elaborates: "You poke the hot tip of the iron into the fuel line just above the top barb and push it down the length of the fuel hose and into the seemingly useless cupped washer at the base where you just work the tip around a bit to completely sever the hose. The whole process takes a few seconds due to the very hot tip of the weller. You can grab hold of the barbs immediately after hose removal and they are barely warm. I would not use any other method now as the soldering iron works perfectly without any damage to the barb or internal plastics of the injector. You do however need to use the correct soldering iron; I ended up using a Weller electric iron which seems to have a temperature control in the tip. I must also say that I have not been able to reliably regenerate the tip for soldering purposes. This is not a problem because the tips are readily interchangeable."

David Johnson suggests a wire wheel: "My plan of attack is to cut all the hoses in the middle between rail and injector. Then I use my bench grinder which is set up with a wire rope wheel. It makes quick work of the remnants of the hose on the injector and does not gouge the barb end. The wheel's strands are flexible enough to get under the cup. As for the rail I have an air die grinder which I use with a similar, though smaller and slower, wire wheel and it is simply a matter of abrading the material off. Actually took me less than 3/4 hour to do all 12 recently."

Cut suitable 8mm or 5/16" (7.9mm) EFI hose into ten pieces 1-3/4" long. Make doubly sure that all ten hoses are the same length; different lengths can cause problems with the clampless barb connections. Install the ten pieces of hose onto the rail first; remember to put the dished washers in place. Use no lubricants on either the hoses or the barbs; they should be assembled dry, and they should push on easily. Position dished washers onto the injectors, and then push the entire rail down onto the injectors one bank at a time. After pressing the rail down onto the injectors, pull upward forcefully on the rail to help the hoses establish a good grip on the barbs. Leave the 1A and 1B hoses until last, and cut those hoses to whatever length seems to fit right. Reconnect the fuel inlet and outlet, and then turn the ignition on for two seconds at a time for several cycles so the fuel pump can repressurize the system. Start it up and check for leaks.

HOSE ASSEMBLY REBUILDING: Many of the lines (fuel, power steering, etc.) in the Jag consist of metal tubing with threaded connectors and a short length of hose in the middle somewhere, all sold under one part number. When it's been in there too long and has dried up and started leaking, the section of hose can easily be replaced with suitable hose along with suitable clamps. It is suggested that before you cut the original hose off, you place measured marks on the tubes on either side of the hose so that when you reassemble, the same overall length can be established. You should

also put alignment marks, so the new assembly won't be twisted. Finally, if the hose is within sight of the exhaust system or other hot parts, it might be better to wrap it with some aluminum foil to prevent the radiant heat from cooking the new hose.

Some hose assemblies in the fuel system have clampless barbs to connect metal tubing to hose, similar to those fittings on the rail described above. However, these may have a deep cup covering the end of the hose instead of the dished washer used on the injector hoses; this deep cup looks like a crimp collar except that it isn't crimped. The deep cup can make it a bit more difficult to get the old hose off, since getting the razor knife on the hose will be all but impossible and getting a soldering iron tip in there will be no picnic either. To make life easier the next time you replace hoses, you might want to order some of the dished washers used on the injectors, EAC7876, and reassemble the fuel lines with these instead of the cups. That will also make disassembly easier *this* time, since you can just cut the cups off to get them out of your way.

The author's solution here worked well. I used a hacksaw to cut these deep cups circumferentially, separating each one into a sleeve and a shallow cup -- obviously being careful not to saw all the way through the hose and damage the barb underneath. I was then able to simply slide the sleeve up the hose out of the way and slice the hose away using the same method as with the hoses on the rail with the dished washers. When reassembling with new hose, I reinstalled the shallow cup (cleaned up a little) and discarded the sleeve. The finished assembly looks good, arguably better than the dished washers at the rail.

If you get those cups off intact and intend to reuse them, note that when putting the new hose on you may have trouble telling if it's on all the way. So, prior to assembly, slip the cup onto the end of the hose and mark on the hose so you'll know when it is fully inserted into the cup. This is especially important with a really thick-walled hose like the Weatherhead cloth-surfaced stuff described above because it fits so tightly in the cup that it makes it very difficult to get on the barb.

Fuel Tank and Filler

FUEL FILLER CONFIGURATION: In the 70's, the fuel filler pipe on the XJ-S had a flange on it and was rigidly mounted behind the filler door with three screws. This author's '83, however, has no flange; all it has is a small tang that engages a small bracket to prevent the filler pipe from rotating as the cap is tightened. The same three screws are used instead to fasten a metal collar that holds a rubber boot around the filler pipe. Hence the filler pipe is mounted flexibly; it can move around a bit since it is held in place only by the boot, an O-ring seal at the tank, the hose clamped onto its outside, and of course that little tang that prevents it from rotating.

With either design filler, the clamp on the hose connection to the tank is accessible from within the trunk by removing some carpet. Then you can pull the filler out through the filler door after removing three screws.

On the later design, the filler itself inserts into the opening in the tank with a really fat O-ring for a seal, and then the entire assembly is enclosed in a short section of 2" hose. If the fat O-ring works, the 2" hose only serves to hold the assembly together, not to contain fuel or odors. This assembly *might* have been designed this way because Jaguar couldn't find a 2" hose that would positively prevent fuel odors. Remember, the fuel-filler-to-tank connection in most other cars is underneath the car, not inside the trunk -- perhaps for good reason. If you have odors, you might consider pulling this assembly apart and replacing that O-ring, which is part number C46157.

FUEL FILLER CAP: ...is discussed on page 261 under the vapor recovery system.

FUEL FILLERS -- SALOONS: The fuel fillers on the saloons are different from the one on the XJ-S. They are a pair of decorative flip-open fillers on the top rear of the car -- one for each tank, since there are two tanks. Walt Osborn of

Vintage Jag Works: "On the dual filler caps on these cars, the seal for the filler cap is spring loaded and "floats" on four studs, retained by four push-on round barbed retainers. The cap is held at the front by a roll pin which is also the hinge pin. When the seal gets old, it cracks and starts letting debris and moisture into the tank.

"In the past, this seal was serviced as the whole seal and holder that floats on the four studs; part #12685. On series 2 cars the number was changed to RTC 196 for emission controlled cars. In 1988 RTC 196 went NLS (No Longer Supplied). Part #12685 (non-vented) has been available off and on...

"The seal can be easily replaced. You can take the cap off the car or leave it on. Use some pliers and pull the old seal out of its slot. Go around the slot and bend the thin lip outward a little making the entrance to the slot wider. Cut a piece of neoprene flat rubber 1/8" thick x 2-7/16" outside diameter x 1-1/2" inside diameter. If you are worried about the rubber being compatible with current gasoline, there is an alternative. There is a new gasket pair available for series 3 cars as aftermarket part #GCS/L. Use the old gasket and mark the new gasket around the inside hole with a pen and cut the hole out with a razor blade knife, cutting just outside the pen mark. Stretch the new part on, crowd it into the slot and bend the thin lip back down. If you use the later gaskets there is a small hole which is ignored because it disappears under the thin lip."

FUEL FILLER DRAIN: Derek Hibbs says: "The answer for my fuel smell was simple: the fuel cap overflow pipe was disconnected and any spillage during refueling was draining directly into the boot/trunk instead of onto the ground. Reconnected the overflow pipe and no smells (I also take more care when refueling)."

STEENKIN' RIVET: On the underside of the car there are numerous lines that are held to the car with little clips and rivets. One of these rivets is in the panel the tank sits on, and sometimes the weight of the tank compresses the pad enough that the metal tank contacts the tip of the rivet. After some vibration, the contact can wear a hole in the bottom of the tank. Once the tank is drained and removed, it is a simple matter to patch the hole (there are types of epoxy sold that will work well) and find an alternate way of supporting the line under the car.

STRESS CRACKS IN TANK: Officially, the recall supposedly was to prevent excessive pressure/vacuum cycles on the tank, resulting in stress cracks. Obviously, this is something else to check on your tank.

RUSTY TANK: Chad Bolles reports that the seal around the rear windshield starts leaking, and the water soaks the sponge under the tank and causes the tank to rust. Chuck Sparks reports that external rust on the bottom of the tank where it sits on that foam is far and away the most common cause of fuel leaks in the trunk he has seen. The author's car didn't have any leaks there, but it did have some rust -- and there were no signs of any leakage from the rear windshield. It's entirely likely that filling the tank with cold fuel -- or just running the car, which chills the fuel in the tank via a fuel cooler -- may cause condensation on the outside of the tank, which runs down the sides and soaks into the pad.

FUEL TANK DRAINING: The way you're supposed to drain the tank is to remove a rubber plug in the floor of the trunk and loosen a drain plug in the bottom of the surge tank and allow it to drain into a container. The drain fitting works kinda like a big brake bleed nipple; you don't need to remove it, just loosen it a couple turns. Unfortunately, the drain never lines up with the hole in the bottom of the car very well; you might want to consider enlarging the hole and using a larger plug. Hopefully, one way or the other, you can push a short piece of 5/16" tubing onto the drain fitting to route it out the bottom of the car and into whatever container you'll be collecting it in. Kevin Darling says, "An 11/16" wrench easily opened the sump drain from within the trunk." While you're fiddling with that drain, you might consider upgrading it as described on page 253.

Using that drain works OK, I guess, but there is an easier way! Remove the spare tire and disconnect the line from the inlet to the fuel filter. Direct this line into a gas can sitting in the trunk. Remove the fuel pump relay and insert a jumper

in the socket between terminals 30 and 87, which will run the pump and run all the fuel into the gas can, neat as you please.

Of course, either way you drain the tank, it'll be easier if you drive the car until it's really low on fuel first.

FUEL TANK REMOVAL: The main fuel tank is located over the rear axle. It is accessible by removing the spare tire and some other stuff, then pulling the carpet out. Tank removal is pretty straightforward until you get to the last step. The tank sits on a 1/4" layer of foam, and is often bonded to the foam from years of sitting on it so there's no way you can slide it out. Chuck Sparks offers a solution: a machete! Just slice through the foam from wheelwell to wheelwell, and the tank will come right out. You're probably going to want to replace that foam anyway; if the tank has been leaking, it's probably smelly.

FUEL TANK LINING: The fuel tank in the XJ-S is made of stamped sheet steel. This is a sorry choice of material for a fuel tank, and any automaker that chooses it should be ashamed -- and that's most of them. It'll start putting rust particles into your fuel system almost immediately. After it's been doing that a few years, things get more serious. It may develop leaks due to rusting from the inside out; it may develop leaks due to rusting from the outside in; it may develop leaks due to stress cracking; and it may shed enough rust scale from the inside surfaces to plug the fuel pickup, resulting in fuel starvation at high power, which in turn results in burnt pistons.

If you already have such problems, you need to do something -- but if you don't have such problems, you might still consider making some preventative measures at some convenient opportunity. A popular strategy -- for owners of any old cars with steel fuel tanks, not just Jaguars -- is to apply a coating to the inside of the tank. Most such coatings will not only prevent future problems, but they will usually seal up minor leaks. John Whitehead says "I have used gas tank sealer from Bill Hirsch Automotive (see page 700), with great success. I put it in the fuel tank of my '67 XKE which had a number of pinhole-size leaks. Previous attempts to coat the outside of the tank were not as successful. The tank sealer is gasoline and alcohol resistant. A quart can is sufficient as only a thin film is coated to the inside of the tank. I am not sure of the product's chemistry, but it dries to a white Teflon-like film." Obviously, major cracks or holes will require more extensive repairs.

Other sources of similar tank sealer materials include Red-Kote by Damon Industries, Renu (page 704), Eastwood (page 704), and Avon in England. Most modern sealers claim to be suitable for gasohol, but you might want to ask to make sure. Oxygenated fuels, octane boosters, lead substitutes, injector cleaners, and anything else you may be tempted to put in there are also things to ask about. The Hirsch, Red-Kote, and Eastwood sealers (and perhaps others) use methyl ethyl ketone as a solvent, which means you need to avoid putting anything with MEK or acetone in it in your tank. Note that, in the case of oxygenated fuels, lining the tank may be an improvement; MTBE will attack the brazing on a steel tank.

Several people have reported using POR-15 to coat the inside of their tank. It may not be specifically intended for the purpose, but nobody has reported any problems.

You should be warned that lining your own fuel tank is *not* an easy job for the novice. Obviously, the tank must be removed from the car, but that's not the hard part. The inside of the tank must be scrupulously cleaned prior to applying the liner, and cleaning is a serious challenge on the XJ-S tank -- even for shops with lots of experience cleaning and sealing fuel tanks. The XJ-S tank has so many baffles inside that, looking into the filler and fuel level sender openings, you will not be able to see more than perhaps 1/4 of the total interior surface of the tank, even with mirrors. You can just forget about brushing, scrubbing, sandblasting, or the like. The only way you're gonna do anything inside this tank will be by putting things in, shaking it around, and pouring it out.

Bill Eslick: "Many years of racing (Midgets and Sprint cars) have given me opportunities to learn how to clean a fuel tank. Solution: Three pint-sized cartons of BBs. Pour them in the tank and shake the shit out of it. If you are going to coat the thing then shake it dry. Rinse with lacquer thinner, and shake again. This is tedious but works remarkably well. Be sure you use BBs; lead shot can get lodged in baffles, etc. because it's so soft. Also, any errant BBs can be pulled out with a magnet."

A report from this author, who has tried BB's: if you put a BB in the XJ-S tank, you *will* be using a magnet to remove

it. They will not come out any other way. That doesn't necessarily preclude the use of BB's; once you figure out how to use a magnet effectively, it only takes a couple of hours (!) to get a few thousand BB's out of the tank.

Unless things are really bad in there -- lots of loose scale -- most owners would be well-advised to use only liquids in this tank. Still, this is not a simple matter of pouring out the gas and pouring in the sealant. Mike Aiken provides the guidelines recommended for use with the Eastwood product:

1. Wash tank with hot soapy water, then rinse out with a garden hose.
2. Metal wash diluted in 2 gallons of water. Slosh, 5 minutes a side, slosh. This is supposed to remove contamination from surfaces and inhibit flash rust. Says it contains alkali surfactants(?).
3. Rinse with garden hose.
4. 1/2 gallon of muriatic acid obtained locally. Slosh until gray appearance.
5. Rinse with garden hose.
6. Rust remover (phosphoric acid). Rotate until all surfaces are contacted and uniform gray appearance(?). Dump out.
7. 1 quart of acetone obtained locally. Slosh on all surfaces (no specified time). Dump out.
8. Do step 7 again.
9. Sealer. Rotate all around. Let stand 8-10 minutes on each side. Dump excess. A white coating should exist on all surfaces of the tank. Says it contains methyl ethyl ketone.
10. Allow to dry (open) for 48 hours before use .

"If you dumped all this crap in the ground you would have another "Love Canal". It says to dispose of "stuff" according to local law."

The instructions that come with other products may not be as extensive, but they *should* be. Simply applying a single cleaning product prior to lining may work on a *new* tank, but it's likely to result in troubles down the road if done to an old tank with a few years' accumulation of surface rust and gasoline varnish inside. The lining may not stick securely in spots, then later peel off and plug up the pickup.

Aiken: "The key, I believe, is the first step (Ed. note: he means step 2), which is to get all the varnish and other goop off the metal. Rust (and some metal) will be removed by the muriatic acid, but the acid will not remove non-metallic stuff. The cleaner supplied by Eastwood softened but did not remove all the gasoline residual (varnish, etc). Where I could see it I could scrap it off with a stick, so it was not yet removed. So I added a step. With most of the cleaner still in the tank, I added a gallon of acetone. Sloshed it around then let it sit for about two hours, then sloshed it again. It worked. If you see anything but gray metal (maybe some rust and corrosion is OK) the process will fail. The muriatic acid will not remove non-metal stuff, and the liner will only adhere to pure etched metal."

The steps above describe a "metal wash" with "alkali surfactants", but in reality any automotive cleaner/degreaser that can be poured into the tank, sloshed around, and drained out will work well. The objective is to get any varnish and goo out, so make sure that you accomplish that.

The muriatic acid is for getting the major metal corrosion off. Muriatic acid is available at building supply stores (it's used to clean brick walls) and at swimming pool supply stores (used to control ph in pools). The concentration commonly available is 20° baume, which is a suitable strength for this job. Most shops -- as well as the guidelines above -- suggest using a half gallon, but on this tank a full gallon is advisable because the interior of the tank is so convoluted that there may be spots you don't get to with less liquid inside.

Muriatic acid is nasty stuff; Aiken says, "muriatic (hydrochloric) acid is potent and very caustic. Emission of chlorine gas is lethal. You must wear rubber gloves and a mask and be outside." Arranging to be upwind is helpful, too, even if it requires a fan.

Phosphoric acid is available in several products for treating surface rust, including Ospho and Right Stuff De-Ruster,

available at auto parts stores. It chemically converts rust into something inert and paintable. Note that Naval Jelly is also a phosphoric acid-based rust treatment, but unusable here because it's too thick to slosh around inside; you need a thin liquid here.

Note that there should be no rinsing with water past step 5. The residue of the phosphoric acid treatment is removed with the acetone. After rinsing and draining (several times for maximum effect), any remaining acetone will evaporate completely in minutes, leaving the tank clean, dry, and ready for lining.

Tip: each time you put a liquid in, you're gonna have to drain it out. And there is only one opening into the XJ-S tank that will drain the last pint or so, and that's the fitting for the main line to the surge tank -- the one that's intended to be a drain. All the other openings are nothing but frustration, nothing ever seems to pour out of them except when you don't want it to!

A popular idea is to use heat -- either to make the various cleaning agents or acids work better, or merely to dry the inside of the tank after rinsing. If a really big oven is available, this might work pretty well -- but the more common procedure is to use a torch to heat the outside surface of the tank. One should be aware that this method might be perfectly workable on other tanks that are mere cans, but on the XJ-S tank such torching will clearly have more effect on the outer shell than on the baffles within.

Also note that you will only be able to visually inspect or physically touch a small percentage of the inside of an XJ-S fuel tank. That means that you must rely on liquids to accomplish everything you need to accomplish. Trying to scrub the areas you can see will only keep you from being able to judge the success of your work by looking at the areas you can see! Treat the entire tank the same way, and then you can conclude that the entire tank is done when the visible areas look done.

When the liner is poured in, you need to slosh it around to coat all the inside surfaces and drain out the excess. Good luck! First off, the stuff doesn't really "slosh" since it's a little too thick; it might help to dilute the liner with some MEK or acetone prior to pouring it in. Even if you render it sloshable, it's still difficult to coat all those internal baffles; as you rotate the tank over and over, the fluid pours past the baffles without really getting up on them. Of course, the baffles are not a leak concern, but you would like to prevent them from rusting anyway.

When you open the tank up to drain the excess liner, you can just prop it up and let it pour out -- and it'll pour for two hours. Alternatively, you can just drain for five minutes -- getting most of what you will ever get out -- and then tip the tank over to let the remainder run back across surfaces inside to make the coating a little thicker. If you will tip the tank to a different position every few minutes, you can avoid the lining puddling in any one place.

Of course, while you're lining the tank, it would also make sense to line the surge tank -- which is easier to do, although again it's not as easy to drain as you might think. The drain plug in the bottom won't drain the lowest half inch of liquid! You have to tip and tilt the surge tank to get everything to drain out of the big pickup opening, and all the liquids like to flow around the opening rather than draining out it.

And you might also want to consider lining the vapor separator, although it's a bit tougher because the biggest opening into it is a 5/16" hose connection.

If all this sounds like too much for the do-it-yourselfer, there are places that will do it for you. You can usually find a local shop that does this sort of work, although the one found by the author had never heard of phosphoric acid, had been applying liners over bare metal with surface rust for 25 years. For a more reputable shop, you can contact Moyer's Fuel Tank Renu (page 704) about shipping your tank to them for work.

Although this section was written with the XJ-S coupe fuel tank in mind, it's probably equally applicable to the convertible and cabriolet. The Hess & Eisenhart is another animal, since it has two tanks; the upper one is a modified version of the coupe tank and the lower one is completely custom.

FUEL TANK COATING: As mentioned above, a common cause of fuel leaks in the XJ-S is rust on the *outside* of the tank -- specifically, the bottom. Therefore, even if you're not interested in lining the inside as described above, you might want to tackle the job of making sure the outside doesn't rust. The tank still has to come out, but beyond that this

job is obviously much easier. Simply clean off any existing surface rust (and possibly the paint if you want, meaning you can sand-blast the whole outside if you wish), treat it with a phosphoric acid product such as Ospho or Naval Jelly, and then coat it with something that will make really sure it won't rust. Automotive undercoating is a popular idea, as is POR 15. Undercoating is available in spray cans from automotive stores. You can't see the tank after it's installed, so appearance is not an issue; you just want to make very sure it will never rust again.

Note: when you first remove the carpet and look at the tank in place, what you may think is rust may be the remnants of the glue that once held the carpet in place. Be sure you're really looking at rust before you panic.

FUEL TANK REPLACEMENT: The author, having gone through the tank lining process, has arrived at a few conclusions:

1) I'd never do it again. Rather than fiddling around with all this work, I'd just take the tank down to a local fab shop and have them make me an entirely new tank out of heavy gauge aluminum. The cost is reportedly comparable to buying a new tank from Jaguar, but if you buy a new tank from Jaguar you still end up with a rust-prone steel can. While making the new aluminum tank, I'd omit those stupid threaded compression fittings and just provide barbs for connecting hoses. I'd probably have a new surge tank made while I was at it, and completely change its configuration so as to better locate the pump and an in-hose pickup filter.

2) I consider the entire idea of making automobile fuel tanks from steel to be irresponsible at best. Aluminum should be the minimum specification, if only to minimize rust problems. From an automobile manufacturer, though, I would expect a mass-produced version of the fuel cell commonly used in racing. Racing organizations wouldn't consider a simple steel tank acceptable, and with good reason: they're an obvious fire safety hazard. It wouldn't cost auto manufacturers \$20 more per car to provide a similar level of safety in street cars -- far less than air bags or ABS brakes cost.

FUEL LEVEL SENDER: It's discussed on page 594.

Fuel Tank: Hess & Eisenhardt Convertible

FUEL TANKS: This section is of no use to coupe or later convertible owners, but it is reportedly difficult for H&E owners to find information on how this system works so a description is included here. According to Mike Cogswell, "In order to make room for the folding top and its mechanism H&E had to take the standard tank and cut part of it off. It would appear they literally cut the tank and welded in a sloped section. To regain fuel capacity, they added a second tank under the parcel area, basically where the rear seat would have been in a coupe. The upper tank is about 14 US gal. and the lower is about 11.

"As you know, the standard tank has a sump from which the high pressure fuel injection pump draws its fuel. Since the second tank is lower than the first H&E added two concentric hoses. The larger outer hose allows fuel to gravity drain into the lower tank from the upper (which is where the filler neck is located.) Consequently, the lower tank is always full until the upper tank goes dry. Meanwhile, a small submerged pump constantly pumps fuel from the bottom tank to the top tank via a small tube that is located in the center of the large drain hose. The fuel is dumped into the upper tank's sump, where it is available to the main fuel pump. The submerged pump can pump fuel faster than the engine consumes it, but any in excess of the sump capacity will drain right back into the lower tank. Both pumps only run when the ignition is on and the standard pump circuit is energized, so all the regular safety interlocks still work."

Tim Blystone points out that since parking the car nose-down on an incline will cause the fuel to drain toward the forward tank and away from the sump, the auxiliary pump might not keep up when the tank is less than half full. "All of the early tank designs will stall on a sufficient incline."

"H&E went through a couple of different configurations. The main difference is the dams added in the interior of Jags

original tank.”

FUEL TANK LEAKS: This author has only laid eyes on one H&E convertible, and that one was literally pouring fuel out the bottom of the car. Steve Wilke says, “I’ve heard stories from a couple of informed sources that Jaguar Cars repurchased a large number of Hess & Eisenhardt convertible conversions, and these cars were then shipped elsewhere; Brazil was one of the target countries that was mentioned to me. Seems that a large number of the H&E conversion fuel tanks weren’t made properly, and had a propensity for splitting their seams and producing a very pronounced fuel smell. When the owner would call the dealer to report this, they’d say something like “Really? Where is this Jaguar?”. Then they’d send over a flatbed truck, load up the car, and hand the owner a check. Perhaps Brazil has a much lower population of suit-hungry attorneys than the States do. I would expect the population of H&E’s in the States to be quite small indeed by this point.”

If you have an H&E with a leaking tank, there’s certainly no need to ship it to Brazil. It’s a fairly simple matter to fix a leaking fuel tank, or even to simply take it to a local welding shop and have them fab up a replacement tank in heavy-gauge aluminum with whatever fittings and connections you desire.

FUEL GAUGE: see page 595.

FUEL HEATING PROBLEMS: The stock Jaguar fuel pump moves far more fuel than the engine normally needs with the excess returned to the tank. Since this heats the fuel somewhat, a fuel cooler is included in the return line, using the A/C freon circuit to provide cooling. On the H&E, however, the problem is exacerbated by the fact there are *two* pumps running full time, coupled with the fact the car is a convertible so the top may be down and the A/C *off* on warm days! Tim Blystone: “Normally this presents very little problems until the A/C goes on the fritz, or you have one of H&E’s earlier designs. If it is summer, the top is down... the A/C system is off. No cool fuel. Vapor lock from hell.”

FUEL SYSTEM MODS: Tim Blystone: “My modification puts the plastic hose from the H&E fuel cell directly into the supply for the sump tank. A new and longer piece of hose is required. Fuel is pumped by the H&E pump directly into the Jag sump tank and bypasses the need for the tank to be gravity filled. There is a return to Jags original main tank from the sump tank so there is no excess pressure in the sump. The result is a fuel system that doesn’t have the H&E problem with steep inclines or die dead in the middle of a hot southern day.”

Another idea might be to do away with the surge tank and main fuel pump altogether and (somehow) connect the pump in the lower tank directly to the engine. The fuel in the upper tank can then simply gravity-feed to the lower tank and stay there. Basically, the lower tank would serve as the surge tank. The return line from the engine doesn’t require alteration, it can continue to feed into the upper tank. The vent lines from the surge tank can simply be plugged, allowing the existing vent lines from the two main tanks to work as intended. Benefits include more luggage space in the trunk! Before doing this, one would need to ensure that the fuel pump in the lower tank can actually provide the flow and pressure required by the engine. If necessary, just replace that pump with one of known capacity -- one from any large V8 with EFI, for example.

GAS CAPS: The single fuel filler on the H&E is the same as the two on an XJ6. You can read about these on page 244.

Surge Tank and Fuel Pickup -- Pre-1992

FUEL PICKUP: Leonard Berk's XJ-S would run fine when first started, but after a half hour it would start to lose power, eventually coming to a stop. After shutting it off and letting it sit for a minute, it would start and run fine for another half hour. It turned out the problem was dirt in the small surge tank in the trunk. As the engine ran, the dirt would gradually collect on the screen on the pickup and plug it. When the engine was shut off, the dirt would fall back to the bottom of the tank. This is not a freak occurrence; in fact, it is one of the most common failure modes on the Jaguar XJ-S! This same problem happened to this author's '83 and several others have reported it as well.

In fact, it's common enough that it even caught Jaguar's attention. This pickup screen plugging is a very rare example of a problem that has been recognized and addressed by Jaguar. In Issue No. 2 of the XJS Bulletin, Ray Ingman of Classic Spares, Inc., reports that Jaguar issued a replacement pickup screen with a considerably larger screen area. The part number is CBC5649. Anyone working in the area should definitely upgrade.

Ingman apparently doesn't think a lot of this fix; his impression is that the larger area won't prevent it from plugging, it'll just take longer. He may be right, but he might not be. For one thing, the suction at the screen is a function of the screen area, so a screen with more area will have less suction at the surface -- so *maybe* the junk won't have as much tendency to stick. Another possibility: It may be that the larger screen has so much area that it's effectively unpluggable -- you could cover the entire surface with crud and it would still be able to pull enough fuel through the nooks and crannies between chunks to maintain flow and keep running.

John Goodman owns a 1989 XJR-S 6.0 litre: "I have just cleaned out my sump tank, no signs of a filter!" Who knows, maybe Jaguar decided it was more trouble than it was worth.

There is some experience to indicate that the plugged pickup problem is often accompanied by a failed fuel pump. Perhaps the plugged pickup causes the pump failure. Be aware that when you find the pickup problem you may also have to replace the pump before the car runs right again. Apparently, if you can hear the pump whining when driving, you can count on it. Perhaps the cost of this pump is one good reason to check the pickup *before* you have problems.

OK, you're thinking to yourself that you don't have the symptoms of a pickup problem, but you'll now be able to recognize it if it happens and know how to fix it when it does. John Himes would probably suggest you think again. If the sump pickup can get plugged badly enough to shut down the engine, what happens when it's plugged a little less than that? Let's say it's just a little bit plugged, not enough to affect engine operation at 60 MPH but enough to start limiting fuel flow at full power. Just as you're really getting into the interesting areas of the speedometer, the pressure in the fuel rail starts to drop off. The engine starts to run lean just when it can do the most harm; lean mixtures at full power are a recipe for disaster. And you're into the open-loop range of operation, so the oxygen sensors are not able to correct the lean mixtures. Himes was cruising along at 140 MPH, and the next thing you know he was facing several months of down time and several thousand dollars in mechanic's bills to fix a couple of burned pistons. Now, lemme ask again: are you *sure* your fuel pickup is in good shape? In fact, *everyone* with the earlier style pickup screen should definitely upgrade; go ahead and order the part *now*.

Kevin Darling claims that his car starts more easily since he cleaned up his pickup, and has a lower, more stable idle. Neither of those effects can be easily explained, but improvements are always welcome.

There is, of course, another way of dealing with the problem: discard the OEM screen altogether and install an inline screen in the hose between the surge tank and the pump. This would have the advantage that, once this screen had collected a lot of crud, you could clean or replace it and get the crud *out* of the system once and for all. With the OEM setup, you're probably leaving a lot of crud inside the surge tank even when you clean it as best you can. Also, with an inline screen you may be able to pinch the lines and service it without having to drain the surge tank. Finally, if you get a screen assembly with a clear housing, you'll be able to see if it's dirty.

The line between the pickup and the fuel pump is 1/2", and finding a fuel filter or screen assembly with 1/2" fittings may be difficult -- and you certainly don't want to step down to smaller fittings, since the entire objective is to minimize restriction in this suction line! Keep looking; Chad Bolles says NAPA carries fuel filters with 1/2" bars. This author found a suitable unit a local parts store; it's a Wix filter, number 33299. Less than ten bucks. It has an all-metal housing. It's a pretty compact unit, helping ease installation a bit.

Andrew Holley found another one: "Has 1/2 inch fittings and looks just the thing for keeping the crud out of the system. The part no. is 202711 (Volvo)"

There are also various types of high-performance or specialty filters that might be used. Holley makes a unit called a Volumax that includes a cleanable 60 micron screen element. It comes with either 8AN or 3/8" hose barb fittings that screw into the housing, but 8AN is 1/2" so you might be able to find 1/2" hose barb fittings to screw into the housing.

Heavy equipment places that work on trucks and bulldozers may have suitable filter assemblies that can be fitted with cleanable screens, but they are usually big industrial contraptions and will be difficult to locate in the XJ-S. They also have threaded connections, so you'll have to install some suitable fittings for connecting the hoses up.

Another possibility, of course, would be to tee together two or more 3/8" filters. Finding suitable 1/2"-to-3/8" tees may be harder than finding 1/2" filters, but once you've put it together it'd be easier finding replacement filters.

You'll need some 1/2" fuel hose -- another challenge. EFI hose is not necessary, this is a low-pressure application. But finding *any* fuel hose in 1/2" size may require visiting an industrial hose shop rather than an auto parts store. See page 239.

You also need to get some clamps; EFI style clamps would be great, but 1/2" hose is big enough that regular worm screw clamps work just fine.

The OEM fuel hose goes from the pickup tube to the pump inlet, only about four inches with a 90° bend -- too close to put this filter in between. Instead, use a new piece of 1/2" hose to make a big circle from the pickup tube barb CCW past the pump inlet, down, back to the right, up, and back left into the fuel pump inlet. Then install your filter anywhere in this loop that's convenient. Probably three feet of 1/2" hose total, but absolutely no sharp bends.

Wrap some foam around the metal filter so it won't rattle and clang against the floor or battery support. I used the 1/2" foam tape used for sealing doors. After encircling each end of the filter with foam strips, I added some electrical tape to hold it in place.

FUEL PICKUP - SALOONS: Saloons -- either XJ12 or XJ6 -- don't have a surge tank, but they nevertheless have the same problem with clogged fuel pickups, one per tank. Without having read this book, Chuck Sparks came up with a remarkably similar fix as that described above, fitting two generic fuel filters in the lines between the tanks and the selector valve.

FUEL SUPPLY MONITORING: From a fail-safety point of view, the surge tank pickup situation is bad. Regardless of which pickup screen you have installed or how often you clean it, there is really no way to know if it's plugged until you notice the symptoms -- and the first symptoms are likely to be low compression readings in a couple of cylinders!

Of course, a plugged pickup isn't the only possible cause of lean running under hard throttle. A failing fuel pump, an obstructed fuel line, or a fuel filter overdue for replacing are other obvious candidates. Whatever the cause, the result will be the same: if you run it hard, you're gonna be buying new pistons.

Oh, c'mon, the problem can't be that serious! How come other cars aren't burning pistons at full throttle all the time? Well, obviously because their fuel systems weren't designed by Jaguar engineers. On most cars, nobody ever even has to think about the fuel supply; it's just there, and it works. The concept that an engine could run lean because of a plugged fuel pickup strikes owners of other cars as laughable.

Of course, you could resolve to never drive the car hard -- but why else would you own a Jaguar? A better solution would be to have some indication that the fuel supply is holding up *before* you burn pistons.

Two methods come to mind. The first would be to install a fuel pressure gauge or sensor in the rail. Robert Dingli says: "I bought a VDO fuel pressure gauge for about Aus\$40 and connected it to the fuel rail where the cold start injector was once supplied. I believe any pressure gauge designed for hydrocarbons would be suitable and other brands sell for much less. My gauge is mounted in the engine bay as I am paranoid about high pressure fuel entering the cabin.

"There are a couple of things to note about connecting the gauge:

- use high pressure fuel line and fittings.

- don't mount the gauge on the engine as vibration will kill it.
- use a restrictor in the line as the pressure fluctuations will also kill the gauge."

If you have the Digital P system, ideally you'd use a gauge that reads the difference between the fuel rail pressure and the intake manifold pressure. Since the fuel pressure regulators are referencing manifold pressure, this should result in a steady reading at all operating conditions and any variation is a sign of trouble. If you use a regular gauge that references ambient atmospheric pressure, the fuel rail pressure will go up and down as the intake manifold vacuum varies, so you will have to monitor both and do a little math to make sure things are operating properly.

For most intents and purposes, a pair of air/fuel meters (see page 37) is a better idea than a fuel pressure gauge.

SURGE TANK DRAINING: In theory, the easy way to drain the surge tank is to pinch off the line from the main tank to the surge tank and run the pump, which will pump the fuel through the fuel rail and back into the main tank. You don't even have to hotwire the fuel pump relay; you can just start the engine and let it run until it stalls.

Good idea in theory, but in fact may not work too well. As described below, the return line from the engine doesn't simply go into the main tank, but rather goes through the tank and is directed into the vent connection for the surge tank. Running the pump will circulate the fuel from the surge tank around and back into the surge tank, and you will have to run the engine until it burns all the fuel in the surge tank.

So, pinch off the vent line too? Bad idea, because then the pump would pull a vacuum on the surge tank and cavitate long before it empties the surge tank -- unless your surge tank has been fitted with the JLM 2163 vent kit mentioned below, in which case this might work fine.

Forget that method; there are other perfectly workable methods that are very easy. The intended method of emptying the surge tank is to clamp the main line from the main tank, and then remove the rubber plug in the floor underneath the surge tank and open the drain in the bottom of the tank (see page 245). Since the vent line actually opens near the top inside the main tank (as opposed to where it looks like it goes) you only need to make sure the fuel level is below that level so it sucks air instead of fuel. Just plan on this job when the tank is less than half full. Of course, you can do it when it's full; it's just that you will first have to drain the main tank down to the level of the vent before the surge tank will empty.

Another way to drain the surge tank is to pinch off the main line from main tank to surge tank, disconnect a line from the fuel filter and direct it into a gas can sitting in the trunk, and remove the fuel pump relay and apply a jumper between terminals 30 and 87 in the socket to run the pump.

Of course, one way to drain the surge tank is to drain both the main and surge tanks; that way you don't have to pinch off any hoses. See page 245.

SURGE TANK DRAIN UPGRADE: Somewhere along the line, the drain plug in the surge tank changed from C41803 to CBC4518. The newer drain plug is magnetic, while the earlier item was a simple plug. If you are working in the area and find no magnetism in your drain plug, you definitely should opt for a replacement; any particles that stick to that magnet are particles prevented from plugging the pickup screen.

The 1988 Jaguar Parts Catalogue lists only the first part number, but later editions apparently confused things a bit. Wally Magathan says, "According to my parts manual, RTC9900CA, Jan 1989: on page 2D 05, there is a diagram of the sump tank, with the drain plug part annotated as having been replaced by a magnetic plug. One puzzlement, however: the diagram is indicated to pertain to cars equipped with 3.6 engines only. There is no diagram labeled for use with 5.3 engines." Kevin Darling responds: "This puzzled my local Jag dealer as well. But the RTC9900CA parts book is wrong, since both my 1985 and 1990 V-12's have the sump tank."

Supposedly the CBC4518 plug will fit all the earlier cars.

If you're cheap, of course, you could always simply drop a magnet into the surge tank while working on the pickup. It might be more challenging to clean, but it should do just as good a job of keeping ferrous particles off the pickup screen.

SURGE TANK VENTING: The vent line from the surge tank doesn't go to the vapor separator, as one might expect. Instead, it connects back into the main tank about 2" above the bottom. However, this is not a simple opening into the tank. Inside the tank, this fitting continues as a tube that makes a couple of bends and terminates with an open end pointing upward a couple of inches from the top of the tank.

Meanwhile, the fitting for the return line from the engine compartment is at the bottom left rear corner of the tank. Inside the tank, this fitting continues as a tube that runs across the rear of the tank -- there are actually a couple of clips brazed to the inner surface of the tank to hold the tube in place -- and then bends upward and terminates with a 180° hook that pokes its end down *into* the opening of the pipe from the surge tank fitting described above. The connection of the two pipes is not liquid-tight; if you tip the tank over and pour a liquid into one of the fittings, it will leak out of the connection within the tank. But it doesn't appear to be a *very* loose fit; the tube from the return line appears to nearly fill the opening in the end of the tube from the surge tank vent.

In other words: the fuel returning from the engine compartment passes *through* the main tank but really goes directly back to the surge tank, with a leaky connection inside the main tank to allow air to bleed out or something.

Mike Morrin provides a possible explanation for this Rube Goldberg: "Let's say you are nearly out of fuel, with a little fuel still sloshing around the bottom of the main tank. You park, with the engine running on the side of a road with a lot of camber so that all the fuel runs to one side of the tank. The main outlet from the tank is now above the fuel level. The engine can keep running (or restart) for as long as there is fuel in the surge tank.

"With the arrangement you describe, the engine can keep running until all of the fuel in the surge tank is burned in the engine. If the return pipe just went to the main tank, the fuel circulated by the pump would all end up in the main tank, and the surge tank would be empty in a minute or so."

Apparently something about this system didn't work as intended, though; in Issue No. 2 of the XJS Bulletin, Ray Ingman reports that Jaguar issued a kit to provide an additional vent for the surge tank, JLM 2163. The kit includes a replacement pickup tube that features a vent connection. A line from this connection is simply teed into another vent line up near the vapor separator.

Ingman describes the incentive for this fix as a "problem of fuel vaporization within this tank under adverse, e.g. hot, climatic conditions. This results in flat spots and hesitation in engine performance."

SURGE TANK VENT CONNECTION: There are three threaded fittings on the fuel tank in the '83 coupe. The main drain line from the tank to the surge tank requires a 13/16" wrench and the return line from the front of the car requires a 19/32" wrench -- both readily available at most hardware stores. However, the fitting where the surge tank vent connects to the main tank requires a 1/4" Whitworth/5/16"BSF wrench.

Fuel Pump

FUEL PUMP CONTROL: On both the Digital P system and the earlier D Jetronic, the fuel pump is controlled by the EFI ECU via a relay in the trunk. The ECU contains a circuit that determines whether or not the engine is actually running and shuts off the pump if it has been motionless for more than a couple seconds. You can observe this circuit working by turning on the ignition without starting the car, and listening to the pump run; it should shut off in a couple of seconds.

Note: there have been some reports that owners have gotten the idea that they are supposed to wait until the pump stops running before starting the car. This is not the case; the fuel pump control circuit is only provided as a safety device. When starting, the key should be turned from off all the way around to start promptly.

The fuel pump control circuit is unreliable in the 6CU ECU, and sometimes will fail to keep the pump running more than

a couple seconds regardless of whether the engine is running or not. Typically, the starter is engaged, the engine fires, the starter is released and the engine quickly dies -- misleading the mechanic to believe that the problem is related to coming off the starter circuit. Of course, like most electronic failures, it can be intermittent -- runs perfectly for a while, then dies, then inexplicably runs perfectly later.

If you'd like to test this circuit to determine if this is your problem, simply remove the fuel pump relay in the trunk (the one without a red mark on it) and put a jumper into the socket connecting terminals 86 and both 87's. This will allow the pump to run whenever the ignition is on. If the car now runs perfectly, the fuel pump circuit in the ECU (or the relay itself) was the problem. AJ6 Engineering, Beckman, or any other place that repairs ECU's should be able to fix this problem for far less than the cost of a new ECU.

If you're willing to risk the odds that you will be in an accident where you are knocked unconscious, a fuel line is severed, and something ignites the leaking fuel, you can leave this jumper in place permanently -- but a better idea would be to cut the orange wire from the 85 terminal in the socket and connect it directly to ground and reinstall the relay. That way, the relay will continue to handle the heavy current to the fuel pump instead of pulling it through the ignition switch, as is done with the 86-to-87 jumper. Note also that if you happen to have a leaky injector, turning the ignition on without starting the engine can fill a cylinder with liquid fuel, causing considerable damage the next time the starter is engaged.

You might also consider upgrading to the later 16CU ECU. See page 296.

FUEL PUMP POWER SUPPLY: Elsewhere in this book there are lengthy discussions of problems with voltage losses in the original Lucas wiring. The electric windows, the windshield wipers, and the headlights all commonly suffer from low voltage due to high-resistance connections or simply undersized wiring. Why should the fuel pump be any different.

The voltage to the fuel pump, unfortunately, is a far more serious concern. The fuel pump provides a constant flow of fuel. The engine takes what it needs, and the excess is returned to the tank. As long as the engine is at low power, most is being returned to the tank, and a reduction of pump capacity would go unnoticed. When the throttle is floored, however, a fuel pump working at low voltage won't provide enough fuel to keep up, and the engine will run lean -- precisely when the EFI system is in "open-loop" mode and desperately in need of enrichment. The inevitable result will be burnt pistons, in short order. What's worse, it's quite possible you'll spend thousands of dollars rebuilding the engine without ever figuring out why you burnt pistons -- and hence may do it *again* the next time you floor it.

Now, *today*, before the next time you hammer that gas pedal, go out there and measure the voltage across the terminals on the fuel pump itself. You'll have to remove the spare tire, the trunk carpet, and a couple of panels to get at it, but it's not difficult.

At idle, the voltage should be at least 11V. Better yet, have someone hold the engine at 2000 rpm. At that speed, the voltage should be at least 13V.

If it's not, fix it. For analysis, you can use the same VOM while you're there to determine where the voltage losses are -- in the ground connection, in the fuel pump relay itself, in the wiring from the battery to the fuel pump relay, in the wiring from the fuel pump relay to the pump. In the XJ-S, all these items are within a couple feet of each other in the corner of the trunk. In the saloons, the battery is up at the front of the car, so testing each part of the circuit is a bit more involved.

Better idea: just forget the testing and replace everything. Run a new 12-gauge wire directly from the battery post to the fuel pump relay. Run a new 12-gauge wire from the fuel pump relay to the fuel pump. Run a new 12-gauge wire from the fuel pump to ground. Make sure you're providing good connections to the fuel pump relay socket, not just splicing into the existing wires near the terminals -- the existing connections where the terminals are crimped onto the wires may be the problem! If the voltage at the pump terminals still isn't what it should be, replace the fuel pump relay itself -- that's the only thing left it could be. All of this could be done in perhaps an hour for ten bucks worth of wire, connectors, and a relay. Money well spent.

FUEL PUMP NOISE: A noisy fuel pump is a very common complaint. The two most common causes, though, are not the pump's fault. The first is a problem in the mounting. The pump is supposed to be mounted in foam rubber and connected at both ends with flexible hose so that it can vibrate without transmitting sound into other parts of the car. However, its near-vertical mounting often allows the entire pump to slide downward through its mounting until the outlet barb, within the hose, is jammed hard against the trunk floor. This allows the vibrations to be conducted directly into the structure of the car. To prevent this, the author wrapped a piece of soft rubber around the pump and held it securely to the pump body with a hose clamp. The pump could then slide downward only until this rubber contacted the mount, and could not slip any farther. Problem solved.

Ed Sowell has a related problem: "Mine was really noisy for a while. Then I found some jerk had put a floor jack under the boot floor pan, pushing it so that it ran into the pump. Got quieter when I pounded the floor back down."

The other likely cause of pump noise is a plugged pickup or other restrictions on the suction line to the pump. See **FUEL PICKUP** on page 251.

FUEL PUMP MOD: This author had a scrap fuel pump apart and was surprised to find that there is no anti-rotation feature on the pump stator. If it decided to, the stator could start spinning within the pump housing. Just for grins, I worked up a fix which is explained and illustrated at

<http://www.jag-lovers.org/xj-s/book/83FuelPumpMod.html>

Basically, I drilled and tapped a threaded hole in the magnet case and screwed a round-headed screw into it from the inside outward such that the head of the screw would prevent the square stator housing from spinning around within it. I ground off the tip of the screw flush with the outside of the magnet case so it wouldn't interfere with installation in the pump housing.

There it sat online for years, a fix without a problem. Then Charles Welkie weighed in: "Many of us have been wondering if the stator in the Lucas fuel pump does ever actually rotate. Seems my experience today confirms that it can happen. Fuel starvation problem led to the usual (new filter), check the surge tank screen, etc. Still no joy. Upon pulling the fuel pump apart it became obvious that the stator could spin rather freely in the magnet housing. A 6-32 button head machine screw and 3 lock washers later it didn't spin any more. Nice bonus - the pump didn't leak after reassembly either. The test drive was a joy. Good solid response throughout the range."

The question now arises: Over the decades, how many fuel pumps have been discarded and replaced when this modification would have rendered them fully operational? We'll never know, but consider that the typical symptom of a failing pump -- getting too noisy -- could certainly be explained by the stator spinning around inside the case.

FUEL PUMP OVERHEATING: Joe Bialy warns against running the pump with an empty tank, or otherwise with no fuel in it: "The fuel is the only means of cooling the pump windings."

FUEL PUMP FOREIGN OBJECT DAMAGE: Steve Holst had a fuel pump totally seized by a tiny strip of cellophane, possibly from a wrapper or maybe the edge of the Lucas label on the side of the pump. For those of us who like to tinker, it's possible to fix this problem by completely disassembling the pump and removing the cellophane strip -- but just your luck it'd be a metal chip or a piece of sand and the impeller will be scored beyond repair. The message is clear: make very sure nothing can get into that pump inlet except fuel! Fortunately, the line between the pickup screen and the pump itself is very short and simple. Just make sure that there's nothing within that little stretch of plumbing and you'll be OK.

FUEL PUMP VARIATIONS: Peter Smith says, "The pump motor is used on several cars including Volvo, but the rotors are said to be different to provide different flows for different cars." Just in case there is any misunderstanding, let me make the implications here perfectly clear: the fuel pump is *not* an item that you should replace with a pump from a

different car just because it looks the same. If you install a pump with a lower flow rate, the car might run fine at normal speeds but run lean when floored and the ECU is operating in open-loop fuelling mode. The result will be burned pistons. There won't be any warning prior to burned pistons.

FUEL PUMP UPGRADE: In 2005, the author picked up a flyer in an auto parts store touting a new line of Bosch fuel pumps. Instead of the roller pump found in the XJ-S pump, this pump features a turbine pump. John Robison, who works at Bosch, says "If I remember correctly, the impeller runs up around 30,000rpm." Supposedly quieter, supposedly more durable. And, judging by the illustrations, is about the same shape and size as the OEM Lucas pump. So, if your pump dies, perhaps you'd be wise to seek out one of these newer design pumps. If it's suitable for any EFI automobile of similar horsepower and you can get it mounted and connected up, it should work fine. Bosch might even provide a cross-reference listing new pumps for old cars.

FUEL COOLER: Many people see that the air conditioning circuit in the Jag includes a fuel cooler, and assume that this is a high-performance trick. Dragsters often include an ice bucket in the engine compartment to cool the fuel on its way to the engine to get more horsepower.

It's a great idea, but unfortunately not the case. The fuel cooler in the Jag is in the return line going back to the tank. The pump moves much more fuel than is normally needed and most of it recirculates. The fuel being heated while passing through the engine compartment as well as the pumping energy itself would eventually heat up the fuel in the tank significantly, possibly causing vapor lock problems and problems passing EPA emission requirements -- heated fuel gives off more vapor. The cooler is to counteract the heating effect. This may help explain why the ventilation system has the A/C running during most conditions.

Why Jaguar doesn't put the cooler in the supply line and reap both benefits is anybody's guess. Perhaps it's more difficult to make a cooler to operate at the higher fuel pressure on the supply side.

FUEL COOLER - CONVERTIBLE: According to Michael Neal: "This vapor lock problem was such a problem that the convertibles were modified to keep the A/C compressor running all the time. The aerodynamics on the convertibles caused the engine compartment to run even hotter than the coupes. With the A/C compressor running the fuel cooler kept the fuel temp to a decent level."

This author suspects aerodynamics had nothing to do with it. In the coupes, the A/C was always on anyway -- you can't live in there long without it. But with the convertible, you can turn the A/C off and put the top down.

1992-on Fuel System

FUEL COOLER - 1992-ON: Richard Mansell quotes from a Jaguar publication that was sent to him: "It is titled "Technical Guide - The New XJ-S 1992 Model Year Preliminary Information". In it there is a paragraph about the fuel cooler deletion, it says:

"With the introduction of the in-tank fuel pump, the fuel cooler is deleted. This affected the characteristics of the system so that a muffler is added in the line to reduce noise and vibration."

"I wonder why adding an in-tank fuel pump should allow the deletion of the fuel cooler. It also says in another section:

"As a result of the deletion of the fuel cooler, it is necessary to introduce a redesigned hot start system. The thermal vacuum valve fitted to pre-92 MY vehicles is replaced by the following components:

1. Fuel rail temperature switch. The electrically operated switch enables the fuel rail pressure to be increased when the fuel temperature exceeds 70 degrees Centigrade at hot starting.
2. 45 second timer module. The timer limits the time for which the increased fuel pressure is applied.

3. Solenoid vacuum valve. This controls the vacuum signal driven by the fuel temperature switch and the 45 second timer.
4. Vacuum delay valve. This controls the way the extra pressure is applied at hot starting to give a decayed reduction in fuel pressure over 45 seconds, after which the pressure is switched to normal."

FUEL PUMP: John Goodman reports: "The latest XJ-S's had pumps *inside* the fuel tank, so Jaguar may have done this for noise related problems. I suspect that these pumps are lower output because the '93 model XJR-S had twin in-tank pumps, and must be ordered in a matched pair."

FUEL PUMP REPLACEMENT: Noel Keefer found that somebody had already replaced his in-tank fuel pump with a Walbro. "A WALBRO pump ought to be available at NAPA, for cheap. It was a perfect fit." Note that, when you take the old pump out, you'll find it encased in a housing. You have to open the housing up; the Walbro fits inside where the original pump was.

FUEL PUMP WIRING: Nigel Sly, who owns a '93 4.0, reports on a fuel pump wiring issue: "Pull the fuel tank and remove the pump canister/housing, then prise that apart, remove and replace the pump. Took me about 5 hours all in all. Just the pump unit will cost about \$100. Don't celebrate at that cost, when mine failed it was the connector which had toasted, apparently a design fault. New pumps have a different connector, which will not fit the female connector in the evaporative flange."

"First, cut off the connector from the pump, and then solder on an extra 2 to 3 feet of wire to the pump cables, this gives room to allow the pump to be refitted without the evap flange getting in the way. Pop out the through connector which goes through the evap flange (black in colour), cut the right angled bit off the connector, and then drill a small hole down through the connector, which will allow the pump cables to be passed through. Fit the connector back into the evap flange, and fill the connector with mastic/sealant to seal the hole. You will probably need to remove the connector from the external harness as well, unless you can find a matching connector to fit to the pump cables. If cannot find matching connector, cut the connector from the external harness, and then fit matching connectors to the external harness and the pump cables."

"I tried for weeks to get the original pump connector, even tried the makers of the connector, only to be told it has been out of production for years. Jaguar had the pump connector, and hence the evap flange changed in 1994, mainly I think because of numerous failures of the original connector.

"Incidentally, the tank does not need to be completely removed from the car; it needs to be moved back about a foot in order to get access to the evap. flange.

"A replacement pump (in canister), complete with new redesigned evap. flange, and new harness is about \$900, but now as rare as rocking horse s**t, you might see them listed on various sites, but stock is zero."

Sly may be satisfied with his fix of running the wires through the flange and sealing them up, but in general this type of thing is not a good idea. It's possible to end up with leaks *through* the wires themselves, vapors or liquid passing between the copper conductors and the insulation. In general, this type of problem calls for a liquid-tight bulkhead connection, something that the pump plugs into on the inside and the harness connects to on the outside. Better electrical supply houses should be able to provide such connectors, but make sure they're compatible with fuel and ethanol. If all else fails, you could conceivably make such a thing by embedding straight pieces of solid brass in the sealant and then connecting the leads to them on the inside and outside. You might even use connectors to hold the brass pieces in place while the sealant sets up.

Alternatively, you could make one small hole per conductor, and install a small bolt and nut with insulating washers. You must make sure that the head of the bolt seals against the insulating washer, otherwise you will get a leak along the bolt threads. It may prove a challenge to get the electrical leads connected without causing a leak.

FUEL PUMP PLUGGING: Noel Keefer reports: "My '92 [42,000 mi] has two screens *prior* to the pump. It produced the proper pressure and adequate volume for shop tests. But it couldn't go fast very long, maybe 5 minutes. Pulled the pump from the tank and the two screens were clean. So was the inline filter. *All* were perfectly clean. However the pump, a Walbro!, has about a 1/4 inch intake with a screen finer than the two prior filters. It was dirty. I carved the screen out because I'm not particularly fond of removing the tank when I have 3 filters preceding the pump. Now I have 2 followed by the inline and a screen on the return!

"Some may say now the pump is in jeopardy. My answer: "So what?". If the external filter is ever going to be more than a splice in my fuel line let the D*** dirt get to it. But tank removal is now going to be less frequent, if ever."

Rory McKenzie reports: "My friend Mike Dallaire ('92 xjs v-12) told me his in-tank pump fried out and he had to do similar work. He said when he pulled the in-tank fuel filter out, it was all clogged up with the remnants of little polyethylene "packing pillows" which had not been completely removed between the shipping and installation phases."

Vapor Recovery System

VAPOR RECOVERY SYSTEM: When the car is running and drawing fuel out of the tank, there must be a vent system to allow air into the tank to prevent a vacuum from being created. It is no longer acceptable to merely have a small hole in the gas cap; such methods allow fuel vapor to escape into the atmosphere all the time, whether the car is running or not, and would contribute to air pollution. Raw gasoline is a serious air pollutant, and besides that it smells bad.

Unless you live in California or somewhere else where they have intelligently-designed gasoline pumps, you pump 20 gallons of fuel vapor out into the air every time you pump 20 gallons of liquid gasoline into your car. It is simply inexcusable that, decades after the public became aware of the problems of air pollution, every filling station in America doesn't have the same vapor recovery filling systems that California has. But, back to discussing the fuel tank vent system in your Jag.

Avoiding polluting the air via a properly-designed fuel tank vent scheme is easy and doesn't hamper the performance of the car one iota. The only disadvantage to the owner is in the initial cost of installation, but since the car comes with the system from the factory and has therefore already been paid for, there is no reason to remove or disable it.

In simplest terms, a "vapor recovery system" connects the fuel tank vent to a carbon canister. Air can flow freely through the canister into the fuel tank, but when vapors from the fuel tank try to escape through the canister they are absorbed by the activated charcoal. Of course, the charcoal can only absorb so much fuel. Therefore, whenever the engine is running, there is a system by which the engine draws fresh air through the canister. This draws the vapors back out of the charcoal and burns them in the engine.

When the car is not run for extended periods of time, the amount of vapor generated in the tank could be considerable. Gradual changes in ambient temperature and barometric pressure would cause the vent system to "breathe", running a large amount of vapors through the canister. To absorb all this vapor, the canister would have to be prohibitively large. To reduce the amount of vapor the canister has to deal with, there is a "2 psi valve" in the vent line between the fuel tank and the canister. This valve will allow air to flow in either direction, but only after a certain pressure or vacuum has been reached. If the contents of the tank expand and try to escape out the vent, it will prevent any flow until the pressure reaches 2 psi or so, and then it will allow it to pass to prevent damage to the tank or hoses. Similarly, if the contents of the tank contract and try to draw air in through the vent, the valve will prevent any flow until the vacuum reaches a set value -- usually lower than the pressure value -- and then it will allow it to pass to prevent the tank from collapsing. As a result, the vast majority of the smaller expansions and contractions do not open the valve at all, and the amount of vapor the canister must absorb is greatly reduced.

Of course, this means that at any given time the fuel tank and hoses may be slightly pressurized, even when the car is not running. Even the tiniest leak anywhere in the system may become quite significant.

I am sorry to report that the vapor recovery system on the XJ-S is unreliable. Many owners have reported problems, usually indicated by a large “whoosh” but often dismissed as normal until the gas tank cracked or other dangerous symptoms arose. Fortunately, if the symptoms are recognized and addressed promptly, it’s never difficult to make the system work as it should; it’s simply not that complicated or expensive to fix.

VAPOR RECOVERY SYSTEM -- AFTER RECALL: The original XJ-S vapor recovery system pretty well followed the description above. However, there was a tendency for the tank to develop stress cracks from excessive pressure fluctuations as well as indications it did not vent as well as intended (including numerous complaints about fuel odors), so there was a recall to address the system. In general, the recall involved the installation of a “Rochester valve” in place of the 2 psi valve. David M. Johnson: “The Rochester valve (Part CBC 7714) is a cylindrical disk (approx 2 inch diameter) with an inlet from the fuel tank vent pipe and outlet for the vent to connect to the carbon canister. A third outlet at the top is to connect to the manifold vacuum.” A Rochester valve works the same way as the 2 psi valve when the engine is off, but when the engine is running the vacuum signal pulls the Rochester valve wide open to freely vent the tank.

The recall also installed one or two (depending on VIN) vacuum-operated purge valves to provide a positive purge when the engine is running. The left side throttle butterfly housing was replaced with one that had suitable taps for controlling the Rochester valve and purge valves.

For those who have disconnected the vacuum lines from the butterfly housing and want to reconnect them properly, I can give this guidance based on the dealer instructions for the recall that installed the system in the first place: Among the two vacuum hoses that go from the butterfly housing to the area in front of the left wheel well, one is supposed to have a black and white delay valve in it, hanging in the vicinity of the coolant header tank. A hose from the black side of this delay valve should be connected to the front port on top of the left butterfly housing. The hose with nothing in it should be connected to the rear port on top of the butterfly housing. Of course, there were several variations on this system as applied to different cars, but I think that description should cover most of them.

The carbon canister, the Rochester valve, the purge valves, and the associated plumbing are all located forward of the left front wheel; remove the forward panel of the inside wheel well to inspect. The only part of the vapor recovery system not in this location is the vapor separator, which is high in the right side roof pillar on the coupe.

I am sorry to report that, after the recall has been applied, the vapor recovery system in the XJ-S is *still* unreliable. The installation of the Rochester valve sounds good in theory, but unfortunately the Rochester valve itself is apparently extremely unreliable. When it fails, it apparently fails jammed shut, which is the worst thing that can happen to a vapor recovery system.

CARBON CANISTER OVERBOARD VENT: When the recall was applied to the vapor recovery system, one change done was to remove a hose that vented the carbon canister out the bottom of the car. It then just opens into the bodywork cavity. This demonstrates an interesting attitude; of course, if the system is working as it should, there shouldn’t be any odors coming out of this opening. But if, on the off chance, some gasoline vapors make it through this canister, you might be happier if you installed a new hose venting it overboard.

VAPOR RECOVERY SYSTEM -- CHECKING: If your XJ-S has the Rochester valve, the first check is quick, simple, and clear: with the engine running, open the fuel cap. There should be absolutely no “whoosh” or any other symptom of pressure equalization. If there is a whoosh, either the Rochester valve isn’t working, or the system is plugged somewhere.

The second test requires more judgement. When the engine is shut off, the Rochester valve becomes a 2 psi valve, and a small pressure or vacuum can build up in the tank. After parking for some time, a little whoosh is to be expected, but too much is too much. Too long is not the concern; typically, a nearly empty tank will whoosh for a long time (lots of air space inside) while a nearly full tank results in a very brief whoosh. The concern, though, is not the duration but rather the severity. David M. Johnson says, “A huge whoosh and an oil canning sound means the valve is not working --

the vent is connected wrong, or the vent is blocked.”

Another sign of trouble: no whoosh at all. There is a remote chance that the fuel in the tank has remained at the same temperature since shutdown and hasn't developed any pressure or suction at all -- but that's really unlikely, especially if the car has been sitting in the hot sun. Generally, if you don't get a whoosh when the car's been sitting a while, either the Rochester valve is stuck open -- which may sound acceptable but it's really not, it'll quickly saturate the carbon canister and then you'll have fuel odors, not to mention what you'd be doing to the environment -- or there's a leak in the system somewhere, which obviously could cause odors, fires, you name it.

In the US, the duration of the whoosh involves the little trap door in the filler that prevents you from inserting a fuel nozzle dispensing leaded gasoline. Since you can no longer buy leaded gasoline, nozzle notwithstanding, this thing is a relic of a bygone era and could be removed without concern. But if it is there, it effectively restricts vent flow when the cap is removed, and may make a short whoosh into a longer whoosh. Conversely, if the trap door is gone, a long whoosh may seem deceptively short.

If your car doesn't have the Rochester valve arrangement for some reason, whether or not the engine is running makes no difference; either way, there should be a small whoosh.

BACKUP FOR ROCHESTER VALVE: The entire point of the Rochester valve is that the tank should be freely connected to the carbon canister when the engine is running. It is a simple matter to make sure that happens: just tee into the vent lines before and after the Rochester valve and connect up a solenoid valve to bypass it. Connect the solenoid valve to a switched power source so it is energized whenever the ignition is on. That will ensure proper venting when the car is running.

To ensure proper venting when the engine is off, you can install a 2 psi valve in another bypass around the Rochester valve. If you don't have a 2 psi valve, you can probably get one from just about any car in a junkyard; most cars use a simple system similar to the pre-recall scheme in the XJ-S. Or perhaps you can buy a Jaguar part, CBC6820.

Of course, once you have the 2 psi valve and the solenoid valve working together, you could eliminate the Rochester valve. If it jams open, that'd be a good idea.

Obviously, another option would be to install a second Rochester valve around the original.

FAILSAFE FOR VAPOR RECOVERY SYSTEM: There are reportedly several different gas caps used on these cars; some OEM, some aftermarket. Some of them are a total seal, but others have a pressure/vacuum relief valve built into them to serve as a safety in case the vapor recovery system gets plugged. Good idea! If your gas cap is a total seal type, you might want to replace it. Note that if you have the pressure/vacuum relief valve type, it may defeat the whoosh test described above; you'll only get a small whoosh when removing the cap even if the vapor recovery system is totally plugged.

If somebody has drilled a hole in your cap, you definitely should replace it.

FUEL FILLER UPGRADE: The fuel filler on the XJ-S -- at least this author's '83 -- is the old style that turns 1/4 turn. Not only is this a lousy design, but it's also difficult to secure; Jaguar offers a locking variety, but believe it or not their locking gas cap is officially not supposed to be used in the US -- it doesn't seal as it should and therefore won't meet EPA emission requirements. Roger Bywater says, "Most lockable caps have a tang which engages with the underside of the filler neck so the sealing arrangements are probably unable to withstand any significant vacuum or pressure and are just able to stop fuel sloshing out."

On later models, Jaguar made the door over the filler lockable, which eliminated the need for a locking gas cap.

Walter Acker IV points out that it is a simple matter to ditch this dinosaur and install a modern filler from a junkyard. The filler on his '76 is different than the later designs (see page 244), but the general idea should apply equally well to either type. Just peruse the local junkyard until you find a car with a modern tighten-until-it-clicks fuel filler cap on a

filler pipe that looks like it would work in the XJ-S. Remove it, pay the junkyard the five bucks or whatever, then take it home and make it fit. Acker used a Ford filler to upgrade his '76. "The Ford filler that I had put in is just soldered at a radiator shop. I was not specific enough about the position of the Ford filler in the Jag neck to them. You must explain where the bottom of the Jag unit is so that they can line up the Ford unit so that the drain holes in the Ford unit are in a proper position so that the fuel will drain into the tank if there is any leftover in the neck system. The collar on the Ford neck is of the wrong size (smaller) and at the wrong angle for a Jag XJ-S so it must be removed completely so that the Ford unit will slip inside of the Jag unit.

"I checked with the state of California smog reps and they said that it is not a legal modification so if it is detected by a smog rep then the car may not pass smog in CA." Damn shame these guys are so picky, since this cap upgrade will *improve* the car's emissions. "The smog police will give you a problem but the normal smog techs just remove the cap and see it is threaded and test it without ever calling the officials for clarifications."

"The one thing that I like is the fact that when you go to a parts store they have a new style of gas cap. It is called a Prevent which is a pressure release type so that you can release pressure buildup before there is a problem when removing the cap for fuel filling."

Note that you need to pay attention to how high the new cap sits; you don't want to go through the entire modification only to find that the filler door won't close. And having to hack a side off the new cap will reduce the esthetics of this upgrade considerably. Note, however, that the tighten-until-it-clicks cap can merely be turned a couple more clicks if the problem is a corner or something that obstructs the door.

Bernard Embden -- who owns a '78, also with the earlier flanged-type filler pipe -- reports: "A visit to the junkyard resulted in the removal of the fuel neck and cap from a 1987 Ford (hacksawed the fuel pipe right out of the trunk- lucky no sparks). I cut approx 2 inches from the filler tube, and the same from the Jaguar fuel filler pipe. Keep your existing flange that mounts the pipe to the body. You will need to modify it somewhat. Make your cuts dependent on whether you will keep the existing flange or not. Off to the welder. Two trips later (he had no way to pressure test the weld) and I was ready to install. The Jaguar filler pipe is quite large, approx 2 inches I.D. The Ford pipe is 2 inches O.D. This made the welding quite easy because one pipe fits inside the other. Remember to change the tank gasket (large "O" ring thingmajij). No leak, no drips, no fumes. One of those projects that made so much sense that I should have done this years ago."

Regarding finding the right one in the junkyard, Embden says, "Most filler pipes started small and stayed small. However some started larger and then became small. On these you only need the first few inches so it doesn't matter."

This author made this upgrade, but my '83 has the later style filler pipe with no flange. I believe this makes the upgrade *easier*, since you don't need to worry about the alignment of the flange when you have the two pipes brazed together. And, without a flange, if the cap ends up too high for the door to close you merely loosen the clamps and slide the filler pipe a little farther into the tank.

David Low points out that the XJ40 has the tighten-until-it-clicks type of filler, and suggests that it may be adaptable to the XJ-S "if you're handy."

A locking gas cap for the tighten-until-it-clicks type filler is readily available, and appears to seal just fine. These later caps won't ding the paint as badly when you drop them, either, since they are plastic and weigh less than the old metal 1/4-turn caps.

VAPOR RECOVERY SYSTEM -- MAINTENANCE: The vapor recovery system, including the carbon canister, is normally maintenance-free. Activated charcoal can absorb and release fuel vapor forever, it doesn't wear out or get "full". However, there are filter elements within the canister (after all, it is an air intake) that may eventually get clogged, and the carbon itself may eventually get contaminated with fuel additives or other non-petroleum substances, so it is recommended the canister be replaced once in a great while.

If you're *really* a skinflint, the carbon canister can be opened and the filters replaced. There are two, one at the top of the charcoal and one at the bottom -- you must dump all the charcoal on a newspaper or something. Both filters can be neatly replaced with coffee filters. The canister can be held shut with aluminum tape when reassembled.

The carbon canister itself has an opening on the top to atmosphere, and three fittings on the bottom (note: the canister may be mounted upside down, so top may mean bottom and vice versa). The fitting labeled T is connected to the fuel tank, via the appropriate valves and the vapor separator. The fitting labeled P is the purge line to the engine. The fitting labeled C is capped off; it originally was the connection for venting the float bowls of the carburetors, but they are history. Note: if you fit carbs, do not simply open this fitting and try to use it; a screen has been omitted inside as well, and you will draw carbon granules into the float bowls.

One of the possible causes of the common fuel odors is the location of the canister in the XJ-S. On most cars, it is located in the engine compartment where any escaping fumes will simply be blown away by the flow of air through the radiator. But in the location in the bodywork forward of the left front wheel, there is no such flow. The vapors may gather in the bodywork and eventually work their way to the passenger compartment. Of course, there aren't supposed to *be* any fumes escaping, so this is a secondary problem. However, it might be a good idea to connect a length of hose to the atmospheric vent on the canister and route it out the bottom of the car.

Another possible failure mode is that the engine is not properly purging the canister. If the engine is not drawing air through the canister when running, the canister will quickly become saturated with fuel and will cease to absorb, and any further fumes coming down the vent line will escape to atmosphere.

VAPOR SEPARATOR: In the XJ-S, there are several vent lines from the fuel tank. They all are routed to a small vapor separator high in the bodywork to the right and above the fuel tank. This small metal contraption is intended to allow most fuel vapor to condense and drain back into the fuel tank. The vent line to the canister is routed from a point high in this separator, so fuel vapors must be very determined indeed to make it past this point.

Note that the vapor separator has been blamed for many problems. Since it is steel, it is prone to rusting. If a hole rusts through it, fumes will be vented into the bodywork. Also, rust particles may fall inside it and plug the tiny vent passages and hoses.

Vapor Recovery System: Hess & Eisenhardt Convertible

VAPOR RECOVERY SYSTEM -- INCORRECT PLUMBING: David M. Johnson owns two H&E's, and reports: "I found that on *both* of my cars the fuel vent systems were plumbed *incorrectly* (not done by my local dealer). The carbon canister under the front left wheel arch is connected to a vent pipe from the fuel tank, and a vent pipe to the PCV valve next to the LHS air intake. The two vent pipes were wrongly connected, i.e. the fuel tank vent was connected to the valves for PCV pipe (two valves operated by vacuum from the LHS manifold), and the PCV vent pipe was connected to the Rochester valve that should be connected to the fuel tank vent.

"So what's the big deal? Well, the valves that would normally operate the PCV valve only open under vacuum when the engine is *running*. When parked and sat in the sun the tank *cannot* vent! I tested these valves with 10 psi and still the valves would not open. The tank is now a sealed container with fuel vapor inside! There are only two things that can happen:

- (a) The tank will build up a severe pressure and will rupture in time due to fatigue at the weakest location. A pressurized gas vapor canister in my car/garage does not give me a good feeling!
- (b) If you are lucky, one of the vent pipe/fuel connections will leak to relieve the pressure and cause a fuel leak and/or a fuel vapor smell. I am still not keen on this option with the car in my garage!

"If the tank is connected correctly to the Rochester valve, the valve will open at approx. 2 psi to relieve the pressure in the tank, and also opens under vacuum. This stops the tank venting under all conditions and hence does not overwhelm the carbon canister.

"Of course my vent works perfectly now, no gas smells and no severe pressurization of the tank, just a small woosh

when I open the tank cap. I wanted to pass on this info to others, since I consider this a dangerous fault, in this case not a design fault but an incorrect installation by the Jag dealers on *two* cars! Very ironic since the recall was to *solve* this problem.”

“This recall was Hess specific (recall (C002) XJ-S purge kit (Feb 1990). If you check the recalls on XJ-S 86-91 you will find there were similar problems with the regular XJ-S but a different fix. The mod was estimated to be 4.35 hrs for later Hess cars to install Kit JLM2046 and conduct a fuel system integrity test.

“The diagram (figure 6, page 8 of 23) showing the valves and carbon canister connections is not very clear because the fuel vent pipe connections are only partly shown, but the PCV pipe vent connections are clearly shown. I deduced these pipes were incorrectly attached by testing all the valves to determine how the vapor system functioned. I called the Jag dealer the next day to get a copy of the fuel vent recall, and hence confirm the connection was incorrect.

“I do not think the two cars were fixed by the same dealer for the recall. One car is from New York, and the other is from California. That is why I suspect other cars could also be connected wrongly!”

Throttle Linkage, Idle Speed Adjustment

IDLE SPEED ADJUSTMENT: On each butterfly housing, there is an adjustment screw that a lever contacts when the throttle is at idle. These are *not* to be used for setting idle speed. If they have been disturbed, the linkage must be readjusted as described on page 271.

Underneath the rear end of the left intake manifold there is an aluminum housing with two hose connections; one that goes up to the back end of the manifold and one that goes forward to the air filter housing. This contraption is called the auxiliary air valve, or AAV for short. Just below the connection leading to the air filter housing is a bolt. This bolt, believe it or not, is the idle speed adjustment. The bolt itself obstructs an air passage, so the farther the bolt is unscrewed, the more the passage is opened, and the faster the engine idles. It's not real convenient to get to, but a ratchet and a long extension with a swivel at the end will do it.

There's a photo of the adjuster at:

<http://www.jag-lovers.org/xj-s/book/IdleScrew.html>

On this author's '83 (as well as in the photo), the adjuster is a 12mm thread with a head barely larger than the threads, so the head requires a 13mm socket to fit. However, Craig Sawyers reports that later versions (including replacement valves to fit earlier cars) use a metric threaded adjuster with a much larger head: “The old one is indeed metric, M12, but metric fine thread. It is however a special, with a 13mm AF head (standard is 19mm AF). New valve 12mm over the threads, 1.75mm thread pitch and 19mm AF. That is a standard metric M12 bolt. Truly huge by comparison. Jag/Lucas have clearly economised by using a standard M12 coarse thread bolt with the standard head. Adjustment sensitivity with the coarse thread is just fine.”

HIGH IDLE SPEED: If your idle is too high and you've screwed the adjuster in all the way and it won't come down, problems with the Auxiliary Air Valve are by far the most common culprit -- see below. There are other possible causes, though, including a vacuum leak, butterflies sticking and not closing properly, butterfly stops not adjusted properly, or your overrun valves are opening when they shouldn't. There's even one possibility involving a solenoid valve installed in the cruise control during a recall; see page 672.

When the idle gets above 1800 rpm or so, the overrun cutoff feature kicks in and shuts the fuelling off until the rpm drops below 1100 or so, then it turns it back on. The resulting cycling of the engine will get your attention! People get very concerned when this happens, thinking it must be something far more serious than simply the idle speed is set too high, but that's all it is.

AUXILIARY AIR VALVE: The auxiliary air valve (also called an “extra air valve” in Jaguar repair manuals) is in the same housing that the idle adjustment screw is on, and is supposed to open when the engine is cold to keep the idle up. It contains a bulb similar to those found in thermostats that protrudes down into the coolant rail on top of the B bank head. A rod from this bulb pushes a piston up a cylinder against a spring, covering an opening in the side of the cylinder that allows air into the engine.

Although they share the same housing, the idle adjustment screw and the cold idle function of the AAV are separate. The screw obstructs one passage allowing idle air into the manifold, and the piston controlled by the bulb obstructs a different passage allowing idle air into the manifold. Hence, if the cold idle piston jams wide open, closing the idle adjustment screw will still usually not bring the warm idle down within reason.

The bulb may look similar to a thermostat bulb, but it is *not* the same; see the description of the operation of a thermostat bulb on page 205. A thermostat goes from fully closed to fully open in only a few degrees; the AAV needs to move gradually from open to shut over a range of 80°C or more. So, where the thermostat bulb has wax in it that changes phase, the AAV bulb contains an oil; it probably works by simple thermal expansion. For more on this, visit

<http://www.jag-lovers.org/xj-s/book/AAV.html>

Michael Aiken says, “I believe there are many versions of the AAV depending on many variables and the correct one for your model is necessary. My parts manual (which is for 87 to 89MY) shows no less than four part numbers for the extra air valve for the V12: Two for up to SN 8S.57761 and two after 8S.57761. The other variable is emission code.” Mike Morrin calls that “an example of the later parts books not showing the details of early cars. The June 1980 parts book shows C42164 used initially on all cars, then progressively replaced for various markets between 8S.5203 and 8S.11800 with EAC1405 and EAC1590, which were in turn superceded by EAC2273. Interestingly, EAC2273 did not supercede C42164.”

Based upon inspection of several part number AAV’s, it is apparent that the relationship between temperature and piston location is the same for all. The bottom end of the bulbs are all marked “-30”. The only difference between part numbers is the configuration of the opening in the side of the cylinder that the piston slides over. By shaping this port properly, the engine designer can provide whatever airflow/temperature relationship he needs. The port shapes used on Jaguar V12’s actually vary considerably; the web site mentioned above includes photos and dimensions of ports from various AAV’s.

There are two common failure modes for the AAV; the piston gets stuck, or the bulb gives out. If the piston gets stuck, possible solutions are obvious: disconnect the outlet hose and spray a bunch of solvent or carb cleaner into it, or take it off the car and soak it in solvent. Mike Morrin says, “Going along the non-destructive path, if you look down the bore, you will see some smallish holes drilled in the piston. I managed to fit a long self-tapping screw into one of these, and used it to pull the piston up against the spring a few hundred times, while applying WD40 to wash out the crud. It seemed to work, and I have had no problems in the following 12 years.”

If the bulb gives out, chances are it will do so gradually, and the result will be that the piston sits lower and lower at a given temperature. Craig Sawyers, who lives in the UK, hot-water-tested a new AAV and found that it was totally closed by 80°C. He also tested an old but “working” second-hand AAV that appeared to be of identical construction, and it had the exact same sort of characteristics except shifted upward in temperature; if you extrapolate based on the positions he measured up to the boiling point of water, it wouldn’t fully close until nearly 110°C.

Since a lower piston opens the port more, the cold idle will get higher and higher as the bulb gets weaker; when the port is no longer fully closed at operating temperature, the warm idle will start to rise. For a while, this can be countered by screwing in the idle adjuster, but eventually the adjuster will be all the way in and the idle will still be too high.

To make sure the AAV is the problem, remove the left side air filter cover and element, start the car and let it warm up, and check how much air is entering the hole where this valve is connected. You might even try covering the hole entirely; since the warm idle air also goes through this opening, the engine RPM should fall to below a normal warm idle or even stall, although it will be sucking air through the distributor vent scheme like crazy. If the idle drops a little but remains high, your idle speed problems are probably due to something other than the AAV.

Based on observations of several AAV's, it appears that the condition of the bulb can be easily verified: remove the outlet hose, and measure from the upper edge of the outlet fitting down to the inside bottom surface of the piston (which has several holes in it; make sure you're measuring to a surface between the holes). This dimension should be 70mm at room temperature. If it's more like 72mm or more, it's weak.

Note that looking into the inlet fitting at the port might not be a good indicator of bulb condition. Some of the port shapes are fully open at room temperature, while others don't fully open until freezing. Boiling won't necessarily help either; most AAV's are fully closed by 80°C, but at least one type still has a portion of the port uncovered and apparently modulates the idle speed at operating temperatures.

It is considered good practice to replace thermostats whenever the engine has been overheated. Considering the similarities of construction of the AAV, it probably should be replaced whenever the engine is overheated as well. Of course, a new AAV costs one hell of a lot more than a new thermostat. Just the same, overheating is only too likely to be shortly followed by AAV trouble; there are two seals in the base of the AAV around the bulb that are made of nitrile, and they get just as hard and brittle as a nitrile O-ring when things have been hot. There is a sleeve inside the bulb that is probably nitrile as well.

Would you install a used thermostat in your car? Of course not. The idea of installing a used AAV may be just as misguided, even though they are atrociously expensive. Philip Jones says, "I spent a day pulling 4 off a local breaker's stock and found none satisfactory."

AUXILIARY AIR VALVE -- REBUILDING: If you need to replace the thermal capsule in your AAV, the biggest challenge will be finding a suitable replacement bulb. As mentioned above, a bulb from a thermostat will *not* provide the same response. Richard Guevin suggests you check:

Corea Electronics Corporation
138-5, sosabon-dogn, sosa-gu,
puchon-city kyonggi-do, Korea Zip Code: 422233
ph: 82-32-346-3665 FAX: 82-32-346-5326
<http://www.cecom.co.kr/en/page1.html>

Of course, you might opt to use a thermostat bulb anyway. Rather than holding a nearly constant idle during warmup, the idle will gradually rise until the thermostat temperature is reached, and then it will quite suddenly drop to a warm idle. If this is acceptable -- and it certainly is preferable to an OEM bulb gone bad, in which the idle *never* comes down -- just try to find the coldest thermostat bulb you can, so the idle drops *before* operating temperature rather than *at* operating temperature. And make sure the thermostats in your engine are hotter than the bulb in the AAV.

On the series of web pages starting at <http://www.jag-lovers.org/xj-s/book/AAV.html>, procedures are presented for rebuilding the AAV. If at all possible, review this site prior to tackling the job; the photos will be helpful. The short version of the procedure: Put the AAV in a press and push the outlet fitting down until you push it *through* the housing and push the baseplate out the bottom. Press the bulb out of the baseplate upwards, which will destroy a peened-over edge and ruin a flat washer holding the bulb in place. Applying sealant, install your new bulb and retain it using whatever you will trust to work; a 1/2" stainless steel flat washer with a series of tiny holes drilled around the outer edge held in place by a circle of #4 stainless steel screws threaded into the baseplate is a good plan, but make sure the holes in the baseplate don't break through to the other side or they will cause a coolant leak. After cleaning up the piston and other internal parts and making sure they move freely, reassemble by pressing the baseplate in the bottom and the outlet fitting/cylinder in the top. Apply some Loctite 518 around the edge of the baseplate before pressing it in to help make sure it won't leak coolant. Make sure to stop pressing the outlet fitting at the right place, which should be where the inside bottom of the piston is 70mm below the top edge -- unless you've used some other sort of bulb, in which case you might want to stop pressing a little sooner, drive the car for a while and see how you like it, and if it's not right just pull the hose off the top and tap the outlet fitting in a little farther until it behaves the way you want it to.

Some suggest polishing a bit off the OD of the outlet fitting/cylinder to change the press fit to a slip fit, and then retain it with screws through the side of the housing. This makes it a bunch easier to get apart *next* time. A little sealant would

make sure it doesn't leak air, but really it wouldn't be a big deal if it did; you'd just have to adjust the idle screw to compensate.

John Ashcroft of Melbourne, Australia, says, "H&H Spares do a c/o for \$90 AU, trade price; they have someone rebuild them so the bits are available somewhere. Put one of their exchange units in about 5yrs ago and it's still working fine." See page Error: Reference source not found for H & H Prestige Spares.

AUXILIARY AIR VALVE -- CHEAP FIXES: If your AAV isn't sticking but exhibits the "tired" behavior described above, Roger Bywater suggests a fix: "It does seem that the range of movement can change with age possibly due to very slight leakage from the bulb. In such cases it is quite feasible, after assessing the amount of correction required, to just press the top further into the casting body in a vice (with a socket or tube over the bulb) to get the thing operating back in range. Obviously it has to be checked in boiling water before and after and it needs to be done with care because it is all but impossible to get it back if it goes in too far.

"Don't go blaming Jaguar or Lucas for this valve and its foibles, although most of them run for years without trouble. It was a Bosch invention."

Faced with a completely failed AAV, Jan Wikström simply started the car and let the AAV suck a small rag into the opening in the air filter housing to plug the port. If the rag is small enough, it could conceivably plug the port without interfering with the warm idle adjuster. Of course, if it's too small it'll pull it *through* the port and into the engine. I'd suggest something around 2 inches square.

With a little more disassembly, you can do a better job of plugging it. Take the hose off the inlet fitting and jam a plug in there. By making the plug short enough, you should be able to push it past the warm idle passage, which comes off the bottom of this passage, and plug the cold idle port only.

Really cheap and easy: jam a cork into the hole into the opening in the air filter housing. The problem with this is that it will suck through the distributor vent scheme like crazy to maintain idle. Still, if you have a problem on the road, this might be a quick fix until you get home and can do something better.

All of these last fixes, of course, completely eliminate any idle boost when cold. Interestingly, several owners have reported that this doesn't seem to hurt anything! The V12 will idle at 300 RPM with no problem. Some cars have another means of boosting the idle when cold, namely the supplemental air valve at the front of the right intake manifold. This thing stays open for 45 seconds on US-spec cars and 15 minutes on UK/Euro spec cars to compensate for a disabled vacuum advance at idle; you might consider re-enabling that vacuum advance at idle (see pages 304 and 135) while leaving the idle boost functional.

Finally, of course, an entire separate cold idle scheme could be provided; John Napoli says, "just get one or two vacuum solenoids. Wire to toggle switches, pipe the air thru an inline fuel line filter (or plumb to air box) and go to town. These thingies are real cheap. Get generic units unless you have some Jag take-offs in your junk box." For fancier work, you could install temp switches in the coolant circuit to operate these solenoids automatically. By using different temp switches, the idle could drop in steps as the engine warms up and the solenoids shut off in sequence.

IDLING ON ONE BANK: Kurt Hill has a very early XJ-S, and the AAV plumbing looks like the illustration in Section 19.20.16 of the ©1975 ROM or Fig. 3.52 in the Haynes manual -- which don't resemble the plumbing in the later cars at all. In this early layout, there is a tee on the outlet of the AAV, with one fitting connecting to the crossover pipe while another connects to a hose that goes forward underneath the left side intake manifold and connects into it from the bottom.

Hill's problem was that the car ran great at speed, but idled on the right bank only -- and flunked an emissions test big time because the EFI system was still squirting fuel into the left bank that wasn't firing. It turned out that a PO had replaced the hose from the AAV underneath the left manifold with generic hose, and since it has to make a 90° turn, it kinked as soon as manifold vacuum was applied to it. Since this is not only the idle air supply to the left bank but also the crossover pipe, the left bank got no air. Since this hose was hidden under the manifold, it was a difficult problem to

locate; when the engine wasn't running, the hose looked fine.

The easy fix: replace the hose with a molded hose with a 90° bend in it, which is what the car originally came with. Better fix: install a metal spring inside the hose to prevent collapse. Better fix yet: replace the hose with a section of copper piping with a 90° elbow, and connect it at both ends with really short pieces of hose.

Those with later cars don't need to worry about running on one bank at idle (unless they have Marelli ignition!), because the crossover pipe is no longer part of the AAV plumbing but a separate entity. But any hoses under manifold vacuum are always cause for concern for sucking flat.

OVERRUN VALVES: If the throttle is closed at an elevated RPM, the manifold vacuum can exceed that normally found at idle. Under such high vacuum conditions the fuel/air mixture being introduced into the cylinders, even at the proper ratio, can be so rarified that it cannot be reliably ignited with an ignition spark. If that cylinder full of unburned mixture is then exhausted, it dumps quite a load of raw hydrocarbons into the atmosphere. However, as Roger Bywater points out, an even worse result (from the car owner's standpoint) is what happens when the mixture is later ignited within the exhaust system; it can blow the mufflers open. This igniting within the exhaust is what causes the "backfire" upon deceleration that is characteristic of some cars -- mostly pre-EPA cars.

"The purpose of the over-run valves is to limit the vacuum that the engine can generate on the over-run because it was generally considered that when vacuum exceeds about 22" Hg the charge density is so low and contaminated by exhaust residuals that combustion ceases to take place effectively. The over-run valves therefore ensure that any mixture entering the engine is dense enough to fire."

At the front end of each intake manifold on the Jaguar V12 is either a blank-off plate or a little housing with a stub hose connection to the air filter housing. The little housings contain the overrun valves. They are a spring-loaded poppet valve that should open only when the manifold vacuum is higher than a set amount more than idle vacuum. Basically, this limits the manifold vacuum to a level where ignition is reliable. It also tends to make the engine feel as though it has no "compression" on deceleration -- basically, the throttle is being opened a little. In fact, on some other automobiles, the same effect is achieved by physically opening the throttle.

Does your car have overrun valves? Apparently, it depends on whether or not your EFI system incorporates another method of addressing the same problem: overrun cutoff, in which the fuel injectors are shut off under deceleration (see page 274). Bywater: "When the EFI V12 engine was first introduced it had over-run valves and did *not* have over-run cut off. Cut off was introduced in some markets in about 1977-8 and the over-run valves, being no longer necessary, were therefore deleted on the respective cars. I cannot be sure from memory if US Federal emission cars were included but it is possible that they continued without cut off. All manual transmission cars continued with over-run valves because they did not have cut off as it caused unpleasant driveline shunting. Manual ECUs also gave slightly different low end fuelling being able to run at full throttle below the stall speed of a torque converter.

"Cut off on the D-Jetronic system was effective at all temperatures unlike later Lucas Digital cars in which cut off was inhibited at low temperatures, necessitating the return of over-run valves.

"I think it is correct to say that if a D Jetronic engine has over-run valves it would not have over-run cut off, unless of course someone has swapped the ECU at some time.

"In fact, the over-run valves were notorious for losing spring pressure and causing a high or erratic idle speed. The practical solution was to just tighten the nut about 2 turns." Basically, adjust it just tight enough that the valves are closed at idle -- which can be confirmed by putting a finger over the hole in the filter housing with the engine idling. "Setting the over-run valves by checking with finger over the hole is as good as any method. As long as they don't leak at idle but work when you blip the throttle and release it to create an over-run condition they will be OK. You will probably hear them anyway. Again from memory I think they were meant to start to open at 20" Hg but by their nature they are more a sort of progressive leak rather than a step change device so manifold vacuum could exceed this value to a small extent."

ACCELERATOR PEDAL -- EARLY MODELS: Mike Morrin says, "The Jaguar pre-HE service manual seems not to have been updated from 1975 to 1981, which is fine for my car, but I have seen a few things which are obviously wrong for most of the pre-HE cars. A minor example of this is the RHD accelerator pedal assembly: The only type shown in the manual was only fitted to the first 200 cars."

THROTTLE CABLE -- ELECTRICAL PROBLEMS: Ron Brock says, "The starter was acting as though I had a low battery. After replacing the battery to no avail, I started in on the starter. The car would crank over fine sometimes and other times it would barely turn. After receiving several "tips" about checking the electrical connections, I went thru them from the battery forward.

"My problem became clear one night in the garage, I was attempting to start the car with the bonnet up, and it was just dragging. It was then that I noticed a whiff of smoke coming off the back of the engine. I walked around to the front of the car to determine what was "smoking," it was the throttle cable, and was it *hot* (by the way this also solved my sticking throttle problem). It seems that the engine was grounding itself thru the throttle cable. I was unable to remove and clean the standard grounding strap at the engine, so I added a second strap that I purchased from NAPA for \$4 and the car has been fine. Absolutely amazing. I would seriously recommend that anyone have starter/charger problems explore this cheap and easy fix first." See page 555.

THROTTLE LINKAGE BUSHINGS: There is a throttle shaft on each side of the engine, parallel to the heads, that transmits throttle motion to the butterflies. The rear end of this throttle shaft, along with some linkage, is supported by a plate bolted to the rear of the intake manifold. There is a rubber bushing in the plate for the shaft to turn in. This bushing is probably shot -- British nonmetallic parts again. This bushing will dry up, crack to pieces, and fall out, leaving the throttle shaft to wallow around in the opening. In fact, this is another example of a 100% failure mode in the XJ-S; if you haven't already replaced the bushings, they are probably bad right now. The effect on the throttle operation is not good, as it tends to screw up the sync of the two butterflies with each other and with the throttle pot in the turntable. There are also reports that this problem can have adverse effects on emissions tests, especially if one bushing is gone and the other is still on the job.

The part number for the original Jaguar rubber bushing is C34388. However, I don't think anyone in their right mind would recommend the original bushing -- it's rubber, for heaven's sake. Rubber throttle linkage bushings are a relic from cars with rigid linkages from the pedal to the carbs; since the engine moved around on its mounts, some means had to be provided to connect the pedal on the car to the butterflies on the engine without the engine's motion affecting the throttle position. The solution was to have one rotating shaft with one end mounted on the car and the other mounted on the engine; the pedal was connected to a lever right next to the mount on the car, and the butterflies were actuated by a lever next to the mount on the engine. The pedal twisted the shaft which opened the butterflies, and engine motion would rock the shaft back and forth without twisting it. Rubber bushings were needed at the ends of such shafts to isolate engine vibrations from the rest of the car, and to allow the small angular motions of the shaft without any binding.

None of this applies to the XJ-S. The motion of the engine relative to the car is dealt with via a throttle cable. The linkages where the bushings are used involve shafts that are mounted at both ends from the same intake manifold, so there is no relative motion. Totally rigid bearings will work fine.

This application really begs for nylon bushings, but bronze bushings would probably work just as well if you can install them so they wouldn't rattle or jingle. The shaft is 5/16", and the hole in the plate is 1/2". With a little looking, it should be possible to find a suitable generic bushing to use here. A bushing with a single lip will work; retention won't be a problem since it is effectively trapped.

Replacing this bushing looks difficult; it appears to require removing either the throttle body or the linkage support plate, either of which is a pain. You may choose to remove the linkage support plate, since it will permit you to fiddle with the bushing installation away from the car -- or take it with you when shopping for a bushing. If you go this route, make sure to have two EAC2650 gaskets on hand for each side; see page 42.

David Littlefield describes a shortcut: "I was able to replace both my bushings today in my '88 XJ-S without removing

either the throttle body or the linkage support plate. I first loosened the pinch bolt on the short rod that is between the bushing and the throttle body. I then removed the spring clip that holds the spacer that fits against the bushing. By sliding both the spacer and the pinch bolt as far as I could towards the front of the car, I was able to gain enough clearance to push the rod towards the rear of the car for the ball end of the rod to come out of the throttle body fitting.

“Once I had the rod out of the car, I was able to move the pinch bolt even further back-- past the knurled portion and right against the shoulder. I then took the new bushing to my bench grinder. I carefully ground down almost all of the lip on the beveled side. I put the bushing on the rod, then fitted the rod back in the car, pushing the rearmost end in first and then putting the ball end in the throttle body fitting. I then pushed the bushing into place, while still on the rod. Removing almost all of the beveled lip on the bushing allows the bushing to be pressed into place while on the rod, since distortion of the inner diameter of the bushing is minimal. Replacing the spring clip behind the spacer and resetting the pinch bolt completes the procedure.

“As stated in the book, a bushing with a single lip will work since the bushing is effectively trapped. There are no real worries about the bushing slipping back on the rod because the spacer and spring washer hold it in place.

“I used the factory bushing for this procedure, but I see no reason why it wouldn't work with others.” Littlefield gets two demerits for replacing a British nonmetallic part that failed with another part just like it -- but at least, using his method, it won't be too difficult to replace them again.

Jeff Elmore offers a *different* shortcut: “I remembered someone saying that it was easy if you did (something) and slid the shaft back through the throttle housing. Well, after some contemplation, I figured he meant removing the screws from the shaft-to-plate and sliding the plate out of the shaft and sliding the shaft forward through the housing. Well, it worked like a charm and the bushings were replaced in about 20 minutes.”

If you'd like to try a more expedient fix, John Napoli describes a method he credits to Gerry Duff: “We just cut a couple of pieces of rubber hose. Slipped right onto the shafts, and is the right OD. No tools or disassembly needed. Been working fine for almost a year, and when they wear out 5 minutes to do it again. When the repair was done, the rubber hose sections were left long enough so that they could be turned around if excessive - and quick - wear was realized until a more conventional repair could be effected. Last week I asked the owner how it was holding up. He pulled the hoses, and stated that there was no visible sign of wear at all -- he had never needed to turn 'em around.” Note: this author tried using this method on a friend's car, and couldn't get it to work. It apparently requires a particular type of hose we didn't have on hand; we were trying to use fuel hose, which was a little too fat to fit through the hole properly and tended to “walk” off the shaft when the throttle was moved repeatedly. Napoli suggests that the hose used with success may have been vacuum hose.

As Leslie Winfield discovered, a generic bushing with no lip will work if you can figure out how to hold it in place -- and can make installation almost as easy as Duff's fix. “I purchased a 1/2 inch x 5/16 inch bronze bushing 1 inch long, and two 1/2 inch outside snap-rings. I ran a 5/16 bolt through the bushing, pinched it with a nut & chucked it in my drill press (poor man's lathe). I shaved about .005 inch off the OD with a flat file, used a hacksaw with a 24 tpi blade to cut a groove about 3/32 of an inch from each end deep enough for the snap-ring, and then cut the bushing into two halves. With a little fiddling, the snap-ring can be threaded to the inside of the support plate, the bushing can be slid over the shaft and through the hole in the support plate (grooved end first), and the snap-ring positioned into the groove on the bushing. The bushing is now captured on the shaft, and almost no play is observed with this setup. It doesn't look too bad, cost \$1.07, and it should last as long as my '79 XJ-S does.” Of course, if you happen to have purchased bushings with a flange, you can still use this method by cutting the groove in the opposite end from the flange. While buying these bushings, you might want to buy a spare one in case you ever need to replace the thingy in your Lucas distributor -- see page 142.

Home Depot offers a nylon part that can be installed exactly the same way that Winfield installed his bronze bushings. It's stock number 30699 87298, described as “1” x 1/2” SPACER - NYLON”. All of Home Depot's “nylon spacers” are marked for their OD and length, with no marking on the package at all about their ID; there are several ID's available, including 1/4”, 5/16”, and 3/8”, but other than the stock number they are all marked the same. If they happen to be out of the 5/16” ID bushings, you could purchase the 1/4” ID bushings and carefully drill them out.

After bushing replacement, the linkage should definitely be adjusted as described below.

THROTTLE LINKAGE ADJUSTMENT: If the butterfly stop screws have been disturbed, the linkage bushings have been replaced, or any other tinkering has been done that could mess up the linkage adjustment, it should be readjusted. Also note that several owners have found that a rough idle cleared up when this procedure was undertaken, even though one wouldn't expect it to make any difference; the crossover pipe should deal with any imbalance between sides.

I'd like to simply dump the description of this procedure off on the repair manuals since any decent repair manual would provide a step-by-step procedure that's easy to follow, but unfortunately the procedures described in the ROM (Section 19.20.11 followed by 19.20.05 -- not 19.20.25, as is indicated in Step 10 even though such a section doesn't exist) is only barely discernible and the one in the Haynes manual (Chapter 3, Section 47 followed by Section 37) is bloody awful. I will endeavor to explain the process here more clearly.

In further developments, the mid-90's cars with OBD II required much more careful adjustment to avoid fault warnings. TSB #19-36, dated 10/95, says: "Diagnostic Trouble Codes (DTCs) may be set if both throttle valves are not synchronized to begin opening at the same time. The Manifold Absolute Pressure (MAP) sensors will detect a difference in pressure between the two intake manifolds, which leads to the setting of DTCs.

"The most common codes found are: P1106 P0106. The following DTCs may also be set: P0107, P0108, P0125, P1107, P1128. Poor throttle valve synchronization may also cause customer complaints of poor driveability and idle quality."

TSB #19-36 provides improved procedures for adjusting the throttle linkage on the OBD II cars, but it can be applied to all V12's with EFI. As a result, these improvements have been incorporated into the following descriptions of the adjustment procedures. Joe Bialy and Richard Mansell provided some interpretations of this TSB. Mansell says, "I suspect there are different TSB's for the different models. I guess the contents are the same but for a start the throttle pedestal is different on my '96 XJ12 compare to the XJ-S I owned so the picture with the TSB is different."

The linkage requires five distinct adjustments, which must be done in order because each affects the others. Proceed as follows:

Before starting, remove the air filter covers and elements. It is highly recommended that you clean the throats before proceeding, using some sort of solvent (see THROTTLE STICKING below) to get the areas where the edges of the butterflies contact the housings nice and clean. Rather obviously, check the condition of such things as the linkage bushings (see above) before doing the adjustment.

Disconnect the crossrods from the throttle pulley by prying them off the ball joints.

Loosen the locknuts and turn in the butterfly stop screws until they don't interfere with the butterfly motion. Make sure the stop screws turn easily enough to turn with your fingers; if they're hard to turn, you may need to take them out and clean up the threads.

Loosen the clamp on the lever at the rear end of each butterfly shaft, directly below the crossrod attachment. This lever is clamped onto a splined section of the butterfly shaft, and since the clamp takes on some toothiness the first time it's tightened it tends to move in snaps. While holding the butterfly closed move the lever at least one snap in the open direction, both to ensure you have the clamp loose and to make sure the stop within the linkage here isn't interfering with the butterflies closing.

Adjustment 1: Loosen the screws holding each butterfly disk in its shaft, gently press the butterfly closed so that it makes secure contact all the way around, then retighten the screws. This centers the disk in the opening.

Adjustment 2: Set the butterfly stop screws. This screw prevents the butterfly from quite fully closing; if it closed completely, it could easily jam, especially with temperature changes such as shutting off a hot engine and then trying to start it the following morning.

To adjust the stop screw requires a 0.002" feeler gauge. The earliest Jaguar repair procedures specified a 0.004" (0.105 mm) gauge, but after 1978 it was changed to a 0.002" (0.05 mm) gauge -- which works fine for the earlier cars.

Insert the feeler gauge at the bottom, push the butterfly firmly closed on it, and give the feeler a little tug so the butterfly

grips on it. Note that the butterfly should grip the feeler *securely*; if everything is right, it'd take a firm pull indeed to get it out. If it seems to slide out with some smooth resistance, it's probably not gripping it correctly but rather just getting close enough to be bending the feeler around the curvature of the throat. Make very sure there are no throttle stops keeping the butterfly from closing fully on the feeler.

While pulling gently on the feeler, turn the stop screw with your fingers just until the butterfly starts to let go of it. Try it a couple of times until you get the feel of the process, at least well enough that you can do both sides the same way.

Without moving the stop screw from this position, take your fingers off of it and put an open-end wrench on it. Tighten down the locknut while holding the stop screw still with the wrench.

From the TSB: "An improved factory procedure for setting the throttle stop screws, using an air flow measuring gauge, was introduced during the 1994 MY production of V12 engines. All 1995 MY V12 engines are set at the factory using this method." Many garages actually have this air flow measuring device since it is indispensable for synchronizing SU and Zenith Stromberg carburetors. It should work fine here, although you might need to remove the inner half of the air filter housing to be able to get it to sit on the intake properly -- and then you'll need to plug the bolt holes, since they create a vacuum leak. If going this route, you should set one butterfly stop screw per the directions above and then set the other butterfly stop screw to flow the same amount.

Adjustment 3: Adjustment 3 is officially to position that lever against its own stop, take up all the backlash in the coupling under the butterfly stop screw, then tighten that clamp back down. However, it moves in snaps -- you'll never get it to clamp down exactly where there is no backlash. So, hold the butterfly against its stop screw and move the lever towards its own stop until it snaps as many times as it's going to. Tighten the clamp down. When done, the linkage at this corner of the engine should have a bit of backlash: move it one way and it opens the butterfly, move it the other way and it sits on its own stop, and there should be a little movement in between. Again, make sure the stop in this linkage isn't what's stopping the butterfly itself.

Adjustments 1-3 should be performed on both sides of the engine, and obviously everything should end up as close to the same from one side to the other as possible. If nothing seems to feel the same way on the second side as it felt on the first, you probably should start over and do them both again.

Adjustment 4: Adjust the throttle crossrods. Obviously, you will need to put them back on for this procedure. Graphite lubricant is recommended in the ball joints, but it is *not* recommended that you lube them now; the powder might interfere with the adjustment. Rather, adjust the crossrods then snap them back off to apply a little graphite.

Position a spacer 2mm (0.079") thick between the turntable and its idle stop. A 2mm allen wrench works if you have one, but whatever you use try to make sure it doesn't fall down into the nether regions somewhere. The spring tension will hold a 2mm allen wrench in place during this job, but just the same it'd be a good idea to either tie a string to it or at least have the other end over the turntable pedestal itself rather than hanging out over the cliff.

Loosen the locknuts on the crossrods and adjust each link such that the butterfly is just starting to open with that 2mm spacer in place. The thread on one end of each crossrod is LHT, so with both locknuts loose you can just turn the rod itself to make it longer or shorter. They even provide a knurl to help you turn it easily.

"Just starting to open" is a bit tricky; if you have good light, you can carefully watch the lever lift off the stop screw on the butterfly. However, a better idea is to install that .002" feeler gauge between the lever and the stop screw and allow the return spring to hold it. Position it so it's hanging over the throttle body rather than straight up. Now turn the crossrod just until the feeler gauge falls down against the throttle body.

Tightening the locknuts requires three hands: one to hold the 1/4" wrench holding the ball socket still, one turning the 5/16" wrench to tighten the locknut, and a third to keep the crossrod from turning as you tighten. If you have a third hand available, a pair of pliers might be preferable to expecting to hold the crossrod still with fingers. If you don't have a third hand available, a pair of vice grips will work if you carefully prop them on the fuel rail.

Make sure the ball sockets end up properly oriented 90° to each other when the locknuts are tight. The flats on the one at the turntable end should be horizontal and the flats on the one at the outboard end should be vertical.

When done, check your work: put that .002" feeler gauge in the butterfly stop on each side (or one in both sides, if you

have two .002" feeler gauges) and very slowly and carefully turn the turntable (without touching the crossrods themselves) until the feeler gauge drops. Note the gap between the turntable and the idle stop when they drop. Officially this backlash at the turntable stop is to be between 0.062-0.094" (1.57-2.39mm)(the .002" feeler gauge adds a bit to this, but it's negligible).

Also make sure the two butterflies open as close as possible to the same time. If they don't, the TSB allows an additional 0.030" of turntable travel to get the second throttle to move off its stop.

Adjustment 5: Loosen the locknut on the full throttle stop screw on the throttle pulley, and back the stop screw away. Hold the pulley in full throttle position, noting that the butterflies are both full open. Adjust the stop screw until it just touches the pulley and retighten the locknut. This stop screw merely prevents stress on the linkage while the engine is at full throttle and the kickdown switch is in operation, and is not meant to restrict full throttle.

Ensure that the throttle moves freely through the full range of motion. Finally, check for no gap at the turntable stop with the throttle in the closed position. If the cruise control cable is too tight, it can restrict the throttle linkage moving fully to idle.

You will need to warm up the car and readjust the idle speed, since the butterfly stop screw positions have been altered.

THROTTLE STICKING: Apparently, all cars have occasional problems with throttle sticking due to buildup on the butterfly itself. A butterfly cleaning procedure from Randy Wilson: "You are cleaning the throttle plate and surrounding area. The edge of the butterfly and the area of the housing right around it will be covered in black goo. Prop the throttle open and wipe the stuff out with a rag. Use the weakest solvent you can to get it clean. I start with a "WD-40" grade oil, and go to carb cleaner if it's really bad. Oven cleaner is out. Sand blasting is not needed or recommended.

"Warning: Some non-Jag cars, notably later Fords, have a teflon coating on things in an attempt to reduce this problem. Most solvents will damage this coating."

THROTTLE LINKAGE LUBRICATION: Jan Wikström says, "The ball-joints shouldn't be lubricated at all, unless you want to give them a dusting with Teflon or graphite. The reason is that grease hardens and oil or grease picks up dust from the air, increasing linkage wear *and* friction.

Electronic Fuel Injection

If you wish to understand or troubleshoot the Jaguar XJ-S electronic fuel injection system, it is highly recommended that you obtain a copy of "Understanding Electronic Fuel Injection, Ignition and Engine Management" by Roger Bywater and available from AJ6 Engineering (page 713). The book is written as a primer on EFI in general, but since Bywater's expertise comes from years of working for Jaguar many of the examples presented happen to be Jaguar systems. Often, it seems he is talking about these cars in particular.

According to Dick White, "There is a book 'Bosch Fuel Injection and Engine Management' which I found very informative. It contains many references to Lucas." It is available from EWA (page 724), among other sources.

FUEL INJECTION SYSTEM TYPES: The 1976-80 XJ-S used a type of Lucas fuel injection system based on the Bosch "D-Jetronic" design. From 1980 on, the cars used a system referred to as a "Digital P", also based on a Bosch design. The two systems are completely different. Among the differences: The earlier D-Jetronic system used a trigger board within the distributor operated by a magnet in the rotor; the later Digital P system simply derives its triggering from the ignition pulses. The D-Jetronic has a "throttle switch" in the turntable on top of the engine that provides an on-

off pulse about ten times as the throttle moves from idle to full open; the Digital P has a "throttle potentiometer" in the same location, providing a smooth varying resistance as the throttle moves. The fuel regulators on the D-Jetronic system maintain the pressure in the fuel rail at a constant value, while the regulators for the Digital P system vary the fuel rail pressure according to intake manifold vacuum.

The D-Jetronic has no oxygen sensors, lacking the sophistication for feedback control. The North American Digital P has two oxygen sensors, one in each exhaust downpipe, and Roger Bywater reports that the ECU will control the mixture in each bank separately. The Digital P systems in countries without emission regulations had the feedback capability omitted from the ECU, and had no oxygen sensors.

Bywater elaborates on the various systems: "D-Jetronic ran from 1976 to 1980 in the XJ-S but, just to confuse things, ran until 1981 in the saloon. Digital P 6CU first appeared in July/August 1980 on the 10:1 compression flat head engine rated at 300 b.h.p. in the XJ-S. Most XJ12 saloons continued with the earlier 9:1 D-Jetronic engine until the arrival of the H.E. engine in July 1981 but a few saloons were fitted with the 10:1 engine and Digital P. I understand that the improved fuelling accuracy of the Digital P EFI system was what made the higher compression engine viable.

"The 10:1 engine performed very well and was certainly the most lively version of the 5.3 ever produced but there were two things which could make it a bit fragile at sustained high speed. Firstly the cooling ability of the radiator was a bit marginal, secondly the distributor build quality was not too good and we measured errors of up to 10 degrees excessive advance at 6000 revs, which is obviously likely to cause trouble. Not surprisingly, there were tales of piston failures on German Autobahns.

"Those early 6CUs triggered from the coil negative terminal and the ECU was protected internally from the high voltage firing spikes by a 100K resistor in the input circuit. This was not necessary with the Constant Energy system introduced for the H.E. and was replaced by a link. Another important difference, apart from the fuel requirement of the 10:1 engine being different from that of the later H.E., was that full load fuelling was set into the mapped fuelling values so there was no need for a separate full load enrichment switch circuit. This means that fitting an ECU intended for an H.E. car to one of these engines is likely to magnify any tendency to burn pistons because the full load condition will be excessively weak. A number of people have found this out the hard way. Strangely the ECU seems to survive the high voltage firing spikes despite not having the protection resistor.

"The H.E. engine arrived in July 1981 in both the XJ-S and XJ12 saloon so that is when D-Jetronic really ended."

INJECTOR GROUPING: The wiring harness is set up to operate the injectors in four sets of three. Within the ECU these circuits are combined to form two sets of six. In the early D-Jetronic systems, each set of six injectors included three on each bank, and this injection pattern is explained in great detail in the repair manuals. However, in the later Digital P systems (which include oxygen sensors), each group included all six injectors from a single bank so the ECU can monitor the oxygen sensors separately and control the mixture of each bank as a group.

OVERRUN CUTOFF: On the Jaguar V12, some EFI systems feature overrun cutoff and some don't; see the section on overrun valves on page 268.

When the foot is all the way off the throttle but the engine speed is well above idle, the pilot is clearly not interested in power; any fuel provided is a waste of fuel and an unnecessary contribution to emissions. So, if the ECU detects that the throttle is at idle and the RPM is above some set point (1500-1800 or so), fuel to the injectors is totally shut off. As the RPM drops past another set point nearer to idle speed (1100-1300 or so), the fuelling is turned back on to provide a smooth transition to idle -- or to rev it back up to the cutoff RPM. Roger Bywater: "It's easy enough to check on the car by just flicking off one throttle pushrod and opening that throttle to lift the speed without the throttle switch being moved (assuming the switch is set correctly)."

Regarding which EFI systems have overrun cutoff, Bywater says "...all 6CUs do indeed have over-run cut off above approximately 1500 r.p.m. but it is activated not only by a closed throttle signal from the throttle potentiometer but also by the vacuum signal. On a Federal 6CU cut-off commences at nominally 17.5" Hg and fuel reinstates when the vacuum falls to 15" Hg. Cut off on European versions is active over a wider vacuum band which also varies with engine speed.

“16CUs only need the throttle closed signal to activate cut-off above the required speed.”

This feature can easily confuse the novice mechanic that may not be familiar with it. What will sometimes happen is that the car is running poorly, and the idle screw will have been opened up to maintain a reasonable idle speed. Then the problems with the engine are corrected, and the engine then tries to idle faster -- but hits the cutoff RPM, shuts off, drops back to the cut-in RPM, kicks back on, and sits there cycling up and down indefinitely. The mechanic thinks he has really screwed something up this time and begins all sorts of ill-conceived corrective measures when all he really needs to do is close down the idle screw a bit. It's even more confusing, of course, when the overrun cutoff feature is temperature dependent so it doesn't cutoff when the engine is cold but starts cycling upon warmup.

Another common cause of trouble is the infamous auxiliary air valve (page 265). The car is running fine one day, but the next day the auxiliary air valve sticks open and the engine starts ramping up and down upon warmup. The mechanic drives himself crazy trying to figure out the ramping, while what he really should be looking for is the cause of the high idle.

For the overrun cutoff feature to work right, the ECU clearly needs to know the throttle is at idle. On the D Jetronic, there is a special contact in the throttle switch for idle. In the Digital P, the throttle pot must be adjusted properly (page 297).

EFI GROUNDING PROBLEMS: Michael Neal sends this experience: “...the radiator had been replaced and a ground for the fuel injection harness at the right front of the engine compartment had not been re-secured. It had blown two ECUs before I found this. I don't know why but it took the ECU a week or two to blow. After I replaced the ground and ECU there were no further problems.”

Reportedly, if the engine clearly is running very rich or possibly won't even start because it's too rich, it's time to start looking for grounding problems in the EFI wiring. John Napoli relates one experience: “Although ground to the ECU was one of the many things we had checked early on, the owner later went further and checked the ECU connector. He found an intermittent ground on pin 1 at the connector. This pin, according to our schematics, should ground to the frame of the car at the ground points near the battery. This wire was identified in the loom and a splicer to ground added. The car started fine and at this point is OK.”

ELECTRONIC CONTROL UNIT: The following is a list of the ECU part numbers, hopefully mostly correct. Thanks go to Jeffrey Gram, AJ6 Engineering (page 713), and other sources.

D-Jetronic: Type 3CU	LRZ103 and LRZ113?
Digital P: Type 6CU	catalyst version: DAC 2597 and DAC 3586 non-catalyst version: DAC 2596 and DAC 3062
Type 16CU	catalyst version: DAC 4118, DAC 4585, DAC 6335, and DAC 6337 These are the low compression version - presumably 11.5:1 non-catalyst version: DAC 4119, DAC 4478, DAC 4586 and DAC 6336 These are the high compression version - presumably the 12.5:1 Additionally, there is a low compression non-cat version: DAC 6338.

For one year (1981), the XJ-S had Digital P EFI on a pre-H.E. engine. Clearly, the fuelling maps for such a car would differ from those for the later H.E., and the ECU's would not be interchangeable. It's not known if any of the part numbers above apply to the pre-H.E. Digital P.

Note also that the Marelli ignition system provides a cleaner signal to the EFI system, so the ECU's fitted to Marelli-ignitioned cars have less filtering in the signal input circuitry. This may help account for the profusion of 16CU part numbers listed above. The pre- and post- Marelli ECU's are *not* interchangeable.

Richard Mansell quotes from a Jaguar publication on the changes for the 1992 model year:

"The new fuel control system, the Lucas 26CU, replaces the 16CU and provides the following benefits:

- Improved starting performance at all temperatures.
- More efficient engine operation during warm up.
- A diagnostic facility which stores fault data for later retrieval.
- Low quiescent current drain.
- Eprom socket to allow modifications.
- JDS diagnostics serial link.
- Fuel used output.
- Enhanced software.
- Enhanced limp home capability.

With the pre-facelift ECU, (Lucas 16CU), one injection is delivered per engine revolution. In the facelift condition, the Lucas 26CU, there are three injections per engine revolution. The number of pulses is reduced to one per revolution after a set number of injections.

After-start enrichment - The enrichment is now coolant temperature dependent. It decays away over a number of engine revolutions instead of over a time period and is no longer linked to cranking fuelling so that better calibration is achieved.

Acceleration enrichment is reduced; calibration is improved; over enrichment is bettered in the occasions where the driver opens the throttle very quickly.

Full load Enrichment - Where full load enrichment was determined by vacuum operated switches sensing inlet manifold depression, it is now determined by throttle potentiometer position and engine speed.

There is a single 2.5 bar mini fuel pressure regulator instead of two."

Roger Bywater continues: "The 26CU controller introduced in 1991 for 1992 model year was superseded by the 36CU type part way through 1993. 36CU was the next stage of development of the 16CU, 26CU theme and was itself superseded at the end of 1994 by the much more advanced Pecus / Nippondenso system of full engine management."

The people at John's Cars (page 717) say they will test your ECU for you, free of charge. They are confident you will eventually be buying something. They add, however, that since testing requires a car, there may be a few days' delay until they have a car with the correct system on hand for the testing.

Of course, you can probably learn a lot yourself if you have a friend with a car similar to yours. Swap the ECU's and see how many problems go with them.

If your ECU gives up the ghost, please see the comments under Performance Mods (page 310) before spending the major \$\$\$\$\$ for a new one. Also, you might want to contact AJ6 Engineering listed on page 713.

If you wish, you can open the ECU easily enough; it is a simple cover-body-cover sandwich with several screws holding it together. Note that a couple screws have aluminum caps that serve as a tamper indication; it might be wise to inquire about policies regarding exchanging an opened unit before opening.

Take precautions to avoid static electricity discharges while inside this unit. Usually, it is sufficient to keep one hand on the chassis while working.

EFI WIRING HARNESS TROUBLESHOOTING: Matthias Fouquet-Lapar suggests "one thing I would do is to put in fixed resistors for the various sensors direct at the ECU connector" to find out if there's a problem in the harness.

INJECTOR CONNECTORS -- D JETRONIC: The connectors on the early cars are a simple plug that inserts into a rectangular recess on the injector. If you need new connectors of this type, Ed Sowell says you can get them at NAPA. "They have what they call "harness rebuild" parts which is a selection of connectors and pigtail wires with various

connector styles. You buy the connector body and the pigtails separately, and assemble. Be sure to ask for "harness rebuild parts," as you will get nowhere asking for injector connectors. The NAPA numbers are:

housing 2-17411 (this is the plastic connector body)

contact 2-17421 (this is the pigtail with the connector attached-- 2 req'd per connector)

Also discovered that NAPA has the contacts themselves without the pigtail wires."

Tom Simon says, "I have located a source for the injector connectors for pre-HE engines. They were ordered from Fuel Injection Corporation in California. Their web site is www.fuelinjectioncorp.com. The connectors are part number 920155B; they are black rather than the original white. The terminals with no wires are 920121B. They also have the boots (920125B) for the connectors. I ordered 20 connectors, 14 boots, and 50 terminals. The total order including shipping was less than \$35.00."

INJECTOR CONNECTORS -- DIGITAL P: Apparently Bosch decided the simple rectangular plug wasn't secure enough, so they developed a much more sophisticated connector for the Digital P system. These connectors are a rectangular hard plastic box that fits around the connector on the injector, and they have an external spring to provide snappage. These connectors simply pull off, although they can be a real bear sometimes. It might not be a bad idea to apply a little grease or something to that spring or the little point that it snaps around to help get it off next time.

These same connectors are also used on the Digital P temperature sensors.

According to Peter Cohen and others, NAPA offers this connector in parts or as an assembly. The assembly, with pigtails hanging out, is part number 2-17424. In parts, the numbers are

Housing - 4 per box 2-17416

Spring Clips - 25 per box 2-17417

Terminal Ends - 25 per box 2-17418

Michael Bucklew says, "The NAPA parts did not fit due to the lip around the bottom that holds the spring clip. My plugs do not have the lip around the bottom. The NAPA parts were \$14.49 each for the plugs." It's unknown if Bucklew's comments apply to the pigtailed assembly, the individual parts, or both, but at that price who cares? That's too much.

Rue Palmer says the problem is that is apparently the wrong NAPA part number. The connector you need is NAPA part number 2-17427. He describes this as a "Wired Housing (a wired connector minus the spring clip). I had to use the spring clips from the old injector connectors because the new connectors don't come with them."

Lucas lists the parts this way:

housing 526 8917 comes in packages of four

contact 526 8918 comes in packages of 25

spring 526 8930 comes in packages of 25

The Lucas parts, as would be expected, fit fine; this author used them on my harness rebuild.

It appears that the complete connector with pigtails is the most common way to find these parts. Discount Auto Parts also carries Caltherm, item number 08653, "GM Multi-Port Fuel Injector Connector". Costs less than two bucks each.

Cohen: "Other vendors are:

Conduct tite: Fuel Injection Repair Socket #85850

Dorman: Connector kit #643-463"

John Robinson adds, "Beck Arnley makes an OEM copy connector w/pigtail: 158-0017."

Ed Forman says, "I looked at several parts stores, found some that looked like they would work at an Auto Zone store. But the back stuck out too far and hit the plate that holds the injector in place. In desperation I went to a Jag dealer, they had the same type as the Auto Zone store. But I found the right ones at an Auto Value store. They are made by Parts Master part # 84059, they work great. About \$3.00 each, that's better than \$12.50 at Jag."

Patrick MacNamara says, "Best deal I have found on the injector connector housings is from Del City. They were only \$1.03USD each and are complete with 6" pig tails, #73522. No boots though." MacNamara ditched the pigtails since he wanted to use high-temp wire, which meant he needed terminals separately: "The terminals for the injector housings are available from your local Volvo dealer at about \$.75CDN each (Cable terminal #V0978258-2). The terminal connectors from Volvo are nifty two piece quality looking terminals and don't look as cheap as the ones installed by Del City with their pigtails. They have the double OEM crimp with one on the insulation and one on the actual wire which if I understand correctly should negate fatigue. The terminal crimp part seems to be referred to as an open barrel arrangement necessitating special crimping pliers."

So, Patrick, why didn't you get the housings from Volvo as well? "I had purchased one to trial fit it to the Jag injector. They are of a superior design in terms of positive locking with a nice button for release as well as being made from what looks like high impact resistance plastic. Unfortunately the button release and lack of half moon cut out negates the fit onto the angled injector port."

None of the above items seem to include the rubber boot that covers the joint between the wires and the plastic connector. Gregory Wells says, "Wurth markets the rubber boot and as with all Wurth parts, they're expensive. I think the Wurth part number is 5-7120, but I'm not real sure of that. Wurth distributes hardware and shop supplies to repair shops via independent salesmen and as far as I know does not distribute to the retail market, so if you want to chase these down call import repair shops to see if Wurth calls on them."

Rue Palmer says you can get the boots from NAPA: "Harness Boots (for those who want the original rubber boot- 2 per box): 2-18414"

MacNamara adds, "Boots are also available from Volvo at \$1.84CDN each (Housing cover #V0967340-1). These fit the Del City Bosch connectors very well but are slightly shorter than the Jag OEM ones. They are also much sturdier looking."

If you can't find the boots, screw it; the harness will work just as well and just as long without them, and probably look just as good or better. Keen Young says, "My solution was 1/2" shrink tube over 1/4" shrink tube. Put them both on the wires, solder on the connector, slide the small tube up to the connector, slide the large tube over the small one and over the connector, heat. If you look *really* closely, you can tell it's not factory. Got the tubing at the local surplus store for \$.20/foot."

It's also apparently possible to upgrade this connector. Since it's used on so many types of car and has been for so long, it's to be expected that companies have come out with improved versions. Mike Waldron says, "Autotronic Controls, makers of MSD Ignitions (<http://www.msdisignition.com>), make weatherproof (don't need no stinkin' boot) connectors for Bosch style injectors. These are designed to be removable from the injector, thus they don't break! The part number for a bag of eight is: 2400"

Unfortunately, Tom Bennett says, "Nice connectors, only problem is they do not fit! The lock/unlock mechanism gets in the way with the injector hold down. Nice for the other sensors though." Hmmm; sounds like the ones Forman found at the Jag dealer.

Robinson, who works at Bosch, says, "Delphi/Packard Electric makes a great connector that I believe will fit:

15305086 - connector body

12176636 - terminal

12176807 - seal

15326238 - spring

"These are for the new GM eco-tech V6 wire harness. Anybody who carries AMP products should be able to get

them.”

You could just drop into a junkyard and buy a bunch of connectors; lots of cars use Bosch injectors and most of them don't cook them like Jags do. Guy Poppe says, “I gathered 12 from the junkyard from GM cars. Nice and sturdy and clip on -- great. The connectors are too big as they strike the mounting plate. Tried a Chrysler connector from my '94 LHS and they fit. They look different than the GM or Jag ones but again better quality.”

INJECTOR CONNECTOR REPLACEMENT: In case you're trying to keep straight which wire goes to which side on each injector, Keen Young says, “No polarity. The injector doesn't care which side is ground (earth).”

Bill Farnsworth: “Last month I changed all my plastic injector connectors without removing the existing leads. I replaced all 12 connectors in 3 hours. Knowing a bit about connectors and wiring kinda helped too. Here is how I did it:

“Tools required:

Small flat blade jeweler's screwdriver

Small utility or x-acto knife

Hot air (750w) heat shrink gun

A three foot length (appr.) of 1/2 in" shrink tubing

1 Tube silicone glue/sealer

“Remove the connector from the injector. With the utility knife cut away the existing heat shrunk rubber from around the base of the connector leaving enough to maintain a base of rubber against the connector. You will notice that there is a small amount of epoxy glue holding the rubber to the base. Work the rubber and connector back and forth (like snapping a crab leg) until the glue releases. Turn the connector toward you and inside you will see a small slot above each lead. Insert the small jeweler's screwdriver into the slot; this releases the tab holding the lead to the connector. You can pull the lead out now. If it doesn't release, work the screwdriver around until it does release. Or you can just break the old connector off; it's toast anyway.

“What you have left is a clean wire with two leads, and a 3" length of Jaguar rubber boot, all intact. Neat!! If the leads aren't clean, now is the best time to clean them with alcohol.

“Now, slide a 4" or 5" length of 1/2" shrink tubing over the leads and boot. The tubing has to be long enough to go over the entire boot and cover both ends by at least a half an inch to prevent water seepage. Next put a small amount of silicon glue/sealer around the base of the boot that meets up with the base of the connector. Be careful not to get any sealer on the leads.

“Now take the *new* connector and push the leads thru the end until they seat. The base of the connector with mate up perfectly with the boot and the glue will seal up the end of the connection (just like original).

“Slide the tubing up and over the boot and over the base of the connector until it clears the lip by the same distance as the original (look at the next injector connector). Take up your heat gun (a hair dryer might work, but probably doesn't have enough directional control.) and warm up the shrink tubing until you have a perfect fit around the connector and boot and wiring at the other end. Take care to not melt other wiring in the area. Aluminum foil works as a good heat shield/deflector. Move onto the next injector. The first one will take you a while. Once you get a feel for how everything comes apart and goes together, then the whole process will take you 5 minutes per injector.”

IS YOUR INJECTOR HARNESS COOKED? Surprise, surprise. Craig Sawyers explains: “As some of you will have found, the insulation on the wires under the hood gets really brittle with time, and cracks. I was just browsing the Farnell catalogue (major electronic component supplier), and their selection of "automotive cable" uses PVC insulation, with a maximum temperature spec of 70°C. Interesting, think I. In fact, most PVC insulation conks out at 70°C. Some special UL-rated cable goes to 90°C (or 105°C if it won't be moved while it is hot, some hope on an engine). So it is

practically guaranteed that the insulation will fail on a Jaguar, even if it doesn't overheat! This is particularly true of the V12, where both major engine harnesses run smack down the centre of the V."

Is this a serious problem? It's just cosmetic, right? You don't care except the wires look bad, right? Well, ask Rue Palmer, who had a sudden loss of power and immediately pulled over and opened the hood to see what was the matter: "It looks like one of power wires in the injector harness shorted out due to the PVC wire insulation becoming brittle and cracking, which then melted most of the insulation from the wires to the right bank injector harness. It appeared that when the harness shorted it caused all the injectors in the right bank to go to a continual spray condition which flooded out the right bank and dumped raw fuel into the exhaust system. Upon examination the next morning, both the right exhaust and the engine oil had gas in them.

"Additionally, gas sprayed into the engine compartment caused by the injector located at "5 A". It had a hole melted in the housing of the injector body. None of the fuel lines appeared to have been damaged but I replaced them all anyway. To this day we don't know why we didn't have a massive engine bay fire. The wire in some places was glowing when we lifted the hood. I don't think the fire extinguisher that I carry would have put it out if it would have ignited."

Funny thing: the only reason Palmer pulled over that quick is because he had read this book, and thought he was experiencing the Marelli failure described on page 161. His car doesn't have Marelli ignition, though, which was the first clue that this problem was different.

Half the wires in the injector harness are connected to 12V power, and the other half go to the resistor pack and then on to the ECU in the trunk. If any of the latter half short to ground, 12V power will be applied continuously to an entire bank of injectors. This will flood out the bank, but worse it will cook wires and melt injectors because these circuits are not designed to have 12V on them for longer than a couple of milliseconds at a time.

Still, reports of this cause of engine fires are not common -- which makes sense, actually. Once the fire starts, all the insulation in the V will be burned away and the wires scorched, so it will be impossible to diagnose this cause. Palmer is probably an *extremely* rare case for having caught it before ignition.

Sawyers: "It wouldn't be so bad if they had been routed along the fuel rails." Actually, this is fix #1 -- relocating the injector harness *before* it gets cooked. This author moved it off the bottom of the V and up just an inch or so, fastening the harness clips under the intake manifold nuts rather than under the bolt heads holding the valley cover on. This gets it out of the oil deposits and keeps it a lot cooler without changing the appearance of the engine significantly. If you're unconcerned about appearance, it is a simple matter to relocate the harness right up on the fuel rail and tie it in place with zip ties.

If your harness is already cooked, consider fix #2 -- rebuilding the harness using better wire. Sawyers: "The real McCoy seems to be Raychem Flexlite High Performance wire. This stuff is double insulated, with a primary insulation of radiation crosslinked polyalkene, and a jacket of modified PVF2. Operates at up to 125°C and has excellent chemical resistance (ie oils for us) (they say). The problem? It is a factor of ten more expensive than standard automotive cable. This means (in US speak) about \$1 a yard for the most common gauge."

Another possibility is Teflon-insulated wire. If you find a source, buy it and use it. Of course, asbestos-insulated wire would work great, but isn't recommended anyway.

Del City (page 707) offers "cross-linked polyethylene" insulated wire which is supposedly good to 177°C (350°F). That oughta be enough!

Del City will add stripes to wires if you want, but it'll probably entail minimum order sizes beyond reason for the home mechanic. If you find sources of small lots of color-coded wire, good for you, but if you're limited in colors you can color code them with pieces of heat shrink tubing, or even type up little labels and fasten them to the wires with clear heat-shrink tubing. If you wanna get fancy, there are professional wire labelling products available.

To end up with a reliable injector harness, you can either rebuild the one you've got or make an entirely new one from scratch. Either way is about the same amount of effort, but rebuilding the existing one requires less thought. Just mark which plug goes to which cylinder, then take the whole thing off and lay it out on the bench. Strip all the wrapping. One by one, cut out the dried, cracking sections of wire and replace them with new sections. Use heat-shrink tubing to seal all soldering jobs. Of course, you may choose to replace injector connectors while you're at it -- see above.

Making a new one from scratch is not only not really any more difficult, but it results in a considerably neater appearance and more pride in the accomplishment. Again, take the harness off and lay it out on the bench and strip the wrapping. But in this case, merely inspect it to see how the wires are routed and connected, measure the lengths, and make an entirely new harness. If you wanna get professional about it, you can lay down a sheet of plywood and hammer nails into it as a guide to making the new harness, but this really isn't called for on a one-time job.

There are even a couple of minor changes you might make to your new harness. When this author did this job, one change made was the location of the section of the harness that passes from the right bank over to the left bank side. On the OEM harness, this bundle of wires passed under the A/C compressor. The new harness was altered slightly to have this bundle pass to the rear of the compressor and under the cruise control bellows instead, a much more convenient location.

You probably won't be able to find a replacement for the big plug at the right side fenderwell, but the original one is probably OK due to its location away from the serious heat; you can merely dyke it off and splice it into the new harness assembly. If you would rather replace it, you can get some generic connectors and replace the connector on the end of the harness on the right fenderwell that the injector harness connects to. You need connectors with at least five terminals (the original has eight, but you can combine some). You can, of course, connect them up with multiple smaller connectors, or even a bunch of individual spade connectors, but that would look crummy. Perhaps the best connectors available are called Delphi-Packard automotive connectors; they are commonly used in modern GM cars, and they are completely sealed so they won't corrode. They are likewise available from Del City; you can use either a single 6-pin or two 4-pin connectors for this job. If you choose to use two 4-pins, you might actually opt to create two completely separate injector harnesses, one per bank.

Del City also sells new high-temperature looming, but if you want you can just bundle the wires with zip ties every few inches and leave them visible.

If you'd like to review some photos of the injector harness work, visit

<http://www.jag-lovers.org/xj-s/book/InjHarnessRebuilding.html>

I know what you're thinking: "Too much effort; I'd rather just buy a new harness." Wrong. First off, you clearly have no comprehension of just how far Jaguar can gouge the customer for a few wires and connectors; once you price this item, after they pick you up off the floor you *will* be shopping for wire and a soldering gun. Second, remember that a new Jaguar harness is made from the same cheap PVC-insulated wire the original harness was, so all that money only buys you a temporary fix -- it will soon be cooked again. Better to do it yourself and do it right.

Also note that the injector harness accounts for most of the wires in the V, but not all. Once you've got the injector harness fixed, you'll probably want to similarly upgrade the other wires in the area.

RELAYS: There are several relays involved in the EFI system. They are discussed along with all the other relays in the car starting on page 562.

FUEL INJECTORS: If your engine is running or idling rough, one possible problem is a plugged or bad fuel injector. This may be indicated if the misfire always seems to be the same cylinder, although a bad spark plug or wire or mechanical problems in that cylinder are other possible causes. One-cylinder problems have different symptoms than they would have on a carburetor system, because a misfire in one cylinder causes the fuel and oxygen to enter the exhaust unburned. The oxygen sensor will pick up the excess oxygen, and the ECU will conclude that the engine is running lean. The ECU will then richen the mixture to all 6 cylinders on that bank, and then the whole bank sounds bad, not just one cylinder. If you have catalytic convertors, they might start getting toasty as well -- see page 318.

If you have a trip computer in the car, chances are pretty good that the indicated fuel mileage doesn't agree with the actual mileage determined by the odometer and the fill-ups. However, the error should be pretty consistent -- off by about the same amount every time you check. There have been some reports that a sudden change for the worse -- the actual fuel economy gets quite a bit worse while the trip computer is still indicating about the same as before -- may be

an indication of an injector gone bad. The trip computer calculates fuel usage based on what the injectors are *supposed* to be flowing, not what they actually *are* flowing, so when an injector jams open or starts leaking the fuel mileage goes to hell while the trip computer still thinks everything is fine.

If you suspect there is a problem with an injector, John Keppler suggests you use a stethoscope first. "I started the engine, then using a mechanic's stethoscope, listened to each injector. I could hear every one loud and clear except 5A, which was dead silent. I found the bad injector in seconds with a mechanic's stethoscope."

If you have an injector that doesn't seem to be working, pull the connector off and check the windings with a VOM. The windings on an injector should measure 2.4Ω at room temperature, and must not be shorted to the injector body.

You could get lucky like Keppler did. "I pulled the plug on my 5A injector and measured its resistance. The cheap meter I was using read 2.9 ohms. That looked reasonable. I then measured the voltage across the plug contacts with the engine running. I can't remember the voltage I got, but it was identical to the 1A connector (the most accessible plug to use as a reference). At this point, I plugged the injector back in and started the engine. With the stethoscope I could tell that it still wasn't working. Then I tried tapping 12 volts directly across the injector. The injector clicked! Loud and clear! So I once again plugged in the injector and started the engine. This time, I could hear it working just fine with the stethoscope, and the engine ran smooth. I can only assume that I either had a bad contact at the plug that got cleaned up by repeated unplugging and plugging, or the injector was just plain stuck, and hitting it with a good shot of 12 volts freed it up."

If you're not as lucky as Keppler, purchase one of the many fuel injector cleaners available that can be added to the gas tank. The common advice on how to use in-the-tank injector cleaner is -- as concentrated as possible. Run the car down to 1/4 tank, then add the injector cleaner, then run it down to nearly empty before refilling.

If that doesn't fix the problems, the next step is to take the car to any place that specializes in fuel injection work. They can flush the injectors with a cleaner by just connecting a line to the fuel supply line and running the engine.

If this doesn't work, the next step is to depressurize the fuel system, disconnect the supply and return hoses, remove 24 nuts and remove the rack of injectors as a unit. Take it to the same fuel injection shop and have them flush it in a rig. With it separate from the engine, they can use much more powerful cleaners than they can on the engine. Best of all, even if their cleaning doesn't fix the problem, they will be able to tell you if any injectors are bad and which one; they can actually watch them spray on the bench.

If you're the adventurous type, you might try testing the injectors yourself. Unbolt the set from the engine and raise them up a few inches while leaving the fuel supply and return hoses connected. Jumper the relay in the trunk to allow operation of the fuel pump with the engine off. *Immediately* check that no injectors are dribbling fuel. Place a small glass jar around one injector. Connect a couple wires to this injector, and give it a quick zap with 12 volts. Note: do not leave 12 volts connected continuously; only give the injector instantaneous jolts. Observe the performance of the injector. Repeat for all injectors; you can empty the glass jar back into the tank between tests. Obviously, any injector that seems to perform differently than the others is suspect. No smoking is suggested during this procedure, and it would also be wise to avoid electrical sparks.

Tony Gardner reports that J. C. Whitney offers a device for doing such tests called an Injector Inspector. "This device is hooked up to the battery and one can select various combinations of pulses to operate individual injectors. They suggest using it with the injectors in-situ and timing pressure drops but I did not find this very convincing."

"Back lighting with a flashlight is helpful. You can also rig the device to facilitate pumping cleaner through each injector." If you can devise a pressure container with one line in the top and another out the bottom, you can fill it with flushing fluid and connect the fuel line in the top and let the fuel pump push it through the injectors.

The injectors can be replaced individually, and there is nothing wrong with replacing only the one that's gone bad. Replacing the whole set is expensive, and usually not warranted.

The only differences between injector part number 0 280 150 163 (1985-91 front two), and 0 280 150 164 (1985-91 rear ten) is the length of the piece of hose attached to them. These injectors were fitted as a recall to cars with injector part number 0 280 150 105 (1980-85), so those injectors have no functional difference either.

The D-Jetronic cars had either 73143A/0 280 150 023 or 73143B/0 280 150 035 injectors. Some reports indicated that the last three digits indicate an orifice size difference, but Roger Bywater of AJ6 Engineering assures us that the number reflects a minor design change only and that all of these injectors have the same flow specifications. Note that the D-Jetronic injectors do *not* have the same flow rate as the Digital P injectors.

Richard Mansell quotes from a Jaguar publication on the changes for the 1992 models:

"New smaller lighter fuel injectors allowing the fitment of a lower mounted fuel rail, giving improved control of fuelling at small pulse widths."

Fuel injectors tend to be blamed for a lot of problems, probably more than they actually are responsible for. Michael Neal (Jaguar mechanic) says: "The only failed injectors I have seen have been from running water through them or running a car with a blown head gasket to death."

FUEL INJECTOR PULSE CHECKING: Robert Dingli suggests "an oscilloscope or a smart DVM with pulse width or duty cycle readouts can be used to check the injector electrical supply. Some modern ECU's can detect whether an injector is unplugged (or short circuited) and thus it's best to connect the electrical apparatus in parallel with the injector." Michael Neal says the injector pulse width should be around 3 milliseconds at idle.

John Keppler suggests you could go with what you have and check the injector pulse with an old-fashioned dwell meter. Hey, you're not using it anyway; if you still have any cars with points, it's high time you installed electronic ignition modules in them. Keppler points out that a dwell meter is merely a 12V duty cycle meter with scales in degrees instead of 0-100%. Disconnect one injector connector and connect the two leads from the dwell meter to it -- which may require sticking some small flat metal things into the plug. Ideally, buy a new Bosch plug and create a jumper to connect the dwell meter while leaving the injector connected. Fire the engine up and see what happens. Remember to check both circuits (there are two, one per bank on the H.E. and all mixed up between banks on the pre-H.E.).

At this point, I cannot offer any guidance on just what kind of readings to look for. Remember that, while point dwell should stay relatively constant with RPM, injector pulses will indicate a "dwell" that varies with engine RPM and load. Just check the dwell meter readings on someone else's car as a basis of comparison; it probably doesn't even need to be a Jaguar, since pretty much any fuel injector should be seeing the same kind of injector pulses.

INJECTOR SEALS/NOISY FUEL INJECTORS: Each injector is mounted with two rubber rings, a small one at the tip and a large one around the body. These rubber parts isolate the injector from the manifold. There are two reasons you might want to replace your injector seals. The first is noise; Hunt Dabney says: "On the noise issue, I just replaced all of the injector seals and rubber mounts. My injectors are now *really* quiet!" The other reason, of course, is to eliminate vacuum leaks; the smaller ring at the tip is obviously critical for sealing the intake manifold, but the larger is also important for holding the injector securely against the smaller.

Frank Perrick points out that these seals are available at any auto parts store since they are standard Bosch items. The seals come in packages to service four injectors, so you will need three kits for the V12. Here's a tip for getting the guy behind the counter to get you the right parts: When he types all the make and model data into the computer, one of the screens he will face is where he must select the type part you're looking for. One choice is "fuel injector/carburetor gaskets", but if that selection is made it will come up with some obscure part number and claim it's not available. If, on the other hand, he selects "fuel injectors", it will come back with a listing for the "fuel injector seal kit". Or, Perrick suggests you can just carry an injector in there and say "I need these gaskets".

John Napoli found a different kit: "Standard Motor Parts SK-3 does the trick -- handles four injectors (eight rings -- 4 big and 4 little) for less than \$4.00 US." A similar kit, the one carried by AutoZone, is GP Sorensen part number 800-9207. The kit offered by Discount Auto Parts is Tomco part number 27013.

However, not all kits are the same; some carry parts besides the two rubber rings. One such kit is Beck/Arnley # 158-0021 vp 1; B.J. Kroppe says, "The kit included the small, square-sectioned seal between the injector tip and plastic cup, as well as the large rubber washer which I believe isolates the clicking injector from the rest of the engine. The last bit that was in the Beck-Arnley kit was the tiny (nylon?) mesh filter that fits into the top of the injector fuel inlet. This is a

neat design.”

Kroppe also found a set from Python Injection, Incorporated, part number 200-120, with even more parts. “Description: large injector washer (isolator), square section o-ring seal, mesh injector inlet filter, injector tip cup (does not fit Jaguar injectors).”

You might wish to make the extra effort to find seal kits with pintle caps -- see below.

FUEL INJECTOR PINTLE CAP: You can't see this thing when the injector is in place, since it is on the end buried in the intake manifold. When you take the injector out, though, it is the plastic cap that completely surrounds the injector with a hole at the tip where the pintle is. The original pintle caps are a tan color, and reportedly not very reliable; you're likely to find them damaged. Richard Chapman says, “I got black caps in my seal kit, along with the 2 rings. Just pulled off the old ones with pliers and a twisting motion - not too difficult, just a bit nervous on the first one. I could not have reused the old caps once removed. It was difficult to get the new ones to fully seat inside the recess where the injector tip meets the injector body - lots of fiddling needed except on the 2 different ones which fitted with ease!!! Weird.”

Paul Hackbart says, “The pintle caps are not for spray pattern but for heat protection. To replace them I used a little mm socket so not to damage the solenoid tip and tapped it back on to click into place. I would replace the pintle caps regardless. When I did mine, 3 or 4 were cracked and most of them at the end were missing. The original orange ones are not recommended as all pintle caps by Bosch are black/heat resistant.”

IDLE STUMBLE: A stumble may be a sign of an intake manifold leak. Since the EFI senses manifold vacuum and meters fuel accordingly, it would make sense that an intake manifold leak would only cause a high idle, not a stumble or misfire. However, a manifold leak that is near the intake of one particular cylinder apparently has more effect on that cylinder than on others, and can cause an individual cylinder to run lean. This may be quite serious, since a lean-running cylinder is a candidate for a dropped valve seat -- a very expensive problem. If a leak is suspected, a can of WD-40 makes an excellent leak locator; simply spray on each area while the engine is running and see which spot makes a difference when sprayed on.

The gaskets between the intake manifold and the heads are common leak sources. It appears to be necessary to retighten the manifold-to-head nuts occasionally, especially shortly after a reassembly. In fact, just go out to the garage *now* and torque 'em all down.

D-Jetronic

RECOMMENDED READING: Roger Bywater wrote the definitive guide to the D-Jetronic system, published in Vol. 2, No. 2, *Jaguar Quarterly* (now *Jaguar World* -- see Kelsey Publishing, page 723), 1989. It is *highly* recommended that owners of cars with this system obtain a copy of this article.

TRIGGER UNIT: D-Jetronic cars have a "trigger unit" inside the distributor that provides a signal to the EFI system to trigger the fuel injectors. It is mounted just under the distributor rotor and is activated by a magnet in the tail of the rotor.

The trigger unit originally fitted inside the distributor had magnetic reed switches and a three-wire connector that plugs into the EFI wiring harness. These type trigger units were later superseded with a replacement trigger unit that uses Hall effect circuitry instead of reed switches for improved durability. The Hall effect trigger unit has a fourth wire, separate from the connector, this fourth wire must be connected to a 12V power source that is switched on with engine ignition. Unlike reed switches, the Hall effect circuits require a power supply. Three-wire units are no longer available. By now, most of the original three-wire trigger boards have probably been upgraded to four-wire.

Reportedly, the official Jaguar procedure is to connect the fourth wire to the white wire at the ballast resistor. This, in fact, should provide the proper switched 12V source -- on paper, anyway. However, Ray Reynolds reports that the 12V available at the ballast resistor was so noisy that it caused the injectors in his car to fire wildly, resulting in flat spots and even stalling at some throttle positions. He simply reconnected this wire to a more reliable 12V source and his problems cleared up.

TRIGGER UNIT TESTING: If you have the Hall effect unit, the testing procedure in the ROM won't work. However, either the reed switch version or the Hall effect version are supposed to provide the same signal to the EFI system, so it's still easy enough to test -- you just need to make sure that it has 12V power and a ground connection when doing the testing. And you need to test it in place and using the rotor to activate it; it doesn't matter if it'll work with some magnet you're holding in your hand, if it won't work with your rotor, it won't work.

There are four wires. The one that provides 12V power should be obvious; it's not in the connector with the other three. Of those three, the center one in the connector is a common ground; it must be grounded during testing to complete the 12V power circuit. The outer two are normally open but get very brief closures to the common ground as the magnet in the rotor passes over the trigger unit.

To test, connect leads to these three wires without unplugging the connector. You can unplug the connector, tie small test wires to the terminals, and plug it back in. Or you can just jam straight pins through the wires and connect your VOM to the pins. Turn the engine over and watch for brief closures, once per cycle, between each of the outer wires and the center common wire.

TRIGGER UNIT CONNECTORS: Peter French claims to be one of the few people that still has reed switches in his car rather than the Hall effect sensor. "I also had a good problem earlier with the 3-way connector to the injector switches. The centre (0v) pin had two wires going to one pin and they were "over-crimped". One wire had broken such that the reed switches had no common return unless the idle switch contact on the throttle switch was closed. Net effect was that the car would start and idle fine but cut out as soon as the throttle was opened!"

TRIGGER BOARD SCREWS: As mentioned on page 140, Richard Dowling tapped out the holes in the distributor body to take M4 screws. "My trigger board had 4 special rubber grommets with holes to take the screws. I had no trouble with putting nylon M4 screws through."

ROTOR: Yes, the distributor rotor is an ignition system part -- but in the Jaguar V12 with D Jetronic EFI, it's also a fuel system part since there is a magnet in the tail of the rotor to trigger the fuel pulses.

Mike Morrin reports: "Beware, there are two types of D-Jetronic distributor rotors. The ones with the narrow magnet (P/N 54422422) only work with the old style trigger units, the ones with the wider magnet (P/N 54400048) appear to work with both old and new trigger units."

MANIFOLD AIR PRESSURE (MAP) SENSOR: One man's pressure is another man's vacuum. Yes, the conditions within the intake manifolds on non-supercharged engines are commonly referred to as vacuum, but engineers normally refer to air pressures in terms of absolutes rather than relative to atmospheric, so the sensor measuring the air pressure within the intake manifolds is referred to as the "Manifold Air Pressure" sensor.

Mike Morrin: "I would strongly recommend that all owners of cars with this system periodically check the manifold vacuum sensor for internal leaks. I stress this because when I needed a replacement for mine, I was told that new units are no longer available for the "early" calibration systems, and so I needed to find a good used one. This resulted in me driving around London (I was officially in the UK on business) for 2 days sucking on manifold vacuum sensors at all sorts of dodgy Jaguar parts shops. Of the dozen units I saw, only 5 did not leak, and only one of these was the correct

calibration for my car. There are obviously a lot of cars on the road with leaky sensors.

“The sensor is the aluminium cylindrical thing right in the front right hand corner of the engine compartment. The test is simple, disconnect the center hose from the tee piece between the manifolds (above the distributor) and suck on it as hard as you can, there should be no hissing sound from the sensor unit. Then stick your tongue over the end of the pipe while releasing the vacuum in your mouth. The hose should stick to your tongue for several seconds before it (the hose) drops off.

“Internally the sensor has a barometer bellows, but there is an extra brass (?) diaphragm which provides the vacuum seal. This diaphragm flexes every time the manifold vacuum changes and it is not surprising that metal fatigue sets in and causes a split around the outer edge. This is an example of Bosch design which would make Lucas look good (if Lucas had not insisted on sticking their name over the Bosch logo!).

“If the sensor is leaking, then the engine will be running rich, particularly at part throttle, but this varies depending on the size of the split in the diaphragm.

“I did attempt to repair my faulty manifold sensor, both by adding a rubber diaphragm and by soldering up the split in the brass diaphragm, but both of these repairs resulted in a significantly lean mixture.”

Roger Bywater of AJ6 Engineering (page 713): “If there is a break in continuity to either winding on the pressure sensor the entire system will be dead. Really all that most people can do is check the two windings for isolation and resistance (nominally 350 ohms between terminals 8,10 & 90 ohms between 7, 15) and the assembly as a whole for a vacuum leak. Obviously that will cause excessive richness at light load whilst full load will be unaffected, although in practical terms a minor leak may not be all that important. Electrical failure is extremely rare and I don't suppose the aneroid bellows fail very often, unlike the full load diaphragm on the European version which is prone to splitting around the edge (which can be repaired by careful soldering in the early stages. These devices come apart quite easily once the 4 rivets are drilled out. The pressure sensor being effectively a variable inductance transformer, function testing would entail firing pulses or low voltage AC through the primary winding and measuring what happens at the secondary. In fact the most practical way to test one is to link it to an ECU on a bench rig representing the vehicle installation (such as we use) and measure injector pulses at different loads at a set speed. Obviously not many people will be able to use either method.”

D-JETRONIC REPLACEMENT: Roger Bywater of AJ6 Engineering (page 713) says “it is not that bad a system and shouldn't be that troublesome really if it is properly set up (correct throttle balance is vital). Although odd bits like trigger boards and pressure sensors do fail occasionally, and injectors tend to jam if exposed to water contamination, the ECUs don't often go wrong (unlike early H.E. 6CUs) and really the wiring and connectors are the main problem areas as they age. It is a lot easier to go over the connectors, cutting back the wires and soldering them to the terminals, than to strip the lot out and install a new system.

“If the system is beyond economic repair and really does need to be replaced then I would have thought that by far the easiest route would be to simply fit all the hardware, including manifolds, plumbing and Constant Energy ignition, from any H.E. engine car from 1981-88 and use a 16CU controller (1986-91) and have us install the correct program for the early flat head engine (Super Enhanced option available). This setup has been used successfully on a number of V12 E types converted from carbs to EFI and has the great advantage that all the parts are familiar and easily available.

“Aftermarket ECUs sound great but in practice involve a lot of time and effort to get right and would be hard to justify for a standard engine. It would definitely involve rather more than "just wiring in a new processor" and any improvement in performance or fuel efficiency would be minimal.

Cold Start Injectors

SCHEMATIC CORRECTIONS: In the Haynes manual 478/49015, you should mark Fig. 10.124 and 13.92 at the thermostat switch #298 to show a ground connection on the line at the bottom between the heater and the contact.

Without this ground shown, it's *really* difficult to figure out what's going on!

Also note that the thermotime switch contains a thermal switch and an electric heater. The schematics make it look like a relay. It should show a resistance rather than a coil.

Note also that Section 19.22.32 of the ©1975 ROM shows a schematic of the cold start injector system that is poorly labelled at best. It shows "12V" connected to 86C via a WR wire, when it would have been much clearer to mark the wire "from starter relay" -- there's no power on it except when the starter is engaged. The thermotime switch is at the bottom left, unlabelled and no innards shown. The cold start injectors are at the bottom right, unlabelled and no innards shown. The cold start relay is at top center, unlabelled with the innards shown incorrectly; since it shows five terminals including an 86C, it is evidently attempting to illustrate the system with a bootstrap circuit (see below), but there are no internal diodes shown and there is no internal connection to terminal 86. Ken Gray and Roger Bywater claim the illustrations in the same section in other ROM's such as the early XJ12 ROM show the non-bootstrap relay (four terminals) largely correctly.

COLD START RELAY VARIATIONS: Basically *all* of the schematics showing the cold start injector system on the D Jetronic EFI system show the cold start relay as a simple relay: one coil and one contact, 4 terminals. If the car is really wired that way, the cold start injectors will *only* operate while the starter is engaged. This makes good sense; once the starter is released, it can be presumed that it's because the engine has fired and therefore there is no more need for the cold start injectors to be spraying. In this configuration, the only reason the thermotime switch cuts off after a few seconds is to prevent flooding in case the owner holds the starter on for a long time.

Ken Gray says the early cars were wired differently, though: "In reality, (76 model XJC5.3 Oz spec & also 75 Daimler Double Six brit spec.) the relay is a five terminal relay. It has two internal diodes, and the extra contact is labelled 86C. Diode 1 goes from 86C to 86. This allows current to flow to the relay coil from the start relay ie when the engine is cranking. Diode 2 goes from 87 to 86. This allows current to flow into the relay coil from the main injection relay to allow the cold start injectors to stay energised after the starter has been dis-engaged. Diode 1 blocks any current from feeding back to the starter solenoid once the starter key has been released. The thermotime switch opens after it has timed out and the injectors are de-energised."

Basically, what Gray is saying is that the relay has a built-in bootstrap circuit; once it has been energized by the starter being engaged, it will hold itself energized even after the starter is released until the thermotime switch shuts it off. If your car has such a relay, the schematics should be altered to look like Figure 14.

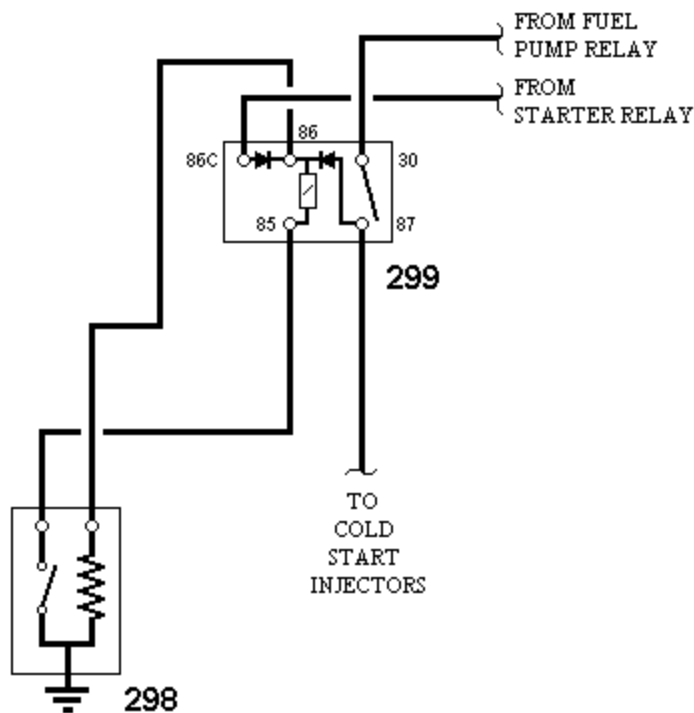


Figure 14 - Alternative Cold Start Relay Schematic

Interestingly, while the Jaguar cars with this system were reportedly connected this way, it would actually make more sense to connect the wire to the heater in the thermotime switch to 87 on the cold start relay instead of 86. It would function exactly the same way, but there wouldn't be as much current going through the diodes. Roger Bywater found schematics of other cars with similar Bosch EFI systems that were wired that way.

The diagrams that this schematic revision might apply to are as follows: In the ROM ©1975, the "Fuel Injection Schematic" following Section 86, and whatever diagram shown in section 19.22.32, as discussed above. In the Haynes manual 478/49015, Fig. 10.121, 10.124, 10.129, 13.92, and 13.96. Check your own car, and if it has the relay described, mark the appropriate schematics accordingly.

Gray: "The relay is a Bosch manufacture with the Lucas sticker stuck on the side. The Bosch number is 0 332 003 028 - 12V, 10A. The Lucas marking is 25RA which I think is the series (not serial) number, because all the relays that are in the same can configuration bear this number, and 33353A which I believe is the important part number."

Gray goes on to point out that the Haynes manual clearly shows the 5-terminal relay he's talking about in Fig. 3.50. He claims this relay is also illustrated in his XJ12 ROM; "My ROM is the red covered Jaguar XJ12 /Daimler Double Six version. Publication Part No. E190/4." Section 19.22.31 of the XJ-S ROM ©1975 shows the cold start relay, but not clearly enough to indicate how many terminals it has.

If your car has the relay Gray describes, it will be a large metal can that looks similar to the starter relay with individual wires connected to spade terminals and it will have a terminal labelled 86C. If your car has the simpler system illustrated in the schematics, it may have 5 terminals but one will be labelled 87a or some such; there will be no 86C.

Roger Bywater isn't thrilled with the bootstrap concept used here: "I know what can happen when the cold start injector(s) are allowed to spray with the engine running. A weak 'spit back' can ignite the fuel from the cold start injector which then becomes a rather noisy blow lamp inside the manifold. A single plenum engine would immediately stop then would easily restart probably without the condition even being recognised. A V12 could have one bank 'lit up' inside but the other bank would keep it running, after a fashion, until the thermotime switch trips out when things revert

to normal.”

COLD START PROBLEMS: William F. Trimble says, “My Haynes manual for the V12 (yeah, I know ... :-)) suggests to remove the thermo-time switch altogether if you have cold-start problems.” This author’s Haynes manual says “A problem can occur on 1980 models causing stalling immediately after cold start. This can be overcome by removing the cold start relay...”

John Braybrooks says, “I have a 1982 XJ-S in Victoria, British Columbia, Canada. I keep my car in a garage and one recent winter my son drove it out so that he could use the garage space to work on his 1929 Model A. When he finished he returned the Jaguar to its rightful location. Next day my wife also moved the car to facilitate sweeping the floor and again returned it. Next morning when I tried to start the car there was no life. I called local Jaguar specialist, Paul McKay, and he immediately diagnosed the problem as flooding. He came to my house and replaced the spark plugs which were the least difficult (5) and we were then able to get the engine running on those cylinders, later more and more came on line until all was well. He informed me that this was a characteristic of this engine and it was not unusual for the dealers to experience this problem with brand new vehicles loaded on and off transporters during the winter. Under the right conditions the cars would not start when delivered to the dealer. Paul warns that if this does occur and you are able to get the engine running of a few cylinders *do not* "gun it" otherwise the unburned fuel will be burnt in the catalytic convertors and the excessive heat could cause a meltdown. If I have to move my car for very short periods in cool weather I now always let the engine run until it is thoroughly warm.”

Roger Bywater explains: “That’s a familiar story. Back in the early 1980’s they had new H.E.’s doing that even in our mild winter after being shuffled around the factory car parks a few times before delivery. That’s why they got rid of the cold start injectors after a period of just having the connectors taped back for the dealers to hook up before delivery to the customer.

“Whilst it may be the case that the H.E. V12 is more prone to cold plug fouling than some other engines, doing repeated cold starts in very cold conditions without getting to even part warm is maybe asking a lot of an elderly car probably with shaky HT leads and things. If I had to move any car, not just a Jaguar V12, repeatedly in severe conditions I would at least let it run to near fully warm every other time then rev it up two or three times to make sure it was clear.”

Digital P

FUEL SUPPLY SCHEMATIC CORRECTION: Fig. 3 on page 19-3 in the ©1982 Supplement and Fig.13.18 in the Haynes manual as well as the same diagram in the Handbook purport to illustrate the fuel supply system for the Digital P. In fact, it’s quite accurate -- if you never had the fuel rail recall performed on your car. Since all cars should have had the recall done, the left half of this illustration should look like Figure 15.

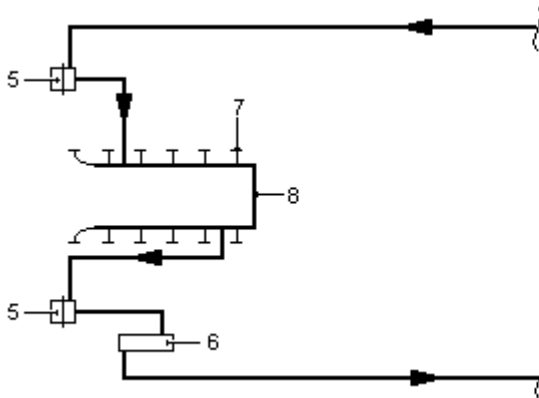


Figure 15 - Digital P Fuel Supply Schematic

There are now two pressure regulators (although the bottom one in the illustration is actually the only one that regulates pressure), and the cold start injectors are gone. Note that for the 1992 model year, Jaguar went back to having a single pressure regulator.

Fig. 4, 18, 20, and 21 and sections 19.60.01, 19.60.03, 19.60.04, and 19.60.05 in the ©1982 Supplement as well as Fig. 13.13, 13.14, 13.22, 13.23, and much of the text in Chapter 13, Sec 5 in the Haynes manual likewise reflect the pre-recall fuel supply system.

HOT STARTING: The fuel cooler works great when the engine is running, but is worthless after the engine is shut off. The heat rising from the engine heats the fuel in the rail, which is not moving. If the engine is started about a half hour after shutoff, it may have difficulty starting.

Jaguar has provided two different fixes for this problem. Both involve a temperature sensor in the boss on the left side of the fuel rail; the boss has no opening into the fuel, but the sensor has a copper bottom that presses against the rail to sense the temperature. The boss itself seems to exist on all XJ-S H.E.'s, since a recall replaced the rail after the hot fuel problems were found.

The earlier type sensor is electrical, and is connected in line with the inlet air temperature sensor for the EFI system. The later type sensor has vacuum connections, and is connected between the intake manifold and the left side fuel pressure regulator. At least one of these sensors has been known to simply fall apart, but owners have had some success simply gluing them back together.

If your car doesn't have either fix (or if it does but still has difficulty with hot starts), there is a work-around for the hot start problem. Turn the ignition key on and off several times before attempting to start, allowing the fuel pump to run for two seconds each time. This will flow cool fuel from the tank into the rail.

CLOSED-LOOP OPERATION: The earlier D-Jetronic EFI systems were strictly open-loop. This means that the ECU contains a schedule of values (a "map") for how much fuel the engine gets at a given operating condition, and that's final. The Digital P systems in markets that did not limit emissions likewise were open-loop only. For North America and other markets where emissions were regulated, however, the Digital P system featured a closed-loop fuel control. There is still a map providing "baseline" fuel scheduling, but there are also oxygen sensors in the exhaust system that monitor the exhaust for excess oxygen. If an oxygen sensor finds excess oxygen, the ECU presumes the engine is running too lean and trims the fuel scheduling a little richer. If it doesn't find excess oxygen, it presumes the engine is running too rich and trims the fuel scheduling a little leaner. The oxygen sensors are essentially an on-off device -- they either detect oxygen or they don't -- so the closed-loop control mode is neurotic, always either correcting one way or the other; it is never satisfied. When operating normally, it is constantly cycling from a hair rich to a hair lean and back again. As a result of this constant feedback correction, the engine is always kept very close to stoichiometric fuelling in this mode.

Oxygen sensors are also known as Lambda sensors; Lambda (λ) is the Greek symbol generally used to denote relative air/fuel mixture, with $\lambda=1$ corresponding to stoichiometric, $\lambda>1$ meaning lean, and $\lambda<1$ meaning rich.

Of course, stoichiometric is not necessarily ideal. For max power, you'd like it a little rich. At max power, it'd better *be* a little rich, because running near stoichiometric is a good way to burn pistons. So, there are two switches -- a roller microswitch on the turntable and a vacuum-operated switch nearby -- either of which will kick the EFI system out of closed-loop mode at high throttle. This causes it to run on the baseline map with no trim, which is of course designed to be a little rich just for this purpose.

A photo showing the microswitch can be seen at:

<http://www.jag-lovers.org/xj-s/book/Microswitches.html>

Michael Neal sends this info on checking the Digital P EFI system: "Monitoring O² sensor feedback voltage just lets you know the EFI is in closed loop operation. This should be checked with a *high* input impedance digital volt meter. A cheap meter will fry the system. Check the voltage at the O² sensor connector with the sensor hooked up and the

engine running. The voltage will fluctuate from 0 to 1 V. With a fairly fast updating meter you should get a voltage swing of at least .3 V. A .1 or .2 V swing shows a problem with the O² sensor, open loop operation, or a problem with the sensor driver in the ECU.

Robert Dingli says: "It is pretty obvious when the system goes into closed loop control. While the open loop controller may be tuned to near $\lambda = 1$ the voltage output will 'flicker' around 0.5V or else sit at a low or high output. When under closed loop control, the perturbation due to the closed loop system can be clearly seen as a low frequency oscillation in the output."

Before checking that sensor output voltage, take note: if your car has a red 2-conductor socket on the end of a wire near the ECU with a jumper in it, you will need to remove the jumper to get it to go into closed-loop at idle in neutral or park. See below.

Besides monitoring the oxygen sensor outputs, you could also check for closed loop operation by monitoring the feedback voltages within the ECU itself. No, you don't need to open it up -- Jaguar provided a 4-connector plug in the trunk near the ECU specifically to enable monitoring of the feedback signals. See page 294.

OPEN-LOOP OPERATION IN PARK OR NEUTRAL: One pertinent fact regarding oxygen sensors: they have to be hot to work. The Jaguar V12 at idle with no load and the timing properly advanced is turning over so easily that the exhaust may not be hot enough to keep the sensors working. When the sensors quit working, the closed-loop control will richen the engine up, and the idle speed will start to drop off. Sometimes the sensors will start working again, and the closed-loop control promptly leans it back out, and the idle comes back up. You can end up with an unstable idle. Typically, if you put the car in gear, the load of the torque convertor is enough to keep the exhaust warm and the sensors working, so the idle is steady.

To avoid the unstable idle problem, early emission-controlled Digital P cars had the starter inhibit switch on the shift lever also connected to the EFI system. In Park or Neutral (starter permitted), the EFI operates in an "open-loop" control mode, where the oxygen sensors are ignored and the EFI controls to a fixed fueling map. When in Drive or any other moving gear (starter inhibited), the EFI operates in "closed-loop" mode, adjusting the fuel mixture to obtain the correct oxygen sensor feedback.

Owners subject to emissions testing need to be aware of this. The regulations require the car to meet emissions in D, which it will if it's running right -- but unless the idle mixture has been properly adjusted, it might not meet them in N or P because the EFI system is in open loop and is not correcting for rich or lean fuelling. Of course, Jaguar's stand is simple: bring the car in and let our authorized service technicians adjust the idle mixture. Once properly adjusted, it won't matter if the system is in closed loop or not, since the mixture is right and needs no correcting. However, if they test for emissions in N or P in your area and you don't feel like having the idle mixture adjusted right now, you can just pull a jumper from a red 2-connector socket near the ECU in the trunk to put the EFI into closed-loop mode in N and P. If the emissions testing is done in D on a set of rollers or some such, you probably don't need to worry about it, but it couldn't hurt to pull the jumper anyway.

Starting with VIN 134286, the XJ-S was fitted with "3-wire" oxygen sensors. These work the exact same way as the single wire sensors, except that they have a built-in electric heater. The heater keeps the sensor working at all running conditions. Eventually the circuit that puts the EFI into open-loop at idle in Park or Neutral was eliminated as well as the jumper in the trunk, but this change didn't happen at VIN 134286.

When the 3-wire sensors were first introduced, Jaguar wanted \$150 each for replacements -- and even finding a generic replacement could cost considerably more than the older 1-wire sensors. As a result, some owners installed 1-wire sensors in their cars, and either just put up with unstable idle problems or fiddled with timing or idle mixture to avoid them. If you have a car that should have 3-wire sensors but you find 1-wire sensors in it, you probably should go ahead and install 3-wire sensors; they're no longer expensive. At least put the right sensors in when the 1-wire sensors die of old age. After you get the correct sensors in, you might want to check the timing and adjust the idle mixture just in case they were fiddled with to deal with an unstable idle. And if you have to adjust either of those, you'll probably need to reset the idle speed afterward.

OXYGEN SENSORS: First, a clarification: these sensors don't sense oxygen; they sense the *absence* of oxygen. Essentially, a Lambda sensor is a battery that generates a voltage based on the potential difference between the oxygen outside the exhaust pipe and the oxygen (or lack thereof) inside. If there is oxygen on the inside, there is oxygen on both sides, so the potential difference is zero -- no voltage. When there's no oxygen on the inside, there is a difference between inside and outside and the sensor generates a little under 1 volt.

What happens when your oxygen sensors go bad? Well, obviously they will put out no volts regardless of oxygen in the exhaust pipe. The EFI system will either decide, based on the lack of voltage, that the car is running lean and will trim it in the rich direction, or it will default to the baseline schedule with no trim. Roger Bywater: "Later fault logging systems would just ignore a faulty signal, flag a fault warning and either run at mid-range as mapped or run 'safe rich' depending on the strategy." Either way, it's gonna run rich. This is a relatively safe failure mode, as running rich can cause rough running or bad fuel economy but it usually won't cause permanent damage to anything. It sure will impact your fuel economy, though.

Oxygen sensors are available at local parts stores. There is no need to insist on a Jaguar part; a generic replacement sensor will work fine. Brian Sherwood suggests Bosch universal sensor p/n 11025 for the earlier one-wire sensor. Take an old sensor in with you (if possible) to make sure the new ones are the right thread. Don't worry if the fluted sensor portion doesn't look exactly the same. If the wire is the wrong length or has the wrong connector on the end, use a crimp connector to connect the new sensor with the wire cut off the old sensor; the generic sensors usually come with suitable crimp connectors for this purpose.

You really don't want those generic one-wire sensors though. What you really want to do is retrofit the later 3-wire heated sensors. See below.

A generic sensor may come out of the package with the wire wrapped tightly around the body of the sensor itself. Don't unwrap it yet! This wrapping makes it possible to use a normal deep socket to install this sensor, rather than the special sensor sockets sold with a slot down the side for the wire. Of course, on the XJ-S it's not too difficult to just use an open end wrench.

The installation of an oxygen sensor is one of the *most* important places to use anti-seize compound -- see page 29. Fortunately, the sensor manufacturers know this, and even the cheapest generic sensor usually comes with anti-seize compound already on the threads and a little plastic cover over the threads to keep it there until ready for installation.

OXYGEN SENSOR WARNING LIGHT & SERVICE INTERVAL COUNTER: The package a generic oxygen sensor comes in may say something like "Remove negative battery cable for 15 seconds to clear codes" but this won't turn off the dash warning light -- at least, not on the pre-90's XJ-S. The dash indicator on the early 80's XJ-S isn't really a "fault code" per se. There's no point to disconnecting the battery on these cars; it'll just force you to reprogram your radio stations.

An oxygen sensor failure causes the engine to run rich, which results in high emissions. The EPA requires that emissions systems have to work for 50,000 miles, but the 1-wire sensors needed to be replaced every 30,000 miles. To meet the EPA requirements, up to VIN 134285 Jaguar provided a warning light on the dash that lights when the EFI system detects a bad sensor -- right? Wrong. The light is there, but it's only a counter that tells you that you've driven 30,000 miles since the last time the counter was reset -- which, hopefully, was the last time the oxygen sensors were replaced. The "service interval counter" that turns on the light is connected to the speedometer sender, not the EFI system. Your sensors may still be just fine when the light comes on -- or they may have given up the ghost 10,000 miles back! There *are* reports of the oxygen sensors failing before the counter turns the indicator on. It is recommended that the sensors be replaced when the light tells you to, and if the car doesn't appear to be running correctly don't overlook the possibility that they have gone bad even though the light hasn't come on yet. The test of the closed-loop operation described above will tell you if they aren't working. Another clue: the fuel economy will take a precipitous drop if they aren't working, like 2 mpg or more.

The service interval counter is in the trunk, hidden under the carpeted panel on the left side near the filler cap; you need

to remove a carpeted panel in the forward left corner of the trunk to get to it. The rearward-facing end of the black plastic box has an electrical multiconnector, a metal device that looks like a solenoid, and a single-wire connector. If you lean your head in a little farther, you'll see that towards the right (and hidden around the corner of the panel the counter is mounted on) there is also a small protrusion pointing rearward with a tiny white plastic tit on top. To reset the timer to zero when you replace the sensors, use a pointy object to push the *center* of this white plastic button in (a long ways, like a half inch) until you hear the thing reset.

If all that wasn't clear enough, you can look at pictures of the service interval counter at:

<http://www.jag-lovers.org/xj-s/book/ServiceIntervalCounter.html>

Another option, obviously, is to simply unplug the service interval counter. Or remove the light bulb.

Note that the service interval counter described only appears on cars with oxygen sensors up to VIN 134285 -- the end of the 1986 model year. 3-wire sensors were introduced with the beginning of the 1987 model year, and they last 60,000 miles between replacement. Since the EPA only requires that the emissions systems work for 50,000 miles, the service interval counter was omitted.

There was a different type of "service interval counter" behind the dashboard in the early pre-H.E. cars that obviously has nothing to do with oxygen sensors since those cars didn't have any.

The mid-90's cars come with the OBD or OBD II features required by California law, and therefore have fault codes to indicate when sensors aren't working.

3-WIRE OXYGEN SENSORS: Starting with VIN 134286 -- the beginning of the 1987 model year -- the XJ-S came with "three-wire" oxygen sensors with built-in heaters to keep them at operating temperature even when the exhaust is relatively cool. Such sensors were expensive at one time, but Tomco part number 11014 is available at Discount Auto Parts for only about \$40 each. Rusty Beard found another generic: "The Part # is 341-90-06."

Regarding wiring up the generic 3-wire sensor, Peter Cohen says, "I bought a pair of Tomco (boxed as Lucas) 3-wire oxygen sensors. These come with 2 white wires and one black wire. The instructions say to hook black to black and white to either of the white wires. Only problem is, there are no white wires on the Jaguar. It has one black, one G and one NS." Rusty Beard explains how to connect it: "Black wire to G (to ECU). The white wires to Black and NS (This is just a heater circuit)."

RETROFITTING 3-WIRE OXYGEN SENSORS TO EARLY CARS: It's a very good idea to retrofit the 3-wire sensors into the earlier cars that came with 1-wire sensors. Even discounting the lower emissions, better fuel economy, smoother idle, and other possible benefits of upgrading, installing 3-wire sensors can actually save you money; the 1-wire sensors have a useful life of 30,000 miles, but the 3-wire sensors have a useful life of 60,000 miles -- apparently because the heating helps prevent the buildup of deposits.

Randy Wilson reports on replacing one-wire sensors with three-wire sensors in his 6-cyl sedans: "I did it to get the O² sensor up to temp, period. I run tri-Y headers on my cars, which puts the tap point for the O² sensor (the collector) a fair distance from the engine. It's enough distance that, combined with headers not retaining the heat in the exhaust stream, the sensors would cool off too much at around-town cruise speeds.

"This will not get you into closed loop any quicker. The ECU will not go closed loop until the engine reaches a critical temp. But it will help in making sure the sensor signal during low-load closed-loop cruising is valid."

You will need to provide a 12V power source to each oxygen sensor heater. In the later cars that came with 3-wire sensors, the power comes from the fuel pump relay -- which means it shuts off after two seconds if the engine is stalled for any reason. Whether or not this is of any importance, it's not difficult to use this same wiring scheme on earlier cars. Even though the fuel pump relay is at the wrong end of the car, there is an NS wire from this relay to the supplemental air valve at the front end of the right side air filter housing. The two heated sensors will draw less than 5 amps total, and this existing circuit can easily handle that much additional load. Simply splice into that NS wire anywhere convenient

and run leads to both oxygen sensors.

Once you have converted to 3-wire sensors, you can leave the open-loop circuitry at idle in Park or Neutral alone, or you can pull the shorting plug in the trunk to allow the car to run in closed-loop at all times like the later cars. You also can decide what to do with the service interval counter in the trunk; you can leave it there and merely reset it without replacing oxygen sensors every other time it goes off, or you can simply remove it and throw it away and just remind yourself to replace the sensors every 60,000 miles.

OXYGEN SENSOR TESTING: MOTOR/AGE Magazine gives the following instructions for testing an oxygen sensor itself:

“An oxygen sensor can be tested safely with a digital voltmeter, but an analog (needle type) voltmeter will *destroy* the sensor in a heartbeat. A simple bench test has been suggested by Tomco Carburetors to check O² sensor function. All you need is a vise, digital VOM and a propane torch.

“Lightly clamp the oxygen sensor in the vise with the sensor flutes facing upward. Attach the digital VOM leads to the sensor. If the sensor only has one lead, attach the VOM ground to the sensor body.” Ed. note: connecting the VOM ground to the sensor body is the way to connect *all* sensors used on Jaguar XJ-S's. If there are three wires, two are for a heater; only the signal wire should be connected to the VOM.

“Set the VOM on the 2V scale, then light the propane torch (using regular heating tip) and apply direct flame to the tip of the sensor flutes. The voltage should rise to about 0.8-0.9V within 60 seconds. Move the flame away quickly from the sensor tip and the voltage should drop drastically; move the flame back and forth and the voltage should respond quickly. If the changes aren't almost instantaneous, it's time for a new O² sensor.”

David Littlefield says, “AutoZone claims they will check your oxygen sensors on their equipment for free as part of their customer-friendly tool lending program. I think other parts places might do this as well, but I haven't tried it.”

FEEDBACK MONITOR SOCKET: Near the ECU within the trunk is a 4-connector socket on the end of a harness with a dummy plug in it. Two connectors are a black ground wire and a KB wire with battery voltage on it. The other two connectors provide a voltage between 0 and +5V (relative to the black ground wire) that corresponds to the amount of correction the ECU is providing in its attempts to maintain the proper Lambda feedback. The GW wire (pin 4 on the ECU) is for the A bank and the GK wire (pin 10) is for the B bank.

While there is a special Lucas tool that plugs into this socket, Roger Bywater points out that an ordinary voltmeter can be used: “On a 6CU the monitors are voltage outputs. On a 16CU the monitor outputs are square waves which can be converted to a voltage reading by placing a 47 µF capacitor across the voltmeter leads.”

Now, trying to make sense of what voltages you find. First off, you need to figure out whether the EFI system is operating in open-loop or closed-loop mode. If the engine is cold, it will be in open-loop mode. If the car has a jumper in a red 2-connector socket at the end of a wire near the ECU and the shifter is in P or N, it will be in open-loop mode at idle. You will need to pull the jumper to get the system into closed loop at idle with the shifter in P or N. If the car is a later model with no jumper near the ECU and is warmed up, it will be in closed-loop mode.

If the ECU is in open-loop mode, both connectors should be reading a rock-solid voltage; this voltage will be 2.5V on the 6CU as well as the 26CU and later ECU's, but it's lower on 16CU ECU's. Walter Petermann explains: “The µP on the 16CU does not put out a 0-5V signal. I just checked it with the scope, and it's about 3.8v max.” Since the open-loop voltage is at the halfway point on the range, it will be about 1.9V on a 16CU. Whatever the open-loop voltage is, it is the voltage that indicates the ECU is providing no correction at all to the fuelling; whatever the baseline fuelling map calls for is what the engine is getting.

If the ECU is in closed-loop mode and the system is operating correctly, the voltages should be fluctuating up and down cyclically. Roger Bywater says, “print this out and pin it on the wall:

Low Lambda = weak exhaust = ECU corrects rich = monitor rises

“Lambda voltage is low when fueling is weak so the ECU reacts by correcting rich. The monitor then moves high (6CU), or increases the high part of the duty cycle until continuous high (16CU), with full rich correction. The monitor outputs go low when the ECU is correcting by weakening (i.e. Lambda high = rich exhaust).”

If the ECU should be in closed-loop mode and the voltages are held solid against one extreme or another or are stable at the open-loop voltage, something's wrong with the car.

OPEN-CIRCUIT AT THE OXYGEN SENSORS: If you disconnect the oxygen sensors, the ECU will interpret the lack of voltage as a sign of lean operation and trim richer, right? No. Roger Bywater explains: “There is some circuitry which applies a mid-range bias to the inputs through some quite high value resistors.” What this means is that, when the oxygen sensors are working properly, they overpower this mid-range bias circuit to send feedback signals to the ECU. But when the oxygen sensors are disconnected, the mid-range bias circuit provides a backup signal for the ECU to work with. Since it is mid-range, the feedback response is neutral, and the feedback monitor voltages will hold steady at the open-loop voltages. In short, disconnecting an oxygen sensor effectively puts the ECU into open-loop mode.

Interestingly, if you have a 16CU ECU, the same cannot be said for disconnecting the ground shield on the oxygen sensor wires. Bywater: “The bias network is grounded externally via pin 23 through the Lambda screen so if that ground connection is lost the bias goes high and causes the 16CU to trim rich if the Lambda sensor is still connected. If the sensor and ground return are both lost it all sits at mid-range. The 6CU does not seem to react at all to disconnection of ground to pin 23, it still drifts to mid-range as do the monitor outputs.”

IDLE MIXTURE ADJUSTMENT: The Electronic Control Unit for the EFI system is in the right side of the trunk, and there is an opening in the ECU casing -- usually facing downward near the rear end of the box as it is mounted. Roger Bywater: “There is a rubber cap and possibly a metal tamperproof plug inside which can be persuaded out with a fine screwdriver, a turning motion and a little patience. The ECU needs to be removed for this really. Then the spindle is accessible.”

The real challenge, of course, is getting a tool in the hole to be able to turn the knob. Bywater: “It is exactly like a radio volume control shaft - 1/4" diameter with a flat on it. If the correct tool is not available it just needs a short piece of tube to slip over the spindle then just carefully indent one side to engage the flat. Travel is about 3/4 turn. You cannot do any damage by turning the idle fuel adjustment (it moves in ratchet clicks either way) other than by excessive force.”

This adjuster affects the *baseline* fuelling map (before Lambda correction) at idle. If you've read the previous few paragraphs, perhaps you have already figured out how to adjust it. First, you need to make sure your engine is actually *at* idle; check the voltage at the throttle pot as described on page 297, and adjust it if it is not correct. Adjusting the idle mixture will be frustrating if the ECU thinks the engine is actually off idle. You also should ensure that the idle RPM is correct.

Once idle is established, you should look at the voltages at the feedback monitor socket while in open-loop mode to determine what the open-loop voltage is -- it should be 1.9V on a 16CU (with the 47 μ F capacitor across the connections mentioned above) or 2.5V on all other ECU's. Then, if the car has the red 2-conductor socket on the end of a wire with a jumper in it near the ECU, you will need to pull the jumper to put the EFI system into closed-loop mode at idle in P or N (with the engine fully warmed up, of course). This should start the feedback voltages cycling. Monitor the voltage on one of the two feedback voltage connectors and adjust the idle mixture knob until the readings are cycling around the open-loop voltage. Then reconnect your VOM to monitor the other feedback connector; if its voltage is also cycling around the open-loop voltage, you're done. If its voltage is cycling above or below the open-loop voltage, adjust the mixture until both sides are about the same amount off in opposite directions. Now you're done. If you had to pull a jumper, reinstall it.

What do you do if the 1-wire oxygen sensors cool off and quit working during this operation? Good question. The best advice -- short of retrofitting 3-wire sensors -- may be to rev the engine up for a few seconds to heat them back up, then drop to idle and check the setting before they cool off again.

Bywater elaborates: “The need for adjustment in Lambda mode is because if the ECU has to apply a lot of correction

the Lambda swings make the idle unstable and it hunts up and down in time with feedback.”

Note that the described procedure will result in nearly stoichiometric mixture at idle without closed-loop correction, which should pass emissions tests -- but might not provide the smoothest idle. For a smoother idle in P or N, you might consider adjusting it a little rich, although in closed-loop mode (as soon as you shift into D) the ECU will just pull it back to stoichiometric anyway.

The idle mixture needs to be adjusted periodically as the engine wears. As the engine gets worn, it develops progressively less and less manifold vacuum at idle. This reduced vacuum is picked up by the MAP sensor in the ECU and interpreted as meaning the engine is drawing more air, so it responds with more fuel -- and the engine starts to run rich at idle. Adjusting the idle mixture will bring it back into line.

ECU INTERNAL CONNECTIONS: The harness connects to the ECU with a 35-pin connector. However, within the ECU itself, many of the wires from the harness are simply connected together. When trying to figure out how things work, it may be helpful to know what wires are connected internally. To save you the trouble of opening it up to see, I will provide the info here based on the ECU in my '83 (part number DAC 2597). The following groups of connectors are all wired together inside the ECU:

1-2-19	(ground)
8-9-27-28	(“B” bank injectors - open)
11-29	(“B” bank injectors - hold)
12-30	(“A” bank injectors - hold)
13-14-31-32	(“A” bank injectors - open)
16-17-34-35	(ground)

On the schematic in my repair manual, I have drawn boxes around each of these groups to remind me of these internal connections.

ECU INTERCHANGEABILITY: The Lucas 6CU and 16CU ECU's are “pin-compatible”, meaning you can replace one with the other without making any other changes -- provided that everything else in the car is the same, such as engine compression. Don't try putting an ECU from a 12.5:1 spec car into an 11.5:1 car. The 26CU is not interchangeable with the 6CU/16CU.

The 6CU has a reputation for poor reliability, especially in the fuel pump control circuit -- see page 254. Walter Petermann thinks the fuel pump control circuit is just the most obvious symptom of trouble; “Most of my work comes from wholesalers, so I get boxes of them without any reference to what the customer's problem was. In general, they have any combination of the following due to solder joints:

- A few % lean due to bad solder joints in the power supply
- Full lean intermittance on Map sensor
- One or both O² circuits not tracking properly
- Dead or intermittent (chattering) fuel pump circuit

“A rough guess is that about 10% have only a bad fuel pump circuit. Out of these I'd say that on more than 80% you can induce one or more of the other failures by just flexing the circuit board.”

“You shouldn't pay more than \$100 for a used 6CU unless it's been rebuilt by someone who knows what they're doing. The best replacement would be a 16CU. They are a much safer buy "used" than the 6CU's.” Not only do the 16CU's appear to be far more reliable, they also have significantly better processing and programming built in.

HOT ECU'S: No, not stolen. Walter Petermann reports that *some* 16CU's have microprocessors inside that get very hot when running. Apparently several different type microprocessors were used, and one type in particular pulls half an amp and therefore gets quite toasty. The good news: apparently it doesn't hurt anything; while the 16CU has the occasional microprocessor malfunction just like any comparable electronic equipment, there's no significant history of heat-related failure. Just the same, Petermann likes to take one of two actions when he finds one of these hot ECU's. His preferred fix is to replace the microprocessor with one of the type that doesn't get so hot. "Unfortunately the thing has 64 legs and they are soldered on both sides (and through the hole) of the board. Replacing them takes almost as long as rebuilding a 6CU. It's something you never seem to get comfortable doing. There's traces running between the pads on both sides of the board. If someone wants to try it, the replacement chip is an NEC D78C10AGQ."

His other fix is to install a 12V cooling fan (commonly available for cooling computer CPU's) inside the ECU. The fan is installed entirely within, there are no openings made in the case; it merely circulates the air around inside the box, thereby moving the heat from the chip to the aluminum case more efficiently. "Yes, it's a PC fan. It comes with a finned aluminum heat sink and claws to attach to a chip. Unfortunately the uP in the ECU is not the correct size, so the heat sink is not used and must be removed. You can glue the fan in place on the side of the ecu about 1/4" above the microprocessor. There's a convenient small ledge running along the center line of the ecu case that it can also be glued on for extra strength. Power can be taken from the filtered 12V source of ECU pin #22. This is on the yellow 'tubular' cap C304 on the end that's close to the center-line of the ECU. Ground goes to pin #35."

THROTTLE POTENTIOMETER: If your XJ-S has ragged throttle response as though it has a bad accelerator pump, here's some news for you: it doesn't have an accelerator pump. However, the throttle potentiometer, located underneath the throttle pulley on top of the engine, can cause similar symptoms when bad. When operating properly, the resistance across this pot varies smoothly as the pulley is rotated. If it is breaking up, it confuses the EFI computer on accels. The EFI computer, using inputs from the oxygen sensors, can usually keep the engine running reasonably well at constant throttle, but it stumbles during throttle changes.

The original 1980-88 pot, 73200 or EAC2670, is both unreliable and expensive. Sounds like a Lucas part, but it's actually made by Bourns. Clearly, simply stamping "Lucas" on the top has an effect on reliability!

THROTTLE POTENTIOMETER ADJUSTMENT: When you replace the throttle pot, the Jaguar manual says you must adjust it using their special electronic tester. Below is the alternate method.

The throttle pulley assembly must be unbolted from its tower to adjust the pot, meaning the linkages to the butterflies are disconnected; but the idle stop is part of the throttle pulley assembly and therefore is unaffected. You can even start the engine in this condition, as long as you don't go above idle.

Have the ignition on, and the throttle pot assembly rotated to the idle stop. The engine may be running or not. Connect a digital voltmeter (the old needle type just won't do -- go to Radio Shack and fork over the \$40) to the red and yellow leads from the pot without disconnecting the pot from the harness. This can be done by pushing the probes under the insulation on the connector.

Adjust the pot by loosening the three small mounting screws and rotating the pot until the voltage reading is within 0.32 - 0.36V. Tighten the mounting screws and reassemble. Make sure the reading remains within limits when the linkage is all together and the engine is running at idle.

THROTTLE POTENTIOMETER REPAIR: If you wish to attempt to repair the throttle pot, Matthias Fouquet-Lapar sends a procedure: "Carefully undrill 3 plastic melt points from the bottom. After about 2 mm you'll see a screw. Using a small screwdriver undo these screws.

"Open poti. It's actually a very good quality poti, (double contacts), but clearly showed excessive wear on light part throttle position. Using my VOM I could find several places where the carbon really had gone away.

"Mmmmh. I decided to cut off the 4 contacts, shorten them by about 1 mm and resolder them, so they would end up on

the unworn surface. This is a pretty sensitive operation, be sure that you feel confident that you can handle it. You need some good small tools, a fine solder iron, some PCB cleaner *and* a very quiet hand.

“Resolder everything, adjust contact height as before to have the correct pressure when putting it back together. Also check if the contacts are really off the worn track.

“Put it back together, check again with a VOM. Smile, since you just saved a bunch of money.”

“Total repair time was about 2 hrs. However, I think one can do this kind of repair only once, or maybe a single contact could be used instead of two, giving a potential of a third repair.”

This author has had two throttle pot failures so far. In one of them, the conclusion was that the problem with this pot is that the wipers have little points on them so they contact the resistance track in a very narrow groove. Although the track itself is quite wide, the wipers cut little narrow grooves through it until they're riding on the ceramic below. I fixed it by replacing the wiper in entirety! I made a whole new wiper out of brass stock (available at any hobby shop) and fixed it to the plastic rotor with two tiny flush-head screws. The wiper configuration is completely different, with wiper arms cantilevered from one end rather than the double-ended wipers of the original, but most of the difference was simply to make it easier for me to make with hand tools. The significant difference was that each contact touches the track with an area of metal about 1/8" wide rather than the point used before. Basically, the individual wipers were shaped by bending the end to form a folded edge. The pot was temporarily assembled with a piece of fine sandpaper laid over the track, and the rotor turned back and forth a few times to polish a smooth contact surface on the wiper.

Paul Bachman says, “this thread reminds me of a repair that I once did to a mechanical television tuner with a similar failure mode. I went down to the local jeweler and bought some small scraps of 24k gold (about \$2) and soldered them to the wipers. This provided a low resistance contact with very low wiper friction. Never had another problem.”

Of course, wiper modification doesn't always work. Peyton Gill: “I had hoped to be able to repair the pot by relocating the contacts on unworn surface. When the pot was opened I found that the contacts had worn through the conductive surface. One set of contacts had worn so long on the ceramic substrate as not to be usable... As worn as the old pot was I'm surprised that it didn't cause more problems than it did. The nature and extent of the wear would lead me to recommend that everyone check their pot with a VOM.”

In the author's other pot failure, the resistive coating that the wiper slides on was properly positioned to overlap the metal conductor at one end of the travel, but at the other end it barely touched the metal -- and was making intermittent contact as a result. Solution: go to an auto parts store and buy a kit for repairing a rear window defroster. This kit includes a remarkably tiny bottle of copper-colored paint, a tiny brush, and a template for repairing the conductor lines on a rear windshield. Using the tiny brush, apply some of this paint on the metal conductor and overlap it just slightly onto the resistive surface. The result is a very reliable connection.

THROTTLE POTENTIOMETER REPLACEMENT: If rebuilding the pot simply isn't going to work, Jon Heflin suggests you replace it with a better pot -- from Jaguar! From 1988 on, the XJ-S was fitted with a red pot, EAC9634, that is electrically similar but has a much better reputation for reliability. While the earlier black pot was made by Bourns and had Lucas printed on it, the later pot is apparently actually made by Lucas and has the name in raised letters. It is not a direct replacement because it requires replacing a couple of other parts to make it fit, so if you go to the Jag dealer and ask for a new pot for your model year they will still sell you the old style pot. However, the new red pot costs so much less than the Bourns pot that you can buy the parts needed to make it fit and you'll still be out less cash total. Heflin says the red unit is “far superior in design and quality, it's even spring-loaded so as to assure it returns to exact same starting position. I discovered that all that is necessary in order to use the updated unit is simply obtain the new style throttle shaft, shaft adapter, press pin, and an aluminum adapter to which the pot mounts. The old style pot mounts with 3 screws and the new with 2. The total for all the upgraded parts plus a new pot was right about \$100.”

Kelly Spongberg says, “After many false starts, I did acquire all the necessary parts to put the new style "red" TPS on the V12. The parts are as follows:

<u>Part #</u>	<u>Description</u>
EAC-9634	Potentiometer

EAC-9567	Adaptor
PA-103161/J	Pin-Spring (came only as bag of two?)
EBC-3568	Coupling
EBC-3566	Throttle shaft

“One strange note, EAC-9567 fits, but with only two of the three bolt holes lining up. It works fine with the two bolts, just seems odd they would make a new adaptor for this upgrade and it not be perfect. Perhaps it fits the 6.0L as well, or is from that car's parts??

“Both the local Jaguar parts departments were caught unaware that the original black TPS has been discontinued, and also that more than one part was required to install the red unit.”

The “throttle shaft” is the steel part visible on top of the turntable and held to it with two screws; you can remove the two screws and slide it right out. The only difference in the one for later cars is the configuration of the bottom tip. The “adapter” is a sleeve that fits the bottom of the throttle shaft and the top of the shaft on the red pot. The “pin-spring” is a standard roll pin. You can see photos and illustrations of these parts at

<http://www.jag-lovers.org/xj-s/book/ThrottlePots.html>

Patrick MacNamara says: “The Bourns type throttle potentiometer is no longer available from Jaguar. The dealer did not know if the two pots were interchangeable electrically and neither did British/Auto USA. The dealer actually had no suggestion other than to try an aftermarket supplier for the old Bourns pot. Thanks very much! I actually had to provide him with the part numbers for the upgrade.

“The 87-89 parts catalogue lists coupler and drive shaft for the new style throttle pot as EAC 9568 and EAC 9566 respectively, but these have been superseded by EBC 3568 and EBC 3566. The strange thing is that if you pull up EAC 9568 on the Jag parts computer it will list it as still available, but if you pull up EAC 9566 it says it has been superseded by two parts EBC3568 and EBC3566 which are clearly the coupler and drive shaft.

“My 87-89 parts catalogue does not show the VIN changeover numbers for the new throttle pot, but does state engine number changeover as 8S61794.”

THROTTLE POTENTIOMETER SUBSTITUTION: It's a potentiometer, and potentiometers are available at any electronic supply house for pennies. Right? Well, not right. The resistance range of this pot is no problem; the rotation range is. This pot must run through its entire range in 90° of rotation, and most generic pots from electronic stores have something near 270° of rotation. Because this pot is used as a “voltage splitter” with 5V applied to the full range and the wiper picking off nearly zero volts at idle and nearly 5 volts at full throttle, you cannot merely use 90° of a 270° pot -- no matter what the pot's rating is.

AJ6 Engineering offers a throttle pot kit that involves a little gearbox. As the throttle turns 90°, the pot turns 270°, allowing use of the commonly-available and cheap generic pots. Roger Bywater says their kit “just fastens in place of the original and actually costs less than the factory potentiometer on its own. Then if a replacement potentiometer is needed a few years down the line - not that ours is any less reliable than the others but none of them last for ever - it will only cost £35 (at today's prices).”

Another solution for a misbehaving throttle pot is replacing it with a pot from another type car. Brian Sherwood relates his experience: “From my spare parts pile I found a TPS from a Ford, an '83 3.0L V-6, I think; part number E7DF-9B989-AA. It turned in the proper direction, same degree of travel (90 degrees), and had the same resistance as the original at both ends of its travel (from .05 to 3.5K ohms). But no, it doesn't bolt right up. I cut a slot in a steel bushing to fit the drive lugs inside the Ford TPS. The other end of the bushing I crimped down to fit the D shape of the shaft on the bottom of the throttle pedestal, that the old TPS used to fit over. A piece of aluminum strap was used to clamp the Ford TPS to the bottom of the pedestal. The TPS fits snugly in the recess underneath, and loosening the strap allows adjustment. I cut the wire and plug from the old one, crimped on some female spade lugs to fit the terminals of the Ford unit (would have been neater to use the proper Ford plug, too, but I couldn't find that.) Red wire=wiper, green=high side of pot, yellow=low side of pot. With new TPS plugged in and ignition on, I adjusted the TPS to give .36 volts measured between red and yellow wires, at idle position. Bolted everything down, and went for a test drive -- worked

great. Only difference from the original is that now it doesn't surge at cruise anymore!"

Gill, having failed to repair the pot, then went looking for a replacement pot: "What type Ford is it for? That's the same question the guy at Pep Boys asked! I told him it was for a V12 Jag (always enjoy the expressions I get from these counter guys).

"The pot I got at Pep Boys is a Borg-Warner part #EC1046. This was matching cross reference from Brian Sherwood's Ford part #. The only challenge was machining a coupling to go between the throttle assembly which has a shaft with a flat and the pot which has a hollow shaft with two splines within. I took an old worn out 1/4 inch drive socket (5/16) and drilled out the drive end so I would at least have a little flat on one side for the throttle assembly shaft. The other end I took a file and worked a slot on each side to go up into the splined hollow shaft of the pot. Crude but effective.

"I reused the wiring and connector off the old pot. The replacement pot has three small male spade connectors which I had the luck of having the correct size female ends. About 1/2 size of standard spade connectors."

Despite all these success stories, this author was unable to find a workable Ford TPS at a local parts store. There were many, many Ford TPS's to choose from, and basically all of them had the requisite total resistance, but all had too much resistance at the idle end of their travel -- the wiper was physically prevented from getting anywhere near the 0Ω end, and in fact won't get near enough to attain the 0.32-0.36V adjustment at idle. Of course, you can just forget about that adjustment, which will result in the EFI system operating in "run" mode at all times, even at idle, and never actually going into "idle" mode. This may be acceptable, although it may result in an unstable idle, especially in earlier cars with unheated oxygen sensors.

A better solution appears to be to select a GM throttle pot instead. Some GM throttle pots have a simple metal lever on the shaft, so all you have to do is devise a lever on the Jag turntable shaft to engage it and a plate to mount it on. The GM pots all seem to have plenty of range for the idle adjustment. Be sure to select one that turns the correct direction; some of them may rotate the other way!

Also try to choose a pot that's relatively small and compact. If you select one with something hanging out the side too far, then trying to adjust the pot's position at idle may have it running into one of the four posts supporting the turntable assembly. Interference can be avoided by carefully aligning the shafts when making the coupling so that the pot is swinging in between the support posts, but it's a pain trying to keep such things straight in your head; better to choose a pot that could spin all the way around without hitting anything so you don't have to worry about it.

Regardless of which pot you select, David Johnson came up with an excellent method of mounting it. Basically, unbolt the turntable support from the four studs it stands on and take off the sleeves that establish the turntable's height. Cut all four sleeves into two pieces each. Slide one piece onto each stud, and then slide on a rectangular mounting plate you have fabbed up. Slide on the remaining portions of the sleeves, and bolt the turntable support back on. "The kerf was exactly the thickness of the aluminum sheet (3/16), so everything reassembles as if the plate was meant to be there." You can establish the vertical location of this mounting plate by choosing where you're going to cut the sleeves in two. And you can provide suitable holes and slots in the plate to securely support the pot and allow adjustment of the idle position. In fact, it wouldn't be too difficult to apply this method to installing the later Jaguar pot EAC9634 in case you want to save the cost of their adapter, and it would probably result in a more professional-looking installation!

Roger Bywater of AJ6 Engineering reports, "Some years back when we needed a clean throttle signal we used a 5K wire wound pot on a bracket attached to the LH air filter ahead of the throttle and connected onto the end of the throttle spindle by a short length of 5/16 bore hose and clips. Might be a cheap solution to renewal of original."

That idea of using fuel hose as a coupling is a good one -- regardless of where you mount the pot. A pot doesn't take much torque to turn, so the friction in a hose coupling will easily drive it. It doesn't matter if the shaft has a flat or a pin hole or whatever, just slide a length of hose over it and clamp. And the flex of the hose will correct for misalignments.

THROTTLE POTENTIOMETER UPGRADE: Matt Emmons thinks that using a potentiometer here is a bad idea due to inherent wear problems on the wiper. He thinks a Hall Effect sensor would be more reliable because it has no wipers; it works via a magnet moving over a circuit.

Yeah, right. Where are you going to find a Hall Effect sensor that will go in here? And who's going to figure out how to connect it to the Digital P ECU so it works right?

Folks, you simply have to see this to believe it. It's very difficult to find a generic potentiometer that can be adapted to the Jaguar throttle linkage, but it's no problem at all to find a Hall Effect sensor that will fit perfectly! Emmons provides a few web sites:

http://sensing.honeywell.com/index.cfm?Ne=2308&ci_id=154326&N=3449&la_id=1

http://www.techbriefs.com/index.php?option=com_staticxt&staticfile=/Briefs/Oct99/MOC10991.html

<http://www.wabashtech.com/SPD/852rps.php>

“There are more. The Honeywell site was particularly informative about Hall Effect devices in general.

“Most of the manufacturers would not sell them to me in such small numbers, but the one I got is made by Clarostat. It's called HRS100 Hall Effect rotary position sensor and I bought it from Allied Electronics." Here's a link to their catalog; do a search for the HRS100 for details of the device:

<https://www.alliedelec.com/Customerservice/Forms/Literature.aspx>

Connecting it up? Believe it or not, you just connect it up. While the pot took the 0 and +5V leads from the ECU and split off a voltage from somewhere in between, the Hall Effect sensors use the 0 and +5V to power the electronic circuitry and generate a signal between 0 and 5V depending on position.

What's more, Hall Effect sensors are apparently cheap -- cheaper than the OEM pot.

It would not surprise this author to learn that some of the Ford and GM TPS's described above are actually Hall Effect devices. Some of them don't feel as though there's a wiper involved when you have one in your hand.

THROTTLE POTENTIOMETER -- LATER CARS: Charlie Fritz says, “the 95 XJS has a double potentiometer in the TPS with one signal for the transmission and the second for the ECU as before. It has six wires as in the attachment, but I don't know which goes where or how to set it.”

HESITATION: Mark Sampson had a bad battery in his car. “I was also experiencing some hesitation when warm, it has also gone away with the new battery. Interesting.”

Don Snyder: “My car would occasionally hesitate, and sometimes die, when accelerating while the engine was hot. I replaced the oxygen sensors and added a bottle of injector cleaner, and have not had the problem since then.”

INJECTOR RESISTOR PACK CONNECTIONS: The resistor pack for the injectors seems to be fairly reliable, but unfortunately the wiring to it is typical Lucas. Tom Amlie, who has a Ph.D. in Electrical Engineering and entirely too much time on his hands, relates an interesting failure mode that kept his car from starting: “Put an oscilloscope on an injector. Instead of a clean negative-going pulse, it oscillated like crazy. Took the ECU apart and traced the circuits until I understood how it works. There are four power transistors, two for each bank. The "ON" transistor slams the injectors on with full voltage to overcome the inductance. The emitters of the "ON" and "HOLD" transistors are tied together and go to a 0.2 ohm power resistor to ground. When the current to the injectors reaches about 3.5 Amperes, the voltage across this resistor is fed back to a circuit which cuts off the "ON" transistor. Then (in theory) the current through the "HOLD" transistor is adequate to keep this voltage to about 0.6 volts and keep the "ON" transistor off. All of this depends on proper resistances and tight connections.

“Get real! This stuff says "Lucas" all over it! The four precision resistors in the pretty box on the right side just aft of the radiator are connected with an 8-pin plug with round pins, far inferior to the American practice of using rectangular blades with much larger contact area and heavier contact pressure. I must admit that the box is a pretty casting and nicely finished. The "Lucas" decal must be worth a lot, but it is a piece of crap.

“What happened is obvious: The "ON" transistor did its thing and turned itself off. The "HOLD" transistor couldn't pull enough current because the resistance was too high. The "ON" transistor comes back on, switches itself off, the cycle continues, and no fuel flows.

“All is not lost. Clean the contacts and use a very sharp X-Acto blade to spread the split pins a thousandth or two. Don't overdo it and don't cut yourself.

“Wonder how many ECU's have been rebuilt because of this. To be fair, the workmanship in the ECU is superb. Must be made by Bosch.”

EFI WIRING CHECK: Tom Amlie goes on to suggest a general check of the Digital P wiring: “Disconnect the ECU and measure every pin going back into the car with a VOM. Using a long wire with a small alligator clip to reach to the front of the car you can measure the continuity of every wire in the bundle. In particular, make sure that the pins that are supposed to be ground are really ground. A little corrosion can cause a lot of misery. The pins for the "HOLD" transistor should measure close to 7.2 ohms referenced to the power pin on the main relay which is also in the boot. You can also easily tell if the injector harness or one of the injectors is open by measuring from the "ON" pins to the same relay.”

AIR TEMPERATURE SENSOR: In the ©1975 ROM, page 19.00.07 and section 19.22.23 show charts of air temperature vs. ohms for the purpose of checking the sensor mounted on the left air filter housing. These charts apply to D Jetronic systems; if you have a Digital P system, these charts are not valid. The correct resistance for the Digital P air temperature sensor, part number 73197, at room temperature is around 2800Ω.

COOLANT TEMPERATURE SENSOR: As opposed to the air temperature sensor discussed above, apparently the charts of coolant temperature vs. ohms shown in the ©1975 ROM, page 19.00.08 and section 19.22.19, apply equally well to both D Jetronic and Digital P coolant temperature sensors.

Ian Hooton: “If the car doesn't want to start, or when it does there is very little power with the throttle wide open and there is a strong smell of petrol, check the coolant temperature sensor on the left hand bank, just above the stat housing. Remove the connector and bridge the plug with a piece of wire, try and start the engine, you will find it will probably start and run fine. Usually all that is wrong is that the contacts are corroded, clean them up and everything should be ok. This happened to me late last year, and took quite a time to find the culprit. It would appear that the ECU thinks the engine is constantly cold and over compensates by increasing the richness of the fuel/air mixture.”

According to the Jaguar literature, the coolant temperature sensor provides a “minor” trim to the fuel schedules. However, when the sensor fails open circuit or the wires to the sensor are broken or disconnected, the trim turns out to be major indeed. An infinite resistance tells the EFI system that the coolant temperature is a zillion degrees below zero, so it responds by making it overly rich. Not just a little bit overly rich; the car may not even start, and if it does start it'll run very badly and pour out clouds of smoke. And it just gets worse as it warms up, if you can keep it running that long. David Johnson: “When I had a bad wire going to my sensor the smoke was so bad I swore I blew the head gasket. In a matter of 20 seconds there was so much smoke that I thought I had a fire!”

An open-circuit coolant temperature sensor failure happened to this author, and he was able to diagnose it quickly using his own book! One thing that caused some consternation, though, was the fact that the smoke was a light gray color; as any good mechanic knows, running too rich causes black smoke. Johnson: “When I took automotive theory (years ago) the instructor told us white "smoke" meant water. Black smoke meant gas and blue smoke meant oil. I also remember him telling us that on a *really* rich mixture the color is grey. Hard to tell from "white" but it was because the engine is running almost as a fogger.”

One would think this would still be obvious due to the smell of unburnt fuel, but that wasn't apparent either. Johnson: “The smoke had almost no smell.” The smoke from this author's car had an odor, but it wasn't strong and not clearly raw gasoline. The only plausible explanation so far is that the ignition within the cylinders burns the most volatile

compounds most readily, pumping the less smelly fractions of the gasoline out as an unburnt mist.

Just the same, it probably wouldn't be a good idea to be smoking around the car. If the air pump is diverting (the engine is warm), there's no chance of fire within the exhaust system or catalytic convertors simply because there's no oxygen in there; it was all used up in the cylinder. But once the smoke clears the end of the exhaust pipe, there's no shortage of oxygen in the surrounding air. Things could look like the Hindenberg disaster if you get careless.

If the air pump is operating, it would make sense that the symptoms might be different. The engine wouldn't run any better, but the dense smoke could be replaced with a red-hot exhaust system or catalytic convertors. Just in theory, mind you; there are no reports confirming this actually happening to anybody.

The coolant temperature sensor and wiring also suffers intermittent failures, with some Jaguar owners actually monitoring readings while driving to confirm that the problems were caused by this sensor. One of the connectors should give ~2.4 volts with the ignition on and the engine cold (the other one gives 0 volts) and gradually decrease to ~0.95 volts at normal operating temperature. Sudden changes in voltage mean the sensor is breaking up.

Michael Neal: "Don't use Lucas brand. Get a Bosch part, cheaper and better." Good luck figuring out which Bosch part to get. The following part numbers have been suggested as being usable:

73198 -- original Jag part, 1979-89

SNB 802 -- often listed as a superceding number for 73198

0 280 130 023 -- what XK's Unlimited ships when you order an SNB 802

EAC3927 -- what the 1987 *Parts Catalogue* specifies for all engines

DAC4737 -- Jag part, 1989-on -- reportedly offered as replacement for 73198 on earlier cars

0 280 130 055 -- reportedly an exact replacement, but available only in Germany and very expensive

0 280 130 026 -- apparently differs slightly in tolerance, but definitely works well

The sensor should cost about \$30. If someone tries to charge you over \$100, it's time to look elsewhere.

Note that the D-Jetronic system uses sensor 73142, and it appears this is *not* the same critter, not interchangeable with the later sensor.

MANIFOLD AIR PRESSURE (MAP) SENSOR (Digital P): The MAP sensor for the Digital P system is *within* the ECU in the trunk, so a vacuum line is run the length of the car. On page 343 of Haynes manual 478/49015 it states, "Commencing with... vehicle identification number XJS 107102, a vacuum reservoir has been located adjacent to the ECU to eliminate resonance from the inlet manifold vacuum sensor pipe". This reservoir is a plastic chamber about an inch in diameter and three inches long, fitted in the line just before it connects to the ECU. Would installation of a similar reservoir help earlier Digital P cars? Who knows?

ACCEL PROBLEMS: Vince Chrzanowski reports that his car wouldn't start accelerating until a couple seconds after he floored the accelerator, even if the tranny kicks down. Otherwise, the car seemed to run fine. "The vacuum line to the ECU in the trunk was partially blocked. A shot of compressed air cleared it out, and everything went back to normal."

RICH RUNNING: Richard Chapman sends this tip: "If you're getting rich running and fouling check to see if the pressure regulators mounted on both ends of the fuel rail are leaking fuel into the manifold via the vacuum line which connects between the reg and the manifold. With the engine idling pull off the hose at the reg, the engine speed will increase with the extra air entering the manifold through this pipe so block it with something. After running the engine for a minute or so you may notice the presence of some petrol coming from the regulator vacuum connection. If so replace it. They are not the same unit despite similar looks."

INJECTION SIGNAL FAILURE: Chrzanowski sends this report on a problem with his car: “It seems that the engine revs information is sent to the ECU from an amplifier unit atop the engine. The signal is sent via a thin shielded wire. Unfortunately, the wire is routed near some very hot areas and that heat melted the insulation between the center conductor and the shield, shorting the signal to ground. Replacing the defective section of wire restored the signal. In talking with some other local Jag owners, I’ve found that this is not an unusual problem.”

It’s not; in fact, this author had the same problem. One of the W/S wires from the Lucas ignition amplifier rearwards towards the firewall connects to what appears to be a solid white wire but then disappears into a harness wrapping in which it is the only wire. This white wire is actually a coaxial wire, a tiny conductor surrounded by insulation, a grounded shield, and more insulation. Within that harness wrapping, the insulation gets brittle and starts cracking, and the outer layer of insulation being cracked only encourages the inner layer to crack at the same spot. Eventually, the thin conductor begins to short out against its own shield -- often intermittently. Sometimes you can wiggle that wire and make the problem come and go. All the while, the harness wrapping hides the wire’s condition from view.

Since there is a resistor inside the ignition amp to limit the effect of such shorts, the ignition system continues to work, but the injectors don’t fire since the signal isn’t making it to the EFI ECU. That’s why the problem is listed here in the EFI section; you can review the related ignition system issues on page 154.

If you suspect trouble in this wire, you might unplug this connector from the ignition amp and the big connector at the ECU in the trunk and check between pins 18 and 23 for continuity, which would indicate a short. However, since the short is only too likely to be intermittent and therefore look perfect while you have a VOM in your hand, you probably should go ahead and peel that wrapping off this wire near its connection to the amp. If you find the wire inside cracked and brittle, keep removing the wrapping until you get to non-brittle wire, then cut it off and splice on a length of new shielded wire. It doesn’t need to be as skinny as the original stuff, but it’d be nice if it was more heat-resistant. Don’t ground the shield; it is grounded at the ECU, and grounding at two different places can cause ground loop problems wherein the loop picks up interference and then transmits it into the conductor it’s supposed to be shielding.

IDLE STUMBLE: The mid-80’s H.E. tends to “stumble” at idle when warm, even when it runs perfectly smoothly when cold or at higher throttle. This appears to be normal, although it is definitely disconcerting to an owner that spent the kind of money this car costs and expects better from his 12-cylinder engine. Fuel injector cleaning and/or replacement, spark plug replacement, and oxygen sensor replacement have no effect.

The only thing that might help is to readjust the throttle linkage as described on page 271, starting with the butterfly stop adjustments.

SUPPLEMENTAL AIR VALVE / SOLENOID AIR SWITCH: In addition to the coolant-operated Auxiliary Air Valve under the back end of the left intake manifold (page 265), the H.E. has an electrically-operated air valve at the front end of the right side air filter housing to help control idle speed. The first challenge is to get the name right. In most places in the Supplement to the ROM as well as in the Haynes manual and in the Electrical Guide, it’s called a “Supplemental Air Valve”, but in the emission control diagrams it’s called Item H: “Solenoid Air Switch”. Most people seem to prefer Supplemental Air Valve, so that’s what it’ll be called in this book. Please remember that it’s not the same thing as the Auxiliary Air Valve. Obviously, these names are often shortened to SAV and AAV.

To avoid future confusion over the name, it is recommended that you go through all the emission control diagrams in your manuals and scratch through the words “solenoid air switch” for item H and write in “Supplemental Air Valve”. This would include page 17-1 in the Supplement to the ROM and Fig. 13.31, 13.32, 13.33, and 13.34 in the Haynes. Also note that all these diagrams seem to indicate that the valve is physically nearer the rear end of the manifold, but it is in fact near the front.

The Supplemental Air Valve allows air to go from the air filter housing directly into the right side intake manifold, bypassing the butterfly, and therefore boosts the idle; the balance pipe serves the left bank. The original intention is to serve as part of a cold start scheme; a timer operates solenoids in vacuum lines that kill vacuum advance to the

distributor so the idle speed drops, and this valve brings the idle speed back up.

Operation of this valve is described in the discussion of the H.E. emission controls in the Supplement and the Haynes manual, where it is item H on the schematics. On B Emission cars (UK and elsewhere) the timing retard system, including the supplemental air valve, is operated for 15 minutes if the coolant was below 45°C at startup. This kills efficiency and causes the engine to generate a lot more waste heat, apparently to help the 700-pound engine warm up faster so the cabin heater works before you get to your destination. On A and C Emission cars (North America) it's operated for 45 seconds regardless of coolant temp. This short period of inefficient operation helps the catalytic converters light off. The timer -- either 45-second or 15-minute -- is located above the passenger side footwell, just inboard of the fuse block.

Another correction to note: according to the Digital P EFI schematics (Fig. 13.9 and 13.11 in the Haynes), the SAV and the "Vacuum changeover switch" are controlled by an oil temperature switch. As of yet, nobody has reported finding an oil temperature switch in an XJ-S.

On later cars, somebody at Jaguar got the wise idea to use this existing valve to help stabilize the idle when the A/C compressor kicks in. If the cold start timer activated the SAV by sending 12V to it, it'd be simple enough to connect the wire from the A/C compressor clutch to it as well with a diode or two to prevent backfeed. However, that's not how the timer controls the SAV. The SAV is provided 12V whenever the fuel pump is running, and the timer provides a ground connection to open it. So, just connecting up the wire from the A/C compressor clutch won't work; instead, the wire from the clutch goes to an "idle relay" and the relay in turn provides a ground circuit for the SAV.

But Jaguar went yet one more step. If the car is in Neutral or Park, opening this valve when the A/C compressor kicks in boosts the idle too much. So they provided an "idle override relay" to prevent the SAV from boosting the idle when the starter safety switch indicates the shifter is in N or P.

Victor Naumann adds: "Idle relay (black) and idle override relay (blue) are located on the left side of the radiator support in front of the A/C suction hose."

The system that controls the supplemental air valve is covered on page 135.

If your supplemental air valve is NFG, it's not really designed to be repairable. If you want to give it a try, the way to get it apart is to grab the two hose nipples and pull them directly apart. It's gonna take quite a pull, it'll probably require a puller of some sort plus a good way to grip those nipples without ripping them to shreds.

Michael Minglin says, "Best price I could find on a supplemental air valve was \$139. I decided that was too much, considering it was a simple 12V normally closed valve with 3/8" hose nipples. Checked with a local industrial valve supplier and found a 12V normally closed valve with 3/8" hose nipples for \$26.70. These valves come with interchangeable coils; 12V, 24V, etc."

The Grainger catalog doesn't have anything that perfect, largely because most of their stuff -- even with interchangeable coils -- is either 24V, 120V, or 240V. You can get there, though: purchase their stock no. 2G485, about \$32; the catalog says it's only rated for ambient temperatures up to 122°F, but it'll hold up in the Jaguar engine compartment as well as most of the other stuff in there. Plug the "exhaust" opening on the valve. Then drop by your local auto parts store and buy two brass fittings with a male 1/8" NPT on one end and a 3/8" hose nipple on the other. These are Brass-Tite number 43275. Screw these fittings into the valve, install it where the original was, and connect the wires. It doesn't look anything like the OEM valve and it may not provide exactly the same amount of idle boost, but it'll work.

For a slightly neater appearance, replace one of those straight brass fittings with a 90° fitting. This will make the hose to the bottom of the intake manifold shorter and more direct.

For a *much* neater appearance, purchase Grainger stock no. 2G491 instead. Buy only one brass fitting -- the 90° one is best -- and a couple of suitable bolts and nuts. Yank the funny rubber bellows-looking grommet out of the air filter housing and drill suitable holes and bolt this valve directly to the housing. Locate it carefully so it doesn't interfere with all the other stuff in the area. It might be nice to cut out a suitable gasket, but an even better idea is to install an O-ring between the valve and the air filter housing. Make *very* sure the nuts can't come off the bolts inside the air filter housing.

If you decide that your substitute valve -- or the OEM valve, for that matter -- provides more of an idle boost than you need, it should be a simple matter to restrict the flow through this passage a bit. If you're inventive, you can devise an arrangement with a screw obstructing the passage that allows you to adjust the amount of idle boost.

This author found a really neat replacement: a valve from a Toyota. This valve, found in a junkyard and bearing a Nippondenso number 084600-5510, is intended to serve as an idle boost solenoid. But not only is it much better made than the OEM Jaguar part, it also has a thumbscrew for adjusting the boost. You can see this installation at

<http://www.jag-lovers.org/xj-s/book/SAV.html>

INTAKE MANIFOLD SHORTCOMINGS: Bill White, an expert on the Helmholtz theory of intake manifold design, notes that the intake runners to the corner cylinders on the Jaguar V12 are longer than those serving the center eight cylinders. He performed single-cylinder rig tests on the different runners and found that, at the tuned frequency of the manifold, the corner cylinders produced 8% more torque than the other cylinders. This means that these corner cylinders are getting a larger charge of air than the others. One would expect that at other frequencies the corner cylinders would get *less* air than the others.

If this were a carburetted or throttle-body EFI engine, this wouldn't really make much difference. However, being a multi-port EFI, each cylinder gets the same amount of fuel. Since these corner cylinders are getting a different amount of air, they are running leaner or richer than the other eight.

If your system has oxygen sensors, they will sense oxygen from the leanest cylinders and control the fuel supply to maintain stoichiometric there; the other cylinders will simply run a little richer than stoichiometric, which shouldn't hurt anything except a little fuel economy and emissions.

Roger Bywater of AJ6 Engineering (and formerly an engineer with Jaguar) notes: "In this connection I would point out that sample cylinder heads were regularly checked in the flow room at Jaguar and it was not unusual to find a variation of 10% between the flow capacity of individual ports due to core shift on any one head... Also in about 1975 I remember carrying out some tests with calibrated injectors which showed a wide spread of exhaust CO emissions largely due to flow variations from cylinder to cylinder following no particular pattern. This was part of an investigation into why B cylinder bank was always a worse HC emitter than A bank. In fact it had nothing to do with airflow or mixture strength but was a result of the direction of piston rock at TDC relative to the spark plug position. These sort of things are not at all unusual on any production engine of the period."

What can you do? Actually, there is a fix for the intake manifold shortcomings -- offered by Roger Bywater of AJ6 Engineering! It's called the Plus Torque Conversion, and is described on page 113.

Cold Start Injectors

COLD START INJECTORS: The schematics in the manuals show that the cold start injector system was carried over to cars with the Digital P EFI. However, the only Digital P cars with cold start injectors today are apparently the 10:1 compression ratio pre-H.E. models. H.E. cars don't ever seem to have cold start injectors; some early cars came with them, but they were all removed when the fuel rail was replaced on a recall. The square cross section fuel rails now used on H.E.'s has no provisions for cold start injectors; there is a different square cross section rail with connections for cold start injectors that was retrofitted into the 10:1 cars. Some early H.E.'s may still have a harness and a relay in there doing nothing. Early H.E.'s have little covers over the holes in the intake manifolds where the injectors once were, while later cars don't even have the holes.

If you have an H.E. with no cold start injectors, you can scratch through the cold start injection system consisting of the thermotime switch 298, the cold start relay 299, and the cold start injectors 300 on the following schematics: In the ©1982 Supplement or Supplement A, the diagrams on pages 19-1 and 19-2. In the Haynes manual 478/49015, Fig.

13.9, 13.10, 13.11, 13.12 and 13.93.

Early 3.6 AJ6 Engines

Roger Bywater of AJ6 Engineering (page 713) reports that the 1983-87 3.6 AJ6 engine with Lucas 8CU EFI has a problem with worn engines. A worn engine draws less vacuum at idle, but since the 8CU bases fuelling on manifold pressure, it believes that the lower manifold vacuum means the engine is drawing more air and responds with more fuel -- making the engine run overrich. Since these cars lack Lambda sensors for trim it cannot correct itself, and the car runs worse and worse. Bywater says owners complain of “shunting” in trailing throttle, bad idle, and failing MOT tests due to excessive CO in the exhaust, even though the engine is not really all that tired and rebuilding doesn't appear justified. Of course, at full throttle the wear problems are insignificant and the engine runs fine.

Bywater suggests that disconnecting the vacuum advance from the throttle edge tapping and connecting it directly to intake manifold vacuum -- and readjusting the idle mixture and speed accordingly -- may help as a temporary measure if the engine isn't too bad. For a more permanent fix, AJ6 Engineering offers an ECU modification wherein a trimmer screw is added that can be used to correct for engine wear -- and can be corrected back in the event of an engine rebuild.

XJR-S

John Goodman reports that the XJR-S has Zytec ignition and sequential fuel injection -- see pages 172 and 721. “It is essentially the same injection system off the '80's group "C" Le Mans race cars. Jaguar made a big thing about publicising it. But I suspect TWR had a load of spare bits left over and needed something to do with them!”

“Also there are two power resistors on the R/H front inner wing.

“I thought Jaguar's claims for improved fuel economy was bullshine, but it is more economical than my previous H.E.”

Emile DesRoches says, “The XJR-S Product Support Manual lists special software along with a serial port connector whereby a laptop computer can be connected to the Zytec engine management computer (unique) fitted to the XJR-S to perform various diagnostic, calibration functions. Apparently this software was originally provided to dealers upon request from Jag North America for repairing these beasts.”

Goodman: “The ECU can be reprogrammed with different fuelling and timing if only we had the software! And it is not Jag Dealer software, they only have the standard tune parameters!”

Fault Codes

The later cars come with JDS (Jaguar Diagnostic System) or OBD II (On-Board Diagnostics version II) as legislated by the California Air Resources Board (CARB). When those fault codes appear they can cause consternation -- that's what they're for. The owner's handbook provides a list of codes, but of course it never seems to provide enough real guidance. Hopefully some of the reports included here will help.

Defective relays and/or their connections are a known cause of fault codes, as mentioned in the section on relays

beginning on page 562. Barry Ewen says, "When I bought my car 2 yrs ago it had fault code FF67 on it and we swapped the air injection relay with the horn relay; the fault went away and the horn worked too."

Charles Randle says, "I was out to my dealers today and read up on the EPA ordered recalls for all 6.0 V-12 cars. With a '94 XJS with JDS, all I get is a replacement of all major grounding connections. But all 95-96 OBD II cars get a free Oil and Filter change; and replacement of *all* EPA components that have set an OBD II code. Also the EPA warranty has been extended to 150K miles. So if anyone out there hasn't registered their after market car with Jaguar as the present owner; don't pass this up.

FF 3 -- COOLANT TEMP SENSOR: Mark Barker reports on his 6-cyl: "Trip computer displays "FF 3" (Coolant temp sensor failure), when the electric fan motor is dying. Just happened this evening. I suppose coolant temp *is* related to cooling fan.

"Certainly *was* the motor -- brushes gone. I mean *gone*, too. Big pile of black dust fell out of disassembled motor followed by broken bits and pieces sticking to magnet. Found some brushes in scrap motor I had, oiled the bearings. Back together, no more "FF 3". Strange, but true."

FF44 AND FF45 -- OXYGEN SENSORS: Sam Emrick says, "Late-models (at least) seem to have a common problem with bogus O₂ sensor failure code reported (FF44 or FF45). My '94 had this problem."

Charles Randle talks about a recall: "It plainly says for my JDS codes that FF44 and FF45 codes are being caused by poor grounding connections rather than bad O₂ sensors. I wish I had known that before changing them out a few months ago." Since grounds are a common cause of trouble in the Jaguar XJ-S, just go ahead and add a ground strap as suggested on page 555.

FF67 -- SECONDARY AIR INJECTION SYSTEM: Charles Randle says, "My '94 6.0 started having FF67 set a couple of months ago. I read up on it in the ROM, which tells me just enough to understand a dozen things that may cause the problem. However, there is one ambiguous sentence that is a large gray area, so I took it to my local dealer after talking to the Lead Technician on the phone. The simple things I could check myself I did. I determined the Air was coming on and apparently in the right (as printed) sequences. The tech spent an hour verifying this on the JDS, and called Mahwah. Two days later they faxed a "Decision Chart" and a possible problem/solution. It seems the PMCF on all the 6.0's might have come from the factory with the PROM set too sensitive. During any of the secondary air functions the PROM is looking for a certain voltage from both O₂ Sensors. If it doesn't see a signal of this magnitude, it sets FF67. And that is all it does. It doesn't go open loop or any other deregulating function. The bottom line is, the dealer gave me the "Decision Chart" and said I really didn't want to pay him \$78.00 an hour to verify 3 pages of decision charts. He also gave me a mail for service procedure to send the PMCF to Delphi Diesel Systems for testing and installation of a less sensitive PROM. To date I haven't either completed the Chart or contacted Delphi. The JAGUAR NA procedure when the cars were under warranty was to have the dealer ship the PMCF to Mahwah, who then sent it to Delphi and it was returned to the dealer COD for work/parts/shipping. For the time being, I am resigned to ignoring the FF67 and dumping the code each time I won't be using the car for a while. There is no way to disable the PMCF signal without disabling future serious codes that you might want to be notified of."

Michael Hahne concurs: "My '94 XJ12 has the same FF67 deal. I replaced the O₂ sensors and had the recall done, and it still shows up once in awhile. I talked with several knowledgeable folks who said it's probably clogged Air Injection rails. It's a nasty job to clean these out, but hardly necessary for the kind of driving we do. It's mostly an emissions thing. I've driven mine that way, occasionally clearing the FF67 code, for 10's of thousands of miles. No troubles. I drive my '94 XJ12 from Chicago to New Orleans almost monthly. My car now has ~90,000 miles. I drive it daily to and from work, a round trip of ~160 miles. Just drive the beast, and don't worry."

FF69 -- DRIVE/NEUTRAL SWITCH: Alan Baker says, "This is a common fault on the XJ40's of that era, (they use

the same ECU). I'm told that the 'erroneous' Code 69 is caused by the battery voltage dropping too much during cranking. It may be worth checking the battery terminals and connections for corrosion or possibly changing the battery if it is of some age.”

Gregory Wells adds, “I was always told the FF69 involved the way the key is turned to start the car. If you grab the key and turn it to the start position in one motion, the FF69 can be set. If you grab the key, turn it to the run position and pause for just a brief moment before continuing on to the start position, the code won't set. I was told that the ECU circuitry would not "see" the voltage level it was looking for if you passed through the run position quickly, rather than pausing briefly, and this is what triggers the FF69 code.

“This isn't supposition, as we have many, many reports from customers that this procedure does keep the FF69 from being set. The nice thing is that it costs nothing to try it.”

CLEARING FAULT CODES -- 6-CYL: Gary Penovich says, “On a '94, you can clear the fault code from the ECU without disconnecting the battery. It's a piece of cake. Open the dash trim panel that's underneath the passenger airbag by pulling down on it. Unscrew the passenger heater vent cover. Remove the small trim panel from around the heater vent. You should see a purple connector attached to a yellow(?) wire. The connector has only one conductor in it, and it isn't connected to anything. Short that conductor to ground for 3 seconds. It will clear the fault code. The process may be the same for all AJ6 powered XJS, perhaps AJ16 as well.

“I have actually moved the connector outside of the trim by running the wire through the vent cover. Now, I can access it simply by swinging the dash panel downward. It comes in handy after disconnecting sensors while the engine is running. The ECU will flag a fault even if the key is on with the engine off!”

Passing Emissions Tests

If your car is too old and tired to pass a required emissions test, you should have it corrected. However, if you don't have the time or money to get this done right now, John W. Himes makes the following suggestion: “I add a gallon of denatured alcohol to the tank. This makes a very clean burning fuel. The car does not run as good with that in the tank, but it passes emissions very well.”

Harry Trafford says, “I have used 99% isopropanol at 12% with some success. Brings down the CO%. Yes, the percentage is high and the idle had to be adjusted to keep running, but these were desperate people. I had them add 46 oz. to make 3 gal. of premium. After the test, they just bought more gas to dilute the alcohol and readjust the idle.”

“I used 2-propanol because it's what was available at the time. I also had methanol, but it's corrosive and not a good thing to put in British cars.”

Alcohol tends to be hard on some rubber products in the fuel systems of earlier cars, and British non-metallic parts have enough trouble without adding to their woes. Therefore, it is not suggested that you use this method more often than necessary.

Another idea used by some is to retard the timing a bit before the tests. You can't retard the timing by turning the distributor on a car with Marelli ignition, but Jaguar thoughtfully provided a jumper that can be pulled to operate the Marelli ignition system on a slightly more retarded map.

Trafford continues, “I bought a CO analyzer, too. It's a “Gunson's Gastester”. This unit is not a professional system, and you need a lot of patience because it must clear to 0 after you make any adjustment. Says it reads in 1 minute, but I gave it more. It looks and feels cheap, but it worked for me by just following the directions. It's made in England.”

“Here is the address for the guy that sells the “Gunson's Gastester” CO analyzer in Pennsylvania. He will answer your e-mail.

Ray at: r.d. enterprises, ltd.
290 Raub Road, Quakertown, PA 18951 USA
phone: +1 (215) 538-9323 fax: +1 (215) 538-0158
e-mail: rdent@rdent.com

Fuel System Upgrades

CARBURETORS: Replacing the EFI with carburetors is not recommended. Carburetors have several disadvantages: First, a standard carburetor does not correct for changes in altitude, temperature, fuel density, or other variables that make an engine run at less than optimum performance. Corrections usually require an excessive amount of complication in the carburetor design.

Second, since the carburetor relies on a pressure reduction due to drawing air through a venturi, there is always a flow restriction due to the venturi. Using a carburetor with a larger venturi reduces the loss, but the airflow at idle is so small that they have difficulty drawing fuel consistently, and a rough idle and poor low speed performance is the result. The American solution was the progressive 4-barrel, which uses one set of venturis at low speed and an additional set at high speed.

Third, carburetors tend to have problems ensuring proper fuel/air mixtures at all cylinders. With most arrangements, the corner cylinders on a V-8 tend to run leaner, because the path for the fuel/air mixture to get to them is more convoluted, and the fuel gets left behind and drawn into a nearer cylinder. Such problems would be even more serious on a V12.

Problems occur when a cylinder runs lean; burned pistons usually result. In the old days, the engines would simply be adjusted rich enough to avoid any problems. When environmental regulations and fuel efficiency demands rendered this solution unacceptable, the incidence of burned pistons increased.

The time-honored solution to this problem was multiple carburetor systems. The intake path for each cylinder must be similar, and sometimes even a dedicated barrel for each cylinder was used (Webers, etc.).

Obviously, fixing all these problems simultaneously would involve a truly elaborate carburetor system, possibly requiring multiple, progressive barrels for each cylinder.

EFI systems generally come in two types: throttle-body and multi-port. Each type will correct the first and second problem of carburetors, because all EFI systems automatically correct for variables and no EFI requires a venturi. The throttle-body system, which consists of a single injector in the same housing as the butterfly valve, shares the same distribution problems as carburetors, but is much simpler and cheaper than multi-port.

Multi-port EFI, what the Jaguar comes with, is the ideal fuel supply system. Since the injectors serve each cylinder individually, there is little chance of a cylinder not getting its share.

The only disadvantage of EFI is the difficulty in modifying it -- which, of course, the EPA considers an advantage. However, contacting AJ6 Engineering (see page 713) will likely alleviate all such concerns; they will modify ECU's for very reasonable fees.

EFI SYSTEM REPLACEMENT: Electromotive Inc. (see page 716) makes a system called the TEC-I (TEC stands for Total Engine Control) that replaces the EFI computer and the entire ignition system as well. It's got more modern and comprehensive electronics than the Jaguar original, including an optional knock sensor. Also, it is programmable using a PC-compatible computer, allowing the owner to customize the operation to suit his needs. It's not cheap; but if your ECU has already died and you're looking at the cost of the Jag original to get running again, it starts to look cheaper. And if you're having ignition problems as well (this system renders the entire distributor superfluous, you might as well put in a blank-off plate), it starts to look downright reasonable.

If you are performing serious engine modifications, this system is just the ticket. Since it can be calibrated, you are not restricted to the original response curves on your non-stock engine.

AJ6 Engineering (see page 713) also makes replacement EFI systems and components, and will modify the stock ECU on an exchange basis. According to Jeffrey Gram, "if experimenting was wished they could do a single EPROM version, which has up to 8 MAPs. It would be possible to switch between the MAPs if the ECU is depowered between switches by means of a "dial". AJ6 do such programmes to experimenters which then have 8 maps to choose from trying to find the best setting."

Scott Horner found an aftermarket system in New Zealand:

Link Electro
243D Annex Rd
Christchurch, ph +64 3 348-8854

"From them you can buy the ECU, Ignitors, Injector Ballast and Tuning Module (a handheld LCD interface) & the Crank Angle Sensor... You still need to supply a lambda sensor (aftermarket Bosch will do), and the coils...On my car, we used VN Holden Commodore (Australian GM car) coils, 2 coil packs. The Holden uses the Buick 3.8 liter engine, so it's presumable the coils would be available in the US in some form. I have heard these coils only last about 20,000km, but we'll see.

"Any 3 or 6 pack coil combination would do, I have heard Audi have a very tidy solution..."

Robert Dingli reports: "Here in Australia there are many, many aftermarket injection ECU's available. I've tested many of them in cars and on the bench and have found most of them to be garbage. Common faults are production quality, lack of temperature compensation and other instabilities, and general difficulties with setting up a system from scratch. Basically you get what you pay for. A \$2000 Motec or Autronics unit is highly recommended over sub-\$1000 Injec, Linx EMX, Microtec or Haltec. The expensive units also control ignition. The Motec, Autronics and Haltec require a portable PC (to be added to the cost if not available) to make proper adjustments.

"As far as "high performance" chips are concerned, I'm rather skeptical as to their worth. The problem (??) with modern day EFI systems is that they are very close to optimum, being a fine balance of performance, economy and exhaust emissions. Some of the chips available advertise that the systems will still comply with pollution levels. The specs reveal that power increases are only in the order of a few percent for most cars."

"Systems where chip changes may actually make a noticeable difference are:

- Systems with electronically-governed rev limits.
- Racing use where pollution isn't a concern.
- Turbo cars where the electronically-governed boost limits are raised.
- Electronic ignition systems without knock sensors where the timing maps can be advanced to take advantage of better quality fuels.
- Electronically-controlled auto gearboxes where upshift points are raised.
- Older poorly-calibrated systems, e.g. SIII XJ6 Jags set up for cold climates but being run in warmer climates."

According to Ken Wallace, "If you live in a regulated area the smog police will not approve of any of this even if it improves your emissions. You can have your installation certified, but this is very expensive like more than \$10,000 from what I hear."

Robert Gee adds a warning about aftermarket EFI systems: "I worked for a car manufacturer who made their own injection systems (Rover MEMS). One or two people had fitted MEMS to their own cars, mostly for competition use. One guy had a modified peugeot 205 GTi with one in. He had spent a fortune on the thing.

"Now, given that this guy had access to rolling roads, vehicle calibration experts and the like, the driveability was never perfect (an important Jaguar feature - low throttle response crucial on an auto). Also he went through about 3-4 tankfuls of petrol doing the calibration (not too bad at US petrol prices I suppose - more than the cost of an ECU at UK

prices). And this was still with the very fine tuning carried out automatically (This was done with some special adaptive software we were working on which used the lambda sensor feedback signals to adjust the fuelling maps).

“To cap it all, when he came to sell the car it was quite hard since it was non-standard and hence not supported by any garages.

“Put it this way, I could have converted my XJ-S 3.6 to full sequential injection with fully programmed ignition for next to no cost - but preferred to keep it standard and I probably would not have got it any better than the Lucas P digital.

“If there one thing I learn't at Rover it's that the low throttle drivability is what separates a good car from a bad one - and it also takes about 95% of the engineering effort. Anybody can make a car which goes well at full throttle - and I suspect it's the latter market at which the after market fuel injection systems are aimed.”

FUEL INJECTOR ORIENTATION: Strictly a cuteness mod here. Of the 12 fuel injectors on the XJ-S, some have the electrical connector pointing rearward and some have it pointing forward. If you wish, it is possible to reorient any fuel injector to point either rearwards or forwards, even the two front ones -- the connector will easily fit under the arc of the fuel hose.

To reverse the orientation of an injector is not easy unless you happen to be replacing the hoses *or* the rubber seals, in which case it's a snap. While the large rubber seal is off or the hose is disconnected, take the plate that retains the injector off and flip it over. Twist the injector around on the hose. The wiring harness will usually reach either side of an injector, but note that some harnesses are really brittle and fiddling with stuff like this may be asking for trouble.

There's not much good reason to do this. Perhaps you have an idea on how to make it easier to get to the spark plugs. Or, maybe just for a symmetrical look, you'd like the front 3 on each bank to face rearward and the rear 3 on each bank to face forward.

AIR INJECTION

The tubes on the air rails insert into holes in the intake manifolds leading some to believe it's somehow involved with the intake system, but it's not; the lines go through the intake manifold mounting flanges into the heads and terminate within the exhaust ports. The purpose of the air injection system is to provide oxygen in the exhaust stream to enable the catalytic convertors to work.

AIR INJECTION PUMP: Roger Myers reports that the air pump on the XJ-S can be replaced with a GM unit. Take the old one to your local parts shop and ask them to give you one just like it. Chuck Sparks says that A-1 (a rebuilder) lists it as part number 32128.

GETTING THE AIR INJECTION SYSTEM TO ACTUALLY WORK: John Napoli adds, “I have had the opportunity to see the air rails from Jag engines -- both 6 and 12 cylinder versions. Very often, the cars have brand new air pumps and diverter valves and hoses -- so someone spent a good penny replacing all that stuff. And on every one, the air rail tubes (where they stick into the head) were completely coked up. You would need some really ambitious air to get through all this!! Moral of the story: if you are going to maintain your air pump system, don't forget to do the obvious and simple and remove and clean out the air rail tubes. Otherwise you are just wasting time and money.”

You'll also probably need to clear out the passages within the heads. There's nothing complicated about those passageways, they are straight shots into the exhaust ports. You can clear them out with a drill.

AIR INJECTION PUMP CONTROL: Roger Bywater says, “the 2-3 seconds delay on the diverter valve was because of a controlled leak across the actuator diaphragm which allowed the valve to progressively reapply air injection while the manifold was still under high vacuum. I seem to remember that removing the neoprene cover nipple from the actuator stub pipe prevents this leak from building up a balancing vacuum on the reverse side of the diaphragm, thereby totally disabling the air injection system. We sometimes made use of this to take a before-catalyst gas sample from the air rails, fittings having been added for that purpose.

“In fact there can be more to this diverter valve business that is not readily obvious and it can have advantages even with over-run cut off. In the over-run condition the injected air from the pump becomes quite a high proportion of the total through-put so if no fuel were present, as would be the case with over-run cut off, the catalyst would lose temperature quickly. Having a diverter valve to temporarily dump the excess air gives the catalyst an easier time, with less steep temperature cycling and helps to maintain catalyst effectiveness when the fuel reinstates.”

AIR INJECTION PUMP WASTE OUTLET: On the H.E., the air pump only delivers air to the exhaust system during warmup; once the engine is warm, it wastes the air into the right side air filter housing. Michael Aiken points out that it is plumbed “to the engine side of the filter. *Unfiltered air* is being pumped directly into the engine - and this is very dirty air coming out of this pump! I would recommend that the wastegate tube be removed from the air cleaner housing and the opening in the housing blocked.” Aiken adds that the filth coming through this line was actually visible on the inside surface of his air filter itself. He also points out that, in addition to the dust that the air injection pump may be pumping into the intakes, the pump itself is junk and may start pumping bits of itself into the intakes at any time -- rust particles, bearing bits, whatever.

It’s possible that the waste line was routed to the filter housing to reduce noise, but if noise is a concern it should nevertheless be rerouted to the *intake side* of the filter housing, not the engine side.

AIR INJECTION NON-RETURN VALVE: Roger Bywater: “The reason for the check valve in the air rail was not because exhaust back pressure could exceed the pump pressure, but to prevent exhaust backflow into the pump if the drive belt should fail.”

Bruce Battles says that the Jaguar non-return valve “without the T-splitter is a GM part (check valve) Part # STI AV7. Just keep your T-splitter and install on the new GM check valve.” Chuck Sparks provides a couple more part numbers: Tomco 17001 and Std Parts AV-7.

AIR INJECTION SYSTEM REMOVAL: Removing this system is not recommended, as this would be a modification of an emission control system and would be illegal in many areas. Too bad, too; this system accounts for a great deal of plumbing under the hood as well as a belt-driven load on the engine. And on the Digital P cars, it only functions when the engine is cold -- the pumped air is wastegated after the engine warms up to prevent interference with the operation of the oxygen sensors.

Eliminating the load would be easy: just gut the air pump so it only serves as an idler pulley. The existing check valve will prevent any backflow from the exhaust tracts into the gutted air pump. And there’s little chance an emissions inspector would ever notice. Eliminating the clutter and weight is more involved: removing the air manifolds and piping, plugging the holes in the intake manifold, and replacing the gutted air pump with an idler pulley. The emissions inspectors are more likely to notice this if they look under the hood. None of this will affect a tailpipe test, though, since such tests are typically done with the engine warmed up.

If you chose to install an idler pulley in place of the air pump, there are lots of pulleys available for use on automobiles; you can ask for an idler pulley in any auto parts store and be presented a choice of several. You’d need to fab some sort of bracket to position it, and remember that you’ll need to adjust the belt tension with it.

The neatest pulley installation would result from using genuine Jaguar parts. Peter Smith: “I removed my air injection system and used a jockey pulley to carry the V-belt. These pulleys were standard equipment on English cars which did

not have to meet emission requirements in the early days and some of these jockey pulleys may still be available in wrecking yards in England.”

The 1987 Jaguar Parts Catalogue lists the part numbers:

EAC4185	Pulley
C37886	Hub
EAC3042	Bearing
C23128	Setscrew
EAC3041	Bearing Holder
C37875	Bracket

The pulley used as an idler is the very same part number that’s used on the air pump -- so you can skip buying EAC4185, just use the one you have.

You can also probably skip buying the bracket C37875 if you’re willing to add a couple of inches of spacers around the pivot bolt for the air pump.

John Napoli offers a suggestion for plugging the air injection holes in the intake manifold: “Buy 1/4” nail anchors from Home Depot. They are aluminum and look like a large pop rivet. Get them 1” long. Cut them back to 5/8” long with a band saw or hack saw (only cut the body, don’t worry about the ‘nail’). Put the two o-rings from each air tube on the shank of the anchor. Smear on some engine-grade silicone. Insert into the manifold and hammer down the nail all the way. Omit the ‘plates’ and retighten the intake manifold to the engine. Looks great and works great.” This mod is likely to require an extra washer or two on each stud, since the studs may not be threaded far enough to tighten the nuts down on the manifold flange with the plates omitted.

Napoli: “Here is the info on the nail anchors I used -- the ones I got at Home Depot:

Star Anchors and Specialty Fasteners
1/4" by 1"
2615-32178 (part number)
31916 26096 (number under bar code)

“This is for a box of 40. Enough for 3 V12s and 1 Opel Kadette.”

Michael Aiken’s local Home Depot apparently carries similar anchors in a different package: ““Red Head” light-duty anchors. They are 1/4" x 1" hammer-set anchors used for anchoring to concrete. They are easy to install just as John says. They come in a package of 14 -- perfect for a V12 as long as you don't screw up more than two. I have two spares. The part number is 11234. They are in the fasteners dept.”

An addendum to Napoli’s idea: While Home Depot only carries 1” anchors, 3/4” long hammer drive anchors are available at some other hardware stores, usually in the bin right next to the 1” ones. Since the flange on the intake manifold is about 7/8” thick, these anchors can be used without cutting them shorter.

If you set about removing pump, valving, plumbing, and rails with the engine in the car, you will find it very difficult indeed to remove the pipe that goes from right behind the air pump along the bottom right side of the engine and emerges behind the turntable. Some have resorted to ripping this pipe to pieces to get it out. The easiest solution is to simply leave it there. If you ever have the right side exhaust manifolds off for some reason, you can remove it then.

REPLACING THE AIR PUMP WITH A GM ALTERNATOR: If finding or fabricating an idler pulley to replace the air pump is too fiddly for you, note that installing a GM CS130 alternator in place of the air pump is *easier* and probably cheaper. This replacement is described starting on page 580. The GM alternator not only serves as an idler but also eliminates the need for the Lucas alternator and its V-belt in the process.

AIR INJECTION -- 6.0 ENGINE: Charles Randle says the air injection system in the 1993-on 6.0 engine is different; “Suggestions like do away with the system with an idler pulley is not an option.”

EXHAUST SYSTEM

MANIFOLD/DOWNSPIPE NUTS: The nuts that hold the downpipes to the manifolds look like an extra long nut. They actually contain a self-locking helicoil, a special type of helicoil in which a couple of the coils near the center are deformed to provide some friction when turning. These helicoils are held within the nut by a staking on each end that deforms the thread just beyond the end of the helicoil. Whenever these nuts are removed and reused, it is recommended this staking be checked, and re-staked if necessary.

The helicoil design means the parent metal of the nut is thinner than normal nuts. This is countered by the nut being so long. If overtorqued, these nuts will split lengthwise, and internally grip the socket used to torque them. If this occurs, of course, the nut must be replaced. The stud is a normal fine thread, so a normal nut will fit. It is recommended that a stainless steel or brass nut be used due to corrosion problems at red-hot temperatures, and a locknut or lockwasher be used since a normal nut lacks the self-locking feature of the original. Obviously, a locknut that uses a nylon insert for self-locking is unacceptable.

Thomas Alberts says, "I have purchased the long nuts with the helicoil inserts from a Jag dealer, but since then I've seen them at Western Auto hanging on the pegboard in a bubble pack."

Some auto parts stores sell "stud nuts", nuts intended for use on exhaust manifold studs. Generally, they are longer than normal nuts and made of solid brass (no helicoil insert).

Another type of nut that looks right is the coupling nut sold in hardware stores for connecting lengths of threaded rod together. These are typically coarse thread, but even if you replace the stud these nuts would probably not work well. They are generally mild steel, so they aren't very strong and will corrode something fierce on an exhaust manifold.

Getting the exhaust manifold/downpipe nuts on and off seems imposing, but it usually can be done easily enough. The two outer nuts on each side can usually be loosened from above with a box end wrench and a lot of patience, and the two inner nuts can be loosened from underneath the car with a socket, universal, extensions and ratchet. Michael Minglin suggests, "For the outside studs I bent a box end wrench into kind of a "Z" shape so I could slip one end over the nut from the top of the car. I welded an old socket onto the other end so I could use another wrench for leverage, and use a torque wrench to put it back together."

An even better idea: find a 9/16" "distributor wrench". These wrenches are designed to tighten and loosen the bolt underneath a distributor on American cars, and therefore have a deep zig-zag to them.

Be sure to use anti-seize compound when assembling, whether using original nuts or substitutes.

Jaguar provides four threaded holes in each header. In later cars, only two studs are used. If the threads in one pair of holes get boogered up, it should be possible to install studs in the alternate two holes, and rotate the loose collar on the downpipe 90° and reinstall. Rob Warnicke says his '73 XJ12 had studs in all four holes per downpipe, eight per bank: "I don't know when the changed the set up. I was surprised when I tore into my 87 and only had half the hardware to deal with. The new flange and the old flange are essentially the same, with the new one having two fewer ears on opposite "corners". They work the same, just with fewer bolts. One would think that since Jaguar dropped it down to two per exhaust manifold, you could delete two on the older cars as well."

TRANSMISSION/EXHAUST PIPE BRACKETS: When considering the mounting of exhaust pipes, it must always be kept in mind that the engine moves around on its mounts. When power is applied in low gear, the entire engine/transmission assembly can tilt significantly to the right. Typically, exhaust systems are rigidly mounted to the exhaust manifold and unsupported from there to the rear of the car, where they are supported by soft rubber mounts. The intention is that the pipes will flex enough over this length that the engine can move without damage or fatigue.

The XJ-S, of course, has a problematic transmission mount (see page 342). Problems with the transmission mount can cause the engine to move more than intended, increasing the stress on the exhaust system.

The XJ-S also has several joints in the exhaust system around the catalytic converters, which happen to be in the middle of the unsupported span. These joints can vibrate loose under the stress. Add to this the fact that the catalytic converters themselves get very hot when running, and are made of a high-temperature, brittle material. There are reports of the catalytic converters actually cracking within about 50K miles.

Jaguar's solution is to add a pair of small brackets from the torque converter cover to the pipes. The intention is to render the portion of the exhaust system between the manifold and the catalytic converter rigidly attached to the engine/transmission assembly, thereby seeing no stress. The flexing of the system would have to occur from this point rearward.

This solution is mediocre at best. On earlier models, the torque converter cover is made of sheet metal; it is not strong enough for this load and generally ends up pretty mangled. The fix also causes noise; some of the vibration is transmitted to the sheet metal cover, adding a tinny sound to the car.

Later, a beefier cast cover was used. This may represent a solution to the problems, or at least part of one.

EXHAUST PIPE UNIONS: The three-bolt flanged joint in the exhaust pipe just forward of the rear axle is a very interesting device. The seal within it serves as a sort of ball joint. The angle of the pipes at the connection can be changed by tightening some of the flange bolts while loosening others. This enables corrections to alignment so the exhaust system doesn't bang against anything.

Unfortunately, few muffler shop weenies have ever seen such a feature. If they just zip the nuts on those bolts with the air wrench and proudly announce they finished the job in under 30 minutes, it's not likely things will line up.

If you have disassembled your exhaust system at this point and need to reassemble it properly, you will find it most helpful to have an assistant -- or a jackstand, if you are short of assistants -- hold the forward end of the rear muffler up in its proper position while you tighten the three bolts on this fitting. When you think you are done, grab the pipe and give it a good shaking. If it bangs anything, you're not done.

EXHAUST SYSTEM ASSEMBLY: Jan Wikström sends this procedure for assembling each side:

1. "Hang the bent pipe in place. Make sure the insulating compressed-fibre bead is in place inside the rubber. Smear Loctite exhaust joint compound in the joint and offer it up to the flange. Do the screws up looser than finger-tight.
2. "Insert the second muffler and engage its hanger. Smear the Loctite stuff on the sliding joint and join it up.
3. "Push in a finger-thick stick (conveniently brought by crazy dog) on each side of the tail muffler to jam it in the centre of its asbestos-lined pocket.
4. "Push the bent pipe clear of the brake calipers and jam in another stick between the pipe and the bleeding nipple.
5. "Shove the front muffler over and up until it sits right with another finger-thick stick between it and the heat shield. (memo: get a bone for the helpful dog)
6. "Look at the tail muffler to check that it isn't sitting too high or low through the see-saw action of the pipe. Waggle the pipe accordingly.
7. "While holding everything in place, tighten up the flange bolts about half tight.
8. "Fit clamp and slot cover piece, liberally smeared with you-know-what. And do up the sliding joint about half tight. Check that both hangers have ample space for the pipe to move.
9. "Remove all sticks, hold your breath and check clearances. If the exhaust can shake normally on the hangers

without touching anything, tighten flange and clamp fully. If not, first apply brute force as required...

“The Loctite stuff is great; when the heat comes on, it foams to maybe three times its volume and makes a tight seal. A tap with a hammer will break it when you want to open the joint.”

IMPROVEMENTS IN LATER DESIGNS: Stefan Schulz reports: “I've just replaced pipes on the left side of my car's exhaust system. Observations:

“Jaguar seem to have realized that some of the exhaust parts weren't brilliant and actually made some improvements, to wit:

- The intermediate pipe now has an extra kink so that it no longer prevents access to the gearbox sump bolts.
- The locating pin arrangement for the over-axle pipe has changed so that it now looks a lot more reliable. Stress is distributed over a much larger cross-section of the hanger-to-pipe joint now.
- The old band clamps used in various places were labelled "Aeroquip". Presumably that points at use in flying equipment. Which is a scary thought, as both which I removed used Nyloc nuts - not a smart thing to do on a hot exhaust system! The new band clamps are actually different part numbers and sizes for different locations, and they are designed like the mothers of all clamps. Extremely strong and wide - get the genuine Jaguar part for a change. Well worth the money.”

HEAT SHIELDS: The Jag seems to have them everywhere: those hokey little pieces of sheet metal that seem to do nothing but get in the mechanic's way. Not so! While some performance cars are designed to go fast for the magazine road test and never see 100 mph again, the Jaguar is designed for the Autobahn -- not just 140 mph, but 140 mph all day. Under these conditions, the exhaust manifolds and downpipes can get red hot. Items that hot radiate heat (emit heat as infrared light - you can feel it from a distance). The belts, electrical insulators, boots, hoses, O-rings, etc. (all of which happen to be black) absorb this radiant heat and cook. The heat shields are not there for passenger protection or to aggravate the mechanic; they are necessary to prevent the rubber and plastic parts from destruction.

Particular attention should be paid to the heat shields around the catalytic converters, because they get hot even when you're driving slow. If these heat shields are not in place, the boots on the steering rack (\$\$\$!!!) won't last long.

Heat shields are no more complicated than they look. You can easily make them out of scrap sheet metal. Hoses and the like can actually be provided considerable protection by merely wrapping them with ordinary aluminum foil.

HEAT SHIELD BOLT SEALS: The heat shields over the exhaust manifolds on the H.E. are held on by two bolts of different sizes. The larger rear bolt is actually a plug for a port into the exhaust tract, presumably because Jaguar used the port in past models or anticipated the need for such a port at one time or another.

This fat, stubby bolt is sealed with a copper washer. If your local auto parts store has a rack of red cards titled “Help!”, it probably has a package of two sealing washers that are the correct size: number 66265, “Brake Hose Bolt Washers”, ID = 33/64”, OD = 45/64”. These same seals fit the banjo bolt under the oil pressure sender -- see page 46.

CATALYTIC CONVERTORS: According to Randy Wilson, the XJ-S has “two different types of catalysts in series. The first cat after the engine is a three-way. The second is a single function reduction cat.” Since it is a dual exhaust system, there are two of each for a total of four catalytic converters.

There is a honeycomb insert in the downpipe, immediately adjacent to the exhaust manifold. This is part of the catalytic converter system.

Note that sometime in the 90's, perhaps with the introduction of the 6.0 in 1994, the catalytic converters were upgraded with new designs that are far less restrictive. These new models reportedly do not have the honeycomb within the

downpipes themselves.

CATALYTIC CONVERTORS -- MELTDOWN/FIRE: When a cylinder fails to fire, the unburned charge of fuel and air is pumped into the exhaust system. If the catalytic convertors are up to temperature and operating, they will “burn” this mixture, and get hot as a result. If there’s a lot of misfiring going on, there is a risk of a serious fire starting at the cats and possibly destroying the entire car. Roger Bywater expounds at length on this concern: “Back in the 1970’s when I was working in Emission Control Dept. at Jaguar one of my responsibilities was complying with Japanese Heat Damage Tests. Amongst other things this meant having a catalyst overheat warning system (via a thermocouple in the cat) and the test procedure called for one spark plug to be disabled while idling to prove the system worked. The mixture from the dead cylinder would then be burnt in the catalyst which would obviously get a bit hot. On the old oxidising catalyst systems this was not unduly dramatic, but even so because the carb XJ6’s had the cat well back under the car, if driven any distance in this condition, they could end up with the rear seat springs popping through the top of the seat!

“Now when we started using Lambda sensors on the 4.2 EFI engine the situation changed alarmingly. When a plug was disabled the Lambda sensor would detect the spare oxygen from the dead cylinder and the system would react as if the fuelling was too weak so swung to the rich limit in trying to correct it. The catalyst now would be getting a supply of air and extra fuel and would start to glow in no time at all, even at idle.

“Of course the main reason the cat got hotter on the 4.2 EFI with Lambda was not so much because of having feedback as because it was a lot nearer the engine than had been the case with the oxidising cats. Also one cylinder out on a 4.2 6 cyl puts through a lot more fuel than one out on a 5.3 12 cyl so the 4.2 cat had a lot more to burn.

“In fact on the carb engine with oxidising cat we had to disable 2 cylinders to provoke the cat to overheat enough for the test. On the EFI with a 3 way cat one cylinder was more than enough and we had to keep reconnecting the lead periodically during the test to stop the cat rear cone temp going over 1000°C, and remember this was at idle!!!

“I am sure this is far from unique to Jaguars and is made worse by the presence of a pressurised fuel supply with the potential to make sure almost any underbonnet fire will have catastrophic consequences.

“Really if any catalyst car develops a misfire it should not be driven. It is a bit like when the oil warning light comes on - driving another couple of miles could prove to be very costly! It is perhaps realisation of this sort of problem that prompted California ARB to come up with OBD & OBD2 with the requirement for really powerful fault monitoring techniques.”

See page 161 for warnings on how faults in the Marelli ignition system can burn your car to the ground and page 169 for how overheating cats can cook the Marelli crank sensor.

CATALYTIC CONVERTOR TEMPERATURE MONITORING: The regularity of the Marelli distributor rotor failures (see page 161) has resulted in suggestions for monitoring the temperature of the catalytic convertors in hopes of avoiding expensive damage. This plan has a distinct advantage over monitoring the various possible causes of overheating, since it will alert the driver to overheating problems in the cats irregardless of whether Marelli is at fault or something else. A jammed fuel injector, a faulty fuel regulator, ECU problems, any number of things can cause a catalytic convertor to run hot, and with a large engine such as the Jag V12 it doesn’t take too large a problem to cause some serious overheating.

There are lots of ways to monitor cat temperature. Some sort of fusible link -- perhaps even homemade, like out of silver solder or something -- could be installed on or near the cats that would melt and break a circuit when the link’s melting temperature was reached. Some sort of bimetal strip or coil could be used to open and close a contact at a certain temperature. A thermocouple or two could be installed in, on, or near the cats. There are optical sensors that will detect and measure infrared radiation. For a really half-assed indicator, a pair of normal insulated wires could be twisted together and installed so that a hot cat would melt the insulation and cause a short.

The first problem is figuring out what temperatures we’re talking about. Bob Gallivan forwards a guideline: “This is

from "How to Tune & Modify BOSCH Fuel Injection" by Ben Watson: The minimum operating, or light off, temperature of the converter is 600° F, with an optimum operating temperature of about 1,200-1,400° F. At a temperature of approximately 1,800° F the substrate will begin to melt."

In Japan and the Middle East, catalytic convertor temperature monitoring systems are required by law -- so you may be able to obtain the necessary parts from Jaguar. Richard Mansell says, "Browsing through the '87 XJ-S parts manual I have found the bits and pieces used for the catalyst monitoring on the Japanese spec cars. They appear to use a catalyst mounted thermocouple, DAC1226, along with a little black box, DAC6943, known as "Module-catalyst switching". Also listed on the same page are sensor-thermal, DAC1043, which appears to be bolted to the floor although it does not say where. There is a harness, DAC3573, to plug it all together."

Andrew Corkan and others have pointed out that you can "buy a commercial dual-needle exhaust temperature monitor from Summit Racing. About \$250 US, works but has a big goofy dial you will have to mount." See page 720 for Summit.

Michael Aiken suggests, "If people are serious about monitoring cat temperature there are relatively inexpensive probes and gauges - they are used on snowmobiles to monitor exhaust gas temp for tuning. They even have digital gauges. They can be found at any snowmobile (motorcycle) shop or snowmobile catalog.

"I looked into a setup in a catalog I have. A dual analog Westach gauge (one 2" gauge, two needles) goes for about \$85, a 3" gauge is \$100. Two probes (\$30 ea) would be \$60 for a total of \$145 to \$160. The two needles in the gauge point at each other and should register the same under normal operating conditions. One rising significantly above the other would indicate a problem! The probe is mounted in a 3/16" hole with a stainless steel clamp (no welding). The gauges read from 400°F to 1600°F. The only problem I see is the leads to the gauge from the probe are only 4 feet long. It's not far from the exhaust in a snowmobile to the gauge panel."

Corkan again: "A DIY thermocouple option accessible to everyone might be to get K type thermocouples (~\$20 each). Then get a specialized thermocouple amplifier (Linear Tech #LT1025 is a cheap option, ~ \$10 each) and wire the output of the amplifier to a comparator (a cheap one from Radio Shack) that will turn on a light when the amplifier output goes above a certain point."

Since there may be some question about just how hot is too hot, John Arthur suggests, "What we need is a reference temperature. Fortunately the excellent design of the car means that one has already been provided at enormous expense. That's right -- the other cat! What is needed is a measurement of the difference of temperature between the 2 cats. There are industry standard thermocouples that are used in labs and workshops for measuring oven temperatures. Some are simple and could be clamped to the outside of the cat and others have a threaded boss that would be best screwed through the exhaust just behind the cat. Connect 2 of these thermocouples, one per cat, back to back and the voltage developed across the ends will be proportional to the difference between the temperatures of the 2 cats. You have to take the thermocouple wires back to the electronics but they are available with a length of 2 metres which should be enough. These things are reasonably linear and a temperature difference of, say, 300° Celsius would give an output of around 12 millivolts. Some enterprising electronics guy could doubtless produce a simple amplifier that would enable a warning light or buzzer to sound. Two amplifiers and 2 gauges and you could read the actual temperatures. There are even ICs available which compensate for the slight non-linearities of the thermocouple.

"I have found a reference to Analog Devices AD595 as a thermocouple amplifier for Type K thermocouples. However these cost over 12GBP plus tax in 1996. A simple generic op. amp. such as a 741 or equivalent would cost pence/cents and do the same job of alerting you to a major temperature difference."

Note that monitoring *only* the difference in temperature may not be a good idea, since failure modes other than the Marelli rotor failures may threaten both cats equally. The typical cause of high cat temps is a misfire, and a misfire on both banks can cause cat overheating on both banks. In fact, such a failure mode is described on page 168.

CATALYTIC CONVERTOR NOISES: Gerald Foster reports, "The dealer is turning out to be not so dumb. If I had gone with them I would have saved buying a power steering pump and water pump the independent dealer sold me. (Yes, a bad cat can sound like a grinding power steering pump)."

CATALYTIC CONVERTORS -- CHECKING: Greg Maddison suggests that you can visually check the front cats for plugging by disconnecting the pipes between the first and second cat, unscrew the oxygen sensors, and insert a small light into the hole. "I used a small Mag light with the shade removed." Looking into the back end of the cat, you should be able to see the light through the core.

CATALYTIC CONVERTOR REBUILDING: Greg Maddison says, "The original Jag parts are \$800 each so you can see how changing all four would be quite an investment. I found a company that rebuilds them for much less than new ones cost, they are called Jag Services." See page 694.

AFTERMARKET CATS: LaRue Boyce says, "Caution on the aftermarket cats! Both pieces were not "true" and couldn't be joined together without a lot of modifications."

GENERIC CATS: Generic cats are available from J. C. Whitney for, like, fifty bucks each. Sure, you have to figure out how to plumb them up, but considering the cost difference you have plumb of incentive.

CATALYTIC CONVERTOR GUTTING/REMOVAL/REPLACEMENT: Catalytic convertors are not inherently particularly restrictive in an exhaust system; in a properly-designed system, removing the cats has very little effect on performance.

Unfortunately, this is not a properly-designed exhaust system. The general concensus is that the stock exhaust system on the XJ-S is very restrictive, and the cats are a key part of that restriction. Simplest fix: take off the downpipes and cats and bash all the innards out of them and reinstall.

Of course this will reduce the restrictions considerably, but for the optimal flow it'd be nice to have smooth pipes instead. One possibility is to replace the US-spec downpipes with the European versions that have no catalytic honeycombs inside. Unfortunately, they don't have oxygen sensor ports either, and it'd be nice to maintain those. However, oxygen sensor ports are commonly available from places like Jeg's (page 717) or Summit (page 720) and can be welded into the downpipes.

If you must face the emissions inspector, neither of those options will be acceptable. There are others that might be, however. First, you could consider fitting some aftermarket catalytic convertors, preferably something broad and flat to fit under the car and less restrictive than the originals. Or, you could consider retrofitting the later OEM cats to the early car! According to John Napoli: "I happened to be at my local Jag dealer as someone was taking delivery of a new pair of V12 head pipes. I noticed that these pipes did not have the corrugated metal inserts in each of the four down tubes. These inserts are ostensibly part of the catalyst system, and are present on many V12s (including my '82 XJ-S H.E.). Anybody who has seen head pipes with these inserts in place would reasonably conclude that they add a lot of restriction to the exhaust. The replacement pipes I saw today have a different shape to the cats -- more streamlined and seemingly smaller than the cylindrical cats on the head pipes with the inserts. The parts man said that both types of pipes are available (with the inserts and without), both are fully certified smog-wise, and that the design without the inserts is considered a better performer because of the reduced back pressure. The downstream cats are required with both designs. I did not inquire as to price, but it seems that anyone replacing their cats should consider these replacements, as the Jag V12 rewards you for anything that helps it breathe better."

EXHAUST PIPE TIPS: The XJ series Jaguars have a unique style of tip on the exhaust system, a sort of S-shaped extension that places the outlets right out on the corners of the car. This is not a mere styling feature; these tips were supposedly designed to correct a problem with exhaust fumes recirculating back into the car. The shape puts the outlets out into the airstream coming around the car rather than into the dead air space behind the car. If you wish to replace

these extensions with some generic replacement tips, be prepared for fume problems when driving.

Of course, the aerodynamics are significantly different between the various XJ models and all of them have the S-shaped tips. While the fume problem may be the case with some of them, it's not likely to be the case with all of them. Some people claim to have no problems, while others complain bitterly of the odors. Pay your own money, take your own chances.

You might not really want to replace them anyway. The generic pipe tips available locally are usually cheap chrome-plated steel, and the chrome comes off quickly and the steel underneath rusts away to nothing. The stock Jaguar tips are made of stainless steel, so there is no plating to flake off. No matter how dirty they get, they can always be made to look new again with a little work with some Comet cleanser.

J. C. Whitney offers stainless steel exhaust pipe tips, basically a 9" long straight piece of stainless steel pipe cut off either straight or at an angle at the end and held in place with two setscrews. The ones to fit "1-5/8" to 1-7/8" OD pipe" will fit the stock XJ-S muffler nicely; catalog number 12xx0949U for the straight cut end, 12xx0952Y for the angle cut tip. Note that the outlets on the mufflers are turned down slightly, so these tips will not sit horizontally but will angle downward a bit.

TAIL PIPES: Ernie Laprairie reports: "Just had two dual-tip Pacesetter resonators installed instead of the bulky Jag style. Looks great and still quiet, only about 8 inches long plus chrome double tips on each side."

ADDING A CROSSOVER PIPE: One typical performance enhancement to dual exhaust systems is to add a crossover pipe: a connection between the two exhaust streams to permit each exhaust pulse to escape through both systems. This idea has been used with dramatic results on V8's, and many cars come with them from the factory.

There may be precious little performance improvement from adding a crossover to a V12, though. First off, six cylinders per bank results in smoother exhaust flow than four, so the pulse flow benefits of a crossover are smaller. The exhaust pulses on a V12 alternate between banks while there are successive pulses on the same bank on a V8, which is another reason the crossover helps the V8 so much.

There is another reason to consider a crossover, though: sound. Without a crossover, the note from each pipe is that of a six-cylinder; with a crossover, each pipe sounds like a 12-cylinder. The Series III E-type was fitted with a crossover pipe, and Roger Bywater claims it was strictly to make the car sound proper.

To avoid screwing up the EFI, a crossover should be installed after the oxygen sensors.

A crossover has two disadvantages: First, it can make the exhaust system, already a pain to work on, even more difficult to assemble and disassemble. Second, being able to check the exhaust from each bank helps with engine fault diagnosis. Both of these problems can be minimized by including a flat face flange in the crossover, and making a flat blank-off plate that can be bolted into the connection when doing engine analysis.

Summit Racing (page 720) offers "balance tube kits" for less than \$50. These require no welding to install; simply cut sections out of each pipe, install tees with clamps, and install a connecting pipe with clamps.

MUFFLER REMOVAL: AJ6 Engineering (page 713) offers a pair of "Silencer Substitute Pipes" to eliminate the mufflers forward of the IRS. They claim a 15-20 hp gain for this change; they also mention the inevitable change in exhaust note.

Members of the xj-s@jag-lovers.org discussion list generally report that removing the mufflers forward of the IRS and replacing them with straight pipes or less restrictive mufflers results in only a slight increase in sound, and the sound that results is pleasant. However, removing the mufflers rearward of the IRS and replacing them with straight pipes or less restrictive mufflers usually makes the car unacceptably loud, and the sound is not pleasant.

If your objective is the sound, consider modifying the intake system first as described on page 108. The sound that

results is wonderful, and only appears at serious throttle; at light throttle or idle, it makes no sound difference at all.

LARGER PIPES: AJ6 Engineering (page 713) offers a "Large Bore Exhaust System" and claims improvements of 20-25 hp. They mention that this may only be justifiable if the entire system needs replacement anyway. Keisler (page 718) also offers a package. Both systems include downpipes that lack the catalytic converter that's integral with the OEM downpipes on US-spec cars. Martin Karo says, "You can (and I did) section in a flat performance cat in the long straight pipe section."

Scott Horner, who has an extensively modified XJ-S, says, "I have 2-1/4" pipes the whole way from the exhaust manifolds to the outlets....You do have to be careful adjusting these for clearance thru the cage, but I was able to bleed the brakes at the weekend without any problems whatsoever..."

AJ6 notes the inherent difficulty with fitting anything really big through the IRS. If you're that kinda guy, you can forget about ground clearance and just run some big pipes *under* the IRS. This also eliminates several bends in the piping, further reducing restriction. The Keisler system supposedly goes this route. Note that the IRS subframe is mounted on rubber and moves around a bit, so pipes going under the IRS should *not* be attached *to* the IRS -- unless attached with rubber mounts.

Roger Bywater of AJ6 Engineering adds that they also offer "a new V12 extractor exhaust system that is cheaper and better than a conventional large bore system for road use."

PIPE INSULATION: A performance trick popular with competitors is to thermally insulate the exhaust system. This keeps the heat in the exhaust gases rather than permitting it to escape through the walls of the pipes and into the engine compartment or under the car. The result is an improvement in exhaust flow, and thereby an improvement in performance. In the case of a V12 Jaguar, there is another very significant benefit: lower underhood temperatures.

There are a couple of ways to accomplish such thermal insulation, including wrapping the pipes, coating the pipes, and coating the pipes on the inside. Wrapping the pipes is probably the cheapest option, but it can be difficult to accomplish in a cramped engine compartment with convoluted manifolds. It's also potentially dangerous. Brian Schreurs says, "I must advise against traditional "header wraps". If oil gets on them somehow, they can catch fire. It's happened in my F-body club." Back in the old days, the wraps were made of asbestos. "It could be that the wrap itself didn't catch fire; it just acted as a handy absorber for the leaking oil, and only the oil burned. I don't care to learn which one it is on any of *my* cars."

Wrapping also makes the manifolds themselves run hotter, because they're not getting the air cooling on the outside. This might be harder on heavy cast iron manifolds than on headers; Tom Bennett says, "The material I had thought of using is Cool-It from Therma-tec, just read the back of the box, DO NOT USE ON CAST IRON MANIFOLDS!"

Ed Hyatt says, "According to my books on turbocharging, header wrapping is only acceptable on race cars. Because of the additional heat stresses they place on the header, deterioration is *greatly* accelerated and cracks are common. Distortion was also severe and common. It was discovered that after a header was removed, it could not be used again because it was distorted too much." Coating might not cause the same issues simply because it's not as effective. Coating on the inside has the opposite effect, helping the manifold run cooler.

As far as coatings go, the word is that there's Jet-Hot and there are cheap imitators. Greg Peters reports from down under: "I found a company, which is also in the US, called Jet-Hot Coatings (www.jet-hot.com.au). They have a ceramic coating product that I had applied to the cast iron exhaust manifolds, engine pipes and the intermediate exhaust pipe before the first mufflers. This coating has had a dramatic effect on the heat generated by the exhaust, because this heat cannot escape through the metal of the pipes it is contained within the gases and exits out the back of the car. Now the floor doesn't get hot, the AC doesn't have to work as hard and the under bonnet temperatures are now negligible. Basically I am very happy with the result and Jet-Hot products."

Schreurs provides the US website and additional details: "The website is www.jet-hot.com. Here is the idea. Instead of wrapping headers in wraps, we get our headers coated with something (other than paint, which burns off in a couple of

minutes), generally a ceramic coating of some kind. The coating serves several purposes:

- 1) prevents rust; left bare, headers rust really fast.
- 2) controls heat by containing it, which is good in two ways:
 - a) by reducing the dissipated heat, underhood temps drop
 - b) by keeping the exhaust hot longer, it increases the velocity of the exhaust gases, the engine scavenges better. This process has diminishing returns, there is a point where you want the exhaust to cool, but it is not in the headers.
- 3) looks cool.

“Members of my F-body club have tried many different brands of coating, either by design (price sensitivity, usually) or by happenstance (the headers occasionally come pre-coated). The *only* brand of coating that is consistently praised for its quality is Jet-Hot.

“Jet-Hot takes your headers, cleans them for you (of anything -- rust, paint, previous coating, whatever), advises you if they need repairs, then coats them inside and out. A lot of other places only coat the outside.

“Of course all this extra service, plus the quality of the product, makes it about the most expensive coating on the market. But, where I know of several club members who had their headers recoated by Jet-Hot, I don't know of anyone who has gone from Jet-Hot to another brand.

“It used to be that the only finish you could have was a chrome-like silver finish (except that the Jet-Hot coating doesn't go blue like chrome does), but lately they've introduced several hues. The durability of the finish is excellent; a friend put Jet-Hot coated headers on his daily-driver Mustang 18 months ago and they look as new.

“The cost is the only drawback. But I would strongly recommend Jet-Hot to anyone planning to keep their car a very long time.

“I am looking at a diagram of the H.E. exhaust system. I think I would consider coating the downpipes as well as the manifolds, but of course the cats would have to be gutted or replaced with straight pipe -- the coating would destroy them.”

Jeb Boyd says, “I agree with Bry in a big way. The Jet-Hot process, albeit expensive, is a proven HP gain and it drops exhaust temperatures. It also helps everything cool off quicker upon shutdown. I've used the stuff in my shop and on my own cars.

“It is always best done on new parts if you can, but it does work very well on used parts such as cast iron manifolds as well.

“I have used Jet-Hot for almost ten years and have been *very* happy with their product and service. They turn the stuff around in a guaranteed 72 hours, and you can get rush orders as well. I believe that they have a certain amount of popular stock on the shelf as well.

“My MGB GT has the satin black coating on its exhaust manifold for about two and a half years and it still looks stellar! It *is* expensive, but if you're an anal retentive wacko like me, there's nothing like it!

“I have had them Jet-Hot the caliper halves on a couple of cars as well. Boy, is *that* cool! They will also coat suspension parts, alternator shells, and other bits.

“No interest, yadda yadda, but I love the stuff!”

Jet-Hot:

Heat management coatings
55 E. Front St. Bridgeport, PA. 19405
order: 1-800-432-3379 tech: 610-277-5646

DRIVETRAIN

The XJ-S was originally fitted with a Borg-Warner Model 12 automatic transmission, but in 1979 this was replaced with the GM400 automatic. According to Ed Sowell, "If it's a BW12 the dipstick/filler neck will be at the left side of the engine bay." The dipstick/filler is on the right side with the GM400.

In the mid-70's reportedly 352 XJ-S's were fitted with 4-speed manual transmissions and the official Jaguar repair manual dedicates an entire section on maintenance, but there is precious little information available on that tranny for inclusion in this book. The XJ-S's fitted with the six-cylinder AJ6 engine were available with a 5-speed, but there is no info herein on that tranny either.

OVERHEATING: An automatic transmission generates waste heat as a result of the "slipping" of the torque convertor. It always slips; more at low rpm and less at higher speeds, but the only way it won't slip at all is if there's a "lock-up torque convertor" fitted -- popular on some modern transmissions, but not on the GM400 or Borg-Warner transmissions used in the XJ-S. There is a cooler provided to deal with this waste heat; it's in the end tank of the radiator, and therefore rejects the transmission heat into the engine cooling system.

If there are faults in the automatic transmission, it can greatly increase the amount of waste heat generated. David Hodges had a transmission that he knew was malfunctioning, and before he fixed it he did some careful testing. With calibrated temperature sensors in each bank of the engine, he drove 125 miles at various continuous speeds. Then he installed a small transmission cooler and made the return trip under nearly identical driving and weather conditions. He showed conclusively that, with known transmission faults, the small transmission cooler lowered the *engine* temperatures significantly -- from just a few degrees at low speeds to as much as 18°C above 100 mph. Hodges adds: "At idle with the separate transmission cooler the engine cooling fan (electric) runs for shorter periods of time before it switches off and the gap between switching back on is most definitely longer."

Hodges' conclusion: "Bearing in mind the V12's tendency for overheating and the trouble many have in curing it, a faulty transmission could be leading many up the garden path. I only noticed the initial problem with the gearbox whilst driving very hard. It makes you wonder if a gearbox that is 'iffy' and has gone undetected could be contributing to the overheating problem so many have experienced."

There is much discussion on keeping the GM400 cool on page 336. Much of what is said may apply equally to any automatic transmission.

SHIFT CABLE -- ELECTRICAL PROBLEMS: William F. Trimble reports: "The Jag would not start -- nothing when the key was turned to the start position. Shortly thereafter smoke started coming out of the shifter quadrant on the console.

"We took part of the console apart and found that the shifter cable had melted, freezing the car in park. A check underneath revealed that the lockout switch and wiring looked OK, and that there were no obvious problems with any of the wiring under the car." Eventually, the problem was found: a loose ground cable. "The high current load imposed by the starter could not get through the loose ground cable. The current chose the next best available route, which was through the shifter cable to the body." This problem is reportedly common enough that some parts clerks are familiar with it.

Avoid this problem and install an additional ground strap. See page 555.

BORG-WARNER MODEL 12 TRANSMISSION

BORG-WARNER/GM400 BOLT PATTERNS: The bolt pattern for the transmission/engine attachment is the same for the BW12 and the pre-1993 GM400, and apparently was the same for the Series III E-type with manual transmission. However, when the GM400 was incorporated, the dowel pin arrangement was changed. Robert C. Warnicke: "I have a '73 pre-H.E., '84 H.E., T400 and BW sitting in my carport. The bolt patterns appear to be the same. The H.E. has two dowels on the back that are much bigger than the dowels on the pre-H.E. At least one of these dowels is in a different place as well. I don't know how important the dowels are with all the bolts, but one will have to be removed off the pre-H.E. for the T400 to fit, and the other will be loose in the T400 hole unless something is fabbed to make it fit tight."

It is possible to remove the dowels and bolt a transmission to an engine despite dowel pin conflicts. However, the alignment of the engine/transmission mating may not be as good. If misaligned, the flexplate may flex at each revolution, and will quickly fail.

Scott Horner points out there is also a difference in the end of the crankshaft. The crank that mates to the GM400 has a relatively large pilot diameter in which the protrusion on the front of the torque converter sits. The crank that mates to the BW12 has a smaller pilot diameter. When faced with this problem, he was able to machine the stub on the front of his GM400 torque converter to fit the BW12 pilot hole on the crank.

BAND ADJUSTMENT: Michael Neal offers this tip: "If you attempt your own band adjustment on the B/W don't overtighten them. The car will come to a very sudden halt. A quick adjustment: tighten them finger tight and back off the adjuster 3 flats."

WARMING UP THE TRANSMISSION?: According to a tip passed on from the Heart of America Jaguar Club, if you have a Jaguar with a Borg-Warner automatic transmission (pre-1979 XJ-S), you should let the car idle in neutral for 10-20 seconds before driving. This is because a one-way valve that prevents fluid from draining from the torque converter is unreliable, and the torque converter may have drained. The fluid pump does not function in park, so it must be in neutral to do any good.

FLUID: If you have the early XJ-S with the Borg-Warner automatic, the owner's handbook specifies Type F fluid. However, there are reports that some Jaguar dealers refill these transmissions with Dexron anyway, because they feel their customers appreciate the smoother shifts resulting from the slipperier fluid. This might not be a good idea, since firmer shifts cause less wear.

GM400 TRANSMISSION

REPAIR MANUALS: Craig Sawyers says, "I rebuilt my GM400 using just the ROM. However, I wish I'd bought Ron Session's book on "The Turbo Hydra-matic 400" - tells how to take all variants to bits and overhaul using "real world" tools. Includes performance tuning too."

Richard Chapman adds, "I have it and it gave great insight into the internals. Some of Ron's suggestions do not seem to get acceptance in the industry it would appear."

George Balthrop suggests "Haynes Techbook 10360 "GM Automatic Transmission Overhaul", which covers both the TH400 and the TH700, provides information on the function of this transmission, special tools, in-car repairs, testing & trouble-shooting, full overhaul & modification."

GM400 AUTOMATIC TRANSMISSION INTERCHANGABILITY: It is well known that the later XJ-S's are fitted with the GM400 automatic transmission. What is less known is that this transmission (through 1992) has a housing designed specifically to mate with the Jaguar V12. Because the GM400 has an integral bell housing, a GM400 from any other car will not fit.

The innards are interchangeable, though, so even though it's not easy to replace your transmission, it is easy to have it rebuilt. It's not even particularly difficult to remove (as transmissions go) and there are several access panels under the interior carpet to make maintenance easier.

If the tranny is apart, it is recommended that the sprags be replaced with high-performance aftermarket models. The Jag is hard on even the trusty GM400, and has a tendency to tear it up.

As a result of a complete revamp, the 1993-on 6.0 liter V12 has a standard GM engine/transmission bolt pattern. Cars with this engine come with a 4-speed version of the GM400 called the 4L80E; the E means it is controlled electronically. It cannot easily be retrofitted to earlier cars. The earlier basic 3-speed GM400 was posthumously renamed the 3L80.

GM400 - MINOR DIFFERENCES: John Goodman reports: "I may be wrong here, but I *think* Jaguar revised the tranny a few times throughout its history. My '88 car shifted much faster with less "slurr" than my friend's '84."

Richard Mansell says, "The Collectors guide does mention that "the GM400 transmission was recalibrated for improved responsiveness" from 88MY."

Goodman adds that the GM400 in the XJR-S has different shift characteristics. "The factory-modified GM400 came as standard on the 6.0L XJR-S from '89 to '93 Part no. SPE 1027. The owners handbook says "JaguarSport modified shift points". In my car ('89) I would consider under normal driving the shifts to still be quite soft, under hard acceleration they are by no means harsh, but seem to be a little quicker. However, what is noticeable is its ability while in drive to kickdown into first at higher road speeds, (up to about 38-40 mph); this is quite useful."

"The bell housings are different because it no longer needs the Marelli speed sensor. The valve body is changed and recalibrated and a different spring in the rear accumulator (whatever that is). The XJR-S manual and all the other related bump I have collected makes a *big* point of stating it is unique."

Richard Mansell says, "As well as suspension mods the SportsPack modifies the gearbox change points. This means that the car will change down into first at up to 49mph (standard GM400 - 30mph) and down into second at up to 98 mph (standard GM400 - 85mph). During full throttle kickdown acceleration the car will also hold first up to around 64mph and second until around 105mph."

Besides these functional differences, there are also physical distinctions -- including the shape of the pan and therefore the shape of the gasket that fits. John Himes: "If you are looking to fit a new filter or shift kit on your General Motors Turbomatic 400, check the serial number for the date of manufacture (first 2 numbers), or at least the shape of the pan. Pre-88 models are a little different than 88 and newer."

DEXRON II/III FLUIDS: John Horner passed along this info from "an applications specialist at Texaco's lubrication division.": "Since Type A, Type A Suffix A, DEXRON, DEXRON-II and DEXRON-IE fluids are obsolete, customers with transmissions calling for any of these earlier vintage fluids should use DEXRON-III. DEXRON-III fluids are designed to be back-serviceable for automatic transmissions used in passenger cars and light trucks manufactured since 1949.

"There are a few synthetic DEXRON-III ATFs available but they may be hard to find. They are also more expensive than mineral-based ATFs. Synthetic transmission fluids basically share all the same advantages that synthetic motor oils enjoy over conventional mineral-based oils. These include improved low-temperature fluidity, oxidation stability and reduced volatility.

"Compared to the old Type A fluids (and even newer generation fluids such as DEXRON-II or IIE), a mineral-based DEXRON-III fluid will help prolong the life of a transmission. DEXRON-III fluids retained the low-temperature

fluidity of DEXRON-III fluids and incorporated major improvements to the frictional stability, high temperature oxidation stability and material compatibility.

“For your information, and as a point of reference, when GM introduced DEXRON-III fluids they increased the drain interval to fill-for-life under normal service and 50,000 miles for severe service.”

John T. Horner adds: “Mobil lists a Dexron type synthetic ATF. Check the web site at:

<http://www.mobil.com/>

“I think most of the other synthetic providers also have competing products.”

FIRMER SHIFTS IN A BOTTLE: The owner’s handbook specifies Dexron 2D or Dexron III automatic transmission fluid for the GM400 transmission. Draining this fluid and refilling with Type F fluid will result in firmer shifts. The Type F fluid is less slippery.

Alternatively, there are aftermarket fluids available that are less slippery than either Dexron or Type F, resulting in firmer shifts yet.

DRAIN & REFILL CAPACITY: The repair manuals seem to agree that a drain and refill of the GM 400 transmission will require 9.6 US quarts or 19-point-something US pints. However, Larry Barnes reports that it only took about 6 US quarts on his car. Reason unknown, but it probably had to do with not fully draining the torque convertor or the transmission cooler.

DIPSTICKS: Sean Straw says, “I snapped pix of the dipsticks on both my 1985 and 1988 XJ-S’, and I was surprised to find that the dipsticks *are not the same length*. The top handles are the same (except for the colour of the plastic), and both are a spiral metal spring shaft, but the 1985 has a flattened metal tab at the bottom, while the 1988 has a plastic gauge.

“The Jaguar part number for the complete dipstick is EAC 8313, which according to my local dealer is superseded by EBC 4037, which is listed as the part going through 1996. The parts catalogue does not list a separate part component for the gauge at the end.

“As a comparative reference, the 1985 dipstick shows the HOT min mark at 27 1/8" (end of measure to the base of the dipstick handle), and the max mark at 26 9/16", while the 1988 shows the same marks out at about 1 1/32" longer. Cold on the 1985 is 27 1/2" and 27 1/4" (min, max), vs the 1988 at 28 11/16" and 28 5/16" (min, max).

Straw can’t say for sure that somebody didn’t put the wrong dipstick into one of his cars. It certainly wouldn’t be difficult to find an incorrect dipstick; “My Buick and the Jaguars all have the same TH400 trans, and the dipstick on the Buick is a good 3 inches or so shorter than on the 1985.”

PLUGGED FILTER: George Balthrop says, “If you have a turbine-like whine that is audible at idle when you bend down to listen under the front door, that is most likely the transmission, caused by a plugged filter & gummy fluid. This is particularly likely if the car has sat without regular use for months. The whine (from the transmission pump) will vary with engine speed as you drive the vehicle.”

MOANING SOUNDS: In response to complaints about cars that will “moan” for a minute or two after cold startup, Jim Schultetus says, “A trans filter that is partially clogged will make a moan noise when cold as the fluid is thick and doesn’t flow well. This was common complaint on the 400 turbo regardless of vehicle make.”

On the other hand, Stefan Schulz says, “Trans oil pump sucking air and cavitating. Can be alleviated by renewing the o-rings and if necessary the intake tube.”

Slightly different explanations -- but either way, the fix is exactly the same: Drop the transmission pan and replace the filter, making sure to get the intake tube and O-rings installed properly when reassembling. Continue reading for more concerns related to this same set of O-rings.

GM400 SLIPPING: It is occasionally reported that the GM400 transmission slips; sometimes when cold, in first gear, or under other specific circumstances. Leonard Berk reported that his slipped until he deliberately overfilled the transmission fluid, then it worked fine. Randy Wilson provided this explanation:

“On GM vehicles, a loose/fallen filter is a normal occurrence, and is known for causing weird problems. The most common problem is the transmission briefly finding neutral right after a hard turn. Most THM transmissions, the 400 included, hang the filter low in the pan. The filter is supported by the o-ring on the pickup pipe (pipe from filter to valve body), which snaps into a machined groove at one end and a steel clip at the other end. If the o-ring is bad, or the filter has fallen, the fluid pickup point is effectively raised to the bottom of the valve body, about an inch up from the filter.”

Jim Cantrell provides more elaboration: “The o-rings on the filter and at the pump inlet are known to leak in cold weather which results in pump cavitation. Pump cavitation can usually be heard - a whining sound of the pump. On the 400 in the cold (talking 40°F and below), it will usually last about 30-60 seconds. It still moves since it’s actually pumping oil. It’s just sucking in air from the o-rings and this gives the cavitation.

“Second hypothesis is that once cold, the o-rings leak and air leaks into the oil pickup tube and drains the oil. The result is the pump runs dry until oil starts flowing.”

Since the GM400 dipstick has warnings not to overfill, perhaps overfilling should be done only as a diagnostic measure. If it fixes the problem, suspect a dropped filter. Just go ahead and change the filter (and O-ring!) and fluid.

Richard Chapman says, “I recommend using 2 O-rings on the oil pickup tube connection to the pump within the trans, this is a common point where air can creep in. Also check that the valve body bolts are not loose while you’re in there.”

Greg Meboe says, “The filter came with one O-ring only. The B&M shift kit came with 2 additional rings, and it said that 2 rings should always be fitted to eliminate air being sucked into the pump. I was able to get three on, and still have plenty of pipe engagement into the trans case. The pick up tube is held in very securely now.”

Mark D Young had similar problems, and watched as a mechanic worked on it: “He had indicated that he thought the filter had dropped into the bottom of the pan and he was correct. There is little but a push-fit O-ring used to secure the filter. He used two flat washers and a circlip to install a new filter securely. The O-ring fits over a pipe that goes up into the tranny and seats in a recess. This chap cut a lip near the extreme lower end of the pipe and fiddled with a washer that cleared the pipe diameter (just) and then he pushed this up to past the recess and slipped the circlip into the recess.”

Apparently sometimes it’s not the O-rings; sometimes it’s the plastic pickup tube itself. Craig Sawyers says, “If the tube is cracked, it is dead easy to replace - it just pulls out.”

Slipping is not good on the transmission, and the sooner it is corrected the less damage will be done.

GM400 FLUID AND FILTER REPLACEMENT: Before buying a new pan gasket, note the shape of the gasket needed; as noted above, they aren’t all the same.

Dale Green says, “If the transmission filter is dirty, then when the fluid is cold, there is a delay in adequate flow through out the transmission, which in turn will delay the shift change. By either changing the fluid and filter or by having a flush done at a shop with the flush equipment, you can then determine if this cured your problem, or if a rebuild is due.

“As the fluid gets contaminated with deposits from the wear of the internal parts, the fluid becomes thicker. As these deposits are collected by the filter, the filter becomes clogged. These deposits also cause the internal parts to become sluggish as they plug the clearances around the parts. Once the fluid is warmed up, there is a better chance of flow, but the conditions mentioned should be used as a sign to change the fluid and filter.”

Since the GM400 has no drain plug, draining the fluid requires removing the pan. To remove the pan, the forward

mounting bracket must be removed. Therefore, changing the fluid and filter in the GM400 transmission requires complete removal of the transmission support -- see page 342. The correct reassembly of this system is not obvious, and non-Jaguar (Aamco?) mechanics will often reassemble it incorrectly, and perhaps even omit some of the parts. Taking this book along to the shop may be helpful; having an experienced Jaguar mechanic service your GM400 transmission may be the best course of action.

Steve Kennedy adds worse news: apparently some shops have figured out that they can drain the fluid without removing the transmission mount by simply bending the pan down. When all done, simply bend it back into place (probably with some sealant, since you can't replace the gasket this way), reinstall the bolts and refill. He suggests you question the shop closely to make sure this isn't what they have in mind.

This author once made a suggestion to replace the double-ended bolts at the rear end of the pan where the transmission mount is attached with bolts and spacers. That way, perhaps the pan could be removed next time without disassembling the transmission mount; just remove the bolts and slide the pan forward until the spacers fall out and the pan clears the transmission mount. Patrick MacNamara responded: "When I got the Cat, someone had already replaced the double-ended bolts with regular ones and spacers. The first time I changed the filter and gasket I tried the trick you describe. I ended up with a leak at the back of the pan from too much compression and twisting trying to fit it back in place. There is definitely enough room to slide forward and down but the replacement of the cork gasket and pan into the small space spelled disaster. I did the job again two days later with the complete mount disassembly..."

If you're doing this job at home, Brian Schreurs provides a procedure: "Prepare to get messy. I hope you have a nice big drain pan.

"Remove the bolts along the back row. Loosen the rest of the bolts progressively from there: back side bolts a lot, front bolts hardly at all. At some point as you keep progressively loosening the pan, the weight of the trans fluid will break the gasket's seal and the pan will drop. Of course you were loosening the bolts progressively so the back edge of the pan will drop rather further than the front, and most of the fluid will dump out the back where your drain pan is handy.

"Keep removing bolts progressively and the pan will keep tipping down, depositing more and more fluid into the drain pan. As you get to the last few bolts there will not be very much fluid left to spill on you. (remember to do the bolts progressively, you do not want the weight to be concentrated on the front of the pan too early, or you risk bending the lip of the pan)

"As you undo the last few bolts with one hand, hold the pan in position against the trans with the other. Then carefully lower the pan, only to suddenly discover that you missed a bolt, which unbalances the pan and dumps the remainder of the fluid down your sleeve. Startled, you let go of the pan which is heavy enough to pull that last bolt free of the caked gasket material; it drops into your drain pan and splashes the side of your face with Dexron III.

"After cleaning yourself off, see to it that you scrub the inside of the pan clean. Clean up the magnet too, and don't forget to put it back in. Scrape the remains of the gasket off the trans and the pan. A gasket scraper works much better than a screwdriver and is cheap. Change your filter even if it looks ok -- it is not. It never is. No matter how often you change your trans filter, you do not change it enough.

"If you find little bits of metal in your trans pan that are large enough you can actually identify them as little bits of metal, not just sludge, then count on something expensive needing to be replaced in the none-too-distant future.

"Getting the new gasket aligned right may seem like an impossible task, what with its odd shape and the fact that it was no doubt balled up by the filter manufacturer. You'll find that the bolt holes are slightly undersize to provide a good seal so if you jam 4 bolts (1 in each corner) through the pan & gasket ahead of time, the weight of the bolts will go a long way in forcing it to keep its shape. Don't tighten any bolts till you have all of them started."

Richard Chapman has a suggestion: "You can avoid a lot of mess by pumping out the trans before you remove the pan; this method does not get out all the fluid and leaves a bit less than 1" in the pan. This is enough to get it off cleanly if you can keep it level. Method: disconnect the lower cooler line (beside the alternator) either at the trans pipe end or the radiator end. Regardless the lower pipe from the trans is the outlet. The other end will dribble a bit, so have a plug handy. Do whatever to run a tube from the lower line into a 1-2 gallon can. Run the engine at idle and the trans internal oil pump will pump fluid into the container, when it starts to splutter, you're done - takes less than 1 minute.

“Before doing this run the engine a few minutes if it has stood for a while. This will ensure there is some lube in the trans. Do not rev the engine, idle only as the fluid returning from the cooler is used to lube the bearings in the trans and with this all disconnected there is none.”

The lack of a drain plug is apparently deliberate; the designers wanted to ensure that mechanics would not change the fluid without changing the filter. But it does make it very messy for the do-it-yourselfer to remove the pan. Ian Jenks reports that B&M Racing (see page 714) offers a drain plug kit (B&M #80250) which can be fitted while the pan is off. Also, J. C. Whitney offers two replacement oil pans for the GM400 with drain plugs, one “original capacity” and one that’s 1/4” deeper for “extra capacity”. They’re both chrome plated, and cost only about twenty bucks. Larry Barnes reports that “...I purchased a J.C. Whitney chrome transmission oil pan (standard size) with a drain plug (“GM TH400 Original capacity”). It did *not* fit. Bolt pattern was correct, but the pan was not deep enough for the filter. So, if you are thinking of getting the same pan, get the 1.25” deeper than original “extra capacity” oil pan.”

Steve Chatman retorts: “I ordered one of the chrome-plated over-size transmission pans from J. C. Whitney as mentioned in The Book. At least with a Series II XJ12, it doesn't fit. The pan contacts the exhaust pipe and, even if you try to insulate that, the bolts along one side would be inaccessible. I regret not ordering the regular size. Thinking back to the comment in the book, the author said that it didn't fit over the filter, right? Well, neither does the original. I believe that both push the filter up slightly.” Aaaargh! Maybe better just stick with the stock pan and add a drain plug kit.

Peter Cohen says, “A few years ago, I was availing myself of the free half hour inspection that Jag dealers were doing to try to bring in service revenue. The mechanic spotted the cork gasket on my oil pan, and commented on its "aftermarket" nature. He said that the real Jag gaskets were better, because the cork tended to leak (mine was, in fact, leaking in a minor way). Since then, I have used Jaguar trans pan gaskets, even though they cost more than the filter kit. IMHO, it has been worth it.” Of course, if the cork gasket does the job... After all, there are a lot of Chevys out there with transmissions that don't leak.

The filter is held in place by the O-ring on the suction tube on one end, and a bolt at the other. This bolt is shouldered so it cannot be tightened down on the filter, so the filter is free to rattle around a little. This is apparently deliberate; there are no parts missing. Randy Wilson says “That bolt is shouldered for a reason, though I can not tell you exactly why. *All* GM tranny's of that general era use a floating filter that sort of lays in the bottom of the pan. At least the 400 has a positive bolt. Others use a cheesy spring clip.”

FLUID LEAKS: Michael Pakonis looked for a leak for a while. “At first it looked like the pan gasket, so I changed the gasket, refilled with fluid only to find it still leaking. After laying under the car with a rag and parts cleaner looking for the leak, I found it, it was the detent solenoid plug in the side of the case; bad O-ring and the plastic plug work harden, fell apart when I removed it. I would suggest anyone changing the pan gasket to replace this plug, GM Part number 8629503, \$10.00.”

SHIFTING PROBLEMS: If your car isn't upshifting properly, Robert Warnicke says, “One thing to check is what happened to me. The little plastic elbow in the vacuum line to the modulator got too close to the pipes and melted shut...”

Or, the modulator itself could be bad. Bill Freeman says, “the original vacuum modulators on the GM-400 transmission get weak and *will* fail.” Being near hot exhaust components doesn't help; see page 169.

GOVERNOR DRIVE GEAR FAILURE: I'll let George Balthrop explain both the problem and the solution:

“**PROBLEM:** While cruising at 70, suddenly & without any noise or warning of any kind, the transmission kicked out of top gear, and when I pressed the throttle, the engine just revved as if in Neutral. I coasted to a stop on the shoulder and checked for transmission fluid leak -- level OK and nothing under car -- not wet. Got back in, and car would back up normally, and pull forward normally, it just wouldn't upshift from 1st regardless of the selection: 1, 2 or D. It would

freewheel in D or 2 when let off accelerator (no engine braking) so I limped back home via back roads.

“CAUSE: Nylon gear on shaft of governor had worn away in the middle of its length, where it rides on the metal gear on the output shaft. This is believed to have been caused by rust buildup on the metal gear (above at-rest fluid level) from the car sitting unused for several years. If the governor does *not* turn, its spool valve which is operated by centrifugal force will never open to send fluid under pressure to the shift valves, so no upshift.

“FIX: The governor may be removed without getting under the car, accessed as follows:

- 1) Slide the right seat fully rearward & remove the carpet from the Right footwell floor;
- 2) Peel up the carpet & pad on the Right side of the transmission tunnel to expose the access cover, located just ahead of the seat and approximately even with the shift lever.
- 3) Remove the access cover which is attached to the transmission tunnel sheet metal by 3 screws and 2 studs/nuts @ 1/2". The uppermost screw is at the top & hidden by the carpet just below the leather console cap, but may be removed with a #3 Phillips or Pozidriv equivalent, without removing any part of the console.
- 4) Place a drain pan on the ground (*not* in the car) under the access opening & remove the four 1/2" bolts securing the governor cover, on the right side of the transmission, above the right-rear corner of the transmission pan. All four bolts may be removed using a 1/4" socket set with U-joint via the access cover opening. Remove the cover, & some fluid may drain from the transmission case, but it shouldn't gush into the car.
- 5) The governor is the part just under the cover; grasp the top of this part and twist without pulling. If it turns, you have found your problem. Now remove it by gently pulling as you twist. The governor should pull straight out through the access hole. There is a nylon gear on the inboard end of the governor shaft. If this gear is worn so that the center is dished or smaller diameter than either end to such an extent that the teeth are nearly gone in the center, then the governor is not being turned by the output shaft gear and the shift valves never get pressure via the spool valve in the governor.
- 6) Replace the nylon gear. I found a transmission parts & repair facility (County Transmissions in Vienna, VA) where very nice & experienced personnel replaced my worn gear for \$5 (no labor charge) took several minutes to explain how the wear probably occurred (rust on output shaft gear) and even explained how to replace the gear again if this one goes bad, and gave me a second replacement gear for another \$5. Now *that's* service!
- 7) Remove nylon gear by tapping out retaining split pin. Clean spool valve beneath & entire assembly. Fit new gear to shaft, driving it fully home against the shaft end. Using a 1/8" drill bit, drill a hole for the split pin, *half way* through the shaft of the new gear, then rotate and drill from the other side to meet the 1st half and finish the hole -- this to avoid the shaft breaking. Tap in the new split pin and peen the ends to prevent slipping out.
- 8) Replace and top up with fluid as necessary, and smile when it upshifts. Carry that spare gear though, because there are several possible causes for the original gear wearing, and the cause may still be present and do the same thing to the new one. I figure several nylon gears ought to clean the rust off the metal output shaft gear though ;-)"

Balthrop advises that if your car won't shift out of 1st, "It takes less than an hour to get to the governor (the first time you do it--maybe 20 minutes once you've been there), so rather than mess with other tests, I would advise just pull it & check it out."

Martin Runneals adds: "The transmission mechanic that fixed mine said that it probably was caused by a worn bushing on the output shaft. This allows the metal gear to skip and wear the plastic gear faster. The permanent fix would be to replace the bushing. My '84 has been running fine for almost a year with the simple fix. Since the plastic gear is only \$5, I'll definitely pick up a spare gear.

"He also told me that the worm gears were made of brass at one point, but they would also strip. Then you would have to clean the brass out of the teeth of the corresponding gear on the output shaft."

KICKDOWN: Since there seems to be a lot of confusion about this term, I will first endeavor to define it. Kickdown does *not* refer to the normal downshifting of the transmission due to increased throttle. Kickdown refers to the *forced*

downshifting of the transmission by a very definite pressing of the accelerator pedal all the way to the floor, and pushing it hard enough to operate a separate “snap” that the driver can feel when the pedal is moved the last quarter inch or so. It is intended to be a distinct enough feel that the driver can easily choose whether he desires kickdown operation or merely full throttle without kickdown.

In the case of the pre-1992 Jaguar with the GM400 transmission, kickdown is accomplished via a microswitch mounted on the throttle cable attachment at the turntable. A photo of this microswitch can be seen at:

<http://www.jag-lovers.org/xj-s/book/Microswitches.html>

After the throttle is wide open and the turntable is against the stop, further pressing of the pedal can move the turntable no more. Instead, the cable housing moves in the opposite direction against a very strong spring, strong enough to ensure that the driver must really want it to move. When the cable housing moves against this spring, a microswitch closes a contact sending current to a solenoid within the GM400. This solenoid causes the transmission to downshift *now*. At any reasonable speed, it will downshift to at least 2nd; below 30 mph or so, it'll downshift all the way to 1st, and the engine will scream.

The results should be obvious and dramatic. Unfortunately, all too often this system doesn't work, and the owner doesn't even know it; since the vacuum modulator will cause the transmission to downshift (gently!) under heavy throttle, they presume that everything is OK. It is easy enough to check the kickdown operation, though.

The first thing to do is learn what that snap at full throttle feels like -- which can be tough if it doesn't work! So, you've got to check that operation first. With the car shut off, make sure pressing the accelerator hard operates the microswitch on the throttle cable as it should.

If not, the mechanism might be jammed, and you'll have to correct it before you can go any farther. David Peek says, “This was quite an easy job given that I am a dedicated pen pusher with no socket set (yet). At the back (facing the windscreen) of the housing holding the taper unit there is a small phillips head screw; remove it (be careful not to drop it). This will release the spring which holds the taper in position (nothing falls out). A good dose of WD40 and a few pulls on the throttle cable outer soon released it for me. Push the throttle cable outer back towards the housing to compress the spring and put the small screw back in to retain.

“Apparently the best way of keeping it in working order is regular use of the kick down - what fun!”

Dennis Roberts says, “Flooring the throttle caused the sheath to slide and the switch to close, so I didn't understand why it wouldn't downshift unless there was a problem with the transmission. Hoping to find a simpler solution, I put an ohmmeter across the switch and saw that when the switch closed it still had a small resistance. Using my finger to move the switch would cause the resistance to drop to zero. I concluded that the switch was really not closing all the way until I pulled with my finger. So I examined how to adjust the movement of the sheath. First I lubed the sheath and groove to see if this would cause the switch to close tighter; no change. So I adjusted the large nuts that attach the cable/sheath to the bracket (same bracket that holds the switch). I moved the nuts closer to the end of the sheath, tightening the cable. This caused the throttle to open farther with the same pedal position; and it caused the throttle to hit the full open position before the pedal hit the floor. Further pressing on the pedal then caused the sheath to move farther than it had before the adjustment. This caused the switch to close tighter than before and the resistance to drop to nearly zero without help from a finger. Now the transmission downshifts every time I floor it without sticking my foot through the floor.

“One word of caution: Be sure not to overtighten the cable since this will not allow the throttle to fully drop back to idle. On mine this was a fairly close adjustment: Very little adjustment would cause the cable to be too tight to idle or too loose to cause a downshift.”

There is, in fact, a common problem here. The throttle pedal consists of a steel bar that is bent at an angle with a pivot at the corner. You push on one end of the bar with your foot, and the other end of the bar pulls the throttle cable vertically downward. Unfortunately, spirited use of the kickdown feature has been known to bend that bar at the corner, so that it is a wider angle than it should be. The result is the problem Roberts was facing above: pressing the pedal all the way won't operate the kickdown switch, because the pedal hits the rubber button on the floor first. If you just keep adjusting the cable the way Roberts describes, you will eventually run out of adjustment altogether; it will become

impossible to get kickdown and idle with the same adjustment.

The solution is simple enough: bend that throttle pedal back the way it's supposed to be. Just crank the angle closed a bit. Precision is not required, but it might help to take it out of the car and put it in a vice. It's easy to remove. Of course, once you've got it bent properly, it might just bend itself out of shape again. So, the author simply tied a piece of steel wire between the two ends, positively preventing the angle from opening up.

Once you have the throttle pedal bent properly, Roberts' contention that the cable adjustment is "a fairly close adjustment" goes away. You'll find you can adjust the cable all over the place and still get both idle and kickdown with ease. It's a good idea to adjust it so you get kickdown just as the pedal hits the button on the floor so you don't overstress anything stomping the throttle.

Oh, one other concern: sometimes you can't get kickdown simply because the carpet has gotten out of place and is keeping the throttle pedal from moving as far towards the floor as it should. Deal with it.

Once you've got that cable working properly, we can move on to actually road-testing the kickdown. Make sure you know what it feels like to press the accelerator all the way *without* kickdown as opposed to *with* kickdown. Then, take the car for a drive. If you have a hard time telling the difference between kickdown or no kickdown, it ain't working. There is nothing subtle or gentle about kickdown; it should provide a swift kick in the pants.

If the cable is moving the switch properly but the kickdown still doesn't work, check fuse #5; there should be power to the kickdown switch on the LG/W wire when the ignition is on.

Next, check that the kickdown switch itself makes good contact. Physical adjustment may be necessary, since problems may be caused by the switch not positioned correctly or the roller arm bent. Obviously, the microswitch itself may be defective; check it with a VOM. If it's NFG, you can find a replacement microswitch -- complete with the little roller on the lever -- at a good electronics supply house. It's actually a standard configuration microswitch.

Next, check the inhibit switch on the shifter. One of the microswitches (hey, the car is covered with them) within the console and operated by the cams on the shifter is a microswitch that closes only if the shifter is in D. This prevents the operation of the kickdown solenoid in any gear other than D. Note that this same switch also prevents operation of the cruise control in any gear other than D, and it does so by grounding a signal line from the cruise control *through* the solenoid in the transmission! Problems with this inhibit switch may be mechanical in nature as well; it might not be positioned properly for the cam to operate it reliably.

The next possibility, as Greg Meboe points out, may be that the wire at the transmission isn't connected right. "The kickdown connector on the outside of the transmission case had two separate connection points on it, in the shape of a "T". The vertical connector which "bisected" the horizontal connector was the kickdown one. I had been explicitly told that the horizontal connector was the proper one to connect the kickdown wire to, so that's what I did. When I took apart the tranny, I saw that the horizontal connector went to what looked like some type of sender on the valve body, whereas the vertical connector (which I hadn't used), went to the kickdown solenoid."

For the final test, it helps to be under the car with your ear near the transmission and all quiet in the area. Have an assistant turn on the ignition, put the shifter in D, and operate the kickdown switch, and you should be able to hear the solenoid within the transmission click. If there's no click, make sure you are getting 12V at the wire to the connector; if so, time to drop the pan and replace the solenoid.

Believe it or not, it can pass all those tests and *still* not work. It's possible for the solenoid within the GM400 to audibly click and yet not provide a kickdown. Tony Bryant says, "The solenoid in my trans would click, but the screen inside it was blocked. A rinse in kerosene fixed that. Also gave an opportunity for a well needed fluid and filter change."

Mark Johnson says, "Seems there's a small screen and a seal in the solenoid assembly, and on mine, lots of hot stop-and-go traffic before I bought the car apparently had cooked the seal. The result was that the seal cracked and fell out, allowing fluid to seep past it all the time. I finally found the problem and bought a new part at the Chevy dealer - presto! Like getting a new transmission. If you get the click but still have kickdown problems, you might want to check this out."

Richard Mansell quotes from a Jaguar publication on the changes for the 1992 model year:

"The kickdown switch is no longer located in the underbonnet area but is changed to the XJ6 type and is positioned under the accelerator pedal."

PLAYING GAMES WITH THE KICKDOWN: Hey, that kickdown switch just connects two wires together and the transmission drops into a lower gear. Give you any ideas?

Al Askevold says, "My kickdown on my '90 never worked most of the time and clicked back off when it did engage. Throttle cable stretch or bad machining on the indent for the switch roller I do not know but I gave up on adjustments and tried a mod that another lister sent in.

"Very simple mod, just mount the switch on top of the mounting plate and run the switch off the throttle rod. Very adjustable and I have my kickdown at just over 3/4's so I now have a normal passing gear when needed and a solid full throttle kick in the pants."

Matthias Fouquet-Lapar has another idea: "Simply add a button in parallel to the kick-down switch of the GM400. You can mount it where the two switches of the power windows are, and if your arm is on the centre console, you hand really "falls" on it.

"If you push it, it's like a full-throttle kick-down for the transmission, so the normal protection should work. You don't need the shifter to find you pushing it into 'R' at 60mph :-)

"And it's really nice. If you want to bypass, click (and hold down) just 1 second before and then push. It really makes a lot of fun. In normal driving situations you have almost always enough time for this gear change, and then you really have the power. I'm even thinking to get this into the steering wheel, so I don't need to take the hands of the wheel. Maybe I'll use the horn contacts. Hey, this car really has power!!"

Steve Gallant suggests putting a switch in parallel with the kickdown switch -- the kind of switch that you turn on and leave on, not just a momentary button. "The kickdown solenoid changes the shift characteristics of the transmission. The reason most people think that the kickdown solenoid always forces a downshift is because to engage the switch in the first place, you have to depress the throttle all the way to the floor. And this does indeed force the downshift, but only because vacuum is sufficiently low to do so.

"Activating the kickdown solenoid all by itself (i.e., without depressing the throttle) does not cause a downshift, because vacuum pressure is unchanged. You still must hit the throttle, thus reducing vacuum to force a downshift. However, activating the solenoid changes the pressure at which a downshift will occur, so closing the parallel kickdown switch makes the throttle more sensitive. Meaning that downshifts will occur with smaller throttle changes, or at a lower 'rate'. The downshift does not occur at a fixed point, because it depends on the how fast you increase the throttle. If you accelerate slowly, pressure does not change too fast and normal shifting occurs, but hit it, and you cross the pressure threshold resulting in a downshift.

"And if you do everything gently, you get upshifts (and no downshifts) just as you would without the switch engaged...but it will downshift with less movement and hold a lower gear to a higher rpm. When you get tired of this 'sportiness' you can just disengage the switch. It's that simple.

"Anyway, best thing for you to do is just give it a try. Close the switch with a jumper wire and drive around."

Justin Pashley: "I would just like to tell you how to make a neat job of the button. I got the bits from a local scrap yard who currently have a 1989 XJ-S convertible. I used the electric window plastic switch plate that has space for an extra button for the convertible roof (the XJ-S with a sunroof has the same plate). I also used the cruise control button from the same year of car as the switch to enable / disable the sport mode. Note, this will only work from 1987 car onwards as the earlier car did not have this switch surround.

"The whole job cost me £2.50 and took 10 minutes to fit."

VALVE BODY REMOVAL: Tom Bennett passes on this tip, which he claims to have gleaned from a Chilton's: "If you leave the solenoid bolted and then undo the valve body bolts about an 1/8" and gently push on the steel spacer edges

so that it just separates from the valve body, it is possible to remove the transmission valve body without the check balls flying out! When you remove it completely the steel spacer stays in place and so do the balls.”

GOT BALLS? Some GM400 transmissions have six check balls in the valve body, and some have seven. Note that the versions with seven balls, apparently 1987 on, also use different valve body gaskets. Compare your new gaskets to the old gaskets *very* carefully to make sure you have the right ones.

CHEAP GM ACCUMULATOR: Sandy Gibbs reports, “My tranny (GM400, 1987 XJ-S) went belly up. I took it to the shop for a rebuild. The mechanic showed me a small plastic cuplike looking thing which he said had caused my transmission to burn up. He claimed this piece (called the accumulator) was usually the problem when a GM400 dies. This information was confirmed by the owner of the parts place (which deals exclusively in transmission parts) where I bought all my parts for the rebuild. GM knows about the problem and now supplies an aluminum accumulator which won’t break. It seems to me that anyone who plans to have some transmission work done anyway might want to invest in a new accumulator.”

Thomas Alberts adds, “You are talking about an accumulator piston. One of the two accumulators has a plastic piston that can fracture with fatigue after high miles. It is a common failure mode. The piston breaks leaving a 1/2” hole that hydraulically “shorts out” parts of the transmission logic and leads to clutch packs burning up. It prevents kickdown and can cause second and (I think) first gear to engage simultaneously forcing one of the clutches to slip in second. It is pretty easy to replace the piston with the transmission in the car. It involves removal of the oil pan and valve body. I wouldn’t advise everyone to rush out and do this, but if you are ready to replace filter and fluid it would be worth the extra effort to put in the aluminum piston.”

Greg Meboe had this problem: “As I was lowering the valve body, I could feel there was some spring force trying to push it down on me. When the last thread disengaged, the valve body sprung down and stuff went flying. Turns out the plastic accumulator piston had been broken, which is why there was a spring force pushing down on the valve body.”

Steve Barker tells all about doing this repair yourself: “NAPA supplies a plastic replacement. The GM dealer said he can get the part, (parts departments don't actually stock parts anymore) the GM part is 8626883 about \$20. I called a transmission shop and he had the aluminum part, a valve body gasket and a 6 ball and 7 ball valve plate gasket and photocopied a ball location sheet and gave me some hints, all for 21 bucks.

“When you drop the valve body, leave the two bolts in that hold the solenoid. This will hold a plate in place that holds the balls. The two tubes on the valve body just slide into two drillings in the casing, there are no seals to replace. Because the plate that is held in place by the solenoid bolts will have separated from the case, it is possible that the gasket will be damaged. There are two different gaskets, one for a 6 ball unit and one for a 7 ball unit. Mine (89) is a 7 ball.

“Holding the plate up, remove the two bolts, let the solenoid dangle and keeping the plate level, put it in a clean level spot. Now remove the old gasket from the case and discard. Put the 6 or 7 ball gasket on the plate and to hold the balls in place while you reinstall the plate, put a dab of petroleum jelly that has been in the freezer on each ball. Then you can replace the plate and hold it with the same two solenoid bolts. Keep those two bolts loose and run a couple of bolts into their holes to align the gasket before you tighten the solenoid bolts.

“The piston is mounted in the back of the valve body. It's kind of confusing in that there is a servo piston assy on page 44-20 that goes in the case; this isn't the one. (The page numbers refer to The XJS Service Manual 4 volume set with the Ed2 supplement.) The one we're after is item 34 of the Control Valve Assembly diagram on page 44-18. You push the piston all the way in (watch it or it will spit fluid at you), and remove the c-ring and withdraw the piston.

“Installation is the reverse. To put the valve body back in, it helps to put two of the 5/16" bolts through and hold them to keep the valve body gasket in place. You also might have to jiggle it a little to get the two tubes into their bores. I managed to do the job without dropping the balls but you would definitely want a tub under there to catch them if you tip the plate.”

BAND ADJUSTMENT: Huh? There is no band adjustment on the GM400! Pekka Eklund clarifies: "You can adjust the bands on GM400. You just drop the pan and the valve block. Then you have access to the accumulators. Open them carefully and you'll find piston and "conrod", I don't know the right word for that stick.

"Jaguar did offer at least 3 different length sticks for GM400. By making this stick longer (I welded mine) you can adjust the band. When you have the accumulator open, consider a change in the piston ring material too. That should not be made of teflon, because it will leak after few thousand miles and allows the band to slip.

"The stick has the right length when the drive shaft turns when you push the accumulator piston up. And you should not be able to turn the drive shaft by hand then."

SPEED SELECTOR CABLE TRUNNION MOUNT: This is the little bracket that holds the shift cable housing to the transmission housing. The bolt that holds the trunnion mount to the tranny housing goes in from above, and cannot be removed from underneath the car. The only way to remove it is to remove the console, shifter mechanism, and a panel underneath to get at the bolt. It is suggested that if you ever have an opportunity, cut a hole in the panel inside the console and fit it with a rubber plug or cover, so the trunnion mount bolt can be removed by simply lifting the console cover (three screws) and removing the rubber plug.

If you are trying to remove the engine/transmission assembly and must disconnect the speed selector cable, the above trunnion mount problem may appear to be a real holdup. It is not, however. The attachment of the swivel joint to the end of the cable is a removable clamped-on device. Simply loosen the two hexes from each other, and the entire joint slides off the end of the cable. Then the cable can be slid through the trunnion, allowing the removal of the engine/transmission from the car.

KEEPING THE TRANSMISSION COOL: Greg Meboe: "One other thing I did to prolong the life of this box was to insulate the metal oil cooler lines which run 1 cm. away from the RH catalyist. I used a multi-ply aluminum foil wrapped and stapled over loose fiberglass cloth weave."

In the May 1995 issue of Australian Jaguar Magazine, John Pearson says "Most Jaguar engines run fairly warm...and transmissions prefer cool running, so you may consider incorporating a neatly positioned transmission oil cooler...This is especially recommended on V12 powered cars with the GM T400 'box...'"

In stock form, the GM400 is kept cool by a heat exchanger in the end tank of the radiator -- the same setup used in many other automobiles. It seems plausible that this method is used to take advantage of the thermostatic control of the engine temperature; since the engine won't run cold because the thermostats won't let it, the transmission won't run cold either. If this is the case, then it might make sense to install any additional transmission coolers in the line *before* the heat exchanger in the radiator, so that the heat exchanger can still control the transmission fluid temperature -- by heating the fluid if necessary, which would mean that the added transmission cooler becomes an *engine* cooler.

Bill Fernandez says this isn't so: "*There is no such thing as too cold for an automatic*, the colder the better. Routing the trans lines through the radiator first and then through the cooler and back to the trans box will work just fine. Routing the lines from the transmission to the cooler only and back will also work just fine.

"Some may think that a cooler is unnecessary in the XJ-S; I beg to differ for several reasons. A trans cooler is a *must* in the XJ-S for long dependable transmission life."

Fernandez puts considerable blame on the catalytic convertors. "These buggers generate a huge amount of heat and nearly lay on the sides of your transmission, cooking the fluid and baking the clutches."

Of course, one major factor in the durability of the GM400 in the XJ-S is undoubtedly the fact that the engine is prone to overheating -- which means the transmission is as well, since their operating temperatures are linked at the radiator. Getting the engine temperatures under control would go a long way towards making the transmission last longer.

See the note on transmission overheating on page 324.

SOFT SHIFTS: Yes, those gentle shifts are suitable for the Jaguar image of luxury. Unfortunately, they are apparently to blame for the GM400's poor durability record in this application. Per Jim Cantrell: "Old transmission types know this phenomenon well. Take a Cadillac with the same transmission as a truck and the Cadillac will last half as long. You can tell when you pull the pans on those box luxury cars - lots of transmission dust in the bottom (clutch wear). Seems that grandma and grandpa would rather have to replace the transmission every now and then than to have their tushes bumped during shifts. I guess that this allows them to have a deeper sleep while careening down the highway."

If durability is more important to an XJ-S owner than the gentle shifts, use of alternative fluids (see page 327), boosting the line pressure (see below) or installation of a "shift kit" may be in order.

RAISING THE LINE PRESSURE: Tim Blystone sends this idea in response to the suggestion of using Type F fluid on page 327: "The F-Type fluid is somewhat thinner and is supposed to allow the tranny to shift faster and more positively. It does no harm and neither have I ever been able to see any good it does either. I would rather use Dexron 3, remove the pump and replace the pump pressure spring with a new red spring. Used in Corvettes. This will raise line pressure and make the whole thing shift more positive."

GM400 TRANSMISSION MODS: Helpful sources include B&M Racing (page 714), TCI (page 720), and Turbo Action (page 720).

GM400 TRANSMISSION SHIFT POINT MOD #1: The 5.3 liter Jaguar V12 was designed prior to the fuel crunch of 1973 and has "over-square" engine dimensions -- the bore (90 mm) is considerably larger than the stroke (70 mm). Such a design is conducive to high performance at high RPM and is therefore ideal for racing applications, but results in poor low end torque. However, to optimize fuel economy, it is best if an engine is turning rather slowly, so the stock GM400 automatic transmission is set up to keep the V12 in the RPM range where its performance is poorest.

The point at which the GM400 shifts is determined primarily by a governor that responds to engine RPM, and is varied by two things: 1) a vacuum modulator that makes the car upshift promptly when vacuum is high (light throttle); 2) an electrical switch on the throttle linkage that forces the tranny to downshift, and remain in lower gears until 5000 RPM, when the pedal is pressed all the way to the floor ("kickdown").

The vacuum modulator is a bolt-on device on the right side of the transmission. *Some* of these modulators are adjustable by removing the vacuum hose and inserting a straight blade screwdriver into the vacuum fitting. Turning the adjustment changes the preload on the spring, therefore altering the shift points.

The vacuum modulators are available in several sizes, and since they are a standard GM part, are found in any auto parts store for reasonable prices. In general, the smaller they are, the more vacuum required to make the tranny upshift, so the longer the car will remain in the lower gears. Of course, it is recommended that you make sure to buy one that is adjustable.

Alan Jenks "fitted a B&M adjustable vacuum modulator (B&M #20234). This fits all TH400's."

Rather than buying a smaller modulator, Greg Meboe modified his existing one: "I needed to increase the spring pressure against the diaphragm. I did this by collapsing the modulator body around part of the spring in a vise, effectively shortening the working length of the spring. I imagine I took about 30% of the travel out of the spring. This had the effect of *increasing* the effective spring rate. The vacuum modulator modifications produce an upshift between 500 and 1500 rpm's higher than before, depending on throttle position."

GM400 TRANSMISSION SHIFT POINT MOD #2: For absolute maximum performance, shift points should be selected that surround the peak on the horsepower curve -- without exceeding the redline, of course. The engine should be allowed to run past the power peak, so that when shifting the engine doesn't drop back too far below the power

peak.

The published stats rate the Jaguar V12 at 5000 RPM. With the large steps between gears on a three-speed transmission, the engine should be taken to the redline of 6500 before shifting to optimize performance.

The GM400 slushomatic transmission, of course, was designed with the 1950's-design pushrod V8 in mind. Not only does it normally shift at relatively low rpm, it absolutely *refuses* to allow the engine to rev beyond 5000 rpm; it will shift at this point even if you have selected low gear with the lever. The above modification to the vacuum modulator will not affect the limit where the GM400 will force a shift.

The governor assembly is contained under a sheet metal cover on the right rear side of the transmission, and there is an access cover under the carpet of the XJ-S to get to it. If you remove the governor and grind a little weight off of each of the counterweights, the engine will shift at higher RPM under all conditions. This modification will allow the engine to run faster than 5000 RPM, where the stock GM400 will force a shift no matter what.

It may make sense to modify the governor as described, and install a *large* vacuum modulator to keep the light-throttle shifts at a reasonable RPM.

According to Chad Bolles, the GM400 in the 1991-92 XJ-S was programmed differently than earlier cars, providing higher RPM shifts under power, better downshifting, and holding low gear forever if the shifter is held in 1st. It may be possible to retrofit the changes into earlier cars (replace the governor, etc.) or to buy the later transmission and retrofit it.

GM400 TRANSMISSION SHIFT POINT MOD #3: If you want serious performance from your XJ-S, install one of the many available "shift kits" for the GM400. Keep in mind when you select your kit that your objective is to allow higher RPM shift points at full throttle (when the kickdown switch on the throttle cable is activated) or when manually shifting; High RPM shifts when taking it easy are of little benefit and will hurt fuel economy and passenger comfort. Many shift kits offer more firm shifting, some shift at redline at all times (!) and some even render your car a 3-speed manual.

Most shift kits can be installed by simply lowering the pan from the transmission and removing the valve body within. Replace a few springs and the like, and reassemble. See the notes on page 326 regarding the differences between pre- and post-1988 GM400 transmissions.

Alan Jenks reports on a "'Shift Improver Kit' from B&M Racing to the Turbo Hydromatic 400 automatic transmission. There are two kits, one for pre-1988 TH400 (B&M #20260) and one for post-1988 (B&M #20261). The kit can be fitted in two forms, either 'heavy duty' (stage 1) or 'street/strip' (stage 2). Stage 1 provided firmer shifting without compromising the quality of the ride, which is what I wanted."

Per Chad Bolles: B&M makes a product called a Transpak, "with this you can set up the trans to shift like you want, from very hard, to normal street." B&M also makes a Racing Kit, "this is a race *very hard* shift kit (neck snapping)." Finally, in what should probably be listed as GM400 Transmission Mod #3A, there is a replacement valve body. "The B&M valve body changes the shift pattern to 123NRP instead of PRN321."

Jim Hall says, "I installed a TransGo competition shift kit recently. In addition to very positive shifting, it has the added benefit of allowing downshifts to 2 and L at any speed. I'm delighted with it."

Jim Cantrell says, "The TH400 in modified form normally has a whine in first gear. This is the planetary gears. I don't really understand why, but installing a shift kit seems to increase the whining. It is considered normal behavior and at least on the one I have, has gone nearly 100k miles with no problems."

Jan Wikström had his local tranny shop "lock up the freewheel on 1st gear, which gives me respectable engine braking and a better "feel" in the really low-speed twisty bits. Caution: it's now possible to engage 1st at any speed..."

Paul Burke reports on "some information regarding "tweaking" of the GM400 box. It describes removal of four of the six balls, shift improver plate (different valve body transfer plate) and plugging one of the passages. The article was in *Musclecar Review*, February/March 1997 starting on page 58."

TORQUE CONVERTOR REPLACEMENT: First off, you might wish to note Roger Bywater's comments on the stock GM400 torque convertor on page 33.

There are torque convertors available that have a higher "stall speed", which sorta means they engage at a higher RPM. This is wonderful for the Jaguar V12, but does require removing the tranny to change. According to Thomas E. Alberts, "B&M tells you to try for 500-750 RPM less than the RPM at peak torque."

Michael Kenrick reports that the torque convertor from a 3.8 Buick Regal Turbo can be used to provide a more suitable stall speed.

According to Chad Bolles, the later model XJ-S uses the HI-Stall convertor. "It is the same converter used in the 427 L-88 and LS6 and LS7 Chev, flash stalls around 2600-2800rpm, the difference being the Jaguar converter has 6 lugs on it where the Chev has 3." He adds that a Chevy convertor may be used in the Jag, leaving the other three bolt holes unused. Reportedly, some GM torque convertors use six bolts as well.

Bolles also explains the difference between stall speed and "flash stall". Stall speed is the RPM the engine runs at continuously if the brake is held and the accelerator is floored in gear. Note: this is very hard on the equipment, and causes a lot of heat in the transmission; such tests should only be done for a couple seconds, and the car should be driven around at normal speeds for a while afterward to allow the transmission fluid cooler in the radiator to cool the transmission back down. "Flash Stall, hold the brake, trans in gear, quickly mash the acc pedal, watch the Tach, it will flash to about 2500-2800 rpm, but if you just hold the brake and ease the acc pedal down the converter will not reach the same rpm before it tries to spin the rear tyres. Don't ask me why, I just know that that's how it works."

GM400 RATIO CHANGE: Thomas E. Alberts says, "...I agree that the standard gearset is poorly matched to the XJ-S... Note that the modified gearsets, like TCI's, lower the second gear ratio as well as first. Observe:

	TH 400	TCI gearset
1st	2:48	2:75
2nd	1:48	1:57
3rd	1	1

I think it would make a very nice improvement and without any sacrifice of top end speed."

ADDING OVERDRIVE TO THE GM400: John Goodman has heard about "overdrive units manufactured by American Overdrive Inc. designed for autoboxes, GM400 included? This effectively changes your GM400 into a six speed.

"Two possibilities here would give much better acceleration. The unit can be supplied with the internals reversed so you have underdrive first, underdrive second and underdrive top. Or install a lower axle ratio and leave the overdrive in and switch it out for "Sport Mode"."

ALTERNATIVE TRANSMISSIONS

TH700R4: One way to deal with the shortcomings of the GM400 or BW12 is to replace it with the more modern TH700R4. One large benefit is that the TH700R4 will provide much better performance from a standing start: the torque convertor provides a larger effective reduction, and first gear is much lower than the GM400's 2.40:1. Plus, it has four gears, including an overdrive 4th. The overdrive 4th can enable the installation of a lower final drive ratio, making the get-up-and-go better still without sacrificing the top end cruise.

John's Cars (page 717) provides the adapter hardware necessary to fit the TH700R4 to the Jaguar V12 5.3. Scott Horner says that Dellow (page 715) does as well, and Chad Bolles of Jaguar South (page 717) announced his adapter: "Just think, XJ-S'ers: 30% lower rpm at 80 mph -- that means about 1900 rpm. Gas mileage up around 20 to 30%. 0-60 times in the 6 second bracket. Tyre smoke from the stoplight. A loss of about 30 to 50 lbs by getting rid of the Turbo 400." XK's Unlimited (page 697) offers a "conversion kit".

If you have the '94-on 6.0 V12, you probably don't need an adapter; the TH700R4 will probably bolt right up, since those engines have a standard Chevy bolt pattern. You probably aren't as interested in the swap, though, since the 6.0 also comes with the improved 4-speed GM400 and enough torque for respectable takeoffs.

MANUAL TRANSMISSION: The shift points, cruise speed RPM, fuel economy and top end can all be optimized by replacing the GM400 or BW12 with a manual transmission. This is a major task requiring the installation of flywheel, bell housing, clutch, clutch pedal, console modifications, speedometer fiddling, etc. Changing the final drive ratio (differential gears) should be considered, since 5- and 6-speeds generally have an overdrive top gear and the final drive ratio is already tall enough.

Jaguar did make a few XJ-S's with a 4-speed manual transmission, but these were early cars. The transmission and clutch were similar to those used in the SIII E-Type, but those cars are valuable today. Trying to obtain the hardware needed to convert *your* XJ-S to a manual transmission from either source is likely to be difficult and expensive. Besides, you end up with only 4 gears. For most people, it makes more sense to adapt a modern 5- or 6-speed from some other model car.

The author of this book *has* performed this modification on his car, using a 5-speed Borg-Warner NWC transmission from a Camaro and making a lot of components from scratch. Now such a task is much easier, because you can purchase many of the necessary components or even entire kits for this conversion. General info for those considering such mods follows, much of it provided by Mike Frank.

There are five transmissions commonly considered. One is the Borg-Warner NWC 5-speed, which comes in Camaros, Mustangs, and several other vehicles; it has an integral shifter (no external linkage), and there are a couple different locations for this shifter. Reportedly the Mustang shifter configuration is better for the XJ-S than the Camaro configuration. This tranny is adequate for a stock XJ-S V12 but may be marginal if extensive engine mods are done. There are lots of ratios available.

There are 5-speed conversion kits using the "JT5" transmission, which is supposedly the same thing as a BW NWC only different. Only conversions for E-types and other older Jaguars are mentioned, but since the E-type SIII V12 is included, it may be possible to figure something out for the XJ-S. JT5 kits are offered by Terry's Jaguar (page 696) and Vicarage (page 704).

Another possibility is the Borg-Warner 6-speed used in the Dodge Viper and the later Firebird, Camaro and Corvette models. It has some advanced features such as carbon composite synchros. This is a massive tranny, and will probably handle whatever a Jag V12 can be made to dish out. There are a wide variety of ratios available.

The third possibility is a Getrag 5-speed. It is supposedly also adequate for all conceivable uses. The Getrag is a novelty in the US, but is reportedly fairly common in Europe. SNG Barratt (page 696) offers kits using this transmission; again, only E-types are mentioned, but the SIII V12 is included.

The fourth possibility is the Tremec 5-speed, described by Jim Swarr: "Tremec is owned by Dana Corporation which is well known worldwide for its transmissions and rear axles. The Tremec 3550 and TKO is their performance line of transmissions. Tremec made the famous Ford "top loader" 4-speed. This is a modernized version of that with an overdrive. It has a heavy duty aluminum case, rollerized gears and internal rail shifter. The gear ratios are 3.27, 1.98, 1.35, 1 and .68. The only gear ratio option is a .82 overdrive. It is a very strong transmission; I have one in a customer's 750 hp drag car. I would suggest that you use the TKO because it has a bigger input shaft and output shaft. A bellhousing needs to be fabricated (welding a plate to a stock bell) for your car to fit a Ford transmission, or if you can adapt it for a Chevy 4-speed I can convert the Tremec to fit into the Chevy bell. If you have any more questions please call me at 610-489-4029 anytime after 10:30AM EST."

Concerned about the toploader's reputation for notchy shifting, Inder Singh says, "In a followup question on the subject, Mr. Swarr assures me that Tremec has made a number of improvements to its shifting characteristics."

Keisler Automotive Engineering & Electric (page 718) offers a kit using the Tremec TKO, and Conversion Components Ltd. (page 715) offers a Tremec kit.

The fifth possibility is the Toyota Supra transmission -- but apparently there is confusion about *which* Toyota Supra transmission. There are three general types. The first type is generally referred to as the W58, although technically there were W55, W57, W58, and W59 transmissions differing chiefly in ratio only. This transmission is described as "an all-alloy case 5-speed and can be distinguished by 9 bolts and 2 dowels holding the box to its bellhousing." There are four possible stick positions: 18", 19", 20-1/2" and 21", as measured from the front of the box.

If you get your own Supra W58 tranny from a junkyard, note that before installation it is recommended to remove the front cover of the transmission which holds the input shaft bearing and the input end of the layshaft and replace the light-duty layshaft bearing with a generic industrial-duty bearing of the same size -- a five-minute job. Reportedly the bearing that's in there has 8 balls, and the generic bearing will have 12. Winston Good reports: "After much trouble I thought I should include the part number that I found to do this 5 minute job: KOYO BLO6307NR C3. The box I got says 6307. I believe the NSK number is HR6307NX. All the specs are at the NSK website. Mine took longer than 5 minutes since the press is at the machine shop."

Dellow (page 715), sells kits to install a W58 in a Jaguar. Note that, despite the fact that Dellow is located in Australia, getting all the hardware needed from them might still be cheaper than buying the transmission itself locally.

Dellow also offers some Supra 4-speed boxes.

Conversion Components, Ltd. (page 715), also offers 5-speed kits using Toyota Supra gearboxes. They modify the shifter location to make it more ideal for installation in the Jaguar.

There is also some history of the Toyota "steel case" 5-speed from Celicas, Crowns, Coronas, Cressidas, etc., being used in Jaguars with success, even though it is described as not quite as strong as the Supra. This tranny has 7 bolts holding it to the bellhousing.

W58 transmissions have a long and glorious history of successful use in Jaguars with 6-cylinder engines. They have also been used behind V12's and the owners have been happy with them -- at least, up until they broke. There *are* reports of failure. If a V12 has a Supra transmission behind it that hasn't broken yet, the W58 may in fact be up to the task, or maybe the owner has just been lucky so far -- or maybe it isn't a W58. Which brings us to the second type of Toyota Supra transmission.

According to Tony Bryant, the W58 was only used in non-Turbo Supras and a 2L Twin Turbo model sold only in Japan. From 1986 to 1993, the 2.5L Twin Turbo and 3L Turbo were fitted with the R154 transmission. "The R154 has *huge* & *wide* gears. It has inch deep ribbing all over the case. It is 50% heavier than the W58. Makes the W58 look like a dinky toy. There is *no* parts interchangeability. Not even close. I've had them both apart at the same time. A friend with a Tremec came over to have a look. He said the Tremec has noticeably smaller gears."

The third type of Supra transmission is the V161 six-speed used on the 3L Twin Turbo from 1993 on. Bryant: "The V161 is different again, apparently even stronger than the R154."

So, if you're considering putting a Supra transmission in your XJ-S, there are people that will suggest a W58 transmission and even outfits that will sell you a kit to use one. But, really, if you're going to that level of effort and expense, it really only makes sense to insist upon the R154 or V161.

Once you decide on a tranny, there are details to deal with. John Napoli tells us about Tilton (page 720): "They cater to the racers. They sell a full range of bellhousings for the V12 that accept popular manual transmissions. You can even get a small-diameter, multi-plate clutch with a small, reverse-rotation, gear reduction starter that mounts backwards on the bellhousing, alongside the transmission. Imagine -- starter changes in the XJ-S without removing exhaust pipes, and from inside the car!! Be still my heart."

Jaguar made a lot of manual transmission XJ-S's -- with the AJ6 engine. Still, maybe some parts would be helpful for the V12 conversion. Chad Bolles reports, "The pedal box from the 5sp XJ-S will fit any XJ-S, but the problem is it will

only work on an XJ-S with ABS, and I have found no way to make it work on a non-ABS car.” Aaargh! Note that that AJ6-powered XJ-S existed in Europe before the advent of ABS brakes, so perhaps there is still a possibility there.

Vintage Jaguar Works (page 697) offers a pedal box with clutch pedal and master cylinder.

AJ6 Engineering (page 713) suggests that the ECU needs the overrun cutoff disabled “to avoid driveline shunt at low speed.” AJ6 Engineering also can remap the fuelling to deal with wide open throttle below 2000 rpm -- a situation that simply cannot exist with the A/T so the original map may not have been optimized all that well in this realm.

One final note: The mid-80’s US-spec XJ-S EFI operates in closed-loop mode in D and in open-loop in P or N. There’s a reason for this; it can develop an unstable idle in closed-loop without the load of the torque convertor. If you install a manual transmission, you may need to operate in open-loop all the time (which is terrible for fuel economy) or find some other way to switch from open-loop to closed-loop. Or, you can operate in closed-loop all the time and work to minimize the idle instability; upgrading to 3-wire oxygen sensors might help. Adjusting the idle mixture trim on the ECU may help.

TRANSMISSION MOUNT

Yes, the transmission mount in the Jaguar XJ-S deserves its own section in this book. This mount would have made Rube Goldberg proud. The design utilizes a spring to take the weight of the transmission, as opposed to the rubber supports used on most cars. It also has a vertical post assembly containing a “special washer with rounded edges” within a rubber bushing. This assembly allows a very limited range of motion: some vertical travel to allow the spring to work via the post assembly sliding up and down within the bushing; very little horizontal or axial travel, since the special washer fits snugly within the bushing; and a little tilting (torque reactions) via the special washer behaving as a ball joint within the rubber bushing.

The desire to use a spring doesn’t adequately explain the complexity of this assembly, however. It’s possible that there was also a safety objective. In the 70’s Volvo was advertising that their transmission mounts would guide the engine under the car in a front-on collision instead of the engine coming into the passenger compartment, and perhaps Jaguar had similar intentions in mind. The part that connects to the bottom of the center post is sometimes called a “collision plate”, although it’s also called a “tie plate”. Perhaps crash safety is a plausible explanation for the complexity, but it’s certainly not obvious how this design makes the car any safer in a crash.

Note: If you disassemble the mount and lower the transmission significantly, Thomas E. Alberts suggests you take care that the top of the engine does not damage the heater valve.

If you have the mount apart, consider servicing the driveshaft U-joints while you’re there. See page 348.

RUBBER BUSHING & SPRING CUP REPLACEMENT: Finding the rubber bushing (CAC3227) or the rubber spring cups (CBC2517) in place and intact appears to be a rare occurrence. They are often missing, damaged or mislocated, evidence of previous mechanics working in the area who didn’t understand how the support goes together. Even if the parts were installed properly, they are often severely deteriorated, sometimes to the point where there’s little evidence they were ever there beyond a puddle of rubbery goo in the bottom of the spring support. Some people claim their original parts were made of foam rubber, but apparently this is a material breakdown of the solid British rubber that makes it crumble so as to appear to be a deteriorating foam material.

To properly install a new rubber bushing requires removal of the spring support; you cannot simply jam the rubber bushing in from below. With the spring support removed, install the rubber spool into the center boss so that one lip of the spool is on top of the support and one lip is within the recessed opening on the bottom. It should be securely snapped in place in the boss.

If you are disgusted with the lack of durability of the spring cups, you can easily make substitutes by slitting rubber or vinyl tubing lengthwise and slipping it over the end coils. Note that there are supposed to be spring cups on *both* ends of the spring, but apparently the upper one is difficult to get in so mechanics leave it out. John Whitford, installing a new CCC6759 spring, says, "There were seats on both ends of the spring I pulled out. The top one had been badly mangled by the motion. I left off the top seat when I refit the spring. I tried to fit it (by itself) around the raised part of the spring retainer and it was stretched and distorted when I got it all the way around. I'm sure the spring popped out of the old one and then chopped it up. Everything went back together just like the book and as of the first test, I'm clunkless." Maybe the new spring was designed long enough to be used without the upper cup.

Paul Hackbart notes that John's Cars (page 717) offers replacement bushings and spring cups: "The transmission mount bushing from John's Cars is no different in design. Both the bushing and the cup at the end of spring are for sale in polyurethane." Polyurethane would seem too stiff for the bushing, but LaRue Boyce says, "I put in the John's Car bushing last month and it works great." Since this bushing must be squished to be installed in the support boss, having it made of something as stiff as polyurethane would obviously make it more difficult to install. Boyce adds, "...it is a little difficult. I tried a vice, etc., but the only way I could get it in was to use lots of oil on the bushing and angle it in and press with a flat screwdriver. Not very scientific but it finally went in. Mine works great and I have no complaints, much better than the handful of part that fell out. It appears to be made of the same stuff as John's steering rack bushings." Note that, if you must lube it to get it in, it'd probably be a good idea to use a special lubricant made for polyurethane since some hydrocarbons will attack polyurethane. Hackbart adds, "The trans. mount bushing from John's Car's does not come with that special red grease used with polyurethane however. It is the same type of grease included with rebuild kits for brakes; you can get it at any auto parts store."

XK's Unlimited (page 697) also offers polyurethane spring buffers and center bushings.

POLY BUSHING FAILURES: Paul Hackbart also reports on a failure mode of the John's Cars bushing. If the transmission is forced to the upper limit of travel (such as by running over something that hits the bottom of the tranny and knocks it upward), the washer (double washer on the GM400 mount) at the bottom of the post -- which is supposed to provide a bump stop limit to upward travel by hitting the bottom end of the bushing -- can actually push the center portion of the bushing right through the boss on the spring support, shearing off the outer flange of the polyurethane bushing and leaving it rattling around the bottom of the post.

This problem may actually occur with the stock rubber bushings as well, we just wouldn't know it because they end up in too many pieces to figure out what happened. Such shear damage could probably be avoided with either type bushing by replacing the bottom washer with a fender washer with a larger OD, so that it contacts the full surface of the end of the bushing rather than just the center portion of it. Since the outer portion of the flange will be put in simple compression in such a configuration, it should render the bushing safe from shear damage. Note that the washer used shouldn't be too big or it might contact the inside surface of the "dome" on the tie plate and make noise.

Note also that the reason the GM400 mount uses a double washer is probably to limit the upward travel to about 1/16" less than it would be with a flat washer, so if you're installing a flat fender washer you should do something to similarly reduce upward travel. One idea would be to cut the sleeve on the post about 1/16" shorter and install a small 1/16" thick washer on the post *under* the flat fender washer (just above the tie plate), which would work. Another idea would be to cut a large rubber disk out of a truck tire inner tube, put a hole in the center, and install it on the post around the lower sleeve. That way, when the transmission moves upward, the flat washer will hit the bottom end of the bushing with a thin layer of rubber in between, softening the impact and limiting the upward movement. Most of the time, this rubber disk will simply sit on top of the bottom washer and do nothing. If the hole in the rubber disk is made just a hair smaller than the OD of the sleeve, it can be pushed onto the sleeve and will stay in place by itself while you install the rest of the parts.

TRANSMISSION MOUNT SPRINGS: Mike Morrin: "The BW12, GM400 and manual springs are different parts; the BW12 spring is painted black/yellow, the GM400 spring is painted black/red. The manual transmission spring is black/blue." See more info on the GM400 spring on page 346.

Borg-Warner Transmission Mount

This author owns a car that came with a GM400 transmission, so the section on that mount is more comprehensive than this one on the BW transmission mount. The concept behind the BW mount is obviously similar to the mount used in the later GM400 cars, so it is recommended that the BW owner go ahead and read the section on the GM400 transmission mount and study the illustration. Maybe later versions of this book will contain a similar illustration of the BW mount.

We're not totally helpless on the BW mount, though; following are some notes. While the center post in the GM400 mount is attached to the transmission with two bolts through an aluminum base plate, the center post for the BW is a simple double-ended bolt that threads directly into the transmission case. A dish-shaped spring seat is held in place by the BW post, while the base plate of the GM400 post serves as its upper spring seat. Since the BW post doesn't have the shoulder that the GM400 post has, an additional sleeve must be used *above* the "special washer" to provide the proper shape for the bushing to slide up and down against. Fig. 1.7 on page 24 of the Haynes manual, as is typical, leaves one of the two sleeves and the special washer out altogether. However, Fig. 1.12 on page 29, although showing the mount for a manual transmission, shows the two sleeves and special bushing correctly.

The upper end of the rubber bushing impacting the base plate of the GM400 post provides a downward bump stop limit to the mount's travel, but the BW post doesn't have a base plate so a special "double washer" is installed between the uppermost sleeve and the hex on the post itself to serve as a bump stop. As shown in the illustration on page 345, the surface of the GM400 base plate is not flat but rather a bit conical, perhaps to soften the blow when the rubber bushing hits it. The double washer used at the top of the BW mount has a similar shape, as Mike Morrin describes: "It is 2 washers spot welded together, the first is a 1/8" thick flat washer with 1/2" ID which fits the spigot, and a 2" OD. The second has a 3/4" ID which just fits over the sleeve, a 2" OD. The second washer however has a profiled thickness which is 1/4" thick near the centre and tapers down to a thickness of 1/8", 1/4" from the outside edge, and is flat from there out. The same part is used on the BW66 in the XJ6."

Don't get confused by the various diagrams and exploded views, many of which are incorrect. Mike Morrin says, "The problem is that the XJ-S and e-type parts books show the double washer on the top, but the XJ12 parts book shows the double washer on the bottom. I have seen them assembled both ways." Fig. 1.7 in the Haynes manual likewise incorrectly shows the double washer at the bottom.

Both the GM400 and the BW mount schemes have a washer at the bottom end of the post to serve as an upward bump stop limit to the mount's travel. The one on the GM400 is a "double washer", but it's not like the one described above; it's a simple matter of two flat washers welded together. The bottom washer installed on the BW post is a simple flat washer.

I'm sure you've been following all that perfectly, so I don't need to explain how to assemble the mount -- but I will anyway. For cars fitted with the BW automatic, the double washer must be positioned on the post *before* the spring support is installed, since it cannot be inserted through the bushing later. Mike Morrin says, "I sat the double washer on top of the bushing"; this may be an excellent method, since the spring support isn't all that heavy and if the double washer falls off you can simply try it again. After the spring support is bolted in and the jack is removed so the tranny is sitting on it, the order of parts installed on the post is sleeve, rounded-edge washer, sleeve, double washer, collision plate, nut.

GM400 Transmission Mount

The Borg-Warner transmission mount was complex enough, but when the same idea was adapted to hold up the GM400 transmission it got even more confusing. A picture is worth a thousand words here. Exploded views abound but many seem to be missing a few parts, which doesn't help someone trying to figure out how it goes together. Figure 16 is a section drawing of the assembly, in hopes that it will be of some help.

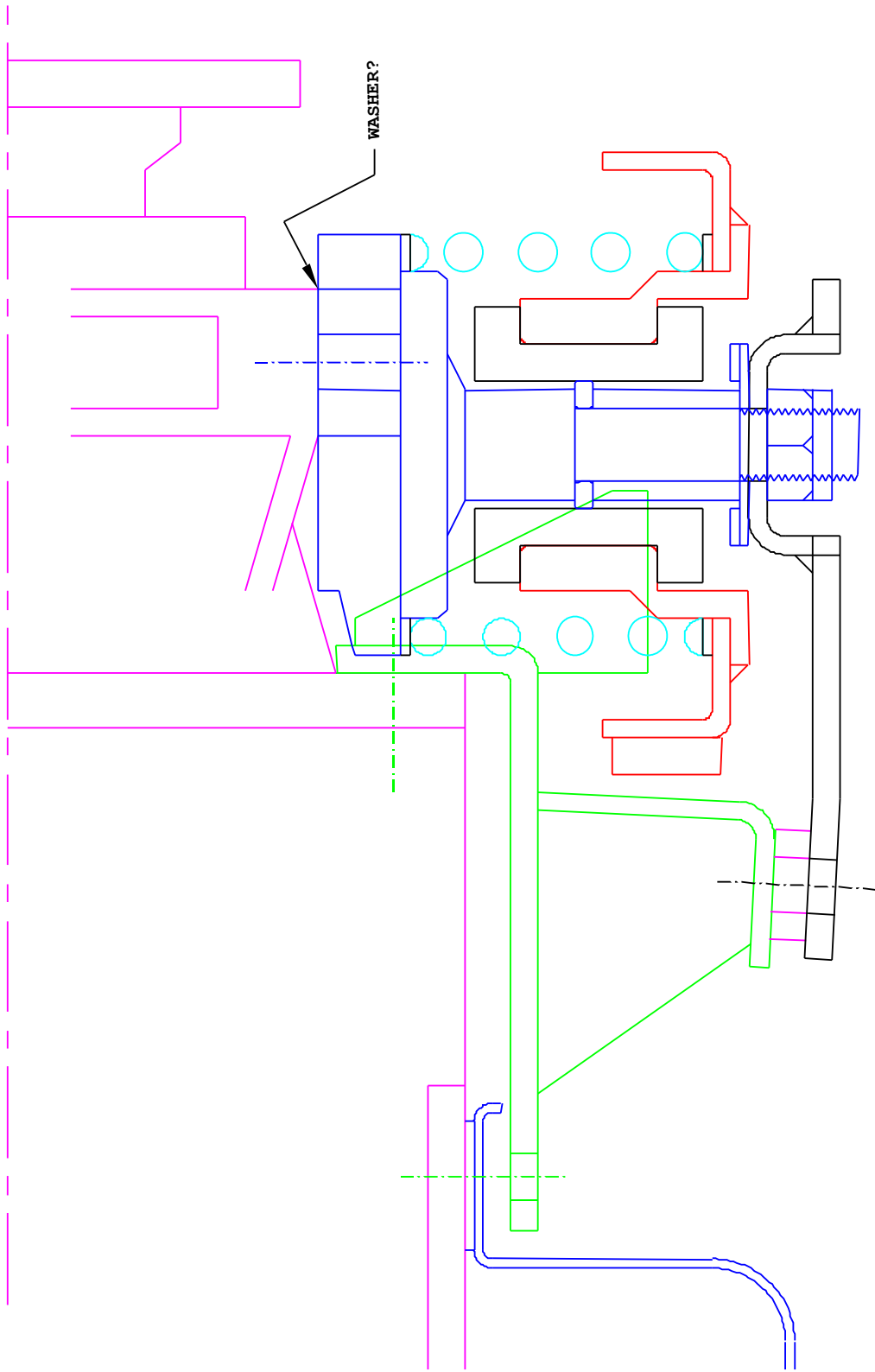


Figure 16 - Assembly of Transmission Mount (GM400)

Note that almost everything in this diagram is attached to the transmission itself, which means it moves up and down with the transmission as it bounces on the spring. The only parts in this diagram that are motionless relative to the chassis are the spring support, the bushing within it, and the bottom coil of the spring. There is a major support plate rearward of the spring support that is not shown in this diagram for clarity, but it's one of the most obvious things in your way when you're under the car.

Also note that the two rearward arms on the spring support attach to the support plate with 1" spacers.

SPRING: Michael Neal reports that the GM400 tranny support spring (CAC2327) does not hold up well, and recommends it be replaced every 30,000 miles (when the tranny fluid and filter are supposed to be changed). Apparently it gets weaker as it gets older.

Peter Cohen reports that the springs changed part numbers a few times, perhaps indicating Jaguar's attempts to improve this thing's durability. "CAC2327 superceded to CAC2327/1 and then superceded to CAC2327/1*" He reports that the CAC2327/1* "is a thicker coil!!!"

John S. Whitford says, "I bought a new spring because the one I pulled out was only 3 9/16" high. Jaguar has a new part no. CCC6759 for the spring and it was exactly 3 3/4" high. It even had paint codes on it like the front road springs do. Blue and Violet. No clue what they mean though." Neal responds: "That is the number of the only spring I've been using for a few years now. It is the latest and greatest unit but still collapses easily."

John's Cars (page 717) offers a replacement spring that is supposedly better than the Jaguar springs. Brian Radovich of John's Cars: "The only difference I spec is a high silicon steel which has a much better tensile life than the Jag bit."

Unfortunately for John's Cars' reputation, the vendor making springs for them reportedly made a batch of the springs out of the wrong wire, making the springs too stiff. This may seem counterintuitive, but imagine how your car would ride if you installed springs in the suspension that held the car up in the air and the suspension hard against its stops. This is exactly what happens here; the transmission mount only has about an inch of travel and the spring is supposed to support the weight of the tranny in between the stops (as shown in Figure 16), but the overstrong spring held the transmission up against the upper stop. This, of course, causes all the vibrations of the engine/transmission assembly to be conducted directly into the chassis. Owners who installed the faulty John's Cars spring have had to disassemble their transmission mounts to reinstall the stock spring. A stiffer spring could be used provided it is also shorter so that it still holds the transmission in the correct position, but such was not the case with this spring.

Radovich found the problem and corrected it, so you should now be able to get a usable spring from John's Cars: "I will warranty any spring I have sold - and any poly mounts that have suffered as a result."

GOT A COUPLE EXTRA WASHERS? There have been several reports of washers being found between the vertical post and the housing of the transmission (see Figure 16). Reportedly, with the mount assembled correctly it was still possible for the forward U-joint on the drive shaft to hit the support plate, causing a "clunk". The washers were added between the post and the transmission housing to hoist the transmission by the thickness of the washers, just enough to eliminate the clunk.

GM400 TRANSMISSION MOUNT REASSEMBLY: The two rearmost pan bolts should be double-ended bolts with the head in the middle, so that after installing the pan there are studs available for holding the forward bracket in place. If such bolts are missing and unavailable, normal bolts can be used by inserting suitable washers between the bracket and the pan. The washers should total 3/16" thick. A better idea might be to thread nuts onto studs, screw the studs into the tranny, and then tighten the nuts to hold the pan on securely while leaving the other end of the stud to hold the tie plate in place with a second nut.

While apart, the spring support (CAC2438) should be cleaned to remove all the crud that has collected in it. The crud often appears to be the dissolved remains of the original rubber parts, but we will endeavor not to draw any conclusions about Jaguar's materials engineers. The crud must be removed to allow the spring and lower spring cup to seat

properly.

The transmission must be jacked all the way up into the tunnel before the spring support is installed. Once the spring support is securely bolted into place, then the jack can be lowered, allowing the transmission to sit on the spring and the center post to protrude through the bottom.

Easier said than done, of course. With the transmission jacked up hard against the tunnel, bolting the spring support in place may still be difficult. Paul Hackbart came up with a nifty solution, but you need to have one of the better floor jacks to do it: "Larger jacks have a removable/floating circular dish piece that raises the car. Well (Dummy!) simply remove disk leaving 3/4-1" hole. The long bolt goes straight through the hole as the mount is jacked/pressed up and is perfectly balanced allowing you to tighten all 4 mounting bracket bolts. So, allow one jack and 2x4 to hold up tranny under sump and your larger one with dish removed exposing hole to jack up mount."

Once the spring support is bolted in and supporting the tranny and the jacks have been removed, the assembly of the parts on the center post is as follows: the first item to be installed should be a special washer that has rounded edges, C29011; it will need to be crammed into the rubber bushing somewhat. Next is the sleeve, C30157. Third is a part that looks like two washers welded together; it should be installed with the larger opening facing upward. Then the tie plate is installed, followed by the large self-locking nut; there is no washer directly under the nut.

If the special washer C29011 is missing, a 1/2" splitting lock washer bent flat will serve.

Two small spacers should be installed between the tie plate and the forward bracket. If they are missing, 3/8" washers totaling 1/4" in thickness may be used.

After assembly, there should be no more than 3/4" between the tie plate and the bottom of the spring support. Check that the transmission moves freely on the mount; since the spring is soft, you should be able to bounce the entire engine/transmission assembly up and down a little with your hands. If it appears to be immovable, something is not right. It also should not clunk when moved.

Gerry Halpern had a howling noise coming from the transmission area on acceleration. "I got a copy of the assy drawing from a local parts guy and reinspected it again this weekend, frankly hoping to find something that I had installed incorrectly. Alas, I couldn't find a thing wrong. Laying there on my back looking up at the trans mount I pushed upward to make sure that I got movement; sure enough, it seemed to move OK. However, I decided to loosen the 4 bolts holding the mount, then moved the trans up and down. I could see the mount move and realign itself. Voilà! I could now move the trans quite freely up and down. I tightened the mount bolts and sure enough problem solved. Point to be made is that the trans mount should be positioned so that the mount can be moved easily up and down against the spring pressure. Two of the bolts are awkward to get at with the exhaust in place and there is a great deal of tolerance in the bracket slots making it easy to misalign."

Keeping in mind that the engine/transmission is entirely supported and positioned by the two motor mounts and the transmission mount, misalignment of the transmission support might be due to problems with the motor mounts. If the transmission support doesn't wanna line up, maybe the thing to do is loosen the motor mounts and see if you can realign *them*.

VARIATIONS: On page 49 of the Haynes manual, there is a picture labelled "49.5A Aluminum spigot bolted to transmission" (all the photos in the Haynes manual reflect parts from a Daimler Double Six with a GM400 transmission, obviously pre-1985). The post shown in Figure 16 is steel, so if this spigot is really aluminum it's something different. It also appears to have the entire external shape of the post incorporated in the post itself, so there's no need for a "special washer" or a sleeve. Mike Morrin says, "The GM400 mount in the pre-H.E. parts book shows the spigot with the ridge machined into it, there being no part numbers for the "special washer" or sleeve." If that's actually the case, the reassembly instructions above are correct except that you can leave the special washer and sleeve out of the order. On the other hand, maybe what you *really* want to do is find the later design steel post; it's unlikely the design was changed without a good reason.

Sometime in the 90's, the post design was changed again. This final configuration had the external shape of the early aluminum post so no special washer or sleeve is needed, but it is made of steel.

Paul Hackbart says there also may be a difference between the way the steel posts are constructed. They all consist of a steel shaft pressed into a cast aluminum base, but some have a set of splines visible around the edge of this press fit. This may reflect a problem with the shaft breaking loose and turning while the mechanic was trying to tighten or loosen the self-locking nut -- but it's also possible that all post assemblies have splines and it's just that some extend up far enough to be visible.

TRANSMISSION MOUNT SUBSTITUTION: If you simply cannot figure out how to get the transmission mount back together despite all the guidance above, there are ways to substitute a more simple and basic mount scheme. John's Cars (page 717) offers a "no-nonsense" transmission mount, but you might not even need that; Chad Bolles says, "The extension housing for the Turbo 400 in your car is nothing but a Chev part. On my car I removed *all* the nuts, bolts, brackets, and the rest of the crap. I went to Parts America (Western Auto) and found a rear mount that fit a Buick, had two (2) holes in it and one stud. I then made myself a new rear crossmember, and reassembled the whole deal. Now I can change trans fluid without removing the rear mount."

Of course, Jaguar didn't provide such an involved mount scheme for nothing. One of their reasons was that a spring absorbs vibration better than a block of rubber. Imagine, if you will, how well your car would ride if you took the springs out of the suspension and replaced them with big blocks of rubber. Dan Jensen says, "I cannot comment on the GM 400 mount offered by John's Cars. I can comment on the effect of a TH 350 in my '83 XJ6 with the John's Cars rear transmission mount for this unit. There is noticeably more vibration transferred to the car. While John's claims this should not be the case (transmission the cause?), I prefer the factory mount." Other owners, however, claim they cannot feel any degradation in smoothness with the John's Cars mount -- perhaps because their original mount was assembled incorrectly! We'll never know for sure; you'll have to take your own chances if you decide to go this route.

DRIVESHAFT

SLIP JOINT ALIGNMENT: Craig Sawyers suggests that when removing the rear suspension, it's easier to just yank the drive shaft apart at the slip joint than to unbolt it from the final drive unit. "There is a pair of arrows stamped on the two halves so you get the splines aligned and end up with a balanced driveshaft. Both halves are balanced dynamically at the factory. The arrows are faint; I marked mine before disassembly, before I noticed the arrows after cleaning it up."

UNIVERSAL JOINTS: The XJ-S was clearly not designed with ease of servicing the forward drive shaft U-joint in mind. Applying a grease gun to the zerk fitting, as well as removing the drive shaft itself, require the transmission mount to be removed; if you have it out anyway, you may wish to address the drive shaft. However, drive shaft inspection also requires that the main support plate be removed. Jaguar provided two bolts up within the tunnel to make sure this task was as unpleasant as possible.

According to Chad Bolles, the U-joints in the drive shaft are a GM standard, and Spicer 5-153X or Tru Cross 153 will fit. The U-joints in the rear axles are also a standard; Spicer 5-160X or Tru Cross 160 will fit. All of these should be available at your local auto parts store.

Some mechanics claim that having a grease fitting on a U-joint does more harm than good. In theory, if the seals in the U-joint are any good, it will never need regreasing; if the seals are bad, regreasing won't help for long. And undisciplined use of a grease gun is the best way to destroy the seals. Even if you're careful with the gun, it's more than likely that the grease injected will all go to one bearing and leave the other three ungreased; it's a path-of-least-resistance kind of thing. If you believe all that, you might as well choose replacement U-joints that have no zerk fittings and save a couple bucks.

FLANGE BOLTS: The flange bolts are occasionally found to be loose. Craig Sawyers: "Yup. Par for the course. However, the 15000 mile service for the car says "Check tightness of propshaft coupling bolts", so Jaguar obviously recognises that they loosen. Actually, I think it more likely that the bolts stretch slightly. While you're under the car, check the ones at the other end (gearbox). Betcha they're loose too."

It's also very important that the self-locking feature of the nuts is in good order. These bolts are too short to attain any sort of anti-rotation action due to bolt stretch, and lock washers aren't used here. If the nyloc nuts turn too easily on the bolt threads, replace them.

FINAL DRIVE

REAR SUSPENSION/DIFFERENTIAL REMOVAL: It's discussed on page 384.

DIFFERENTIAL TYPES: The XJ-S has apparently been fitted with at least two different differentials ("final drive units" for you Brits). From 1976-1985, the differential was a Salisbury 4HU Powr-Lok that came with either 3.07:1, 3.31:1 (1976-1982), or 2.88:1 (1982-1985) ratios.

From 1985-1987, a 2.88:1 Dana unit was used.

Now, follow closely. From 1987 to 1993, the XJ-S was fitted with a GKN Power Lock differential with a 2.88:1 ratio. The 87-93 differential is essentially the same item as the pre-85 differential (a speedometer sender was added; see page 593). According to Richard Griffiths, in the meantime Salisbury had been bought out by GKN. Later, GKN was bought out by -- wait for it -- Dana! But this was apparently after the XJ-S changed to outboard brakes. Dana (<http://www.dana.com/>) grew to be a huge corporation with annual revenues in the billions.

In this book, we will use the same convention that is commonly used among Jaguar owners: the pre-85 unit *and* the 87-93 unit will be referred to as a "Salisbury", regardless of whether it was actually made by Salisbury or GKN. The 85-87 unit will be referred to as a "Dana".

From 1993 on, the entire rear end of the XJ-S changed. A suspension similar to that on the XJ40 was used, with outboard brakes rather than inboard. Along with the engine being enlarged to 6.0 litre and the fitting of the 4-speed GM 400, a 3.54:1 final drive was used.

Apparently the AJ6-powered XJ-S's, 3.6 or 4.0 litre, all have 3.54:1 final drives.

All XJ-S differentials are "limited slip", although the feature has often been given different names.

The official Jaguar service department repair procedure for final drive units is to replace them as a whole.

SALISBURY VS. DANA: Differences between the Salisbury and the Dana include:

- On the Salisbury, the bearings on the output shafts are held in the case with five bolts. On the Dana, the bearings on the output shafts are held in place with three bolts.
- The Dana has no drain plug.
- The input flange on the Salisbury is circular. The input flange on the Dana is rectangular.
- With the Salisbury, the inboard brake calipers are bolted to lugs on the flanges holding the output shaft bearings, with the bolts installed from the inboard side outward. With the Dana, the inboard brake calipers are bolted to bosses on the case itself, with the bolts installed from the outboard side inward. In order to access those bolts, the Dana is fitted with brake rotors with access holes.

- The limited slip internals of the Salisbury are the “disc type”, while the limited slip parts of the Dana are the “cone type”.

Greg Wells of Coventry West says the gears from a Salisbury will not fit the Dana case.

DANA QUALITY: The Dana unit has a bad reputation. Apparently, the lack of a drain plug and the fewer bolts on the output shaft bearings gave an initial impression that it was “cheap”, and Jaguar’s return to the Salisbury unit after three years convinced many that there was something wrong with it. However, there’s no telling what supply problems Jaguar was dealing with in the mid-80’s, especially with a buyout going on at Salisbury, so there may be other explanations for the flip-flop.

Apparently, the real problems with the Dana are not in mechanical shortcomings in the unit itself, but rather in support and maintenance. Ian Hissey says, “I have just removed the Dana diff from my XJ-SC, and replaced it with an overhauled Salisbury. A number of reasons, including changing from 2.88 ratio to a 3.31 ratio, but also, here in Aus the cost of replacement bearings, etc., for the Dana was extortionate, more than double the Salisbury, and also the Dana is not a true limited slip, has a cone arrangement, which is not as effective as a Salisbury LSD.” Note that Hissey’s preference for disc-type limited slip over cone-type is not universal; it’s apparently a good topic for argument among performance buffs.

Greg Wells of Coventry West says, “The main problem with the Dana as we see it is that it is different and requires special Dana-style rear brake rotors.” Note that the only difference between the rotors used with the Dana and the rotors used with the Salisbury are the access holes, so the Dana ones could be used on the Salisbury. It would therefore make sense to stock only the Dana style, but Wells says the ones with holes cost significantly more than the ones without holes so they stock both. Obviously, you could buy the cheaper Salisbury rotors and drill access holes in them for use on a Dana.

“That, plus the fact that it doesn’t have a drain plug and people thus change the diff lube even less often compared to the Salisbury. Our rebuilder, Dick Maury, says that the L/S clutch setup in the Danas is not quite as good as a Salisbury in his opinion and that the carrier may not be as strong, but he also points out that we have seen Danas in 6.0L TWRs, so they obviously can handle the power.” Apparently, the items that fail on the Dana are “those silly little clutch retainers”, whatever that means.

DANA DIFFERENTIAL SERVICE: When working on a Dana unit, you can get the seals from Jaguar, bearings from a local bearing house, and the clutches, shims, and those silly little clutch retainers from any performance shop that has access to Dana rear end parts. When ordering, they will usually ask for a ring gear diameter and an “axle” spline count.

DIFFERENTIAL BREATHER: John Goodman reports on special parts for the XJR-S: “Looking through the parts list I notice that there is a revised diff cover with additional baffles. <Quote manual> ..."the diff rear cover is redesigned to improve breathing at high road speeds. The altered baffle plates direct oil flow so that turbulence is kept away from the oil breather.””

DIFFERENTIAL OIL CHANGE: Getting the fill plug out is no picnic. It has been suggested that removing the center reinforcing plate under the final drive unit (14 bolts, 6 with nuts) may be worthwhile. Don’t worry, the whole car won’t fall apart while the plate is out.

Many Jag owners suggest a length of plastic hose and a squeeze bottle for topping up or filling up the final drive unit. The hose should be long enough to feed out the right side wheel well so the oil can flow downhill.

Brian Sherwood points out that if you open the boot, remove the spare tire, and peel back the matting forward of the fuel pump, there is a round metal plug; removal of this plug provides access to the fill plug on the differential. “I just popped it out with a screwdriver, did my lube thing, then pressed the plug back in with some RTV around the edge.”

Note that while the diff can be topped up with conventional gear oil, a drain and refill requires an additive for limited-slip units.

According to a salesman at Quality Jaguar, the XJ-S final drive unit uses both natural leather and natural rubber seals. Therefore, synthetic lubricants are *not* recommended. It is recommended that synthetics be avoided in the special additive as well.

DIFFERENTIAL GASKET: British Auto USA (see page 692) offers a differential cover gasket (part number 3931) that is supposed to be better than the original -- thicker and better material.

TEFLON: Dennis Hurvitz reports: "While having a quickie lube joint change the oil in my wife's car (ok, I was pressed for time), a guy pulled up in an older Mercedes to thank the manager. Seems the Mercedes guy had a differential whine and the manager recommended replacing the differential fluid with some new mixture containing teflon. The owner made a point of thanking the manager, because the problem (sound) mostly went away!"

Unfortunately, lubricants containing teflon are not recommended for limited-slip differentials, and all XJ-S's have limited-slip differentials. Still, if you're facing a diff rebuild anyway, perhaps you can add the teflon to quiet the whine and do without the positraction until you get around to having the diff rebuilt.

INPUT FLANGE RETAINING NUT: It's a really big nut, obviously it should be tightened down really tight, right? Wrong. This nut is used to set the preload on the input shaft bearings. Between the bearings is a "crush sleeve", and during assembly this nut is tightened just enough to provide the proper bearing preload while compressing this sleeve. If the nut is overtorqued, the entire final drive assembly must be torn down to install a new crush sleeve.

REPLACING THE INPUT SHAFT SEAL: The instructions are in the service manuals, but I'll repeat the main point of trouble here: When you're done, the big nut does *not* get torqued! It gets returned to *exactly where it was before*, which means you must mark where it was before you touch it!

Once properly marked, the rest of the job is reasonably straightforward. Mike Morrin fills in some details: "Holding the flange was no problem, the handbrake did the job perfectly.

"I don't think the splines should have locktite on them, they are fairly tight to remove anyway. It is however a good idea to put a little silicone sealant on the last bit of the splines in the flange to stop oil from creeping out along the splines. I also applied a little silicone sealant around the periphery of the seal.

"The new seal I fitted was marked "National USA 9316" and "S-10048-1-28". The new seal is neoprene, the old seal was leather (no wear on the shaft at all).

"Overall, it is a relatively easy job (particularly with the car on a hoist), but I think you do need a small puller to get the flange off the splines."

DIFFERENTIAL OUTPUT BEARING FAILURE: One of the common failure modes of the Jaguar differential unit is the failure of the bearings in the output shafts, possibly because these bearings take lateral loads imposed by the working of the suspension. Whatever, the failure is usually indicated by clunks from the rear when driving or the tire rubbing the wheel well where it formerly had clearance. Checking by grabbing the top of each rear wheel and shaking vigorously in and out clearly indicates a problem. Closer inspection shows that the output shaft is free to move in and out, and the only thing limiting movement is the brake disk banging back and forth within the caliper!

According to Jan Wikström, "it's very likely that all you need to do is replace the bearings and seals. This is not difficult, but you'll need to take the rear subframe off your car. You *can* do it from underneath, but that probably takes longer because of the difficulty in getting the brake calipers off and back on. Besides, taking out and dismantling the

complete rear suspension gives you a great opportunity to check *everything*.”

The output shaft assembly for the Salisbury differential is available as a pre-assembled unit under a single part number: AEU1802 for the right side, AEU1803 for the left. This simplifies repair considerably; by getting this assembly pre-made, the mechanic doesn't have to fiddle with bearing preload, crush sleeves, etc., he just removes the old assembly and bolts in the new. Obviously, there is a core charge on the old assembly, so it can be rebuilt with new bearings and seals.

CLUNK: Julian Mullaney shares an unpleasant experience: “I had a clunk on my '87 XJ-S from the rear end. My clunk was because the diff itself was loose in the mounts. The mounts in this case were 4 cone-shaped bolts which attach the inner lower wishbone mounts to the diff casting. The bolts screw right into the diff, and are wired in place. These bolts had just become a bit loose even though they were still wired together from the factory. The constant rocking with power on/off had worn the fit between bolts and casting. You can easily check for this by jacking the car up high, putting the trans in P, crawl under and look for movement in the joint while violently rotating the rear tires back and forth.” This is reportedly a fairly common problem; it should be noted that proper torquing and lockwiring of these bolts is very important. Many owners use Loctite on the threads as well.

Jan Wikström adds, “If the PO has omitted the security wires on the bolts, they come loose - and then the U-shaped shims fall out and the diff is *really* loose.

“The inner pivot bracket is shimmed to the diff to line up with the pivot mounting holes in the cage; with the bolts tight, the pivot spindles should slide in and out easily. If those inner pivot carriers aren't correctly shimmed, it's jolly well impossible to get the trunnion bolts out without slackening the diff bolts - which is *very* hard to do because the trunnion bolts block access to the bolt heads. You need a very thin open-ended spanner.”

“My second XJ had pivot spindles that couldn't be moved; somebody had botched the assembly and just forced the whole thing together without shims. I had the devil's own time finding a thin enough spanner to loosen the mounting bolts enough to slide the spindles out.”

“To get this right requires an extra step in the assembly procedure: you measure the space between brackets and diff (bracket mounting bolts finger-tight, bottom plate out) and get spacers to that thickness. Now, there's not a hell of a lot of space between the suspension arms and the bracket-to-diff bolts; unless you have some extremely thin spanners (and thin fingers to get the locking wire on), you now need to pull the inner pivot spindles. Put the spindles back in without the suspension arms and tighten the bejusus out of those bolts (the torque is in the book); now try the inner pivot spindles. If they don't slide out easily, you need to tinker with those shims. Apply lock wires and assemble the inner pivots.

“Now bolt on the bottom plate; you'll find that the complete assembly is rigid.

“Another thing I noted on that car was that the final drive had been flopping around to such an extent that the rear sub-frame was fractured on top, where the four top final drive mounting bolts are (invisible without taking it out). There's a (1/4 in? 5mm?) steel plate inside the double-walled top of the sub-frame (as I found when I welded fatigue cracks in my first one); the retaining bolt heads have an underside taper matching a taper in this plate. With your diff slopping back and forth, there is good reason to suspect fatigue cracks in the top.”

FINAL DRIVE RATIO CHANGE: There are many ratios available to fit the Salisbury final drive. However, be aware that if the ratio is changed significantly, the differential carrier will also have to be replaced. Since the lower ratios (higher numbers) require a smaller pinion, the ring gear needs to move closer to center to mesh properly. This could be accomplished by making the ring gear thicker or adding a spacer, but instead a replacement carrier is used with the mounting flange in a slightly different position. Unfortunately, the carrier costs more than the gears.

If you have the Dana final drive unit, Greg Wells of Coventry West reports that he can only get one set of gears to fit: 2.88:1. So, step #1 for changing the final drive ratio is to replace the Dana unit with a Salisbury. Wells adds that, thanks to the popularity of that change, Coventry West can no longer offer core credit on Dana final drive units -- they

have more on hand than they can use. So, changing the final drive ratio on a Dana-equipped car means buying an entire new Salisbury final drive unit outright and simply discarding the Dana -- an expensive proposition indeed.

SUSPENSION & STEERING

GREASE (ZERK) FITTINGS: Unlike the newer American “low-maintenance” cars, the Jag has zerk fittings all over the suspension. Periodically it should be gone over with the grease gun, but please be conservative. It is tempting to grease fittings too often and to pump too much grease, which will destroy the seals or gaiters on the joint.

The following is a list of the grease fittings on the car:

- All six universal joints -- good luck getting at the forward one on the drive shaft (see page 348). The protective covers on the rear axle U-joints have openings for greasing, but they may not line up. You can relocate them as necessary.
- All four corners of the flat plate under the differential (lower swingarm inner joints). There are holes in the plate for access to the zerk fittings.
- The needle bearings in the lower pivot joint of the rear hub carriers; the fittings are just inside the rear wheels at the bottom.
- Both front hubs. The fitting is on the side of the hub near the outer cap. With some wheel designs, the wheels do not need to be removed. Rumor has it these fittings have been deleted in later cars.
- Both upper front ball joints -- remove the front wheels for access. If these ball joints have been replaced with XJ40 ball joints, there are no grease fittings.
- Both lower front ball joints. The fittings point inward, underneath the car. If these ball joints have been replaced with XJ40 ball joints, there are no grease fittings.
- Steering rack -- see note on page 374.

Also, the rear wheel bearings should be greased by removing the small cap on the hub carrier and spooning a little grease into the hole. Don't overgrease, because the excess merely spins out and coats the inside of your wheels.

The pre-1983 Jaguars also had zerk fittings on the tie rod ends, but the later cars were fitted with “improved” tie rod ends with no such fittings.

The ball joint zerk fittings are designed with a relief system to prevent the grease gun from applying too much pressure. Under the fitting itself is a plastic washer that covers the relief hole. When the joint is full of grease, any additional greasing will force the plastic washer to bend, allowing the grease to come out adjacent to the fitting itself.

When installing the zerk fittings on these ball joints, note that overtightening the fitting onto the plastic washer will deform the washer and open the relief hole.

Michael Neal sends this tip on lubricating the lower ball joint: “If the grease comes out from behind the plastic washer as soon as you apply it then the passage is plugged. The best way to clean the passage is to remove the lower plate and zerk fitting. Ream out the passage and apply some grease to the cup before reassembling. The grease in the passage hardens after a relatively short amount of time and plugs the passage.” It is possible to remove this cup and clean it out without getting involved in the access and rebuild procedures discussed on page 366; Put a jack under the spring pan on the A-arm and jack it up, bend back the locking tabs and unbolt the cup, clean it out, regrease, and bolt it back on with the same shims in place.

Craig Sawyers pointed out that it might also help to unload the ball joint. James Berry says, “The grease finally went in, as Craig Sawyers suggested, if the car is jacked and the weight is taken off the hub. With the grease gun attached to the zerk, under pressure, the hub was moved right and left until finally the grease gave up and went where it was supposed to (I think).” It can be surprisingly difficult to get grease into this joint, even with the taper pin disconnected from the hub carrier! The pressure of the grease itself tends to press the ball against the upper ball seat, totally sealing off the path the grease needs to pass through. It may work best to have the weight of the car on the wheels and turn the steering back and forth while greasing -- if you can figure out how to accomplish that.

See the note on lubricating the water pump on page 212.

Don't overlook the zerk fittings themselves as a possible source of trouble. Each zerk fitting has a tiny spring-loaded ball check valve to allow grease in but not out. It is susceptible to corrosion and jamming. They are also easily damaged by impact.

RIDE HEIGHT: XJ-S owners are often concerned about whether the car is actually supposed to sit that low, or if something is wrong. The ROM describes a check, but it presumes you have original tires with full tread. It also presumes you have "slip plates", devices you set the front tires on so they can slide around and not bind the suspension travel. The following is a derived procedure that subtracts the tire rolling diameter out of the equation in order to determine if your car is sitting at the "correct" ride height for the tires you have on it, and all it requires is a level section of concrete.

Position the car on level ground with nobody in it, no heavy stuff inside or in the trunk, a full tank of gas, the emergency brake off and the shifter in N. Push the car back and forth a few feet. When pushing rearwards, push on the front bumper and deliberately bounce the front of the car a little while pushing. When pushing forwards, push the rear bumper and deliberately bounce that end as well. This is to make sure the car is fully settled in its position.

Measure the height to the center of the front wheels. With any luck, they should be the same, but if they vary slightly determine the average.

Subtract 6-3/8" from this height. This gives you the correct height above the ground for the flat bottom of the cross member between the front wheels.

If all four tires are the same, use the same front wheel center measurement (do *not* measure the height of the center of the rear wheels) and subtract 4-7/8". This will give you the correct height above the ground for the edges of the plate between the rear wheels with a full tank of gas. If all four tires are not the same, what do you care what the correct ride height is?

So much for the "correct" ride height. Now, to describe what you actually have, a story from B. J. Kroppe: "My former supervisor (a Jaguar employee) did vehicle packaging for the F-Type. He started with XJ-S drawings and came across some things which didn't add up. So he went to the assembly plant and measured some XJ-S vehicles and compared them to the drawings. He discovered that the cars being produced (this was mid-late 1980's) were very much lower than the drawings said they should be.

"After some investigating he learned that over the years more features had been put on the car, making it heavier, but springs had not been changed to accommodate for the added weight, thus causing the lower ride height in the actual cars vs. what the drawings were saying."

In practice, it appears the XJ-S may ride about a half inch lower than the "correct" ride height, even when new. If yours is significantly lower than that, however, it's probable that either the shocks or the springs need replacing.

SAGGING FRONT END: If your Jag seems to be riding low on the nose end, a likely culprit to check is the front shock absorbers. The XJ-S uses gas shocks, in which the damping fluid is held under pressure by a small amount of gas within the chamber. A side effect is that the pressure causes the shock to try to extend. This extending force helps raise the car a little, especially when the suspension is soft. The Jag was designed for these shocks, and if they lose pressure, the nose sags. Since the pressure may be lost while the fluid is still present, the low nose may be the first sign of failing shocks. Of course, the rear shocks are also gas type and may cause the same problem, but it doesn't seem to happen as often.

If the front sags and the shocks aren't the problem, see Craig Sawyers' comments on rust problems on page 372.

SHOCK ABSORBERS: To check the front shocks, jack up the car and remove the front wheel. From inside the engine compartment, remove the locknut, nut, rubber doughnut and seat from the top of the shock absorber. Then reach into

the wheel well, grab the top portion of the shock and pull it downward. If it is in good shape, it should move downward smoothly with a hiss, and when released should move smoothly but forcefully back to its full extended position by itself. If the motion is not smooth, or the shock compresses easily and quickly with no damping effect, or fails to extend itself when released, replace the shocks.

The traditional tests of shock absorbers involving pushing the car down and noting its recovery or noting the car's reactions over bumps are not entirely applicable to modern gas shocks. If a gas shock loses its gas charge, it may still appear to pass these tests; if it still has fluid in it, it will still provide some damping. The damping effectiveness is greatly reduced, however, and will get much worse over a series of bumps. And, as noted above, the car's ride height will be affected. There seems to be no substitute for disconnecting the shocks and checking them by hand. Checking the rear shocks will require a spring compressor to remove the springs from the shocks.

The original shocks on the XJ-S are Boge. Shocks are also offered by Unipart, Spax, Armstrong-Girling, Bilstein, Monroe, Gabriel, KYB, and Koni, some of which are actually reasonably priced. The only consistent reports received by this author regard the Gabriels -- consistently negative. They should probably be avoided, despite their lifetime guarantee.

Monroe, sold by NAPA and many other auto parts outlets in the US, used to offer reasonably-priced, serviceable shocks for the XJ-S. However, reports are that they came up with the "Sensatrac" design and it went to their heads, and their prices are no longer reasonable.

Terry's Jaguar Parts (page 696) offers some "competition gas-filled shock absorbers" with adjustable spring supports and spherical bearing mounts.

Matthias Fouquet-Lapar points out that Bilstein is now online:

<http://www.bilstein.com/>

"There is lots of tech info."

RIDE HEIGHT -- HESS & EISENHART CONVERTIBLE: The H&E seems to ride low even when the shocks and springs are in good order, especially at the rear. This is apparently because the H&E is heavier than the stock coupe, but the springs were not altered.

One possible solution is suggested by John Warr: "The shox recommended by Koni for the front of the XJ-S are gas charged, those for the rear are gas charged, adjustable spring height." Terry's Jaguar also offers "competition" shocks with adjustable spring supports. Coupled with the fact that Jaguar provides shims for the front springs, it may be possible to set the ride height of both ends where the car looks right.

Of course, another possibility may be to use the springs from an XJ12.

VIBRATION AT PARTICULAR SPEEDS: This is a common complaint with the XJ-S, with owners frustrated that wheel balancing or other efforts have no effect. Marty Sullivan fixed the problem on his H&E convertible with a correct alignment; see below. The H&E also has some dynamic absorber weights mounted behind the headlights, so an investigation of vibrations should include a check to make sure they are mounted properly. Chris Carley, who owns a '91 (factory) convertible, fixed his problem by replacing "the S-rated Dunlop Qualifier tires 235/60 15 that came new with car with Yokohama AVS V-rated 235/60 15. Well - why didn't I do this a year ago? The shakes are gone, the car steers & brakes much better. Also rides smoother and sits at a better ride height. I noticed the shakes were less when it was cold (read Florida 60°F), so I can only assume they flexed too much when warm and went out of round?"

ALIGNMENT: First off, note that while many cars are aligned only at the front, the XJ-S requires that all four wheels be aligned. Although there is really only one adjustment at the rear (camber), it is likely to take most of the mechanic's time if any adjustment is necessary; it requires that the driveshafts be unbolted from the differential unit and shims changed.

Randy Wilson sends a warning to be careful which alignment shop you choose to align a Jaguar: “The generic American tank has shims to align the front suspension camber and castor. These shims are placed at both the front and rear pivots of the upper control arm. By adding or subtracting shims equally at both ends, you change the camber. By adding or subtracting shims at one end only, you change the castor. Jaguars do not work this way, but look like they do to the uninitiated. The Jaguar has shims at the upper pivot just like the Chevy/Ford above, but they must be used as camber adjustment only with equal amounts of shim change at both front and rear pivots. The castor adjustment is done by a separate set of shims at the upper ball joint. If some hack jumps in there and adjusts camber and castor by staggering the pivot shims, you will end up with a car with a sort of correct alignment (dynamic castor gain will not be as Jag intended), but the car will just eat upper control arm bushings.

“The good news is that the XJ front subframe is one stout critter. Unless it has been seriously whacked, it is rare for camber or castor to need adjusting. Alignment is usually just a matter of setting the toe correctly after the latest steering rack change/rebuild.”

Peter Havas adds, “It is easy to remove the two bolts holding the carrier, and dropping the washers behind the spring tower, or confusing the number which go on each side when you re-assemble. Additionally, I have taken some front ends apart which have been re-aligned in the states, and "U" spacers were substituted for the originals to save time. These fall right out when the bolts are loosened.” They also have a nasty habit of falling out when driving; if you don't believe that, just check out how many alignment shims you can find laying on any stretch of road.

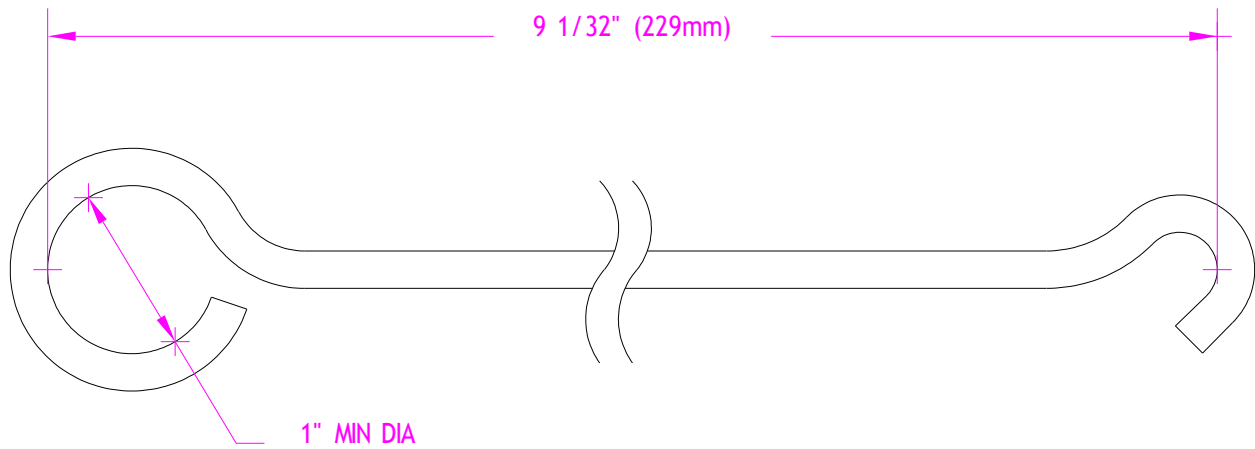
The castor is adjusted by rearranging the shims either in front of or behind the upper ball joint -- but the *total* number of shims surrounding that ball joint should always be four. Just move them from front to back, don't remove any or add any to the total.

There are reports that the spec books in the alignment shops consistently list the wrong alignment specs for Jaguars. Just to be sure, take your own repair manual with you, and if the numbers that you have disagree with those they have, insist they use yours. They shouldn't care, it's your car and your money.

The XJ-S really needs to be aligned according to the procedures outlined in section 57.65.04 of the ROM -- namely, that the ride height must be restrained at a specified position for the alignment. The standard alignment shop shortcut of aligning the car at whatever ride height it sits at is *not* acceptable; both the front and the IRS geometries change with ride height, and many (most?) XJ-S's don't sit at the correct ride height by themselves. Failure to establish the correct ride height during alignment may result in a shaking in the front end at 50-60 mph -- a notorious problem in the H&E convertible, perhaps because the H&E convertible is also notorious for a low ride height.

If you're gonna pay good money for an alignment, you might as well insist it's done properly. Of course, it's not likely the alignment shop you choose will have the special tools used to establish the ride height on Jaguars -- unless you go to a dealer. So, if you're going someplace other than the dealer for the alignment, you'd be well advised to take the tools with you -- and the instructions from the repair manual showing how they're used.

The tools for setting the ride height of the front suspension are made from short lengths of tubing, and there's enough info to make them provided in section 57.65.04 of the ROM. The tools for setting the ride height of the rear suspension are a pair of metal hooks, and are described only as Jaguar tool no. JD.25. These would be even easier to make than the tubes, if only you knew what the key dimension was -- and just what is this book for, anyway? Figure 17 should provide the info needed.



REAR CAMBER SETTING LINK JD.25
(2 REQ'D)

Figure 17 - Jaguar Alignment Tool JD.25

Note that although the official Jaguar tools are made from a single 9/32" steel rod suitably bent, there's no reason you shouldn't be able to screw together suitable tools from eye bolts, threaded hooks, threaded rod, and some coupling nuts -- all available at any hardware store for peanuts. Remember that you'll need to make two.

These tools might actually be a suitable thing for local Jaguar clubs to keep on hand for the benefit of their members. Apparently, these exact same tools have been used on all Jaguars that use the same IRS as the XJ-S -- which means all E-types, all XJ6/12 SI/II/III -- basically all Jaguars made for about four decades. In fact, the dimension shown in the drawing was provided by Michel Carpentier, who got it from a Mk10 service manual. At the time the Mk10 was made, the tool was called a J25; the tool names were changed to JD after Jaguar bought Daimler.

When *either* end of a Jaguar is being aligned, the ride height setting tools should be in place on *both* ends.

In what must be considered a serious shortcoming, the Haynes manual does not discuss this ride height setting procedure at all, and lists an incorrect tool number (JD21 -- actually the number for a bushing tool of some sort) without going into any detail about using it. It suggests that alignment is not for the home mechanic, but provides a few generic guidelines for what is done -- just enough to get you in trouble. If you have only the Haynes manual, it is recommended that you obtain a copy of the alignment instructions from a Jaguar ROM or shop manual before having an alignment done by a non-Jaguar shop.

Finally, note that most of the above info probably applies only to the pre-1993 XJ-S with inboard rear brakes. From 1994 on, a completely different IRS was used with outboard brakes, and it presumably requires different alignment procedures.

If you'd like to try tackling the alignment job on your own, Tony Watts points out that there is a description of how to perform your own alignment with simple tools on the WWW at:

<http://www.vtr.org/maintain/diy-alignment.shtml>

ANTI-ROLL BARS -- WHAT THEY DO: An anti-roll bar (also known as a sway bar, anti-sway bar, or stabilizer bar) is simply a spring that resists one wheel from traveling up or down without the wheel on the opposite side moving likewise. For a car to lean, one wheel must go up (relative to the car) while the other goes down, so the anti-roll bar is a spring that resists leaning. This has many benefits, including reducing the shift of the center of gravity caused by the leaning, and better traction and tread wear due to keeping the car, and therefore the tires, upright in a corner.

It is a good idea for the roll stiffness to be balanced between the front and rear end of a car. If one end is stiff and the other isn't, then when the car tries to lean in a corner the outside tire on the stiff end takes all the load while the outside tire on the other end takes it easy. Typically, this will cause the tires on the stiff end to behave poorly and wear rapidly. In general, adding roll stiffness to one end of a car helps the handling of the other end.

If the front end is stiffer than the rear, then the car tends to understeer, or plow its way through a turn. This is the accepted norm here in the US. In this case, when the car doesn't seem to be going where the driver wants it to go, he merely turns the steering wheel farther -- a design considered defensible in this age of litigation. If the car has balanced anti-roll stiffness or is stiffer at the rear, there is the possibility that the car will oversteer in a corner -- the rear end will swing out. The correction is to turn the steering wheel in the direction of the slide -- a design considered indefensible in court, and possibly exposing auto manufacturers to liability.

For those who prefer to drive a car rather than have the car drive them, adding a rear anti-roll bar or replacing an existing rear anti-roll bar with a stiffer one on an understeering car is a good idea. The car will have more neutral handling characteristics. Also, there is a more "precise" feel to the steering, even when driving slowly. In general, the car will feel more stable. And the front tires will usually wear much longer, and wear less on the edges and more uniformly across the tire.

Ah, but what about the ride? When driving over two-wheel bumps (such as speed bumps), the anti-roll bar merely turns on its pivots, and the ride is unaffected. When driving over one-wheel bumps, however, the motion of the wheel over the bump will have a more pronounced effect on tilting the car. This effect can be quite noticeable. In cases where a series of one-wheel bumps are encountered, the occupant can feel downright jostled, especially if the added anti-roll bar is very stiff.

The above is a very brief discussion of anti-roll bars. A more complete discussion would include the effects on particular types of suspensions, most notably suspensions with shortcomings that an anti-roll bar tends to compound. Also, some cars have suspensions with an inherent anti-roll stiffness, and don't require a separate bar. However, the Jaguar suspension has no such situations, so there is no need for further discussion here.

Anti-roll bars are customarily described by their thickness, this being an indication of their stiffness. In general, the stiffness of a typical anti-roll bar (solid circular cross section) is proportional to the 4th power of its diameter -- a 1" bar is more than three times as stiff as a 3/4" bar! However, the thickness of an anti-roll bar can only be used for comparison against the thickness of another anti-roll bar that mounts the same way on the same end of the same type car. Because of differences in the leverage of the anti-roll bar linkage as well as in suspension geometry and center of gravity, a 1/2" bar may be quite stiff on one car while a 1" bar may be barely adequate on another.

Aftermarket anti-roll bar kits often take advantage of the geometry issue to make their bars adjustable. While an OEM bar typically has a hole or eye at each end where the end links attach, competition models will often have a clevis attachment or "slider link" that clamps down anywhere on the end of the bar. By moving the attachment inward from the end of the bar, the leverage is changed making the anti-roll bar stiffer. You could even move the sliders for an autocross weekend and move them back on Monday. Some wise guys have even figured out how to sell you just the adjustable end links that will clamp onto the OEM bar inward of the eye at the end, thereby allowing you to adjust the OEM bar stiffer (but not less stiff).

It's also worth noting that the anti-roll bar isn't the only thing that flexes as a car leans into a turn; the inner mount bushings, the end link bushings, even the tires themselves all flex, sometimes largely negating the effect of a stiff bar. Aftermarket kits sometimes use this effect to provide a sort of poor-man's adjustability: they will provide end links that have springs behind the bushings that allow them to slip a bit before they apply the full effect of the bar. The result can be non-linear, where the anti-roll bar seems very weak at first and then becomes effectively much stiffer after a bit of lean.

It just so happens that this flex issue is critical in the Jaguar XJ-S. The way the rear anti-roll bar (when there is one) attaches to the rear suspension is via attachment points on the radius arms. However, these radius arms attach to the lower swingarms with a very soft rubber bushing. You can make the rear bar only so stiff before the bar isn't flexing at all, it's these rubber bushings doing the flexing. To increase the rear anti-roll stiffness beyond that point, you'll have to replace those bushings with poly or something -- or completely revise how the end links attach to the rear suspension.

Modern kits often feature hollow anti-roll bars. Compared to solid bars, a hollow bar of the same diameter would be weaker -- but that's not the comparison to look at. Here's what's important: Compared to a solid bar *of the same stiffness*, a hollow bar will be larger in diameter yet lighter in weight.

ANTI-ROLL BARS -- WHAT YOU'VE GOT: Really good question, actually, since apparently there are a lot of different configurations. Most of the info in the chart below was provided by Chad Bolles.

	Front Anti-roll Bar			Rear Anti-roll Bar		
	P/N	dia.	Bushing P/N	P/N	dia.	Bushing P/N
1975-82 5.3	C36887/1	7/8"	C32925	C42178/2	9/16"	C44931/2
1982-87 5.3	C36887/1	7/8"	C32925	None	n/a	n/a
87-on 5.3, 6.0	C36887/1	7/8"	CAC4651/7	None	n/a	n/a
5.3 SportPack	CBC5579	1"	CBC5580	C42178/3	5/8"	CBC4901
6.0 SportPack	CCC7198					
4.0 Coupe	C36887/1	7/8"	CAC4651/7			
4.0 Convertible	C36887/2		CAC4651/6			
4.0 Cpe SportPack	CCC7197		CBC5580			
XJ6	C36887	3/4"	C30502	None	n/a	n/a

Typically, the brackets holding the anti-roll bar bushings will not change with bar size; the outside of the bushing remains the same, only the size hole through the middle varies, so the same bracket can be used throughout. Note that the brackets for the front anti-roll bar on the XJ-S were originally C30500 (r) and C30501 (l), but after VIN 179737 changed to CBC5336 (r) and CBC5337 (l). Some of the same bushings were used before and after this change, so either set of brackets is apparently compatible with any bushing.

ANTI-ROLL BARS -- SUGGESTED CHANGES: As noted above, the 1982-on baseline XJ-S has a 7/8" front anti-roll bar only, and understeers accordingly. However, cars prior to VIN 106452 came with a 9/16" rear anti-roll bar as well. These parts can be added to the later XJ-S, and were designed by Jaguar to provide balanced handling when used with the stock front bar. The radius arm assemblies must be replaced to provide attachment points for the anti-roll bar, or attachment points can be welded onto the existing radius arms. The mounts on the underside of the car were still being provided as late as 1988 and possibly later: a reinforced area with two studs on each side of the car, just above the radius arms.

For the pre-1982 anti-roll bar assembly, the part numbers and quantities are as follows:

<u>ITEM</u>	<u>P/N</u>	<u>QTY</u>
Radius arm assy	C41831	2
Rear Anti-roll bar (9/16")	C42178/2	1
Bushing	C44931/2	2
Bracket	C42114 or C3054	2
Link	C42907	2

This is a really light bar, and the change in ride from adding it is minimal. It does help the handling considerably, however.

While adding a light rear anti-roll bar can do wonders for the balance and handling of a street car, it by no means eliminates body roll entirely, and certainly will not make an autocross champion out of the XJ-S. For those who wish to get serious about cornering, an excellent plan is to replace the 7/8" front bar with a stiffer one, and to install a suitably heavy-duty item in the rear to match.

"Sportspack" models come with a stiffer front anti-roll bar, and a rear anti-roll bar that is stiffer than the pre-1982 model described above. The part numbers are as follows:

<u>ITEM</u>	<u>P/N</u>	<u>QTY</u>
Front Anti-roll bar (1")	CBC5579	1
Front bushing	CBC5580	2
Radius arm assy	C41831	2
Rear Anti-roll bar (5/8")	C42178/3	1
Bushing	CBC4901	2
Bracket	C3054	2
Link	C42907	2

Addco (see page 713) offers a 7/8" rear bar, along with a 1" front bar. Note that a 7/8" rear bar would be almost four times as stiff as the 5/8" bar that comes on the Sportspack! It is clear that the two Addco units are intended to be used together; Addco does not offer a rear bar suitable for use with the stock front bar under the mistaken assumption that all XJ-S cars come with a stock rear bar as the pre-1982 models did.

Unfortunately, since their kit assumes the existence of a rear bar, it doesn't include the links and other parts needed to connect the rear bar to the rear suspension of later cars. To use their kit it will be necessary to purchase the links from Jaguar, and the radius arm assemblies will need to be either modified or replaced. When ordering, check that the Addco kit comes with a bracket (a bushing will be included, since it is larger than stock); if not, the Addco "D" series or "W" series are suitable brackets.

Gran Turismo Jaguar (now defunct) offered anti-roll bar kits for the XJ-S with two features of note: First, the rear bar appeared to have an end link assembly that mechanically attached to the radius arm without needing to weld on an attachment. Second, while their bars could be installed the same way the OEM bars were installed, they could also be set up with slider links that provide an adjustment to the anti-roll stiffness.

POLYURETHANE SUSPENSION GOODIES: Polyurethane (or urethane) is much stiffer than the rubber used in the OEM mounts and bushings. It is also more durable. And, due to the nature of aftermarket supply vs. original Jaguar parts, considerably cheaper.

Craig Sawyers says that Classic Spares (page 693) offers several parts. "They are called Superflex, polyurethane, and come from Australia originally. They are sort of a translucent purple colour. Bottom wishbone (i.e. swingarm) bushes, top bushes, rack bushes and anti-roll bar bushes too."

It would probably be a good idea to update all comparable parts on both ends of the car at the same time. Stability at speed in a softly-sprung car requires a careful balance of compliance in suspension parts and tires, and making one end stiffer while the other is still soft may result in dangerous instabilities.

Front Suspension

CLUNKS - FRONT: If something in the front goes “clunk” when you drive over a bump, check the rubber bushings on the top of the front shock absorbers. British non-metallics again. Any generic rubber shock bushing will do, and will do better than the original. David Littlefield says, “Generic replacement bushings are available in the "Help!" section of your local auto parts store. Look for the area with a variety of parts on red cards. The part number is 31018 and they come two to a pack. The pack also says "Ford/Mercury" on it, so if you can't find the "Help!" products, perhaps you can ask for a Ford/Mercury replacement. You will need two cards (or four bushings altogether). I paid \$2.58 per card at Pep Boys. I would describe them as being about the size and shape of a medium sized mushroom cap; only, of course, with a hole through the center.

“Replacement is a breeze. I did both sides in a little over an hour. The biggest operations are jacking up the car, removing the tire, and removing the hinged side of the air filter on each side. Removing the old bushings and installing the new ones is a straightforward and simple procedure.” Note: you can easily compress and release the shock while you’re there, thereby checking that it’s in good shape -- see page 355.

“The old bushings were the consistency of foam rubber after five years and about 25,000 miles. These were Jaguar replacements done after the car had traveled 32,000 miles over four years on the factory installed bushings.

“Bottom line: About \$5.00 and an hour and a half of my time for a fix that should hopefully last a long, long time. This versus about \$25 in parts and \$75+ in labor to the dealer for a fix that would last, at most, about 30,000 miles.”

Note that the XJ-S has steel washers that fit between the bushings and the chassis; purpose unknown, but it won’t hurt to put them back in with the new bushings. Littlefield says, “The real purpose of the washers seems to be to let you know your bushings are bad by clanking around and driving you nuts until you replace them!”

Some people want to know just how much to tighten the nuts when putting in new bushings or new shocks. The answer: all the way. The posts on top of the shocks have a shoulder, and the nuts should be tightened until they sit down on this shoulder.

Another common cause of clunks is loose diagonal supports across the top of the engine compartment. Make sure the bolts at both ends are tight.

Also check for a failed subframe mount. When the rubber within the mount is torn but still in place it would seem that it shouldn’t make any sound, but it does. There are two doughnut-shaped mounts at the front, and two V-shaped mounts near the steering rack. If the rubber is torn or otherwise damaged, they should be replaced.

FRONT SUSPENSION CHECK: You may be confident that your front suspension is just fine, but this test is so quick and easy you might as well try it. Stand beside the car and grab the top of a front tire and shake it vigorously in and out. If everything is OK, the only thing you will feel is the flexing of the tires, and you will hear nothing.

If you feel any slop, or you hear a “clunk” back and forth, your front suspension is *not* up to snuff. You should check the following items, which are discussed in more detail below:

- 1) Adjustment of the wheel bearings.
- 2) Condition of the ball joints, upper and lower.
- 3) Wear groove on bottom of front axle.
- 4) Bushings at inner end of upper and lower swingarms.
- 5) Front subframe mounts.

Perform this test and correct any problems noted before having your car aligned. The repair or replacement of ball joints, tie rod ends, swingarm bushings or subframe mounts normally requires realignment, and it’s a shame to have to do it over.

Peter Havas says passing the shake test doesn't necessarily mean all is OK: "The suspension is too heavy to give any accurate indication by shaking it. Okay, if we're talking metal to metal, then yeah give it a shake. But a dried out bushing, frozen on the inside won't move. Bad lower wishbone bushes don't display any bad behaviour at all when pushed around. I would suggest:

"Uppers: Remove the wheel. As the bushing is a mushroom shape and protrudes from the yoke of the wishbone, check that the lip holding the metal backing plate is not torn or worn to the point that you can peel it back from the plate. The plate at the end should be uniformly held in by the rubber. Check for obvious cracking, and if the bushing is rust coloured, or seems to seep rust from the mating surfaces around the yoke, or the backing plate. Insert a longish bar diagonally through the upper wishbone, and flex the fitting to check for any undue movement, water seepage, or cracking.

"Lowers: On the steering wheel side (rhd or lhd) check that the rear bushing is dry. If it is oil soaked, dig around the nut to see if the bush has become spongy. For the other bushes: ensure that the wishbone is centered on the fulcrum, and no rubber is protruding around the castellated nut. Remove the split pin and nut on the front two bushes, and check that there is no rust between the fulcrum (carrier) and the bush. With the car supported on jack stands, put a length of 2x4 under the lower wishbone and lift while an assistant checks that there is no play in the bushes. If no assistant is available, feel for play or obvious shifting when the suspension is moved. Using the same longish bar from the upper test pry the wishbone directly away from the fulcrum to see if there is any play.

"The lower bushes, especially in the front, tend to freeze to the fulcrum and "squash" for lack of a better term. The constant chaffing heats the rubber so it starts to come out around the nut on the end. Usually after many miles, the set of the wishbone on the fulcrum is evident. It really starts to show when someone has changed to nice sticky tires, and the suspension is doing all the work it can. Because of their tendency to freeze up, they often don't display any movement at all when static, and people tend to pass them up: "If it ain't broke don't fix it.""

It should also be noted that, contrary to common belief, a car will not periodically require realignment for no good reason. If a car was correctly aligned at one time and no longer is, it is because parts are either worn or damaged, and merely realigning without addressing those parts is unwise.

FRONT HUB REMOVAL: Michael Neal suggests the brake caliper *not* be removed when pulling the hub, to avoid fiddling with steering lever shims (see page 435). Instead, unbolt the disk from the hub by inserting a socket through an opening in the dust shield. Then, remove the hub leaving the disk in place.

That works, but really fiddling with the shims isn't bad.

If you do separate hub and rotor, it's probably a good idea to mark it first so you get it back together the same way. Couldn't hurt, and may help avoid brake shudder problems.

FRONT WHEEL BEARINGS: According to Chad Bolles, the XJ-S uses standard front wheel bearings, available in any auto parts store. The pre-1977½ XJ-S outer is an A-2, the inner is an A-6. The 1977½-up car uses A-13 for the inner, A-12 for the outer.

FRONT WHEEL BEARINGS/SEALS SERVICE INTERVAL -- ABS-EQUIPPED CARS: Bruce Segal reports from Canada: "Jaguar was recommending that the front wheel bearing seals be replaced every 15,000 mi (24,000k). At the same time the bearings should be looked at and replaced if there is any evidence of water ingress. I don't know if this applied anywhere besides Canada. We found that after going to this procedure front wheel bearing failures disappeared."

Stefan Schulz provides a possible explanation: "It could well be the likelihood of contaminant ingress that causes Jaguar to specify the change interval. The grease seal at the inside of the front hubs was changed with the advent of ABS. The pre-ABS grease seal looks like it will properly do the job, since it sits firm in the hub casing and its sealing lip rotates (and presumably experiences friction and wear) over the relatively smooth surface of the stub axle. The post-ABS

grease seal works the other way round, it sits on the hub carrier and its lip touches the hub proper which rotates relative to it. The hub's inside surface in that area is nothing like as smooth as the sub axle's surface, so I'd expect that grease seal to fail much earlier."

"I have had my XJ-S for almost three years and 42,000 miles now. R&R'd stub axles and front wheel bearings when I bought it and bearings again about 10,000 miles ago. They needed it."

Segal again: "In my environment (winter, salt, water) the new type seals do not provide a long term solution -- thus Jaguar Canada's very short replacement recommendation. We've found that quite often the bearings had started to rust from the salt water getting past the seal."

If you have an ABS-equipped car, perhaps while you have the hub off for an overhaul it'd be a good idea to polish up the contact surface on the hub to help seal life.

FRONT AXLE WEAR: The inner races of the inner front wheel bearings tend to turn on the axles. As a result, they eventually wear a groove in the axle, on the bottom where the load is. This allows the wheel to wobble even when the bearings are adjusted properly, and your Jag starts driving like a Pontiac.

To check for problems, remove the front hubs and check the stub axles for a wear groove. Run your fingernail along the bottom of the axle from the upright outward. If your fingernail catches at all, the axle should be replaced.

According to Richard Griffiths, the inner race is *supposed* to rotate on the axle. This distributes the wear evenly around the inner race rather than concentrating it on the bottom. "With proper lubrication, heat treat and tolerances etc., the effect of a "walking" inner race on the axle is a beautiful mirror-like burnished surface, not galling and wear as some have noted."

Well, there's little an owner can do about heat treat or tolerances, and on the XJ-S inner race rotation is clearly a problem -- and bearing wear is *not* a problem. So it makes sense to ensure that the inner races will *not* turn by using Loctite 640 or some similar high-strength bearing retaining substance. This may shorten the life of the bearing by some negligible amount according to some engineer's theories, but in the real world it will positively eliminate the wear on the stub axle. Use it on the inner race of the outer bearing, too, since it has been known to have the same problem. Adjust the front wheel bearings as described below.

FRONT WHEEL BEARING ADJUSTMENT: Section 60.25.13 of the ROM, Step #4, indicates that the front hub bearings should be adjusted to attain end float measurement of 0.002"-0.005" (0,05mm-0,15mm). However, Technical Service Bulletin 57-15 revised the end float spec to 0.001"-0.003".

If you don't happen to have the type of dial indicator needed to measure end float, this author recommends the following procedure: Tighten the retaining nut to perhaps 20 ft-lb while turning the hub to make sure everything is seated properly. Loosen the nut then spin it back on until it seats, normally a very distinct point; *continue to tighten* about 1/10 of a turn while turning the hub. Fit the lock and install the cotter pin.

This may seem tight, and in fact may be tighter than the official Jaguar procedure (measuring end play) would result in. Any bearing expert will tell you that proper operation of a roller bearing requires some preload. When tight, the weight of the car is distributed among the rollers. When loose, the slop allows the load to be taken by only one or two rollers at a time, and the unloaded rollers may slide rather than roll.

Another method that has been suggested is to tighten the nut to 25 ft-lb while rotating the hub and then back the nut off one flat.

If you're using Loctite on the inner races as suggested above, you might opt to apply the Loctite to the inboard race, assemble, tighten the nut to 25 ft-lb while rotating the hub and leave it there long enough for the Loctite to set. Then pull the nut and outboard inner race back out, apply Loctite there, and then do your final assembly and adjustment.

Note that having the bearings adjusted too loosely -- as well as having a grooved front axle, as described above -- would be detrimental to seal life. And the seals on the ABS-equipped cars may be marginal already, as mentioned above.

FRONT WHEEL BEARING CAPS: Apparently, some bearing caps are a total seal, while others have a small hole in the middle. It is suggested that if you have wheels that don't keep dirt out of this area, put a small piece of aluminum tape over the hole. Or, just pry it off and take it down to the local auto parts store and buy a generic replacement.

CHECKING OF BALL JOINTS AND TIE ROD ENDS: To test joints such as these, it is helpful to find a convenient way to "shake" them, or to move them in such a way that will cause them to slop one way and then the other. In the case of tie rod ends, this is easily done by moving the steering wheel back and forth just a little. With ball joints, if the front tire shaking described under FRONT SUSPENSION CHECK on page 362 caused a "clunk", that same motion will work for this test.

This test requires two people. Place a single finger on the joint in question in such a way that one side of the finger is against the hardware on one side of the joint, and the other side of the finger is against the other side. While holding this position (may be difficult, since the car should be sitting on its wheels) another person should provide the shaking motion. If the joint is OK, no motion can be felt between the two parts. If the joint is loose, a human finger will easily detect the slop. Typically, any slop at all is unacceptable, the joint should be replaced.

With either ball joints or tie rod ends, though, the more common indication that the joint needs replacement is that the protective boot is torn open. On the joints on most cars, the boot is not replaceable, and the joint will last as long as the boot -- so when the boot goes is when the joint gets replaced. This is true of the Jaguar tie rod ends as well, but not necessarily the ball joints; since they have replaceable boots, it's possible to keep replacing the boots until the joint itself wears out.

ANTI-SEIZE COMPOUND: See description on page 29. This note is to point out that many suspension components involve tapered fits, such as the ball joints and the front axle in the hub carrier. It is suggested that anti-seize compound be used on the tapers themselves as well as the threaded nuts. It does no harm, and can make the assembly much easier to get apart in the future. In tapered fit applications, care should be taken to ensure the entire fitting is thinly coated, since the anti-seize compound will not be spread during assembly as it is on threads.

BALL JOINT GAITERS: The gaiter used on the original Jaguar ball joints is a Rube Goldberg assembly in itself, and the parts are available separately. The gaiter itself (C43216) is a clear flexible plastic item, with a steel ring molded into it to make the small opening fit snugly around the ball shaft. The gaiter fits into a plastic collar (C22970) which the Haynes manual calls an "insert", and a rubber ring (C22969 -- looks like a skinny O-ring) fits into a groove on the gaiter to hold it snugly into this plastic collar. The plastic collar snaps onto the ball joint itself. If you are replacing the gaiter and don't have a rubber ring, you can simply tie the gaiter to the plastic collar with some wire. The same gaiter assembly is used on both upper and lower ball joints.

Note that the plastic collar only goes on one way. There is a barely-perceptible ridge around the ID on one side, and that side must be installed toward the ball joint. The ridge snaps into a groove on the ball joint, leaving the collar situated such that it can be rotated on the groove. If you try to install it upside down, you will have to jam it hard against the housing and you may still not manage to get it to snap into place correctly.

In the Haynes manual, Chapter 11, Section 10, steps 2 and 3 tell you to remove the retaining ring, gaiter, and collar separately. You may be able to remove these three items together as one part -- or as a handful of chunks, as is typical. However, during reassembly it may be necessary to install them separately because the collar can be a bit of a challenge to get snapped onto the ball joint.

This author's experience is that this transparent gaiter has a life expectancy of less than five years. The clear plastic turns dark brown, then rots and falls out in crumbs. As with any grease-filled assembly protected by a boot, once the gaiter rips open and sand and water get in, the ball joint itself is quickly ruined. Since the gaiters are available separately, you can make the ball joints last almost indefinitely by replacing the gaiters *before* the old ones get rotten and rip open.

The gaiter provided in the QH lower ball joint rebuild kit (see below) is different than the original. It is a solid black rubber item with no metal reinforcement. A metal clip is provided in the kit to be used in place of the rubber ring on the large opening. The QH kit does *not* include a new plastic collar, which leads to a question: are you supposed to reuse the original plastic collar, or are you supposed to use this gaiter without the collar? It really doesn't work well *either* way. Here's what seems to work best: using a small pair of snips, carefully trim the flange on the side of the collar that ends up inside the gaiter down to about half its original breadth. Now the black rubber gaiter will fit it properly.

The black gaiters in the QH kits are also British, and don't seem to last much longer than the clear plastic Jaguar originals. They dry rot and start cracking at the seams. In addition, they are rather poorly designed; they are a simple dome shape with a hole in the top, and this shape doesn't really flex properly when the ball joint is swivelled to one or the other extreme position. The pulling to one side tends to pull the small hole around the tapered post hard enough to stretch it open and allow dirt to get in. Fortunately, this gaiter works well enough in the nearly centered positions where the joint spends 99% of its time.

Chuck Sparks suggests that a thin layer of red Girling "rubber grease" (see the discussion on brake caliper assembly on page 428) be applied to the inside surface of the gaiters prior to assembly. The idea is that this coating might help keep the grease from your grease gun from contacting the rubber the gaiter is made of. Since the two may not be compatible, keeping them apart may make the gaiter last longer. Well, maybe a shaky theory, but applying the red grease couldn't hurt.

There are better solutions to the gaiter situation here. One would be to find a non-British gaiter from some other application that fits. Mike McLaughlin says, "Once again I'm reminded of a product out of marine catalogs... There are available several sizes of black, flexible bellows that may be far superior to the automotive product. They are used to route the marine steering arm, throttle and gearshift cable ass'ys through bulkheads to the outboard engine and in some applications, house a u-joint and/or exhaust gasses to the outdrive (volvo, mercruiser). A poke about in a marine supply house may well reveal the ideal product..."

If you can't find a good gaiter that fits, you can fabricate your own gaiters from shoe leather or inner tubes or something. It's really not difficult, and it's especially not difficult to do better than the OEM items.

The best solution, though, is to replace the ball joints in entirety with the XJ40 items as described on page 368.

LOWER BALL JOINT ACCESS: The overhaul procedure in 60.15.13 says to disconnect the brake line and the tie rod end. Both are unnecessary unless you really prefer to work on the bench. Obviously you need to be careful not to stress the brake line.

The Haynes manual, Chapter 11, Section 10, Step 1 tells you to remove the stub axle carrier as described in Section 8. Section 8 tells you to remove the brake caliper and the hub/disk assembly, both of which are unnecessary for ball joint work. It also suggests separating the upper ball joint from the stub axle carrier, but if you're not working on that ball joint at this time it would obviously be much easier to separate it from the A-arm by removing the two bolts and keeping track of the alignment shims.

You can pretty much ignore the directions in the repair manuals and simply follow the following steps. Obviously, start by putting the front of the car on jack stands and removing the road wheel. The steering must be turned back and forth a couple of times, so it's really easier (and safer) to lift the entire front end of the car and place on stands rather than trying to lift just one corner. Note that the car will probably get lifted off those jack stands at various points in this process and set back down on them.

Once the lower ball joint is apart, there will be nothing to prevent the road spring from snapping the lower swingarm downward around its inner mount bushings. To keep the car's weight on that spring, support the suspension with a jack under the outer corner of the spring pan on the lower A-arm. Stay away from the lower ball joint.

Before disconnecting the upper ball joint, you need to make sure there's no load on it. This is important when taking it apart, but it's even more important when reassembling; it's really difficult to insert the bolts in the holes while lifting the car with one hand! If the rubber bumpers in the upper A-arm are on their stops, the road spring may be pulling the A-arms down and applying tension to the upper ball joint. Jack the lower A-arm up until the spring is compressed far

enough that the rubber bumpers on the upper A-arm are not touching their stops. This may require jacking a pretty long ways, nearly standing the car on its opposite corner. Dale Knaus says, "The way I change the ball joints is to start by blocking the opposite rear corner of the car at the jack point. By blocking under the opposite rear, the jack will lift more of the car and compress the spring more." Others suggest adding weight to the corner of the car you're working on, such as placing bags of feed or cement on the fender.

Once you know the upper ball joint is unloaded, separate the hub carrier from the upper A-arm. You can remove the nut and use a ball joint separator to pop the tapered pin loose from the hub carrier, but if you're not planning on servicing that upper ball joint it's easier to simply remove the two bolts holding the joint to the A-arm (make sure to note where the alignment shims go). You'll need to turn the steering a bit towards that side to get the outboard bolt out.

Tilt the top end of the hub carrier outward to get access to the nut on the lower joint ball pin. Loosen the nut a few turns but don't remove it. You need to loosen the nut far enough to get past the nyloc insert so the nut turns freely; once the tapered pin is popped loose it's free to spin, which may make it difficult to remove the nut if it won't spin easily on the threads.

Use of a fork-type ball joint separator on the lower joint will not only destroy the old gaiter, but the plastic ring and the upper ball seat as well. The fork type separator doesn't work very well here anyway; better to have the screw-type separator on hand. Even better, usually you can get it apart without using any separator tool; jam something between the inner corner of the hub carrier (right next to the lower ball joint) and the A-arm, and forcefully rock the upper end of the hub carrier outward. Once it pops loose, the hub carrier will fall, and if it still has the brake assembly on it it's quite heavy; that's why you loosened that nut but didn't remove it!

If you're careful, you can accomplish all this without disconnecting the tie rod or the brake line; it might help to turn the steering wheel one way or the other. Of course, this implies you're willing to rebuild the ball joint right there. If you prefer to carry the hub carrier to the bench, obviously you'll need to disconnect the tie rod and brake line and bleed the brakes once you've reassembled everything.

If you separated the upper end by unbolting the ball joint, use one of the upper ball joint bolts to connect the *inner* end of the upper ball joint to the *outer* holes in the upper A-arm. This provides a convenient support for the hub carrier once the lower ball joint is apart. If you popped the pin loose at the upper ball joint, you can slip it back together and install the nut loosely, or use more conventional means such as hanging the hub carrier with wire. Once the hub carrier is supported, you can remove the nut on the lower ball pin entirely and proceed to rebuild the ball joint.

LOWER BALL JOINT REBUILDING: The original lower ball joint is a rebuildable assembly, with parts books showing part numbers for the individual components; apparently there is no single part number for the overall assembly. Before the advent of the XJ40, Jaguar offered a rebuild kit for the lower ball joint, part number 12803. That's not a misprint; for some reason, there is no C or other letters before the number.

The lower ball joint from the XJ40 (the 1988-on XJ6) is a one-piece throwaway item (see below) that will replace the entire ball joint assembly on the XJ-S, and costs less than the Jaguar rebuild kit. Hence, Jaguar reportedly no longer makes such a kit, and authorized repair shops merely replace the joint with the XJ40 item.

However, an aftermarket parts company, Quinton Hazell, makes a rebuild kit for the original rebuildable ball joint; the part number is QSJ221RK or something like that. QH's prices for this kit are much more reasonable than the Jaguar parts prices ever were, and it is cheaper to use this kit to rebuild your ball joint than to install the new XJ40 unit. It's still a better idea to go with the XJ40 joint, though, because it comes with a better gaiter.

The original, rebuildable lower ball joint is assembled with shims to provide a properly snug fit between the ball and the socket. It should be noted that these shims are intended to provide a proper fit at assembly, *not* for removing the slop from a worn joint. If a joint develops slop, it should be rebuilt with new parts or replaced entirely, not merely readjusted.

The ROM, Section 60.15.04, describes re-shimming the lower ball joint without disconnecting it from the stub axle carrier, but frankly this is questionable; you will have a difficult time determining the correct snugness of that ball joint without being able to manipulate the ball pin by hand. Besides, you probably need to replace the gaiter while you're in

there anyway, so use the overhaul procedure in 60.15.13 instead.

When rebuilding the lower ball joint, don't lose the shims that come out. Although the QH kit includes shims, there may not be enough to provide all new shims.

Bernard Embden suggests: "I found that, under pressure, grease was spitting out between the shim and one lower ball cup. Putting a straight edge against the ball joint surface at the knuckle revealed an uneven surface which had to be trued up before completing the rebuild. I believe that these lower ball joints are subject to a lot of abuse as the car runs over debris, etc. Checking with a straight edge should be part of any rebuild."

It is recommended that you trial-assemble the ball joint dry (no grease) in order to establish the correct shimming. It's amazing how grease can make a sloppy joint feel tight.

Thoroughly grease the ball and socket parts prior to final assembly. Although the joint has a zerck fitting, its use is no substitute for proper greasing at assembly.

LOWER BALL JOINT SUBSTITUTION: As mentioned above, the lower ball joint from the XJ40, part number CAC9937, will replace the original ball joint on the XJ-S perfectly. This ball joint is made by Lemförder in Germany; the Lemförder part number is 030 260 004 834. It has no grease fitting, it's not rebuildable and the gaiter is not considered replaceable (not available separately) -- but it's still the better choice in ball joints! The gaiter built onto the Lemförder ball joint is an excellent design, shaped like a bellows to allow the joint to move back and forth without stressing the rubber or pulling open a gap. It also has metal spring rings at both ends to hold it snugly to the joint.

So, your choice seems to be: replace the gaiters on the original ball joints every five years, or replace the entire joint with the XJ40 part and forget about it for some time -- perhaps ten years anyway.

The XJ40 lower ball joint also provides a bit more clearance for aftermarket wheels.

When installing the XJ40 ball joint, the shims from the original joint are not used. They were only needed to provide internal clearance in the rebuildable joint.

When replacing the rebuildable ball joint with the XJ40 ball joint, note that the upper ball seat of the original ball joint must be removed. It's a metal ring, and it actually looks like it could be an integral part of the hub carrier, but it's not; it's pressed in from below. Charlie Marino suggests using the old ball pin as a tool for removing it; "I placed the ball end of the ballpin on the upper seat from the top and hit downward into the seat with a hammer. About 4 medium hits drove the seat out through the bottom of the stub axle carrier."

UPPER BALL JOINT REPLACEMENT: The official repair manual calls for "Steering Joint Taper Separator JD.24", but we don't need no steenking separator! Put the car on jackstands and remove the wheel. Put a jack and block of wood under the lower ball joint and jack it enough that the rubber bumpers on the upper A-arm are not touching the subframe. Loosen the nut on the upper ball post several turns, but do *not* remove it. Lower the jack so that the rubber bumpers sit on the stops and the full spring force is applied to separating the joint. If you're lucky and the previous mechanic used anti-seize compound on the taper, you'll hear a pop as it comes loose. If more difficult, a little judicious tapping on the side of the hub carrier may help.

Make sure to note where the shims are located between the arms and the ball joint. Even if you plan to have the car aligned, at least it will drive better on the way to the shop. The shims are supposed to lift right out, but they weren't made quite right; they tend to catch the bolt on the inner corner on the hook-shaped end. If this corner is filed slightly, reassembly will be easier.

UPPER BALL JOINT SUBSTITUTION: On the original XJ-S upper ball joint C23024, the gaiter C43216, plastic ring C22970 and rubber ring C22969 are exactly the same parts as those on the lower joint -- see the discussion on page 365. This means the gaiter is replaceable as it is on the lower joint, but it also means it will need replacing on a regular basis. Other than gaiter replacement, this ball joint is not rebuildable like the lower joint.

As with the lower ball joint, the XJ40 upper ball joint CAC9938 (made by Lemförder) is a better choice; in fact, many parts houses may automatically ship you this part when you order an upper ball joint. The gaiter on the XJ40 upper ball joint is just like the one on the XJ40 lower ball joint: not replaceable, but a much better design than the XJ-S gaiter. Like the XJ40 lower ball joint, the XJ40 upper ball joint has no grease fitting. The Lemförder part number is 027 260 005 834.

UPPER BALL JOINT -- SLOPPY MOUNTING: Walt Osborne of Vintage Jag Works (page 697) points out that the original upper ball joint on XJ's was mounted with a pair of long 3/8" bolts while the XJ40 upper ball joint is mounted with long 10mm bolts. As a result, when the XJ40 upper ball joint is installed in an earlier car using the original bolts, there is about 0.020" slop in where it will get positioned as the bolts are tightened down.

This is not exactly the world's most pressing problem. Wherever the ball joint is when it is snugged up, having the car aligned will deal with it. There are only two situations where this slop can have a detrimental effect: 1) If you hit a pothole so hard as to slam the ball joint against one limit of this slop or the other -- move it despite how tight the bolts are holding it still -- it could affect your camber. 2) If you work on your front suspension for some reason and unbolt the ball joint and reinstall it, it may not end up in exactly the same place. In either of these cases, we're talking about a worst-case scenario that the ball joint will relocate by 0.020" -- barely noticeable.

However, Osborne also points out that fixing this slop is pretty easy. Merely drill out the holes in the swingarms to 10mm, file the openings in the four alignment shims per side a hair bigger, and install the XJ40 ball joints with 10mm bolts.

First challenge: finding a 10mm drill bit. In the US, good luck! Fortunately, you can forget it. Mal Stewart reported, and this author has confirmed, that 10mm bolts will fit in the holes in the swingarms without drilling. They're snug -- in a couple of places, I had to polish the inside of a hole a bit with sandpaper -- but you certainly won't need to use a 10mm drill bit. I did opt to chamfer the edge of the hole under the bolt head to make sure the head seated properly.

Second challenge: Finding suitable bolts. Of course, you could try getting the OEM bolts for an XJ40 from Jaguar. Osborne suggests using generic 10mm bolts of the correct length with the head of the outboard bolt rounded off for clearance as the original bolt was.

The two bolts are different lengths. 100mm is just about perfect for the inboard bolt; I found that Grainger (page 711) has both 100mm and 105mm bolts, with the 105mm bolts being significantly cheaper! They work fine, the extra length is no problem.

You'll probably have to buy 80mm bolts for the outer bolts, but 80mm is too long; the correct length for the outboard bolt is about 68mm. You might get away leaving the bolt 80mm long, but it might catch on the brake disc dust shield near full steering lock, so just to be safe cut the extra off.

You will probably want Grade 8 bolts for this job -- but metric bolts are not rated the same way as SAE bolts. What you want is Class 10.9, which is essentially equivalent to Grade 8. Don't get confused by metric Class 8.8, that's essentially equivalent to Grade 5.

I had difficulty finding 10mm nuts in Class 10.9, so I used Class 8.8 nuts. The strength of the nut is nowhere near as important as the strength of the bolt in this application. The Class 8.8 nuts are available in many places; I found nyloc nuts at Home Depot.

You don't care if the bolts are regular, fine, or extra fine thread as long as the nuts fit the bolts.

I had to file the alignment shims a bit to get them to fall into place properly. The slots are big enough to fit the 10mm bolts, but it won't fit both at the same time! The solution was to file the slot on the inboard end of each shim a bit deeper, so it gets a little closer to the other slot. It took perhaps 30 seconds with a round file.

Both the bolt heads and the nuts I used fit 17mm wrenches. That's considerably larger than the 9/16" OEM bolts and nuts, and raises clearance concerns with the outer bolt. After installation and before reinstalling the wheel, have an assistant turn the steering lock-to-lock while you watch the hub carrier rotate around the upper ball joint. The clearance conditions vary somewhat with suspension extension, so place a floor jack under the lower ball joint, lift it up a bit, and

have the assistant turn it lock-to-lock again. Also note that the clearance varies somewhat with the locations of the alignment shims, so if you have the car aligned you might want to check it again.

Here's an interesting option: replace *only* the inboard bolt on each ball joint with the 10mm bolt, leaving the original 3/8" bolt in the outboard location. The single 10mm bolt will eliminate all the slop in the horizontal direction and half the slop in the vertical direction -- but the horizontal direction is the only direction that affects alignment. This will save you having to buy 80mm bolts, shorten them and round the head, and worry about clearance.

Bob Higgs has another method: "You can do as I did, that is to take a strip of .010" stainless steel shim, wrap it around the 3/8" bolt making a tube shape and inserting this in the upper ball joint mounting hole. You can then use the old 3/8" bolts, no drilling no filing no rounding off required."

Sounds simple enough -- but Higgs doesn't tell you where to obtain .010" stainless steel shim stock. You can buy it at Grainger or MSC or similar industrial supply outfits. It ain't cheap -- but if you're looking to save money you could get the non-stainless stuff. FYI, the ball joints are a bit more than 1-1/8" wide, so that's how long your tubular shims will need to be.

Higgs also fails to mention exactly how you "wrap it around the 3/8" bolt making a tube shape". This task is definitely easier said than done. Maybe there's a special tool available somewhere, but if you're working with normal hand tools you'll probably end up wishing you had just sprung for the 10mm bolts.

One option there would be to cut a strip of stainless steel shim stock about 1/4" wide and several inches long and wrap it spirally to form the shim you need. Since it's just taking up space, the spiral form will work just as well.

Another idea would be to get some thin-walled metal tubing, such as brass tubing from a hobby shop, with an ID of 3/8". Since the OD of such tubing is usually some even amount larger -- the OD of the brass tubing from a hobby shop will be 7/16" even -- you can then just use a 7/16" drill bit to ream out the hole in the XJ40 ball joint. Slide the tubing into the hole and mount the ball joints with the original bolts.

FRONT SWINGARM BUSHING CHECKING: The front swingarm bushings may be checked using similar methods as the ball joints, except that the bushings include some rubber so there will be some slight motion even in a perfectly good joint. Usually, the best indication that a swingarm bushing is bad is that some of the rubber is hanging out of it.

LOWER SWINGARM INNER BUSHING REPLACEMENT: Craig Sawyers provides some insight into removal of the lower fulcrum shafts on this elite precision automobile: "Be prepared for a very sweaty hour or two. Get yourself a four pound lump hammer and batter the living daylights out of it. Be of strong heart and right arm - the SOB's will come out. They rust into the metal sleeve in the bushes. Once it starts to move, you will need a long drift to continue driving it through the hole in the suspension (I used a loooong socket extension I have).

Of course, the bolt will be mushroomed at the end after the abuse you offer it, and you'll need two new ones - they are about £15 each."

"After I spent a cheerful day exercising my arm, and patience, removing mine, I happened to be at the Jag dealer. I was collecting some parts, and chatting to Colin (the workshop head). In the background there was this fearful BANG, BANG, BANG then a rest pause, then BANG, BANG...

"Good grief, Colin - what on earth are you guys up to?"

"Front lower wishbone shafts - sometimes takes hours of that treatment before they move. Sometimes we even have to take it in shifts as each of us tires...."

Uhhhhh, do I even have to suggest that anti-seize compound would be a good idea when reassembling?

Clay Merritt suggests a saw: "Once you drop the crossmember you can get to the fulcrum shafts with a reciprocating blade, then tap them out from inside."

Doug Dwyer presents a counterpoint: "I've done this job on two Jags and the fulcrum shafts came out with a few taps.

If my experience means anything I wouldn't automatically assume that they'll be seized in place." Actually, being patient and tapping lightly may be the secret, as really beating on it is only likely to swell the shaft and make it more difficult to get out.

SPRING REMOVAL: If you're working on the lower swingarm bushings, trying to adjust the ride height, or any of several other operations, you will need to remove the front road spring -- safely. Needless to say, it is a very strong spring, and care must be taken to either gradually release the compression on it or to hold it securely compressed so that it cannot break loose.

Ideally, you should use a spring compressor that fits this assembly, but that may be difficult to find -- the front spring mounts on the XJ-S seem designed to confound most standard spring compressors. The official Jaguar tool is a threaded device that goes up the middle, but is reportedly so large and bulky that it requires the car be on a lift, not merely on jackstands.

Carlos Artal says, "Get a thick, long threaded rod (size unimportant, but as thick as you can). Get 6 large washers that will fit on the rod, and are at least 5cm diameter. Finally; get some nuts for the rod (if the rod is as thick as mine, the nuts were size 16 metric). I got 4, and you'll see why.

"On the upper part of the x-member, just put some rag under the washers (3) and insert the rod vertically, then insert 2 nuts from the top, so they rest on the washers.

"From the underside, use 2 little blocks of wood, which fit into the "circular pan" the shock base has, and then put on the other 3 washers, and 2 nuts.

"To disassemble, just tighten the lower nuts until you can undo the bolts in the pan." Then back the nuts down to lower the pan until the spring is completely free. "Just one warning!; when you think the spring is completely sprung, keep on going, these puppies are big and dangerous (my first one jumped 2 meters!)

"To assemble, with the same setting as above, the problem is that the spring will make the pan wander from side to side. I used 3 thin rods as "guides" for the entire pan." Others use long bolts or threaded rod screwed into the holes in the swingarm as guides, but note that having anything threaded tends to make the pan hang up on it; it's better to have something smooth.

Dennis Kindig used a similar procedure, and offers these variations: "You may want to fiddle with a piece of bar stock cut at the proper angle and placed between the washers on the rod and the spring pan to help align the pan with the wishbone. There is an angled section of cylindrical bar stock on the "official" tool (\$420 US, by the way) that accomplishes that. I also found that wedging the rod (I used a socket stuffed in there) so that it stayed at the *outer* end of the oval hole in the spring pan gave me more leverage (it pulls to the inside under tension)."

Joe Bialy describes a totally different spring removal method: "Use three pieces of threaded rod about a foot long each. 3/8-24 fine thread. Remove three pan bolts, install the rod with nuts to hold it all together. Remove the other 3 bolts. Slowly and uniformly back out the nuts on the three rods. The pan will back out with them. Reverse the process to install." The problem, of course, is finding threaded rod in fine thread; Bialy says McMaster-Carr (page 711) carries it.

Other suggestions include tying the spring in the loaded position while it's sitting on its wheels and *then* jacking it up -- please be very careful tying it, and make good and sure whatever you use is strong enough for the job. And keep your body parts outta the way anyway, just in case it breaks loose.

Michael McLaughlin says, "Herein is the no brain / no pain / no danger / no unusual tools (requires two jacks and a nut splitter) front spring liberation. Find the complete story at:

<http://www.jag-lovers.org/lists/archives/xj-s/199802/msg00542.html>

"Chock rear wheels and jack car (not wheel). Turn steering to allow access (to left for right wheel). Remove front road wheel. Insert "low" jack under spring pan; raise jack under spring pan and lower car jack until car weight is borne entirely by road spring (and 3 other wheels!). With nut splitter crack in two places and remove upper balljoint retainer nut (not the nuts on the two bolts holding the balljoint). Raise car jack and lower spring jack slightly. Secure axle stub

upright to vehicle w/ shock cord or rope to protect brake line. Continue to raise car / lower spring until all is clear. Spring can now be removed, noting position of spring spacers.” Obviously, you don’t really need to split that ball joint nut, you can simply unscrew it. I don’t see why removing the two bolts holding the ball joint won’t work just as well.

Jan Wikström says, “I have removed and installed front springs with the jack method, unscrewing nothing at all except the spring pan retaining nuts. The only difficulty can be compressing the spring enough when it goes in with spacers; a couple of large volunteers (or four sacks of whatever) on the front wing will do nicely; the alternative is to use temporary 4” long studs. This also helps guiding the spring pan on to the studs, which can otherwise be tricky as the spring must be bent fairly severely.

“I stress that there is no risk at all of the spring going sproing; it is completely restrained by the spring tower and the lower A-arm. Just make sure the jack is solidly based for the first part of the compression.”

RUSTY FRONT SUBFRAME: Craig Sawyers says, “The front sub-frame has a rust pocket at the top of the spring mount. If it rusts through, the spring breaks through, and the car rides low, lower, lower still as the rust progresses.”

FRONT ANTI-ROLL BAR BUSHINGS: If you wish to replace the front anti-roll bar mounts with aftermarket units, there are a couple problems to note. First, the top (bottom? It’s mounted upside down) of the arch of the stock bracket clears the subframe by only about ¼”, and the subframe moves around a little on its soft rubber mounts so the ¼” clearance is minimal to avoid banging. To be acceptable, the height of the arch of the bracket must be 1½” or less.

The second problem is that the bolt holes on the brackets are staggered, with the forward stud being located outward from the centerline of the car and the rearward stud being located inward. As a result, the stock brackets have two different part numbers; C30500 for the right side, and C30501 for the left.

The Addco (see page 713) catalog indicates their “D” series fits the front of the XJ-S, but these brackets definitely will *not* work. The bushings themselves *might* be usable with the stock brackets, but it will require some serious trimming on the bushings at least. Addco’s catalog does not seem too reliable.

Just when things are looking difficult, however, a solution comes along. Addco offers a bushing and bracket set that will fit the front of the XJ-S *perfectly*. The brackets needed are their “S” series brackets, but that doesn’t tell the whole story; their “S” series designation indicates only that the brackets have offset holes, but they have many different types of “S” series brackets to fit different cars. The set that fits the XJ-S perfectly is the set that was designed for the 1967-68 Chevrolet Impala, although (hopefully) you can now merely ask for the ones that fit a Jaguar XJ-S and get the correct items. The bushings themselves are their “W” series bushings.

Addco bushings come with no split in them, as though you are supposed to feed them on from the end of the bar. This is really difficult, as the urethane is stiff indeed and the end of the bar has a formed eye. The bend isn’t easy to get around either. It is a simple matter, however, to cut a split into one side of the bushing with a razor knife so you can just spread it open and pop it into place around the bar. Addco includes a small package of special grease with each set of bushings, and applying a little of this grease to the razor knife makes cutting even easier. Since the loads on the front bushings are vertical, the ideal place to make the split is on one side of the bushing. Use of a saw is not recommended, since you don’t want to *remove* any material, you just want to cut it. The bracket will hold the split bushing securely -- in fact, considerably more securely than the original Jaguar split rubber bushing was held.

If polyurethane still isn’t stiff enough for you, you can fab up “mounting blocks” that are basically two halves made of aluminum with a hole through the middle the size of the bar.

POLYURETHANE ANTI-ROLL BAR END LINK BUSHINGS -- FRONT: J. C. Whitney, Addco, and many other aftermarket sources also offer polyurethane end link bushings, again as a stiffer and more durable replacement for original rubber items. These end link bushings are applicable to the front of the XJ-S, replacing C10996; it would be necessary to cut about 1/4” off the back end of the bushing to make it the correct length. Addco also offers entire end link assemblies, with the 3¾” size being the correct length to replace the parts (C10996, C46186, C33682, and C11045)

on the front of the XJ-S.

Randy Wilson reports problems with using urethane end link bushings, however; the relative angles between the bar and the end link and between the end link and the control arm vary considerably with suspension travel, and the rigidity of urethane end link bushings apparently results in the end link itself being bent back and forth, resulting in it breaking very shortly. Wilson has broken both the original Jag links and the aftermarket links by using urethane bushings. He claims some success with modifying the urethane bushings by machining them to allow more room for flexing, but the jury is still out on long-term results. Perhaps sticking with rubber items would be wise here. Generic rubber end link bushings are available at most auto parts stores; again, it is necessary to cut part of the generic bushing off with a razor knife to make it the correct length.

Both J. C. Whitney and Addco offer adjustable end links, which have a spring within the assembly that can be adjusted to absorb some of the motion and soften the effects of a stiff bar. The spring may also allow the urethane bushings to back away enough to avoid the end link failure problems described above.

Steering

SHIMS: The steering lever attaches to the hub carrier with two bolts. At the rear (longer) bolt, there is a shim (it looks like a thin washer) that goes between the steering lever and the brake caliper. *Don't lose it!* Omitting this shim at reassembly screws up your alignment and distorts the steering lever. See the further discussion on these shims on page 435.

STEERING COLUMN INSTALLATION: If you have lowered your steering column, Rob Reilly sends this tip for reinstallation: "When putting back the steering column use a little rubber cement to hold all the washers in place. Leave the bolts loose and pull the column back about 1/4" before you tighten them; if you don't, you will get binding in the lower column universal joint and bumpy steering."

STEERING COLUMN: The Jaguar Parts Catalogue lists the "upper steering column" as a safety item; it's designed to collapse in a collision. Apparently you're not supposed to fiddle with it, just replace it as a unit. Richard Dowling says there is a plastic section in here designed to absorb energy in a crash: "The plastic shaft appears to be moulded in situ since it has spigots of plastic sticking out of it which lock it in position since they engage in small holes in the tube. These are effectively shear pins, since a moderate force on the plastic shaft will push it up the tube."

He found his to have been already sheared, he expects as a result of work he was doing in the area. "It was a year ago so I do not recall exact details, but the gist of it was that at some stage I had probably sheared off the pins trying to get the universal joint splines to line up at the bottom end of the column. That can be hard work in a very confined space, but I am no Tarzan hence it is obvious that the shear pins are not real strong.

"Most of the mechanism is hidden inside the outer case of the column assembly. Design details are nonexistent in the ROM, and fig. 11.34 in my Haynes manual is the best illustration. You can figure out how to pull the complete assembly apart, no rocket science, but it is fiddly. If the shear pins are shot the column is still useable, since friction tends to hold the plastic shaft in position. It will not ride up the column, since the universal joint and bearing at the bottom prevent this. However, when my steering wheel became sloppy (not dangerously, just a little disconcerting) I found the bottom bearing had dropped out of the column outer casing since the plastic shaft had migrated downwards. You can see in Haynes' fig 11.34 a plastic bush just above the splines. The bush is a push fit in the bottom end of the column outer case, but it can drop out if the shear pins let go. This appears to be the only problem from failed shear pins. However, it needs a quick fix because if it drops too far it may bind up the 2 universal joints in the lower part of the steering.

"The fix is to take a wormdrive clip that will clamp on the lip of the bush which is the same OD as the column case.

This way you can almost clamp the lip to the case, but to make it better buy a flimsy clip and try and bend the edge of the worm drive clip down so it acts as a shoulder to go over the lip. Maybe with a strong clip you could put a few saw cuts around one edge and bend it down easier to make a shoulder. This is an improvisation with column still in car. If the column is out of the car some other improvisation will be even more secure.” Another idea might be to use the worm screw clamp to hold another strip of metal securely to the outer diameter of the housing and bend the edges of that strip down over the lip of the bushing to hold it in place. All of this can probably be done with the column in place, no need to take it out.

“One tedious way to fix this may be to strip the column assembly down again and put a few small screws or roll pins through the tube holes to hold the plastic inner shaft, sufficient to hold the plastic in place while remembering they have to shear in a crash.”

STEERING RACK LUBRICATION: According to the John’s Cars catalog, using the zerk fitting on the steering rack does more harm than good, and they remove them during their rebuilds. Others have reported no problems, but obviously one would be well advised not to get carried away with the grease gun. Stefan Schulz reports: “Perhaps even Jaguar realized that eventually, mine (CBC5708) doesn’t have that fitting any more.”

STEERING RACK LOWERING: Contrary to the instructions in the manual, the steering rack can be lowered far enough to work on the mount bushings without disconnecting either the hydraulic lines, the tie rods or the steering column. The only difficult part is access to both ends of the three mounting bolts.

The steering rack is mounted on slotted holes. You’ll have to trust me on this, because they’re not slotted far and the entire slot can be hidden behind the flat washers under the bolt heads. The intent is to be able to position the rack properly with respect to the lower A-arm mounts, and there is a special Jaguar tool used to check for proper position when reinstalling. Presuming that you don’t happen to have this tool laying around the house, it is suggested that you carefully mark the position of the mounting bolts within the slotted holes prior to unbolting the rack. When reinstalling, simply put it back where it was.

Any time the steering rack is lowered for inspection or repair, it is wise to disconnect the bolts mounting the power steering cooler to the subframe. The pipes on this unit are very fragile, the hoses are short and often stiffened by age and heat, and a new cooler is of course more than \$100. It can generally be repaired by any reputable radiator shop, however.

Chuck Sparks suggests that, while the rack is down, you spread the bosses on the subframe a bit to ease reinstallation. Install a piece of 5/16” threaded rod through a boss with a flat washer, two nuts, and another flat washer in the middle. Spin the nuts outward until they are holding the flat washers against the sides of the boss, then continue to turn them to force the sides apart.

STEERING RACK MOUNT BOSS CRACKING: John Smith suggests you check the front suspension subframe for cracking around the steering rack mount bosses while you have the rack lowered. “The kerbside (passenger side) mounting was cracked along the inside (closest to car centre) 2 inch vertical weld to the subframe and also the half inch horizontal weld on the subframe lip. In other words, the inner vertical of the mounting bracket was broken away from the subframe.”

Smith’s local Jag supplier, as well as others, suggest this cracking is due to the stiffer aftermarket rack mounts. It can’t be directly due to the stiffer mounts, since they won’t change the loads on that boss -- in fact, they probably reduce the impact stresses since the rack isn’t banging around in there as it does with the OEM bushings. However, the cracks may be caused by installers using the bolts to pull the sides of the bosses in to meet the aftermarket bushings rather than space them properly with 5/16” fender washers. Or, since the car is actually driveable for a change, the driver may be driving it harder. Whatever, the possibility of cracked bosses is certainly no excuse for sticking with the crappy OEM bushings; have a welder repair and reinforce those bosses if necessary.

STEERING RACK MOUNT BUSHING REMOVAL: John's Cars offers a rental tool for removing the original bushings from the rack. It is extremely helpful, especially when working with the rack hanging under the car where a bench press won't help.

You can improvise such a tool using two 3/8" drive sockets (one with an OD a hair smaller than the bushing, one deep and large enough for the bushing to fit inside it), a long 5/16" bolt or piece of threaded rod with nuts and washers. It's not always a snap, though; getting them to stay aligned and not cock sideways or jam can be a challenge. John Tompane says, "I was experiencing what others reported, the 'pusher' socket was getting out of line. My solution - I purchased two bronze thrust bearings at the hardware store for a couple of bucks. These look like top hats from the side, or a cylinder with a shoulder. This fit into the 1/2" socket and did two things, one it kept the 1/4" bolt in alignment. Second, the shoulder rests firmly on the back of the socket providing a solid base to torque the nut/bolt. Result = worked like a charm. Without the bearings I wasted hours trying to get the easy one out (passenger side) and quit for the night. After getting the bearings, all three came out in a snap."

Jim Warren went another route: "I used the two socket method. I ground the thrust edges of the pusher to remove any roundness. There is very little of the bushing outer sleeve to push on, and with the factory rounded edges, the socket can easily get cocked slightly and not push squarely."

Another possibility: You can cut through the rubber and remove the guts of the original bushings and then use 1/2" drive sockets with a 1/2" bolt! Or 3/8" drive sockets with a 3/8" bolt. Either should hold the tools together and aligned more securely than a 5/16" or 1/4" bolt through 3/8" drive sockets, and obviously you'll have less concerns about strength with the heavier bolts.

Not everyone has to work so hard, though. Tom Bernett says, "The two socket method worked splendidly for me - no tendency for the pusher socket to get cocked at all. I don't know if it helped, but after the initial tightening of the bolts/sockets, I gave the bolt head a firm smack with a hammer as a little encouragement to break whatever bond there might be. This is the kind of job that you expect to be a real problem. I pictured hours under there with hammers/chisels/drills/saws/etc. You can imagine my delight as I watched all 3 bushings slowly slide out one by one."

A method to avoid: Some people cut the rubber and center sleeve out, leaving only the outer sleeve, then insert a hacksaw and cut through the sleeve on one side; the sleeve can then be collapsed and removed easily. If done carefully enough, it appears to work fine, but a small nick on the aluminum boss on the rack can cause a stress crack later. Using a drill or other means to destroy the original bushing involves similar risks.

Another method to avoid: using a hammer. You're just asking for damage to that aluminum rack.

An obvious method to avoid: Heating the aluminum up to get the bushings loose. Unbelievable as it may seem, some people are willing to try this. The facts that the housing is aluminum which conducts heat *very* well, the seals inside are rubber, and a rebuild costs as much as a three-day ocean cruise for two apparently never occurs to them.

STEERING RACK MOUNT BUSHING INSTALLATION: Don't!!! The Jaguar steering rack mounts are *crap*, pure and simple. Do not install any such bushings, period.

STEERING RACK MOUNTS: Even if the original Jaguar steering rack mount bushings in your car are in fine shape, the steering response is awful. The stock mounts are very soft, which by itself is not necessarily bad. However, for some reason Jaguar chose to position the mounts parallel to the steering forces, so they are loaded axially (shear) rather than radially (compression). See Figure 18. There are bumpers (flat washers with a layer of rubber on one side) on either side of the mounts to limit the side-to-side motion of the rack. This design results in a nonlinear response: When you turn the wheel gently, the steering is somewhat unresponsive, since the mounts flex and absorb most of the steering motion. When you turn hard enough that the bumpers are contacted, the steering suddenly becomes much more responsive. The inconsistency of response makes it difficult to steer smoothly, especially when driving hard; the car seems indecisive about how much it wants to turn.

Besides providing lousy response when new, the OEM mounts are also known for a lack of durability, and of course when they come apart they come apart all at once. Ray Johnson says, "everything was fine and then the next thing I knew I was tacking a 4200# sailboat down the highway."

On the XJ-S discussion list on the Internet, this author mentioned the possibility that this inconsistent response might actually be dangerous, especially with drivers that *never* drive hard and therefore are taken by surprise in the first panic situation they encounter. Of course, the first panic situation may rip the mounts apart -- but do you really care exactly *why* the mounts don't work right in the first panic situation? Jim Downes responded: "Many (too many) moons ago when I was a student, I worked part-time at a Jag/Rolls dealership in Ireland. Occasionally, a customer's Jag would be towed in after a very bad crash. Most customers complained of an apparent loss of directional control during (as Kirby correctly identifies) a 'panic' situation. In almost every case, the bushings were worn and behaved exactly as described above. Absolutely all of the senior mechanics there felt that the bushings were dangerous after a few months of use."

The solution is to replace the steering rack mount bushings with ones that are not merely stiffer but of a totally different design. This modification is so common that virtually every aftermarket business dealing in Jaguar stuff offers a kit. The John's Cars design (see page 717) subjects the elastomers to compression only, and eliminates the inconsistency in the steering response. They use polyurethane, making the mounts stiff but not totally rigid. The entire kit is about \$50, and well worth the money. A similar kit is the Mackay Sure Trak A1598U, available from BPI (see page 692). XK's unlimited (see page 697) offers a kit of slightly different design made of delrin, but the function is similar.

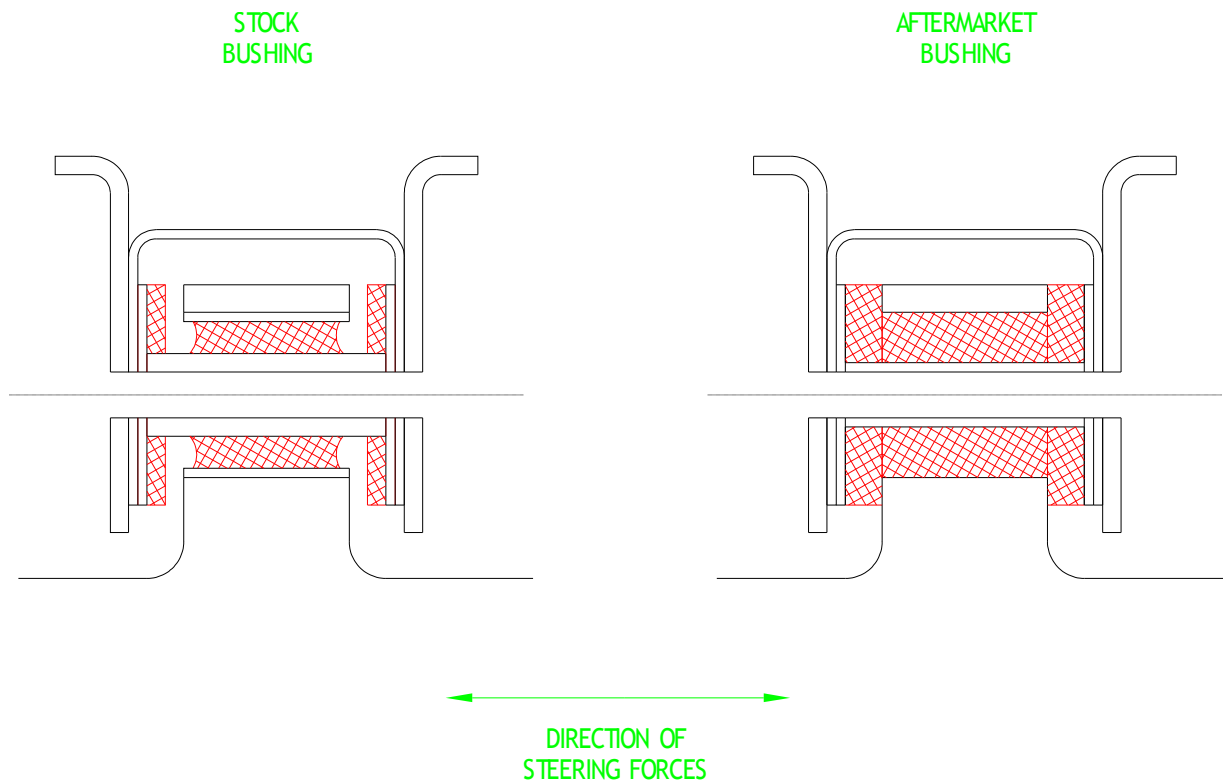


Figure 18 - Original vs. Aftermarket Steering Rack Mounts

Folks, please take this recommendation seriously: even if the stock bushings have not yet failed, even if they are *brand new*, replace them with aftermarket bushings as soon as possible. If you are determined to keep your car "original", please yank those original junk bushings out and carefully box them away for future concours events, and install some good mounts for any actual driving you may do. Downes concurs: "Regardless of perceived 'quality' of feel, when I move the wheel expecting a twenty degree turn, that's what I want, not fifteen or twenty five degrees depending on side-loads, braking loads, road camber or any of the other variables that can influence the 'mood' of the original bushings."

The stock assembly includes a sheet metal U-channel that fits around both bushing assemblies on the driver's side, holding the whole mess together as you offer it up to the car. When you lower the rack, this piece might stay up there; pull it out, it's helpful for installation. The aftermarket bushing set from John's Cars includes a new one of these pieces -- very nice, since the old one might be a little mangled.

Because there has been some confusion due to inadequate instructions provided with these kits, one thing needs to be made very clear: when these aftermarket bushings are installed, they should fit snugly within the bosses on the subframe. There should be no gaps or spaces whatsoever. If the boss is wide enough that the bushing assembly fits with space left over, some 5/16" fender washers should be installed to fill the gaps. The mounting bolts should be *tight*, compressing the boss (Slightly! That's why you need to add fender washers if necessary!) onto the ends of the metal tube within the bushing.

Jaguar itself offers a stiffer mount scheme in its "SportsPack", using one normal mount (CAC 1635) and two special ones (CBC 5928 or CBC 9107). While an improvement, this scheme still maintains the lousy shear-loaded design, and it is still a better idea to get the aftermarket kits instead; they are easier to install (no press fit required, since there is no shear loading) and a good bit cheaper.

The urethane (red) mounts don't last forever, however. Lee Opausky reports: "Installed 5 or 6 years and 40 M km ago, John's poli bushing failed in the last 3 weeks at a very rapid rate. The steering wheel yesterday went to a "full half turn/no change in direction" mode from somewhat loose steering 3 weeks ago. This part was very good to us for many years since it first replaced the "British rubber" and I have no probs with the quality of the part. What I find intriguing is the rapidity of the failure with practically no warning signs. 3 mos ago I had these guys out when the rack had to be lowered to install a new starter, and a visual did not reveal any signs of fatigue. Now they are literally mushed with only the outer rim in one piece - like a slice of orange peel.

"The poli bushings were of orange color and gave excellent service for 5 or 6 years. No oil or other chemical came into contact with these parts (clean car) and all 3 seem to have been affected at the same time to the same extent." Of course, one wouldn't expect just one or two to be affected; when the rack decided to move sideways, it must take out all three to do it.

Larue Boyce: "I installed John's Cars steering rack bushings in my '91 in in January of 1998 at 98,368 miles. I replaced them with the black ones from Welch Jaguar in Dec of 2001 at 140,439 miles when I replaced the rack with a rebuilt from Coventry West. I think the bushings did a great job and were worn out after 42,000 miles along with the heat from the motor and Florida. The bushings had worn, discolored and the end pieces separated into several "O" s."

So far, durability seems to be an issue in urethane aftermarket mounts but not delrin (grey) mounts, and may be due to this being a poor environment for urethane. Jim Cantrell says, "The melting point is about 350°F and the maximum recommended service temperature is 250°F. Above this temperature, the esters boil out of the matrix and brittleness follows. However, they rate poor in resistance to hydrocarbon exposure, acids, synthetic lubricants and hydraulic fluids. Could be something there in the engine compartment besides heat that degrades the material."

Bolles suggests that instead of replacing the original mounts, you merely insert washers on either side of them to reduce the side-to-side travel; washers from mag wheel lug nuts work well. This makes the original mounts last indefinitely, since they hardly move.

Another idea may be to cut out some hard rubber pieces -- preferably with some cord for strength, like old tires or drive belts -- to install on either side of the original mounts, providing a compression member to restrain the side-to-side motion. Make sure to fill the space, leave no gaps; for the rack to move *at all*, it should be compressing material. You might consider removing the OEM rubber-faced washers on each side of each mount and installing fender washers instead along with a broad flat chunk of hard rubber the same or larger OD as the mounting lug and perhaps 1/4" thick.

Since the three mount bushings work in unison, the stiffness of the rack mount system can be controlled by altering just one, two, or all three mounts. However, this author recommends you treat all three bushings the same so as to distribute the load equally on all three mount lugs on the rack rather than concentrating the load on one or two lugs. An alternative idea is to stiffen the two mounts on the driver's side and allow the one on the passenger's side to remain flexible; some suggest this will minimize stresses due to differences in thermal expansion, allowing the passenger's end to "float" a bit while the driver's end remains firmly anchored. It's not likely there are any significant stresses due to

thermal expansion here, though; stiffening all three while making sure the fender washers are positioned properly to avoid stressing the lugs when the bolts are tightened should work best.

STEERING RACK MOUNT BOLTS: If you happen to be working on the rack with either the engine or the front subframe out of the car, you may be able to put the bolts in any way you wish. But for the benefit of those who work on the car later, please install the upper mount bolt on the driver's side from the outside inward, and the lower bolts on both sides from the inside outward. This makes it much easier to install or remove the rack with the engine and front suspension in the way.

If you must replace the mounting bolts, be careful not to use bolts that are too long. When complete, be sure the upper bolt on the driver's side does not protrude too close to the engine block, since the engine moves on its mounts and will beat against the bolt. And the lower bolts should not protrude too closely to the lower A-arms, since they are likewise mounted on rubber and may move during operation.

STEERING RACK REMOVAL: If you have to totally remove the steering rack, one problem is how to remove the pinch bolt that connects the steering column swivel joint to the tower shaft. Remove the oil filter first, then turn the steering wheel until the pinch bolt is positioned where you can get at it.

Also note that the pinch bolt must be completely removed for the swivel joint to be disconnected from the tower shaft. The tower shaft has a recess the bolt fits through; merely loosening it will not permit removal.

You might find it helpful to carefully mark the relative position of these parts prior to disassembly.

STEERING RACK TOWER SHAFT SEAL: This seal is prone to leakage. John's Cars (see page 717) offers an aftermarket seal that is supposedly better than the original. It better be, it's quite expensive.

Len Olsen offers another option: "OEM or aftermarket kits no longer include original 'steel cup' style seal. New type frays quickly. Better than original can be purchased from Autozone, included in kit #7910 (cost \$10).

"Power steering kit #7910 is for a 1980 Chevrolet Camaro, 350 V8, 5.7 liters. The number stamped on actual seal in the kit is '1 PC 7808195', but AutoZone says that as far as they know it is only available as part of kit. Take my word for it, it is better than original for the XJ-S (or any Jaguar sporting the same rack and pinion assembly) being that it is slightly oversize and "beefier". It's been in there 18 months, after wearing out 3 other types of seals in quick succession. Burrs, debris, etc. helped 'do in' the others, but this one's tougher.

"AutoZone had told me that that the unidentified "Powercraft" seal kit #7910 was from a '85 Chev 350ci truck, but it also showed up on their system for a 1980 Chevy Camaro. Oh well, go figure! It worked for my Kitty."

Tom Bennett adds another: "Go to your local seal store and ask for an oil seal with the following #22-30-6mm. The I.D. is 22, O.D. 30 and the height is 6mm; this is 2mm more in height than the Jag "New" style but I can assure you fitting it is no problem at all! The particular seal I bought was blue and flexible, no idea what the material was, not rubber though! Cost about \$3."

Reportedly, one problem associated with the tower seal is incorrect installation by driving it too far into the housing. Be sure not to drive it any deeper than it needs to go.

STEERING RACK REBUILDING: Judging from the experience of other XJ owners on the Internet, you're going to need a rack rebuild sooner or later. They start leaking power steering fluid out of the boots. Replacing the boots won't help, they have deliberate drain holes in them! They're not supposed to hold fluid, they just keep dirt out. The fluid is supposed to be kept in the rack by seals on each end of the power piston itself. If the boots are filling with fluid, rack rebuild time. Of course, there are products on the market that you can supposedly pour into your power steering system to stop leaks, but these will be a temporary fix at best.

There is a "seal kit" available for the steering rack. Note that reportedly the tower shaft seal is *not* included in this kit; check with your source and order the tower shaft seal separately if necessary.

A high percentage of people who have rebuilt their own steering racks have reported failure on the first try, and all for the same reason: when installing the rack bar through the seal on the driver's side end of the rack, the teeth on the rack bar ruined the seal. This typically results in ordering an entire new seal kit to obtain this one seal, and greater care the next try. The repair manual calls for wrapping the rack with tape prior to sliding the seal over it; apparently this is the minimal precaution, experience says to lube it up as well and exercise extreme caution during assembly. It has also been suggested that the seal and the part it mounts into be slid over the rack separately and then assembled, since installation in the housing makes the seal more difficult to work with.

Even with care to not damage that seal on installation, your rack rebuild still might not be successful; you may still have fluid in the boots within seconds after startup. Gregory Wells of Coventry West, Inc. (page 693) says, "We rebuild a large number of Jag racks each month and we find that the wear causing the leaks is usually not just the seals; the sealing surfaces wear, too. And unless these are checked and dealt with in one way or another, the rack will probably leak immediately or sooner than you'd like. Modern elastomer seals tend to wear the metal sealing surfaces more than the old natural rubber seals. We have polishing equipment we use to polish the seal surfaces; if they are too worn to polish out the grooves without reducing the diameter of the shafts below what we feel are minimum specs, we replace the part from the usable spares pile."

POWER STEERING BOOST REDUCTION: Many drivers object to the inert feel of the overboosted power steering, and seek ways to reduce the assist. One of the simplest cures is to install a smaller diameter steering wheel; Momo and others make aftermarket wheels and adapters. The owner of a later car, of course, has a driver's side air bag to contend with.

John Goodman points out that the XJR-S has reduced power assist, and it may be possible to retrofit the valve body onto the steering rack in the regular XJ-S. "I don't think the racks have changed much, the valve is probably interchangeable. Reduces assistance by.... well, you need two hands to turn the wheel at standstill, normal round town corners are OK. On the road it is noticeably heavier but much improved.

"SPC 1034 is the part no. for the rack valve from an '89 parts list.

"SPC 1286 is the part no. for complete rack from '92 parts list.

"SPC 1158 is the part no. for the rack valve again '92 parts list.

"The rest of the steering is std. Front springs/shocks are unique XJR-S items though."

The XJ-S owner is advised to only consider the boost reduction mods *after* replacing the rack mounts with aftermarket items. The rack mounts are the cheaper mod, they will usually provide the feel the driver is looking for -- and they make it easier to take the rack in and out to make further mods like the valve replacement.

STEERING WHEEL ALIGNMENT: If your steering wheel is cockeyed when driving in a straight line, your problem may be in the relationship between the steering wheel and the rack, or between the rack and the front wheels. Jaguar has provided a nifty method of determining which. If you remove the grease fitting from the steering rack, a dowel (or special Jaguar tool no. 12279) can be inserted to engage a notch in the rack. When the notch is lined up with the grease fitting hole, the rack is centered. The steering wheel can then be lined up properly. Once this is done, a misalignment when driving straight (be sure you're on a level road, and not in the right lane of a road that is crowned) calls for correction at the tie rods. If the correction is minor and you are confident that the alignment is otherwise OK, this can be done by carefully marking both tie rods and adjusting both of them the same amount.

Franck Guilloteau says "that "special tool" can easily be replaced with a screwdriver (torx T20 for example) that has the same ID of the zerk (sp?) grease fitting on the steering rack - remove the fitting, insert the screwdriver - move the wheels until it drops in a rack groove - the rack is centered!"

TURNING RADIUS: Dan Jensen reports, “I recently replaced the power steering racks in my ’83 XJ6 and ’84 XJ-S with rebuilt units. After changeout, I noticed a significant, and undesirable, increase in the turning radius on the XJ6. This often made it difficult to make U-turns without backing up, and complicated parking. A check with my local Jag specialist revealed the source of the problem. Some point along the line, Jag added rack travel limiters as part of the inner ball joint lock tabs. These were apparently installed to preclude potential rubbing of the tires on front end components after Jaguar changed the recommended tire size from 205/70 to 215/70. I don’t know if this applied to the XJ-S as well, which had 215/70s specified. By pulling back the inner ends of the rack boots, I could see the thicker locking tabs. I unscrewed the inner ball joints and replaced the wide tabs with the narrower tabs. This caused no noticeable change in toe-in since the thickness of the locking tab between the rack and ball joint is the same on both varieties of tabs. This was a 10 minute job and fully restored the tighter turning radius I was used to. I have not noticed any rubbing of tires on components with the 215/70’s on the car. If others have what feels like a wide turning radius, you might want to examine one side of your rack to see what tabs are used. Apparently rack rebuilders are not always careful about the VIN number and rack changes, but I cannot see how the limiters served any real purpose and, in fact, created a bit of a hazard in my case when making U-turns.”

POWER STEERING PUMP: According to XKs Unlimited, there have been three different power steering pumps used on the XJ-S. Prior to 1976½, the part number was C28457, and the pulley was retained by a single nut in the center. From 1976½-1980, part number C45540 was used, and the pulley was bolted to a hub on the shaft with three bolts. Also, the high pressure line connection is sealed with an olive, visible when the hose is removed. From 1980 on, part number EAC3167 was used and this pump looks just like its predecessor except that the high pressure line is sealed with an O-ring. This last pump is referred to as the “metric pump”. The same three units were used on other Jaguars of similar years.

The XJ-S power steering pump is a standard GM Saginaw unit. However, it is uncertain whether the Jaguar system operates at the same pressure as a GM; so, if you replace the original unit, it is suggested that you remove the pressure control valve from the Jaguar unit and install it in the new one. The pressure control valve is easily removed by removing the outlet fitting and shaking the unit until it falls out.

POWER STEERING PUMP TENSIONER BOLT: The eye end of the threaded tensioner for the power steering pump is held to the engine with a double-ended bolt, C36196, through the timing chain cover. Several people seem to have one problem or another with this bolt. Peter Havas says, “I happen to be past master at this one, having had my pump come adrift at eye-watering speed. The beast is a long bolt, with a 13mm head 8mm shaft, fine thread. I had mine shear off at the front cover. My fix was to purchase a length of 8mm threaded rod, and insert it into the hole, then double nut the bolt to the front cover, and finally re-assemble the eye bolt adding another nut at the end.” Note that on early cars, this is probably a 5/16” UNF bolt instead of an 8mm. Craig Sawyers: “Watch the nut though; the old one on mine was (uniquely) BSF thread. The new replacement one was UNF. Don'tcha just love it?”

Havas: “As an aside, check the two *big* bolts holding the pump bracket to the engine. My back bolt sheared off completely.”

POWER STEERING FLUID: According to the owner’s handbook, you’re supposed to put the same type fluid into the power steering unit that you put into the automatic transmission. This is interesting, since the early cars with the Borg-Warner automatics called for Type F fluid while the later cars with GM400 automatics call for Dexron 2D or III, and the power steering system didn’t change. Apparently any ATF will do in the power steering system.

Apparently Type G fluid was called out in some owner’s handbooks for the power steering. “Type G is an obsolete designator for Dexron. It’s so obsolete that nobody remembers what it was.”

See the discussion on Dexron ATF’s on page 326.

On the other hand, maybe you shouldn't use any sort of ATF in the power steering system. Jeb Boyd says, "I do believe you would be better off using power steering fluid in your power steering system. I was led to believe a few years back when they were experimenting with various formulae for ATF that the additive that was P/S compatible was no longer in ATF. I have been using power steering fluid exclusively ever since with no problems."

Joe Bialy concurs: "I can't speak for Jaguar, but I do know for a fact that late model Ford Escorts had different fluids for the P/S and automatic transmissions when they left the factory. I was never able to get a technical explanation other than it affected the long term well being of the vehicle."

Jim Isbell says, "A neighbor was having trouble with a leaking power steering rack on a 1990 Continental. He is a shrimper and on his boat he uses a power steering pump connected to the engine to drive a hydraulic motor for retrieving his nets. In that pump he uses 30 wt motor oil. So when his cars steering started to leak he decided to try 30wt motor oil. It cured his leak. I was skeptical of the life of the system with 30 wt motor oil in it but his experience with the boat made me take a "wait and see" attitude.

"Well, two months later it's still leak free and still working.

"*But...* something more interesting to me was that when I started reading on the fluids that were allowed in the steering and autopilot on my boat I noticed that the list, which starts with automotive power steering fluid, goes on to include motor oil of varying densities as well as almost any other semi-oil fluid you can imagine. In other words, its not very particular what you put into it. So maybe using motor oil to cure leaks in the power steering isn't so crazy after all."

DRAINING POWER STEERING FLUID: Craig Sawyers says, "In trying to find the source of my leak, I found if you disconnect the hoses at the rack, it just obligingly trickles out (up your arm). I realise that is easier in the UK, where you can get easy access to the unions, than in the US where they are well inaccessible."

POWER STEERING FLUID LEAKS: If your power steering system leaks, you should fix it. Yeah, right! You're just gonna keep adding fluid, aren't you? Well, there is no shortage of products that claim to stop leaks in power steering systems -- but apparently there is only one product that actually *will* stop leaks in power steering systems. John T. Richardson: "I've came across a product that worked well for me on stopping power steering leaks and want to share it: Lucas power steering sealer. While the name might scare you off, their product contains no electricity so it should work. Their product appears to be a really thick, red coloured oil.

"I recently purchased a '91 Ford Explorer w\143K miles and a massive power steering pump leak. It had to be filled up daily and always left puddles of fluid when stopped. I tried this "snake oil" and the second bottle did the job. I never expected such results! No more leaks and the outside of the pump seal is only "damp". Since then I have been using Lucas power steering sealer to top off the Jag pumps on an as-needed basis and that frequency has gone down."

Joe Montgomery: "Having tried about every power steering sealer made, forget them all except Lucas. I found Lucas at the local Pronto Auto Parts. It is as thick as honey on a cold day."

George Harris: "*It works!* As a last resort, just until I get around to finding those d**n leaks, I thought I would try a bottle. I had to drive my '88 XJ6 (XJ40) because the 'S' was off the road for rad R&R. The PS reservoir was empty, so I emptied the bottle in it. That brought it up to 'full cold'. Since then, 2 weeks ago, I haven't had to add any PS fluid! Normally that's at least one complete refill. Since then I did the same to the 'S', and same story! Now does Lucas Oil Products make a stop leak fluid for the tranny and engine?"

No, it's not the Lucas we all know and love; the company that makes this stuff is:

Lucas Oil Products
13365 Estelle Street
Corona, CA 91719
1-800-342-2512 Fax: +1 (909) 270-1902
<http://www.lucasoil.com>

The “Power Steering Stop Leak” is available in *some* auto parts stores, including CarQuest. When this author asked about it, the salesman was very enthusiastic about the product, claiming that if your power steering pump was old and worn and making noise you could add this stuff while the engine is idling and the noise will go away while you’re adding it. The directions on the bottle are simple enough: whenever the fluid level is down, top it up with this stuff. Keep doing that until the level doesn’t go down any more. The bottle claims that “Results are usually immediate.”

Lucas reportedly makes a good injector cleaner and hypoid oil, too. Greg Meboe: “The lady behind the counter swore by them, and said that the store stocked them for trucking fleets.”

Dennis Kindig went another route: “I had been nursing a power steering leak for over a year that required topping up an almost empty pump every week or so. I switched power steering fluids and the leak has gone away. I’m using Valvoline semi-synthetic power steering fluid with conditioner and stop leak (I can’t remember whether the name is SynChron or SynPower, sorry). This looks like standard power steering fluid so I don’t feel like I’m pouring oil in my system. It took a few weeks for everything to dry up but it did eliminate my leaks.”

Peyton Gill didn’t fare as well. “I tried something similar to what Dennis described. It may have been a different product because it was clear and very low viscosity...like water. It was made by Valvoline and the label stated it was for steering rack leaks. Well as usual I should have left well enough alone and added this product to stop a slight leak. Guess what happened??? Starting leaking like crazy.”

POWER STEERING HOSE/TUBE CONFIGURATION: The Jaguar Parts Catalogue ©1987, page 1G 07R, shows simple power steering piping for RHD cars in the illustration: lines go from pump to rack to cooler and back to pump. On the author’s ’83 LHD, the lines go from the pump to a metal tubing loop across the bottom front of the front suspension subframe and back, then to the rack, cooler and back to pump. Jon Schrock says, “Jaguar changed the part for the XJ12 in April, 1978 (Service Bulletin 78-F-1) "to reduce high pressure noise" and presumably did it to the other models about the same time. Specifically they went from a 14 inch line to a 40 inch one. Both my '85 XJ-S and '77 XJ12 have the longer line, but I suspect the latter acquired it after it left the factory.”

The author found it helpful to remove the screws holding this loop to the front of the subframe, put 1/4” spacers behind them, and put them back in. With the loop held tightly to the surface of the subframe, dirt would get caked all around it until you’d have to dig to see the tube. With the tube held 1/4” away from the surface of the subframe, the dirt seems to fall away rather than build up. The loop is probably not intended to provide any significant cooling -- there is still a dedicated cooler in the low pressure side of the circuit -- but improving airflow around this tube couldn’t hurt.

POWER STEERING HOSE/TUBE REPLACEMENT (US-SPEC LHD): Valery Danilov says, “The high pressure hose next to the exhaust manifold was cooked, and although appeared OK, was leaking badly. After wiping it clean, I was able to see the ATF come right through the surface (not a single crack, but rather sponge effect!!!). I would recommend you guys check yours, if it's not leaking, then wrap it with aluminum foil or something.

William Earl says, “I just got my 1990 XJ-S back from the shop where I had two of the power steering hoses replaced. When I brought my car in, there was a 1988 XJ-S getting the same hoses replaced, and when I picked up my car, there was third XJ-S due in the next day for the same problem. I am adding these hoses to my periodic maintenance list, probably at an 80000 mile interval. The problem seems to be heat in the manifold area, even with the insulation around the hose.”

Danilov: “I bought a new hose from NAPA. It is a simple bolt-on, replacing 2-piece original with a NAPA 1-piece design. The new hose is identical in all respects to the old pipe-hose-pipe assembly, except that it cannot be taken apart. It came in a fancy box with a new o-ring included. Part number is NPS 7-1974.”

Jim Moore adds that Jaguar has apparently combined those two pipes too: “My high pressure side used to be a two-piece arrangement. Six years ago I replaced the half that went from the rack to join up with the front half. Jag only sells the one piece now, but it was worth it; car used to growl at low rpm and hard turning, like parking. The growling is gone now.”

Miles Milbank had to replace this line, too. "My problem is that my hi-press hose has been worn thru where it crosses over the sharp (!) fluid cooler fins in the return line - what a monumentally stupid design." Randy Wilson retorts: "The faux-pas is with whoever did the last bit of work on the p/s hose. The factory hose, with the original interlocks in place, clears the cooler just fine."

Wilson goes on to describe the replacement procedure: "Disconnect the hose from all other points. Drop the rack down and back until you can get at the fitting. I do not remove the cat. It is *not* easy, especially starting the new hose without crossthreading the fitting. Make sure the interlocks hook together properly. Aftermarket hoses often do not have the interlock, and require some serious bending to duplicate the OEM hose. If the steel tube at the rack end of the hose is straight, it is wrong."

Of course, if the problem is with the hoses and not the metal tubes or fittings, you can rebuild these lines using suitable hose and EFI clamps, similarly to rebuilding the fuel lines (see page 243). Although the pressure in power steering lines is higher than in the fuel lines, it's no higher than any other hydraulic hose application; any industrial hose supplier can provide hose suitable for use with power steering fluid. Greg Meboe says, "I just brought my old hose into a farm supply place and they made a new one for me in a matter of minutes. Cheap too." The low-pressure line from the cooler back to the pump is nothing but hose and clamps to begin with.

POWER STEERING HOSE/TUBE -- THE METAL PARTS FAIL, TOO: Craig Sawyers says, "Mine seeps around where the pipe unions go into the pinion housing. Fortunately on UK cars, these are easily accessible. However, I've had them off a couple of times, and retightened them to varying degrees and it still leaks. I threw in the towel and took the car to TWR Jaguar (Oxford UK) to have a chat with Denis, their chief technician. Without even looking, he pronounced that the flared end of the pipe was cracked! "Common problem" quoth he; "I bet you found that the more you tightened it, the worse the leak got." Yup. "and that it seeps around the pipe." Yup. "If you undo the unions, and clean them you will see a very fine crack on the flare". Well, I haven't tried that yet, but I think he is probably right. Looks like I'm in for at least one new hose."

POWER STEERING HOSE/TUBE CHAFING (RHD): Stefan Schulz reports on chafing problems on his RHD car: "...above the rack on the left is where the pipes go to the power steering pump. On mine there is a designed-in problem where one of the pipes chafes against a bolt head. This cost me two replacement pipes before I figured out what was going on. No way to get around it with the Jaguar original parts.

"My steering rack is a CBC5708N, which is the UK (RHD) sports pack rack. The pipe is part of the high pressure hose assembly CAC3654 (same as the plain XJ-S). Calling it either hose or pipe is misleading because it consists of alternating sections of hose and pipe.

"One of the pipe sections either constantly chafes on or occasionally rubs against a bolt head near the upper left side of the rack, as seen from underneath the car facing forward. The severity of the chafe will depend to some extent on how much either end of the hose assembly is twisted against its fittings during installation. The design fault appears to lie in the fact that the offending section of pipe is dead straight (which is cheap) as opposed to having a slight bend to clear it (which costs at least an extra GBP0.02 to manufacture).

"Funnily enough, inspection of hoses and pipes for chafes *is* a part of the 7,500 miles maintenance schedule. No prizes for guessing why, in case any more such design gems lurk in the car.

"My workaround, which operates entirely satisfactorily, is to put a hose clip around the chafing area of the pipe, to check it every time I get under the car and to replace it when necessary. So far I only needed to do it once, after about two years of service. The pipe still is as new.

"A hydraulics shop could easily make up a properly formed section of pipe, probably at a fraction of the cost of a Jaguar original as well."

Rear Suspension

REAR END ALIGNMENT: There's no such thing as castor on non-steering wheels, and toe-in is not adjustable on the rear of the XJ-S; if it's off, something is bent. The only alignment adjustment available at the rear is the camber, adjusted by replacing shims between the inner end of the axle and the brake disk. The more shims put in, the more the top of the rear wheel tilts outward.

Note that there are usually some shims between the brake rotor and the differential unit. These are to locate the rotor properly between the calipers, but also affect the camber as well. If working in this area, always make sure all shims are reinstalled properly. If your objective is to relocate the brake rotor without affecting the camber, move shims from inside the rotor to outside or vice versa, but do not add or subtract any shims to the car. If your objective is to alter the camber without relocating the brake rotor, add or subtract shims from outside the rotor and do not disturb the shims inside the rotor.

Randy Wilson offers this advice: "Camber is not a constant. The camber control is taken on two pivoted arms (of unequal length) so that the camber can change on a predetermined curve based on suspension position.

"It is very unlikely for the camber to change from factory specs unless one of three things happens: either something is bent, someone left some shims out during a differential or brake service, or the ride height is wrong. The #1 cause is the last, sagged rear springs. So, when you are told that the rear camber is off, investigate the static ride height before investing a lot of time/money in shim swapping." Better advice: don't make *any* decisions about adjusting shims without ascertaining the alignment properly, which means to lock the suspension height using the specified tools; see page 356.

CLUNK - REAR: See the section on page 352.

REAR SUSPENSION SUBFRAME/DIFFERENTIAL REMOVAL: To work on the differential, as well as many tasks relating to the rear brakes, it is necessary (or merely preferable) to lower the entire rear suspension assembly out the bottom of the car. Fortunately, this is nowhere near as difficult as it appears. It is suggested you read through the tips on removing the inboard rear brakes starting on page 438 before starting this job.

The basic idea is to put the rear of the car on jackstands, position a floor jack under the center of the IRS, unbolt it from the car, lower it and roll it out from under the car. The first challenge: You need to get the rear of the car high enough to get the suspension out from underneath. To get it out the rear of the car, the lowest point of the bottom of the trunk needs to be higher than the height of your floor jack when fully collapsed plus 13". Plus an inch for fudge, just to make sure.

As soon as you get the car propped up and the rear wheels off, the next thing you should consider doing is removing the grease fittings at the bottom of the hub carriers. They'll get busted up sooner or later if you leave them in there.

The next challenge will be getting a jack that can get high enough to hold the subframe up while you take the mounting bolts off, and then lower it far enough to get out from under the car -- which means a stroke of 13" or more. If your jack isn't up to the task, Jan Wikström says "You'll need to shift the subframe in two lifts. I use a 5" thick wooden block on the jack and rest the unit on two cement blocks halfway up."

"You need a friend to stabilise the subframe as you move it down and up (and help you lift it to the workbench; that sucker is *heavy*). To make the job a lot easier, take the spring/shock units out first and refit them last."

When ready to lower the IRS, Jim Isbell describes locating the jack: "Make sure it is under to the point of almost being too far forward. The cage will try to roll forward if the jack is too far back as it is front heavy." The balance point appears to be perhaps three inches forward of the axles.

Some owners have reported good results with putting the wheels back on during removal; that way, the assembly can be rolled out from under the car. It will require positioning the car on even taller stands, though. Disconnecting the spring/

shock units from the lower swingarm first helps because it allows the suspension to squat.

Note that the suspension assembly, standing on its wheels, will show a distinct tendency to roll over. If you try to keep it from rolling over by holding onto the radius arms, you may find that the radius arms can swivel around their attachments to the lower swingarms without warning and the assembly rolls over anyway, probably onto your toe or some such. John Napoli suggests “let it flip upside-down. Now you can wheel it anywhere you like, wheelbarrow-style, using the trailing arms as handles.”

If you’re going to position the suspension assembly upside down -- either during this rolling or later when working on it -- you might consider capping the vent on the final drive unit so you won’t leak oil everywhere.

If you can’t get the car very high, the suspension assembly may need to come out the side rather than the rear. If you position something with wheels under each hub carrier and lower the suspension onto them, you can then pull your floor jack out the rear and roll the suspension out the side. Bob Gallivan says, “I dropped it onto my creeper on one side of the center of the diff & a moving dolly on the other side. Worked like a champ. Rolling it out the side is the way to go.”

Craig Sawyers suggests you don’t use the kids’ skateboards, though. “My thought exactly the first time I tried this. Miserable failure; totally unmanoeverable - works like two independent bogies. Impossible for one person to handle, and requires an act of coordination beyond anything mere mortals can achieve if two try it. Complicated by the fact that the top of the board is resiliently mounted to the wheels, so it tilts in wierd and unpredictable ways.”

Of course, just using the floor jack from the side instead of the rear might work. Sawyers: “I found just balancing it on the head of a trolley jack and rolling it under the car worked just great.”

When several members of the online discussion lists tackled IRS removal, there was a lot of discussion of details. When the smoke cleared, it turned out that several of the problems discussed were related to the XJ saloons rather than the XJ-S; the IRS is identical, but a couple of detail differences apparently cause consternation when removing the IRS as a unit.

The first issue discussed was the need to remove the stainless steel exhaust tips, apparently because they protrude through holes in the bodywork on the saloon. Removal is one of the steps listed in the Haynes manual as a precursor to removing the rear mufflers themselves. On the XJ-S, there is no problem here; you can leave the tips on if you want and remove the rear mufflers with them attached. In terms of repair manual correction, this means that Section 28 of Chapter 11 in the Haynes manual should include a note that Step 2 of Section 27 can be omitted in XJ-S work.

The next item was what to do when the rear mufflers won’t come off! If the pipes won’t come apart at the forward end of the rear mufflers, the obvious solution is to remove the rear mufflers *with* the IRS. Again, removal of exhaust tips is necessary on the saloon and not necessary on the XJ-S -- but you might choose to remove them anyway to keep them from getting dinged up. Jim Isbell explains this procedure with the saloon: “It is complicated greatly if, like me, you’re not able to remove the tail pipes because it’s then necessary to slide the cage forward as it drops so that the tail pipes will drop free in the rear. As the cage goes forward it hits the front exhaust pipes and the drive shaft so those have to be kept out of the way.” David Littlefield points out that none of this is a problem with the XJ-S: “The cage will just drop straight down, the muffler/pipe/tailpipe combination won’t hang up on anything.”

“This combination is best left in the cage until it is on the bench. Then disconnect the lower fulcrum pin from the shocks and push down the axles. This will allow removal of the pipes without too many contortions. Replacement is reverse of removal. I put the whole rear muffler/pipe/tailpipe assembly back into the cage before refitting to the car. The mufflers actually provided some leverage to wrestle the whole thing around. It helped to temporarily hang the over-the-axle pipe on its rubber mounts to keep the mufflers from dragging around and from accidently falling out.”

The next issue involved exactly how to disconnect the mounts holding the subframe to the car along the upper edge of the wheel well. There are four mounts, two on each side, and the questions involve whether to unbolt the mounts from the subframe so they stay on the car or to unbolt the mounts from the car so they come away with the subframe. Littlefield explains: “In my correspondence with Jim Isbell, we determined that it is difficult to get at the rear mounting bracket to chassis bolts (two in each bracket) on the XJ6 and that the Haynes manual recommends removing the suspension cage to mount bolts (three on each bracket) instead -- but just on the rear. On the XJ-S, I had no problem getting to the bracket to chassis bolts on all the brackets. Not a big deal, but I think it might be a bit easier moving

things around if the bracket to chassis bolts are the ones undone.” On the saloon, Isbell seems to feel that it is important to unbolt the forward mounts on both sides before working on the rearward ones; on the XJ-S, it’s hard to see how the order would make any difference.

Franck Guilloteau says, “I believe that there is one important step that need to be added before dropping the cage. Loosen the nuts that hold the half shafts to the differential. If yours are as tough as mine were when I did the camber change (first time), removing them with the cage off is no fun exercise. I forgot to do it the second time when I dropped the cage. Fortunately I hadn't removed the hand brake calipers and was able to use a long pipe clamp to compress the calipers and stop the shafts from rotating. Even with anti-seize compound it was no picnic (air tools did help though). If you have removed the brakes....well good luck!!

“Using a 20" extension and 11/16" deep socket (not to forget the long pipe to use as leverage at the end of the ratchet) you can remove/loosen up 3 of the bolts that hold each half shaft (remove the u-joint cover and rotate shaft until you can get to the nut - use the hand brake to stop rotation). The 4th bolt which has a zerk fitting in the way so you need a shallower socket. It should come last in the removal sequence.” Of course, you might opt to temporarily remove the zerk fitting to get the socket on the nut.

Littlefield: “Or, you can put an open-end wrench on the nut, turn the drive shaft until the end of the wrench contacts the cage and stops the drive shaft from turning. Then take a breaker bar or other long lever and turn the hub by using the lugs. With that kind of leverage, the nuts should break away pretty easily. It is a good idea to put the lug nuts on to prevent damaging the threads. I own an impact wrench and an air compressor, which helped, but there is one nut that is under a zerk fitting and I used the above method for it.”

GETTING THE RADIUS ARMS OFF: The ©1975 ROM, section 64.35.28, step 4, describes disconnecting the rear anti-sway bar link from the radius arm. Most XJ-S’s don’t have a rear anti-sway bar, so you can skip this step.

The point where the front end of the radius arm attaches to the lug on the bottom of the car is a notorious spot for difficulty of removal. There’s usually a goodly amount of rust involved. Mike Morrin describes his preferred method of removal: “I have found that the "no muss, no fuss" way to break the bushes from the body involve the use of a lever or pry-bar with the end shaped so that it will go through the hole in the bush, allowing a lot of leverage between the inside of the bush and the mounting thingy on the bottom of the car. I tried most of my (extensive) collection of C spanners in this role, and found a BSW spanner which looks about 60 years old, and has just the right curve on the outside of the C that when one jaw is poked in through the hole in the bush, the outside of the C makes contact with the thingy. The spanner handle is pushed upward (maybe encouraged with a BFH), and the bush just pops off. Because the joint is tapered, it seems you need to apply enough pressure to start to deform the inner ring of the bush before it will move.”

Miles Milbank offers an alternative method: “Remove all the pertinent fasteners. Place a small hydraulic bottle jack on top of the radius arm and unscrew the jack's adjuster to contact the underside of the subframe mount and jack it up until the large rubber mount is well stretched. Spray liberally with Liquid Wrench or other penetrating oil from all sides, including inside from underneath where the main bolt was extracted. Walk away and do something else for awhile until you hear the assembly pop apart, and the bottle jack crash to the floor. Repeat for other side. If it doesn't work within an hour or so, one can come back every so often and apply a bit more: 1) penetrating oil 2) jack pressure and, finally, 3) a few helpful taps at the fitting to encourage it to give way. One time I have hooked a slide hammer to the lip inside the fitting where the main bolt had lived, and the most stubborn radius arm immediately came off.”

John Napoli describes a method that works for him, but note that it involves removing the entire rear subframe: “The car should be supported by 2 jackstands at the rear lifting points. Get the cage ready for removal: brake lines, emergency brake cable, exhaust pipes opened (exhaust pipe(s) in front and the resonators in back -- the over-the-axle pipes can stay in place). You don't have to remove the driveshaft -- it will pop at its slip-joint. If your car has a two-piece shaft, remove the plate holding the carrier to the unibody.

“Place your floor jack under the cage. Remove the safety brackets and main bolts holding the trailing arms to the unibody. Don't try to remove the trailing arms, though. Remove the bolts holding the cage to the unibody (the four rubber mounts). The mounts will stay on the unibody for removal/replacement later if needed. Lower the cage so the weight is on the trailing arms. You want 'a lot' of the weight of the cage on the trailing arms, but not all of it.

“Take your air hammer, and put a blunt chisel in it. Place the tip of the chisel between the trailing arm and the body (you and the air hammer are standing perpendicular to the car -- you do this from the side, not underneath!). Let the air hammer rip, not enough to cut the metal, just enough to vibrate things a bit. The trailing arms will pop off as nice as you'd please.”

If you intend to remove only the radius arms and leave the rest of the subframe attached to the car, you might be able to modify this procedure and make it work. If you disconnect the radius arm at the swingarm first and find a way to pry it downward, you'd be applying essentially the same loading to the attachment.

Obviously, during reassembly it'd be a good idea to use anti-seize compound on this connection to make it easier to get apart next time.

REAR SPRING/DAMPER DISASSEMBLY: The obvious way to disassemble the springs from the dampers on the rear end is to remove the damper with the spring installed, then use a spring compressor on the bench to separate them. However, Ian Macfarlane provides an alternative procedure: “To change the rear shock absorbers without using a spring compressor, the springs can be held in the compressed state by fitting four elongated “C” shaped brackets (two per spring) over the centre 80% of the spring with the car jacked up under the suspension (preferably with a load in the rear of the car to maximize spring compression). Then, when the car is jacked up under the body, the springs will remain partly compressed and the shock absorbers can be replaced relatively easily.”

REAR WHEEL BEARINGS: Justin Pashley says, “A couple of weeks ago I posted a message asking for opinions for what could be causing the rumbling noise coming from the rear of my car. Initially I thought it was a wheel bearing but after jacking up all the wheels none had any excessive play. Well, everyone who responded said it most probably was still a wheel bearing, even though there was no play. I have now had the rear wheel bearing changed and yes, the noise has gone! So, to anyone else that has a rumbling rear end with no play in the wheels, it is probably a wheel bearing.”

Martin Lappin agrees: “I've had cars that sounded like the diff was toast, no play at the wheels, but change the bearings and everything was quiet!”

Tom Bennett concurs: “Several years ago I had a rear wheel bearing go on my '87 XJ6 SIII. I didn't feel any extra play in the wheel. But, if I remember correctly, I was able to determine it was the wheel bearing by spinning the wheel while listening with a stethoscope on the hub. Compare sides and I think you'll be able to tell if one's bad.”

Jerry Holloway reports, “When I disassembled the drive shafts from the diff and could turn them, it became obvious the outer wheel bearing on the left side carrier was down. Interesting that it didn't show itself until I was able to turn it freely parted from the diff. Showed no extra end-play or anything (couldn't feel it with it turning the diff. either) but man was it starting to grind.”

Interestingly, if you *do* have play in the wheels, it might *not* be the bearings! See below.

According to Chad Bolles, the bearings in the rear wheel carriers are a Bower/BCA part number 18590-18520 for the inner, and 18690-18620 for the outer; available in any auto parts store.

Getting the old bearings out is always fun. Jim Schultetus says, “A neat way to remove the bearing cups is to weld a bead around them with an arc welder or a mig welder. Let it cool down a bit and they will fall out as the weld bead will shrink the cup as it cools. Freeze the new cups and tap in.” Not sure I'd go this way in aluminum housings; use at your own risk.

REAR WHEEL BEARING SLOP: I was thinking of adding an illustration here, but cannot think of how to draw this so it'll make sense. There is an exploded view in the Parts Catalogue and there are a couple of cross section views in the ROM but neither makes it too clear how the stack goes together with shims to establish the proper end play in the bearings. I have decided that a wordy description is probably best.

The stub axle, which is the section of the rear axle from the outer U-joint outward, has threads on the end where a

“Jesus nut” (so called because that’s what you’ll be saying if it comes off!) threads on. This is the item shown in Figure 19. From the U-joint outward, the items held tightly by the nut are: The inboard oil seal track, a shim CAC3818, the hub, and a washer under the Jesus nut itself.

Notice that I did *not* mention any bearing races! The inner races of the bearings fit around the outside of the hub and are not compressed by the Jesus nut. The inner race of the outboard bearing is press fit while the inner race of the inboard bearing fits more loosely over the hub. When the nut is torqued down and pulls the stack tightly together, the space between the inboard oil seal track and the inner race of the outboard bearing is supposed to be exactly right to position the inner race of the inboard bearing to provide .001-.003” of end play. The shim is selected accordingly; the thinner the shim, the tighter the bearings get.

Note that the inboard oil seal track actually serves more purposes than simply as a seal track. It has a large chamfer on the ID on one side to clear the radius on the stub axle between the shaft part and the yoke part. And it also provides a flat surface that the shim is tightened against. The shim is tightened against the innermost portion of this flat surface, while the outer portion has the inner race of the inboard bearing butted up against it.

All of which led to the problem that Sean McKee ran into. Since the inner race of the inboard bearing is not securely clamped, it was apparently free to rotate in his car. As it rotated around the hub, it wore away the surface of the inboard oil seal track. The flat face of the seal track was no longer flat; it was unaffected at the innermost area where the shim was tightened against it, but the outer area was worn back several thousandths creating a circular step in the surface.

That isn’t all it created; it created a quarter inch of play at the top edge of his rear tire! Having the step in the face of the seal track loosened up the end play adjustment, allowing gobs of slop. The protruding unworn inner portion on that face is just like having a shim that’s too thick. He found the same problem on both sides of his car, so it probably wasn’t a fluke.

The fix is obvious: replace the inboard oil seal track. Perhaps less obviously, you can fix the problem by simply grinding the face of the old inboard oil seal track flat again. McKee reports that the seal track didn’t seem especially hard, as though Jaguar didn’t expect that inner race to rotate.

Less obviously still, you could grind the old inboard oil seal track flat and then install an arbor shim in front of it. The ID and OD of the arbor shim would need to be the same as the seal track itself. The whole point of doing this is that, hopefully, the arbor seal will be made of something much harder than the seal track and hence won’t wear as quickly. It doesn’t really matter how thick the arbor shim is; it won’t affect the bearing adjustment. However, any such playing in here -- replacing the inboard oil seal track, grinding on it, adding an arbor shim -- should be followed by an alignment job on the rear end of the car, as this all may affect the camber.

The part number for the inboard oil seal track in the 1987 Parts Catalogue is C.15232, but McKee says there’s apparently a later part number CCC6807. Perhaps Jaguar made the part harder to resist wear!

By the way: if you actually expect that oil seal to seal against oil leakage, you’ll want to apply sealant between the inboard oil seal track and the stub axle at assembly. Otherwise oil could sneak out along the surface of the stub axle itself, bypassing the oil seal entirely. Of course, what’s in here is grease, not oil, but it still makes a mess when it gets out.

Regarding selecting the shim: The ROM describes trial-assembling the hub with tool JD.15 and carefully measuring the end play and subtracting to determine the shim you need for final assembly. The tool is effectively a fat shim, which means you can skip buying the tool and just buy a fat shim. Using the stub axle for this trial assembly may be inconvenient, but you can just use a section of threaded rod with some nuts and washers.

So, after all that fiddling, you finally get to put the shim on order! If you don’t want to wait on shipping, you can either order an assortment of shims before starting or you could just order one really fat shim (you may have already!) and take it to a machine shop and have it milled to final size when you determine what size you need. Mike Morrin says, “I was unable (despite repeated attempts) to buy spacers from the local dealer, so got some sent out from the UK.”

Craig Sawyers says, “The shims (they look like either brass or bronze) are stock items. Part number CAC3818/xx, where xx is the number of thou plus 0.1 inch (so if xx was 14, the shim thickness would be 0.114 inch). Price in the UK is £3.70 each plus tax off the shelf. They are available in 2 thou increments (ie xx is always even), consistent with setting

an end float of 2 thou.” Sawyers provides a later correction: “The part number has changed to CCC6806/xx, where xx has the same meaning as my original e-mail. Available ex-stock in pack quantity of five pieces at £3.65UK per piece plus tax.”

Apparently there’s an easier way: just reuse the shim that came out. Everyone who’s done this job confirms that apparently the companies that make the bearings maintain excellent control of their tolerances so you just take the old bearings out and install the new bearings and the same shim is the one you need. Jerry Holloway says, “I spent hours (ok, too much time anyhow) dial indicating the new bearings on the hubs in. After just a few miles of operation I could clearly see that the original spacer would have been fine. After consulting a couple of sage Jag people (who weren’t in it for the hourly base rate) I found that using the original spacer is exactly what they had done for years, with no problems.”

REAR AXLE FAILURE: Jan Wikström reports on his problem and solution: “The stub axle in the hub carrier (the bit that turns in the rear wheel bearings) is splined for the hub and has a large thread and castellated nut on its outer end. This thread comes right down to the splined part with no fillet whatever and creates a horrendous stress concentration at the end of the thread. Mine suffered a fatigue fracture in consequence; my local parts pusher tells me this is not uncommon, as one would expect from such an elementary error, especially if the nut is overtightened. Accordingly, I ground and polished a shallow rounded groove at the base of the thread of the new part... (see Figure 19 and Figure 20, illustrations graciously provided by Wikström).

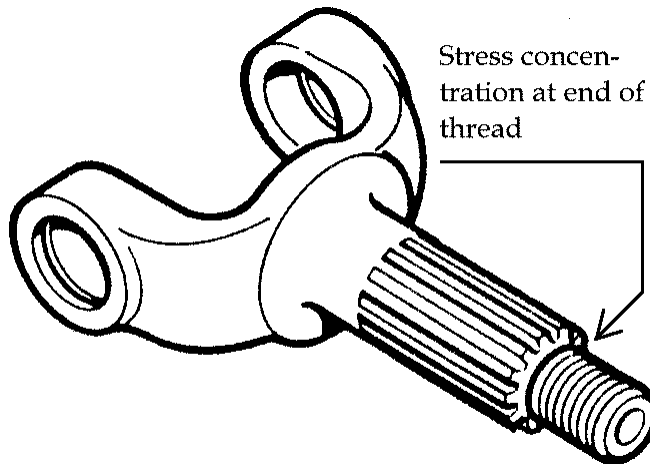


Figure 19 - Rear Stub Axle Failure Location

“The next time you do the rear wheel bearings or U-joints, I strongly recommend having the stub axles checked and modified; any competent engineering shop will know about stress relief. Modifying parts of the Jaguar may be sacrilege to some of us, but fine as the design is, it isn’t perfect...”

If the stub axle has already broken, it is possible to fix it by drilling and tapping a hole in the end and using a bolt and washer instead of the nut. GT Jaguar (now defunct) offered a grade 8 bolt and a specially designed washer for this purpose, and you could easily come up with suitable parts from local sources. This fix may also be used as a preventative measure, since cutting off the stub and drilling for the bolt eliminates the stress concentration in the original part as well as the shallow groove does.

Perhaps one thing to note is that GTJ offered these parts at all; that would seem a serious indicator of just how common this problem is, and how important it is to address it.

Sean McKee reports that the stub axles in his 1990 XJ-S already had a suitable radius in this corner when he got there. Apparently Jaguar addressed this problem somewhere between Wikström’s mid-70’s XJ12C and McKee’s 1990.

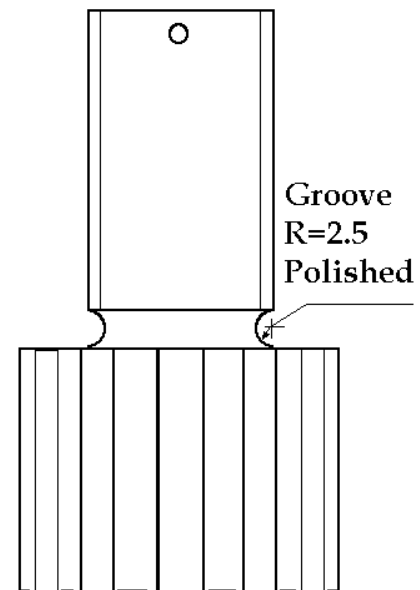


Figure 20 - Rear Stub Axle Modification

REAR HUB CARRIER CRACKING: Joe Bunik reports that the cast aluminum hub carriers on his car had a crack in the area just above and outward of the fulcrum shaft. The crack was parallel to the fulcrum shaft, but just far enough above it to be in the structural portion between the fulcrum shaft bearings and the wheel bearings. What with the rough surface on the cast aluminum combined with the dirt and grime normally covering it, it is entirely too easy not to notice a crack like this. There are some photographs of such a crack on the WWW at

<http://www.jag-lovers.org/xj-s/book/HubCarrierCracks.html>

Such a crack is disconcerting to say the least, and many owners will feel compelled to order replacement parts immediately. However, the crack in the hub shown in the pictures at the WWW site does not appear to be the result of stress; rather than starting at an edge and working across the part as one would expect of a stress crack, it appears to start and end in the middle of the part. It therefore appears to be a casting flaw caused by cooling the casting too rapidly or unevenly. Subsequent reports from owners and mechanics seem to indicate that these cracks are not uncommon and haven't been known to result in structural failure.

REAR SWINGARM OUTER PIVOT: The connection between the outer end of the swingarm and the lower end of the hub carrier involves a pair of tapered roller bearings. These bearings are lubricated via a grease nipple in the bottom of the hub carrier and are sealed with a felt ring.

The design of this pivot joint allows the bearings to be adjusted with shims to be *tight*. When correctly assembled, they roll firmly; there should be no slop or rattling whatsoever. This pivot joint holds the alignment of the rear wheel; any slop means that the wheel is sloppy in which direction it aims.

REAR SWINGARM OUTER PIVOT - GREASING: The grease fitting is obvious, dead center bottom on the hub carrier. But just what good does it do? Patrick MacNamara says, "the relief port for the grease pressure is only about 1" away from the nipple (center of swing arm about 90° around the fulcrum from the nipple facing inboard) adjacent to the hollow end pipe of the lower arm. When cavity is full, it just vents out of the hole and fills the hollow longitudinal portion of the swing arm and no old grease will be pumped out. The only way to get rid of the old grease is disassembly."

On the author's '83, MacNamara is incorrect. There is a cast-in boss facing inboard, but the hole in it has a bottom; it does not open into the pivot joint area. There is a grease relief, though, just *above* this cast-in boss. It points upward and inboard at about a 45° angle. It's a 3/32" hole, completely obscured by all the dirt and grime that has accumulated on that surface of the hub carrier. In other words, MacNamara was in error regarding the location of the grease relief, but he was correct that it was there -- and in its effects.

You might consider plugging the grease pressure relief port. A 1/4" long #4 self-tapping screw will work nicely -- two per car. This will at least help keep dirt and water out.

If you plug the relief port and then use a grease gun to force grease in there under pressure, it'll push against the felt seal. Will it ooze through the felt seal? Maybe; at least, any air in the area will push through the felt. Hence, you *might* actually achieve some beneficial lubrication with the grease gun. I wouldn't count on it, though; you're still not likely to improve the lubrication in there without disassembly.

If you install oil seals as suggested below and plug the grease vent and then force grease in there with a grease gun, you'll probably destroy the oil seals. Your chances are a little better that the grease will just push past the seals if you install them backwards as Ron Moore suggests, but not much better. If you feel compelled to use the grease gun, you might be best advised to remove the vent plug first, then put it back in when done.

Better idea: Richard Dowling reports, "Of all the 24 bearings in the IRS and diff I only had 4 bad ones, namely the outer fulcrum tapered rollers. There was plenty of grease in the bearing cavity, but that around the bearings themselves was pretty old since the new grease goes in the zerk and out the vent next to it.

“In my stripdown I put 2 zerks in for each wheel hub to force grease through the bearings, and a vent hole on the outer side of the fulcrum bearings to ensure grease from the central zerk can exit only after going through those bearings. All this is dead easy when the whole shooting match is cleaned up and on the bench. What about the fulcrum area on your car which is probably like my XJ6, not giving any trouble, but a future concern?

“When I had my XJ-S fulcrum stripped I measured all the items accurately and made an Autocad file (see Figure 21) of the bearing area. From that I could see a possibility of drilling a small hole through the standard assortment of spacers and felt seals into the area next to the bearing race to make a vent, all without stripping the assembly. This morning I tried it on my XJ6 and it works.

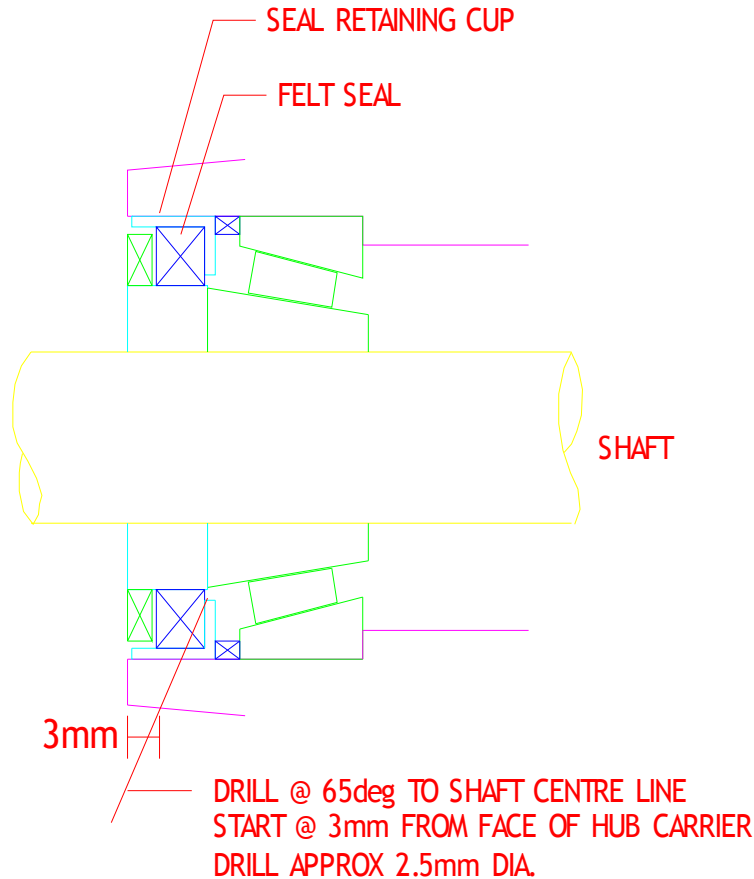


Figure 21 - Rear Outer Pivot Grease Vent

“You take the wheel off, and drill a hole about 2.5mm diameter starting at 3mm from the machined end of the alloy casting. The drill must be at an angle of 65deg to the centreline of the 5/8" shaft running through the bearings. The 3mm and 65deg are moderately critical. I drew an angle of 65deg on a piece of paper and put it under the hub to give me a guide as I drilled.

“On the first one I broke the drill because I was in a hurry. You drill about 5mm though alloy then you hit the mild steel cup that backs the felt seal. You go through the first face of that cup which is parallel with the shaft since it fits the bearing bore, then you hit the felt seal and a little further on you hit the return face of the cup which is at 90deg to the shaft centreline. This latter face is hit at an acute angle of 25deg which is where I broke the tip off my drill. If you exercise patience and take about 5 or 6 minutes to drill each hole, backing off as you break into the felt seal, then going carefully for that return face, it is no problem. Total drill depth is around 12mm.

“As soon as I thought I had broken through I put my grease gun on the zerk and tried it. That also pumps out the swarf. In any event, looking at the pounding on my XJ-S bearing, a small piece of swarf most likely would make no difference.

However, if you grease the thing every 6 months you are pumping grease in a direction that takes the swarf out of the bearing - that will be the least of your worries.

“Small self tappers were used to seal off the vents. I found on my XJ6 that as I pumped, no grease came out of the Jag supplied vent next to the zerk; it must be well and truly blocked. I got plenty of grease out my new vent holes. At first very old and stiff grease, then newer grease sitting in the centre of the cavity, then new moly grease. I also loosed off the 5/8" shaft nuts and rotated the shaft to rotate the bearings which spreads grease and spreads the wear pattern.

“Now I know how it should be done, I guess an hour would cover the job for both wheels. You might want a spare drill, it is not too hard to break one. That is no tragedy, it just means you have an extra hole which may or may not penetrate the bore.”

Since lubrication is a challenge, it might help to use the most suitable grease rather than simply whatever's on hand. Richard Griffiths says, “EP should be fine; in my view grease for this application requires:

- High viscosity base oil at operating temp.

- Water resistant filler

- Oxidation inhibitor additive

- Corrosion inhibitor additive

“Other additives such as Moly are of no significance for this application. In my experience Moly was usually specified for sliding applications; in this case the trick is to keep the rollers actually "rolling" under high oscillating loads while maintaining the oil film. EP should do better here.”

REAR SWINGARM OUTER PIVOT - OIL BATH LUBRICATION: Getting grease right into the contact points between rollers and races is an iffy proposition at best, especially the rollers that happen to be at the top. Unlike wheel bearings or other applications, the motion of the bearings themselves cannot be expected to help move the grease around to where it's needed; these rollers don't move as far as the spacing between rollers.

Richard Griffiths proposes a novel solution: “Two things we know for sure; EP additives work and channeling can occur in "thick" greases leading to lube starvation failures. So if I had your set up with the better seals, I would consider using a hi visc EP oil instead of grease. Highest stuff that will still pour at say -10°F.”

Obviously, having the oil seals installed on the pivot joint as described on page 396 is essential for this idea; the OEM felt seals will simply allow oil to ooze out, and the last thing a Jaguar needs is another oil leak. The oil seals should be installed flat side out, since they will used to hold oil in -- exactly what they were designed to do!

Also, you need to use sealant when assembling. Apply sealant to both sides of *everything* in the stack along the fulcrum shaft to make sure oil can't leak along the shaft to get out. And before the oil seal is pressed into the hub carrier, some sealant should be applied in the recess.

Having an oil-filled assembly sealed airtight would not be good, so using a screw to plug the grease vent as described above is not recommended. As with other containers holding oil such as the GM 400 transmission or the differential, the ideal arrangement would be for the joint to be fitted with a breather that allows the chamber to be vented while keeping oil in and water and dirt out. There are a couple of ideas here. One is to drill the existing grease vent hole out to a larger size and then thread it to hold a fitting of some sort -- possibly the same fitting as the one used on the differential. Another is to press in a small tube and connect a hose to a remote breather, similar to that used on the GM 400; such a remote breather would need to be secured to the hub carrier so it doesn't flap around too much when the wheel bounces over bumps in the road. Remember to make sure the breather connection doesn't interfere with the axle U-joint or its cover; an elbow fitting may be in order. The simplest idea is probably to simply drill the existing grease vent hole bigger but only part way down, not all the way through, and then jam a piece of felt or a cotton ball in the hole.

Richard Griffiths says, “One of those breather plugs with the sintered "filter" center piece would be neat also. See the stuff from the Stewart Warner or Tedeco companies for example.”