Retrofitting Electrolux Wipers to a ’76 XJ-S

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Overview

This write-up describes refurbishment and retrofitting of a ’89-’92 Jaguar XJ-S Electrolux windscreen wiper system to a ’76 XJ-S. Detailed descriptions are given for refurbishment of the mechanical elements, as well as complete diagrams for necessary wiring changes. A list of required parts and sources is provided.

Some of the information provided here may be helpful to ’89-’92 Jaguar XJ-S owners with wiper system issues. The descriptions of refurbishment of the mechanical elements applies directly to any ’89-’92 Jaguar with the XJ-S Electrolux wiper system. Also, it is very likely that the P1-122 aftermarket Volvo Intermittent relay used in the project, which has an adjustable delay period, could be used as a replacement for the Jaguar relay.

For those who would like to see the project without the details, there is an annotated photo album at:

www.efsowell.us

It has bench testing videos, and more photos than shown in this document.

Background

As all drivers of the early XJ-S know, the wipers are painfully slow. After having refurbished mine, including installing a rebuilt motor, there was little performance improvement so I concluded that the problem was inherent in the design, Figure 1. When it stopped again, mid-wipe, last year I decided it was time to replace it with the Electrolux system from a later XJS. Because of its identical mounting bolt pattern and bulkhead connector, the obvious choice was the one fitted to the pre-Facelift models from 1989 to 1992 (DAC6981). Although this unit has been called a “drop in replacement,” we shall see below that, it is *not* “plug compatible.” The addition of an intermittent mode necessitates a different wiper switch and a delay relay. These additions, in turn, require what amounts to a complete replacement of the electrical harness. Also, the DAC6981 has a spray jet on each side, as opposed to the single center jet of the Lucas system, necessitating rerouting of the washer feed hose and a larger pump.

The Electrolux system, Figure 2, is completely different mechanically from the Lucas. The main difference is it employs a reciprocating linkage and bellcrank mechanism to drive the wiper arm posts instead of the gear wheels and rack used in the Lucas[1]. Also, the entire mechanism is integrated with the cowl grille, whereas the Lucas motor unit and wheel boxes were separate elements bolted to the grille. This makes a more ridged assembly, one that is better able to withstand the stresses induced by moving the blades swiftly back and forth across the glass. Also, the motor (KSV 5035/510) is more powerful than the Lucas motor. Similar linkage mechanisms are used on most modern cars, and the same basic KSV 5035 motor/gearbox, is widely used on many cars, differing primarily in the fitted wiring harness.[2]

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[1] Details of the early Lucas system can be found in my write-up *Windscreen Motor Replacement (Lucas with parking solenoid)*

[2] In fact, the KSV 5035, now made by the Ankarsrum company, is used in a variety of industrial equipment. Some parts might be interchangeable but the electrical harness is usually different.

It's important to note that the Electrolux wiper assembly used on the Facelift cars (1992-1996), Figure 3, differs from the DAC6981 in ways that make it not a good choice for retrofitting. First, the entire mechanism bolts to the grille, as opposed to the integrated wiper/grille assembly seen in the DAC6981. For me, this raised a concern that the grille (JLM 10625), to which the might not have the same footprint and bolt pattern as the pre-Facelift cowl cavity. Additionally, there are likely to be electrical issues exceeding those with the DAC6981. First off, the motor harness plug is different from the DAC6981 so the bulkhead connector would have to be changed. Moreover, instead of a conventional delay relay, an electronic control module is required. While nothing is impossible, I believe the Facelift wiper retrofit would be significantly more difficult than using the DAC6981.[3]

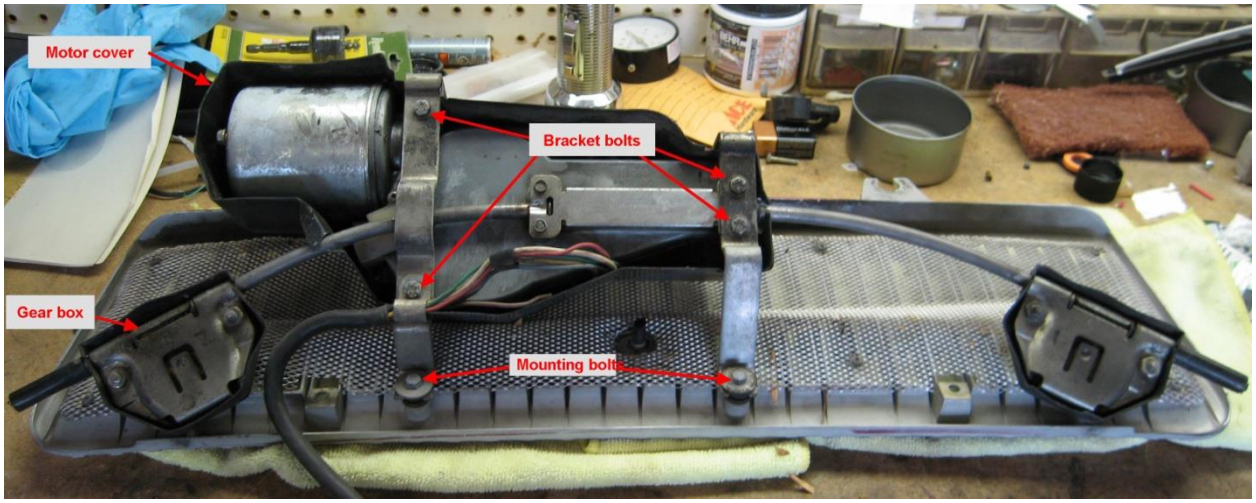

Figure 1 Original Lucas wiper assembly

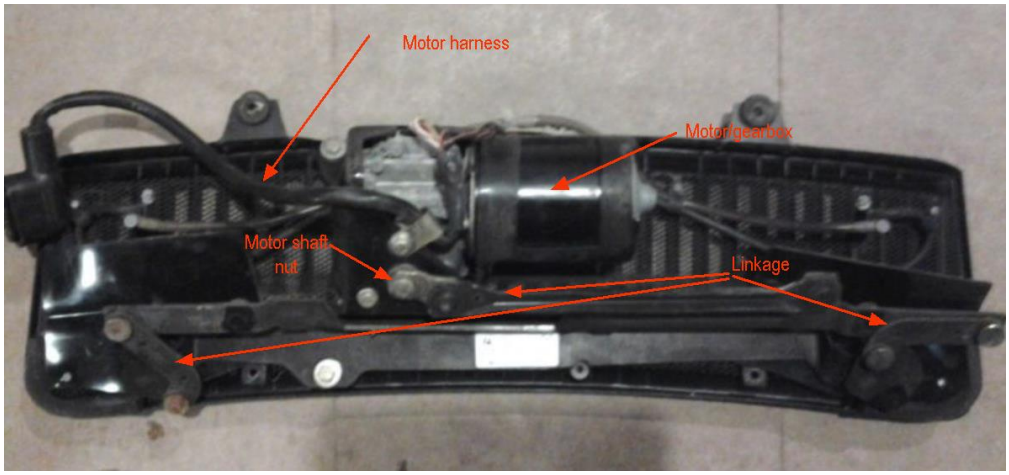

Figure 2. Electrolux wiper assembly (pre-Facelift).

In the following sections we go over refurbishment of the Electrolux wiper system, i.e., everything that's attached to the grille, followed by necessary electrical changes in the vehicle. But first, let's go over the parts you will need.

[3] If anyone wants to try, I have one in very good condition. Get in touch.

Figure 3 Facelift Electrolux wiper assembly ().

Parts Required

A comprehensive list of parts required is given in Table 1.

The principal needed part is the Electrolux wiper assembly. I recommend creating and saving an eBay search for "DAC6981", setting it to email you when anything is listed.[4] Be sure to query the seller on condition, what's included, and return policy. Ask specifically if the motor/gearbox is included, and if it runs since getting the assembly rebuilt costs about $350-$375 *if you have the core*. Another thing to ask about is the various bits that go on the wiper arm posts. That is, the rubber caps (aka escutcheons), jam nuts, or washers that go over the post before the wiper arm goes on. Mine didn't have them and it cost another $40 and another week or two to find them. And finally, ask if it has the washer jets and in good condition. If not, you might be able to get the price down since these are expensive items… like $125 each. But the truth is you might have to replace them anyway because the plastic degrades over time. I managed to patch one up with epoxy but had to replace the other.

Sometimes you'll see a new DAC6981 listed on eBay for about $1500. But, if you're patient you might eventually find a good used one for far less. Or if you're in a hurry, just pick up the phone and call the "usual sources," e.g., Coventry West, Jaguar Heaven, or JagBits[5].

The wiper arms from the OE Lucas will work with the Electrolux. However, you might want to get the proper arms for the DAC6981 because they have the U-style end for attachment of modern wiper blades. They are black rather than the buffed stainless-steel arms originally used on the early XJ-S, possibly costing points at Concours. But then, a good XJ-S judge will probably spot the twin washer spray jets regardless of the arm color. Be aware that there are two different arms, one straight and the other bent (or crooked as the Brits would say) at the end to drop the blade a little lower in the parked position. Also, the bent one has two different part numbers, DAC6148 for right-hand drive vehicles and

[4] I set the Google search for "XJS Electrolux wiper" and the first hit was a really nice

[5] I believe JagBits finds the wanted item by calling the salvage yards. While you could do this yourself, I've found letting JagBits do the calling is easier and faster.

DAC6149 for left-hand drive vehicles. I used the latter. By the way, if you want to park the wipers on the left on your LHD vehicle you can change the cam lobe position in the motor/gearbox to do that. In that case you would use the wiper arm for a RHD vehicle.

If the wiper assembly you wind up with needs refurbishment you will need a few internal parts. For the linkage mechanism, you'll need (for each post) two O-rings and a Nylon washer, not available from Jaguar. The washers are not a standard size, so I had some machined from Nylon rod stock.[6] I did a lot of searching for the O-Rings and ordered several sizes that didn't fit; fortunately, the original ones were still serviceable.[7]

For the electrical side of the project, the principal needed parts are a 1989-1992 XJ-S wiper switch, a suitable intermittent relay (I'll be saying more about the relay later), several different colors of 16 AWG wire, and lots of bullet connectors. I used two different kinds of bullet connectors. The 0.176" molded lead style must be used where connection is to "trailer connector" plugs used in the early XJ-S. Where the need is just an inline connection I used the 0.156" butt-splice male/female sets found in hardware stores. In addition, you might want to get a conventional relay so you can power the wipers with a good, clean 12+ volts without pulling the current through the ignition protection relay. To properly connect the relays into the new harness you need two relay sockets. Rather than using ones with oversized pigtails from the auto part store, I recommend getting sockets with separate contacts from an electronic parts supplier (such as www.delcity.net). It's not too difficult to crimp them directly to your harness wires and you will have a neater implementation.[8] You'll also need a piece of sheet metal to fashion a relay mounting panel above the passenger side footwell.

Finally, you will probably want to refurbish the windscreen washer system, requiring hose, spray jets, several fittings, and an aftermarket pump with enough capacity to feed the twin spray jets. You have to decide on the hose first because there two possible sizes, 4mm and 7/32", and the fittings will depend on which size you choose. I used 7/32" rubber wiper/vacuum hose because it's widely available and mates tightly with common ¼" polypropylene fittings. However, after putting everything together with the 7/32" hose I learned that 4mm clear windshield washer hose can be found at many online stores, including www.WalMart.com . Apparently, it's used on Volkswagens and other European cars.[9] (Do a Google search for "W0133-1630403"). If you choose to use the 4mm hose you will need to use smaller fittings. In fact, you can get "Washer valve Tee" from www.IDPusa.com instead of two separate components. I haven't tried, but I'm pretty sure the 4mm hose will fit snuggly over the nipples on the pump described below, as the 7/32" does.

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[6] Jim Simpson at www.oddparts.net did it for me. Take a look at his Web site. He does amazing things for old cars!

[7] While doing this write-up, I stumbled across a Buna-N 1.5mm cross-section x 9.5 ID ring at McMaster-Carr which matches my measurements of the original better than the others. Since this was after the system was reassembled and installed I didn't have the opportunity to try them but did order them. I'd be glad to send you some since I've got 100!

[8] Get extra contacts too since you'll probably ruin some while learning how to crimp them.

[9] It might be OE hose used on the Electrolux system since the one I bought had clear, soft plastic hose.

The most problematic among the windscreen washer parts are the spray jets and the pump. New spray jets from Jaguar are nearly impossible to find and *very* expensive, probably because they are heated. If there is an aftermarket or substitute part from another vehicle, I am unaware of it.[10]. I'd be very careful about buying used ones since they are not likely to be much better than those you're replacing. Regarding the pump, the problem is the one used on the early XJ-S is too weak for feeding two jets. I first tried an aftermarket pump for the late '80s to early '90s Volvo 240. It's the right size and is easy to adapt to the original XJ-S reservoir bracket, but he problem with this pump is it's unreliable. I returned two before getting one that work then pitched the third one because it was so noisy. I then, after discovering that my reservoir was leaking, I found a US Plastics washer reservoir that included a pump. Unfortunately, it doesn't include a connector harness. By online search I learned that the pump is used on many cars including the Lada, and then found it from an online supplier. I'm sure I could have found a closer source, but I ordered it from the first one I found, in Donetsk, Ukraine!

Table 1 summarizes the required (or optional) parts.

Table 1 Parts List (some optional)

Item	Manufacturer	Part number	Source
Wiper Assembly	Jaguar	DAC6981	Usual sources[11]
Wiper arm, left[12]	Jaguar	DAC6149,	www.JagBits.com
Wiper arm, right	Jaguar	DAC6150	www.JagBits.com
Wiper bushing Escutcheon (2)	Jaguar	Normally part of DAC6981. No part number	www.JagBits.com
Wiper bushing jam nut (2)	Jaguar	Normally part of DAC6981. No part number	www.JagBits.com
Wiper bushing washer (2)	Jaguar	Normally part of DAC6981. No part number	www.JagBits.com
Nylon washers	www.oddparts.net	Custom made	Ed Sowell
O-rings, Buna-N CS=1.5mm ID=9.5 (*Might* fit)	www.usasealing.com	McMaster-Carr 9262K632	Ed Sowell or www.mcmaster.com
Washer/vacuum hose, 7/32" rubber, about 6 ft.	Various		Online sources, auto parts stores, industrial hardware stores.
PolyP elbow, ¼" (for 7/32" hose)	Various	064406	www.usplastics.com
PolyP tee, ¼" (for 7/32" hose)	Various	064418	www.usplastics.com
PolyP Mini check valve, ¼" (for 7/32" hose)	Various	057173	www.usplastics.com
Washer hose, 4mm", about 6 ft.	Various	Volkswagen part# W0133-1630403	www.partsgeek.com
Washer check valve, 2 outputs (for 4mm hose. Leaks if used with 7/32" hose)		IPD Item #105139	www.ipdusa.com
Washer Jets	Jaguar	DAC6398	Usual sources
Reservoir with washer pump	U. S. Plastics Corp.	14138	www.usplastic.com
Washer harness kit	Unknown	Unknown	Online supplier
Wiper switch	Jaguar	AEU2527	Usual sources
Wiper intermittent relay After market replacement part for '90 Volvo 90 & 850 models. Adjustable delay.	Long Serng Auto Parts, Taiwan	IPD P1-122, Item 103226	www.ipdusa.com or Ed Sowell (I have an extra one)
Mini ISO relay SPST 12v 15A fuse bracket	Hella	Del City part #74983	www.delcity.net
Red power distribution block, ¼" (2)	Unknown	Del City part #80000DL	www.delcity.net
Relay terminals, 110" (5)	Unknown	Del City part #73593	www.delcity.net
Relay terminals, .250" (15)	Unknown	Del City part #73592	www.delcity.net
Relay socket (2)	Unknown	Del City part #73999	www.delcity.net
Male & female "trailer style" bullet connectors, 16-14 AWG, 0.176" (6 of each should do)	Noble	Noble 627D & 622D	Various electronics suppliers.
Male & female butt-splice bullet connectors,	Gardner-Bender (GB)	20-163P	Hardware store.

[10] It would be great if someone would make an unheated substitute. It would be far less expensive, and my guess is most XJ-Ses are not daily winter drivers and therefore don't need heated jets.

[11] My usual sources include Jaguar parts suppliers such as Coventry West and Exotic Car Parts, used parts suppliers such as JagBits and Jaguar Heaven, and eBay.

[12] Assuming LHD vehicle with Right side wiper parking.

16-14 AWG, 0.157" (lots of them!)			
2-1 Multi-Wire Shrink Tube Butt Connector, 16-14 AWG	Unknown	Del-City part # 940010	www.delcity.net
Wire, 16 AWG, black	Various		Various electronics suppliers.
Wire, 16 AWG, white	Various		Various electronics suppliers.
Wire, 16 AWG, red	Various		Various electronics suppliers.
Wire, 16 AWG, green	Various		Various electronics suppliers.
Wire, 16 AWG, blue	Various		Various electronics suppliers.
Wire, 16 AWG, yellow	Various		Various electronics suppliers.
Wire, 16 AWG, brown,	Various		Various electronics suppliers.
Wire, 16 AWG, slate	Various		Various electronics suppliers.
Wire, 14 or 12 AWG, brown	Various		Various electronics suppliers.
Ratchet crimper, 22-10 GA, insulated terminals		Del City item# 990160	www.delcity.net

Mechanical Refurbishment

Even though the assembly I bought on eBay (for $140) appeared to be in good condition, I decided to clean it up, replace whatever was broken or worn, and lubricate everything that moved. This proved to be challenging because Jaguar considered the entire wiper assembly a single part, so internal parts were never available separately. In fact, it was not designed for easy disassembly, or even lubrication. Nonetheless, some mechanical refurbishment can be done once the needed parts are sourced.

By the way, if refurbishment is to be done I recommend doing it before removing the old wipers in order to minimize vehicle down-time. Note that in most areas it's illegal to drive a vehicle without windscreen wipers, even when it's not raining.

First, we'll discuss how to test the wiper assembly to be sure it works, and then cover the needed mechanical work. Finally, we'll see what's required to hook it up electrically.

Initial Testing

I highly recommend doing a bench test of the DAC6981 before disassembly. This is a good idea for two reasons. First, if the motor doesn't run you might be able to get your money back from the seller, but probably not if it's in pieces. The second reason is the testing process will ensure the linkage is in the park position before disassembly. This will help you get the linkage properly "synched" with the park microswitch during reassembly, which is very important. See "Syncing the Parking Microswitch with the Linkage" below for a discussion on this issue.

The test procedure will require a 12v power supply at your workbench. I find a 12v battery from a computer UPS to be most convenient. Alternatively, if the workbench is near the vehicle, you can rig a cord with a cigar lighter plug. You'll also need three jumper cables with small alligator clips.

To prepare for the tests, place the wiper assembly upsidedown on the workbench, supported on a pair of 2x4 or the like so the linkage can move freely.

Please refer to Figure 4 and Figure 5 while doing these tests.

The first test is to see if the motor itself runs in slow and fast modes. Connect the power supply ground to C and +12 to G, Figure 5. The wipers should run at slow speed. Then move the +12 jumper to F, which should run the wipers at fast. Failure of either of these test means either the motor is bad, or the

gearbox or linkage is jammed. Return to seller! If it's OK, move on to testing the Run/Park microswitch inside the gearbox.

> **Note:** Because the above tests were without power to the Run/Park microswitch they will most likely not leave the wipers in the parked position. You must continue with the following tests to be sure they are properly parked for linkage reassembly.

Next we'll test the parking microswitch. Four connector pins are used:

- G: Motor slow brush, motor Pin 5 in Figure 4
- H: Microswitch Run Pin, motor Pin 1
- C: Microswitch Park pin and motor ground brush, motor Pin 4
- B: Microswitch Common pin, motor Pin 2

Now, let's do the microswitch test. With the power supply ground still connected to C, put a jumper between B and G. Then, connect +12 to H. From Figure 4 we can see that if the microswitch is in the Run position 12+ will appear at the motor slow brush, causing the motor to turn. It will continue to turn until the cam lobe (See Figure 12) opens the microswitch, opening the circuit and causing the motor to stop. In other words, it's parked. If this happens we know the microswitch is working. If it doesn't, it could be that the motor was already in the park position, but this would be highly unlikely as a result of the previous tests. More likely, the microswitch is bad. To confirm, repeat the first test, running the motor in slow for a very brief time then repeat the microswitch test. If it again doesn't run recheck your connections and try again.

If all the above tests are passed you have a good motor/gearbox, and the system will be in the park position.

> **Note:** Take a few photos of the linkage, including a close-up of where the linkage attaches to the gearbox shaft. When you reassembly the linkage, move the linkage until the bellcrank is about the same position as in your photo. This will assure proper synchronization of the linkage with the motor/gearbox park position.

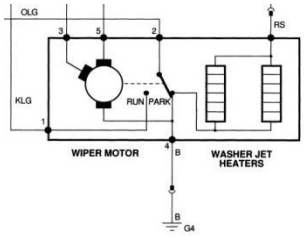

Figure 4 Motor/Gearbox Schematic

Figure 5 Motor Plug

Linkage Disassembly

The only components of DAC6981 intended to be removed for repair or replacement were the motor/gearbox, washer jets, and washer hoses and fittings. However, the linkage can be partially disassembled, lubricated, and worn parts replaced as described below.

The process begins with disconnecting the linkage from the motor shaft. First, with the assembly upside down on the bench, remove the nut that holds the linkage bellcrank to the motor shaft (see Figure 2). Then flip the assembly over and remove the snap-rings on the wiper arm posts, and recover upper washer and seal, Figure 6.

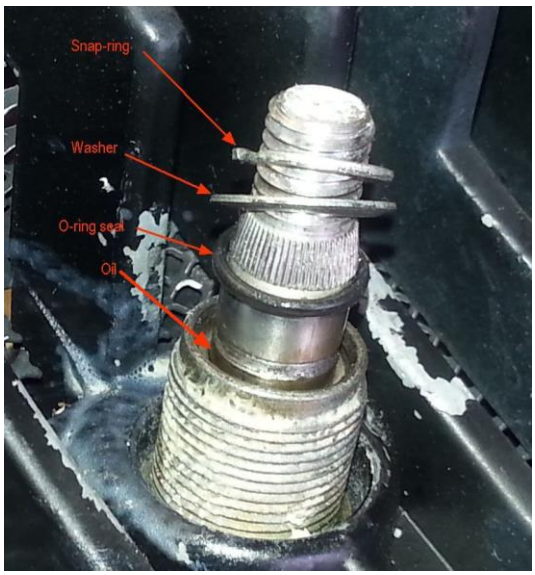

Figure 6 Removing post upper washers & seal

Once the motor shaft has been disconnected from the linkage and the upper washers and seal have been removed from both posts, there is nothing securing the linkage mechanism to the grille. However, removal from the grille must be done evenly to avoid binding of the posts. What works best is gently tapping the posts alternately with a plastic hammer while supporting the grille with the other hand. After the post tops are down to about level with the bushing flip the grille over and tug the posts free a

little at a time, again alternating between the two. If there is binding due to uneven withdrawal, tap the farthest out post back in a little. Once the linkage is free, set it on the bench.

> **Note**: Be careful when removing the snap-ring, washer and O-ring. If the snap-ring slips out of your grasp and flies across the garage, as these things are inclined to do, you might have to buy another wiper assembly!

Figure 7 Left arm post & lower washers & seal.

Carefully remove the lower O-ring seal, nylon washer, & wavy washer, Figure 7. Using great care not to lose or damage anything, clean them and lay out for inspection. In my case the left nylon washer was in good condition but the right one was worn paper thin and ragged, Figure 8. Unfortunately, this part is not available. By measurements of the good one, I determined the dimensions are: OD = 0.750", ID = 0.397", thickness = 0.025". After much searching, I gave up finding anything close enough to use. The main problem is the thickness. If too thin they will be too fragile, and if too thick you won't be able to reinstall the lock ring in its groove. My solution was to buy a piece of ¾" nylon round stock, send it to Jim Simpson at www.oddparts.net, and have him make 40 washers to these dimensions.[13]

[13] Contact me if you need some.

Figure 8 Lower seal and washers.

Not shown in Figure 6 are three other parts will you will need: a rubber cap (called the escutcheon), a jam nut, and a washer, Figure 9. These parts were not on the wiper system I bought, so for quite some time I didn't even know they existed. But, during reassembly, I began to wonder why the top ends of the bushings were threaded. In response to a post on the XJS-Lovers forum, David Christensen and Paul Novak sent photos of these pieces in place. JagBits eventually found a pair of jam nuts, the steel washers, and serviceable pair of escutcheons.[14] In a pinch, one could just leave them out since they seem to be for appearance only. At best, they just back up the O-rings in keeping rain and dirt out of the bushings. On the other hand, the jamb nuts and washers are important because they serve to firmly lock the bushings to the grille. Without them, the bushings could eventually loosen as the pressures induced by the wiper arm forces enlarge the hole in the soft aluminum.[15] By the way, the jam nuts from the OE Lucas wipers fit the Electrolux bushings. The washers could also be used, but the OD is a little smaller than the proper ones for the Electrolux.

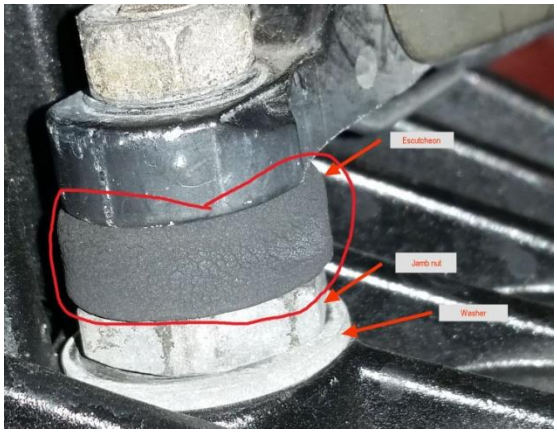

Figure 9 Escutcheon, jamb nut, and washer (from Paul Novak)

[14] Paul Novak pointed out that the escutcheons were used on the '86 XJ6, and were included in the separately available group comprising RTC2881. Unfortunately, RTC2881 is no longer available.

[15] Loosening of the bushings in the grille is a reported problem with the OE Lucas wipers.

Linkage Cleaning and Lubricating

Many years of service, and probably a few years sitting in a salvage yard, will have left the linkage in need of a good scrub and lubrication. I used Simple Green and brushes for the cleaning, followed by a blast of shop air to blow out what was left of the old grease in the joints.

The linkage needs to be lubricated at the joints, the nylon washers at the base of the posts, and inside the post bushing (see Figure 6, Figure 7, and Figure 10). I used synthetic grease (Finish Line) for the joints and washers, and light synthetic motor oil for the post.

Getting the grease into the linkage joints is a challenge. My technique was to pry open a joint using a large, flat blade screwdriver (compressing the wavy washer), then use a tiny gun from Finish Line, Figure 11[16], to force the grease into the open joint. This must be done at a couple places around the joint circumference to get the grease where it needs to be. Afterwards, you can use a feeler gauge to smear it around a bit in the open joint. Be sure to do both sides of the joint between the hard rubber washers and the moving metal.

Lubricating the post and the nylon washers should be done during reassembly. After dropping the linkage assembly into the grille, put a few drops of light oil at the top of the posts before replacing the O-rings and snap ring.

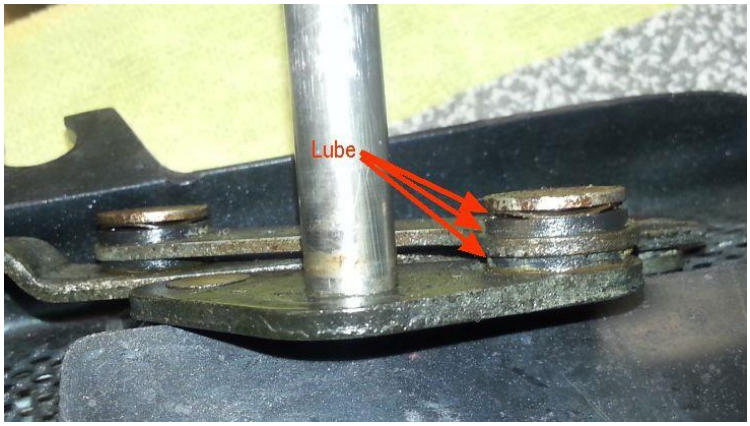

Figure 10 Lubricate linkage joints

[16] The gun costs about $15-$20 on Amazon.

Figure 11 Finish Line grease gun

Repainting the Grille

If you're like me you will want to repaint the black grille to match the dull silver of the early XJ-S as closely as possible. This would be easy if the ridged steel bar to which the wiper post bushing are attached could be removed. Unfortunately, that can't be done easily. The problem is the post bushings are pressed into the grille and would be very difficult to remove. You'd probably have to devise a jig in a press to press them out simultaneously. Instead, I masked the debris screen by slipping thin cardboard between the screen and the grille, and taped the post bushing threads and other needed areas. Once masked, I took it to a body shop and had them spray it. I probably could have done it with a spray can but I've never been very good at that.

By the way, the jam nuts at the top end of the bushing obviously *do not need to be removed* because you aren't going to be able to remove the bushings from the grille anyway. I mention this because to remove and replace these nuts requires a deep, thin-wall 19mm socket. As I learned the hard way, trying it with a wrench results in chipping the new paint.

Linkage Reassembly

Linkage reassembly begins by rejoining the linkage and the grille. First, apply grease to the washers at the base of the posts, followed by an O-ring (see Figure 7). Then, with the grille upside down on the workbench, align each post over its respective bushing and push the linkage down while being careful to keep the linkage parallel to the grille. A light tap with a plastic mallet can be used to get it straight if it becomes cocked.

Once the linkage posts are seated, flip the assembly over. Apply a few drops of light weight synthetic motor oil at the edge of the posts, allowing it to flow down into the bushings. Then reinstall the O-ring, washer, and snap-ring on each post (see Figure 6).

Motor and Gearbox Inspection and Lubrication

The last step in reassembling the wiper system is reinstalling the motor/gearbox. However, depending upon the general condition of the replacement wiper assembly, you might want to service the motor and gearbox unit.

First, remove the gearbox cover plate, Figure 12, then the microswitch, Figure 13. This exposes the gear and worm gear, allowing cleaning and lubricating.

Carefully note the wire the wire colors and connection points before disconnection. Also note the position of the cam lobe. If you did the recommended Initial Test procedure it will be on the microswitch button because the wipers are in the park position. If you dissemble the motor and rotate the gear for cleaning and lubrication, you might want to rotate it back to the original position. On the other hand, this is not essential since you can get it to the park position after reassembly by repeating the Initial Test procedure. Also, note that the lobe is actually on a separate ring with serrations on the center-hole, rather than on the gear itself. This can be lifted off, rotated so the lobe is on the microswitch button, and dropped back on, thus allowing another way to position the cam lobe on the microswitch button.

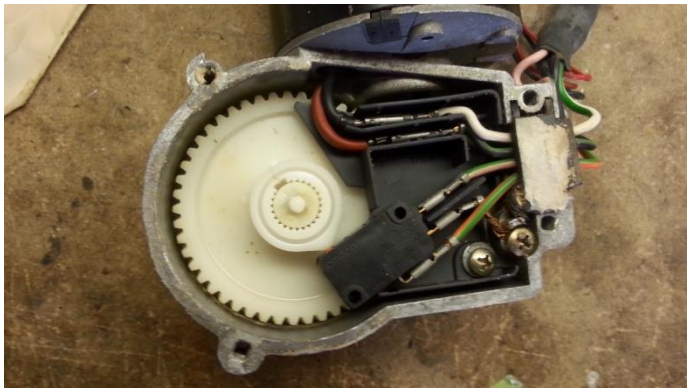

Figure 12 Open gearbox

Figure 13 Microswitch removed.

It's best to clean out the original lubricant since we don't know what kind it is and lubricants shouldn't be mixed. I used brake cleaner and solder brush for the cleanup, and synthetic bearing grease from AutoZone for the new lubricant. The best way to get the new grease all the way around the gear is to first open the motor casing so you can rotate the worm gear, Figure 14.

While the motor is open you should inspect the commutator and perhaps clean it up with fine sandpaper. Also, examine the brushes. In my case the brushes and commutator were in good condition.

I don't know a source for new brushes, or even if they can be changed without replacing the whole brush plate.[17]

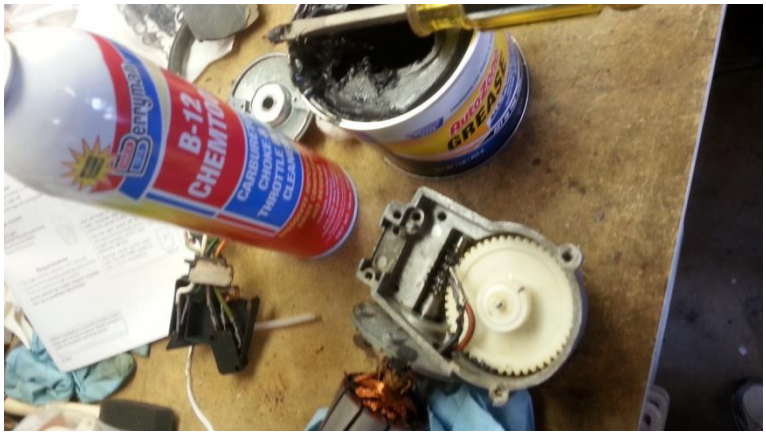

Figure 14 Clean & Lube Gearbox.

When I opened the motor I saw signs of minor water leakage. To guard against later damage I applied a bead of Permatex Ultra Black gasket maker around both ends of the housing during reassembly.

Reinstalling the Motor/gearbox

First, slip the rain shield over the motor/gearbox. Then maneuver the assembly into place below the mounting bracket and align the mounting bolt holes. Using Figure 3 (or your own photo if you took one) as a guide, position the electrical harness. Insert and tighten the bolts. Don't attach the bellcrank yet, as that will be done as part of the synchronization process described below.

Syncing the Parking Microswitch with the Linkage

Before attaching the linkage bellcrank to motor/gearbox output shaft you will need to get the linkage in the proper position. If this isn't done correctly you won't be happy with the results, and damage might be done to the motor/gearbox.

To understand the problem, first note that once the linkage bellcrank is bolted to the gearbox output shaft there is a fixed, mechanical relationship between the rotational position of the arm posts and the linkage bars. Every rotation of the gearbox output shaft causes the wiper posts to rotate counterclockwise, then clockwise, sweeping through an angle of (approximately) 130^{o}. Ideally, that 130^{o} arc will move the blades over the viewing area of the windscreen, stopping near the bottom edge of the windscreen on the desired side of the vehicle. To realize this goal, you must ensure that the linkage is in the correct position when the lobe of the cam in the gearbox is on the button of the parking microswitch (See Figure 12). This is what I call synchronizing the linkage with the microswitch.

Here's the synchronization procedure, assuming we want the wipers to park at the right (reckoned from the driver's position):[18]

[17] I looked around a bit for a rebuilder and found one near me. However, they wanted over $300 for refurbishment of the motor, presumably turning the commutator, replacing the brushes, and testing. It did not include any service on the gearbox.

1. Be sure the cam in the gearbox is on the microswitch button. If you are in doubt, repeat the second part of the test described in Initial Testing above.
2. Position the linkage such that the posts are rotated fully to the counterclockwise position (looking at them as you would from in front of the vehicle). This is where the bellcrank is fully extended; any further rotation of the gearbox output shaft would cause the posts to begin clockwise rotation.
3. Bolt the bellcrank onto the gearbox output shaft.
4. After the grille and wiper assembly is installed on the car, mount the wiper arms (with blades attached) on the posts at an angle that leaves a little space between the lower ends of the blades the windscreen molding. (This will be approximately 20-25^{o} above the molding.)

Performing this procedure will result in the desired operation, while deviating from it probably won't.

To understand why synchronization is necessary, let's see what can happen if the linkage and park microswitch are not synchronization. Suppose step 2 above hadn't been carried out properly. For example, assume the linkage was positioned such that the posts were *only part-way through their counterclockwise rotation* when the bellcrank was bolted to the gearbox output shaft. To be specific, let's say they still had 30^{o} to go before reaching the full counterclockwise position. In spite of this erroneous positioning, after steps 3 and 4 are carried everything will *look* correct, i.e., the wiper blades will be parked and in the right position relative to the lower windscreen molding. *However, the linkage is positioned such that when the wipers are turned on it will turn the posts 30^{o} further counterclockwise, driving the blades down over the molding.* If the initial positioning error of the linkage is extreme, the arms will reach some point where they can go no further, and what happens next is anybody's guess. Two possibilities come to mind. One is the nylon gear teeth will shear. Or, if the teeth don't shear the motor armature will stop turning, raising the current draw, hopefully blowing the fuse rather than burning up the armature.

Windscreen Washer System

While the grille is off you should take the opportunity to restore the washer feed to optimal performance. You will certainly want to replace the hoses, check-valve, and tee, and carefully examine and test the spray jets.

The spray jets, part number DAC6398, are hard to find and very expensive (perhaps because they are heated), so you will want to reuse them if possible. But since they are made of plastic, very old, and likely have suffered lots of exposure to the sun, they will be very fragile. Handle with care! Do not use shop air to clear them. Instead, carefully remove them from the grille, soak in Lime-Away, and blow through using lung power. If they are still clogged, try running a fine wire or monofilament fishing line through them. When reinstalling them in the grille, don't over tighten the screws. In my case, I managed to reuse one (after patching a bit with JB Weld) and find one new one.

If you can't the DAC6398 part you can use an alternative discovered by Paul Novak of the San Diego Jaguar Club. He used the dual-jet spray head DAC2666, originally center-mounted on '79-'87 Series III

[18] Alternatively, they can as easily be made to park on the left side.

XJ6 saloons. Paul fitted one on each side of his ’90 XJ-S. As seen in the photo, Figure 15, he used a short segment of 5/16” hose as a spacer. The hose wall is thick enough to provide a good shoulder to seat against the grille where the nipple passes through the slot, Figure 16. The length of the spacer hose determines how high the jets hit on the windscreen. Paul showed me these in action at a recent concours. They really flood the windscreen! If one waned to be fussy about appearance, it might be possible to fashion a thin, rectangular aluminum shim to fit between the spray head and the grille, thus hiding the exposed cutout.

Figure 15 Dual spray jet from '79-'87 XJ6

Figure 16 Fitted to the Electrolux grille.

When fitting new feed hoses to the jets, the main issue is routing. Basically, you have to pass the feed hose from the pump, through the firewall, and split the flow with a tee to feed left and right spray jets. In addition, a check valve must be somewhere upstream of the tee.[19] It can be placed in the engine compartment, or in the cowl cavity. In order to avoid exposing it to engine compartment temperatures, I chose the cowl cavity. The downside is the grille must be removed to replace it, but it will probably last longer there than in the engine compartment.

The next question is where to put the tee. The routing used in the 1989-1992 cars can be seen, partially, in Figure 2. (Unfortunately, the tee can’t be seen because it’s is hidden by the motor/gearbox unit.) I thought about using that location but finally decided against it because I wanted to be able to easily get at the tee for connection and disconnection when the cowl/wiper system is installed or removed. Instead, I located it on the *right side* of the motor/gearbox unit, as seen in Figure 17.

I also discovered the firewall hole for the Lucas feed tube isn’t suitable for the Electrolux system. The main problem is insufficient space between the firewall and the motor. Consequently, I drilled a new hole on the right side, Figure 18. As you can see, I used a ¼” hose elbow at the hole to get proper hose alignment on both sides while avoiding kinking. There is a potential problem, however, because the hose is not well protected from the metal edge. A bulkhead connector would be better. I’ll keep an eye on it.

Also shown in Figure 17 is the check valve, upstream of the tee. A short length of hose connects the other end of the valve to the elbow passing through the firewall.

[19] The purpose of the check valve is to prevent the cleaning fluid in the feed tubes from draining back into the reservoir. Without it there will be an annoying delay while the feed system refills.

Figure 17 Washer hose tee and check valve.

Figure 18 Passing the washer hose through the firewall

Once the new hose and fittings are in place and properly attached to the grille, it's a good idea to test the washers on the bench before reinstalling the grille/wiper assembly on the vehicle. Remove the reservoir and pump from the vehicle, hook it to the feed tube, and power the pump with a 12 volt battery on the bench. If it doesn't squirt, replace or repair the pump.

Washer Pump and Reservoir

As mentioned earlier, I replaced the OE washer pump and reservoir with an aftermarket product from U. S. Plastics Corporation. Figure 19 and Figure 20 show the assembly and how I installed it. The mounting plate was made from 1/6" aluminum sheet stock and bolted to the original mounting bracket. The thin stock bends nicely to conform curved back of the reservoir as the bolts are tightened. Although I took the trouble to track down a proper connector for the pump, one could have instead used simple femail spade connectors.

Figure 19 Washer pump

Figure 20 Reservoir installation.

Electrical Connections

The early Lucas wiper electrical system was simply the control switch on the steering column (wiper switch) and the motor/gearbox connected by a wiring harness. In the '89-'92 Electrolux system, a delay relay (aka intermittent relay) was added to implement the intermittent mode. Because of differences in the wiper switch and the motor/gearbox, and the addition of the intermittent relay, an entirely new wiring harness is needed.

Diagrams

The main purpose of this Section is to show how to build and install the new harness. In the discussion below, we will be referring to the *wiring harness diagram*, Figure 21. This diagram shows the wires connecting the pins of various components, where connectors and inline splices are required, and gives a general idea of possible routing and bundling.

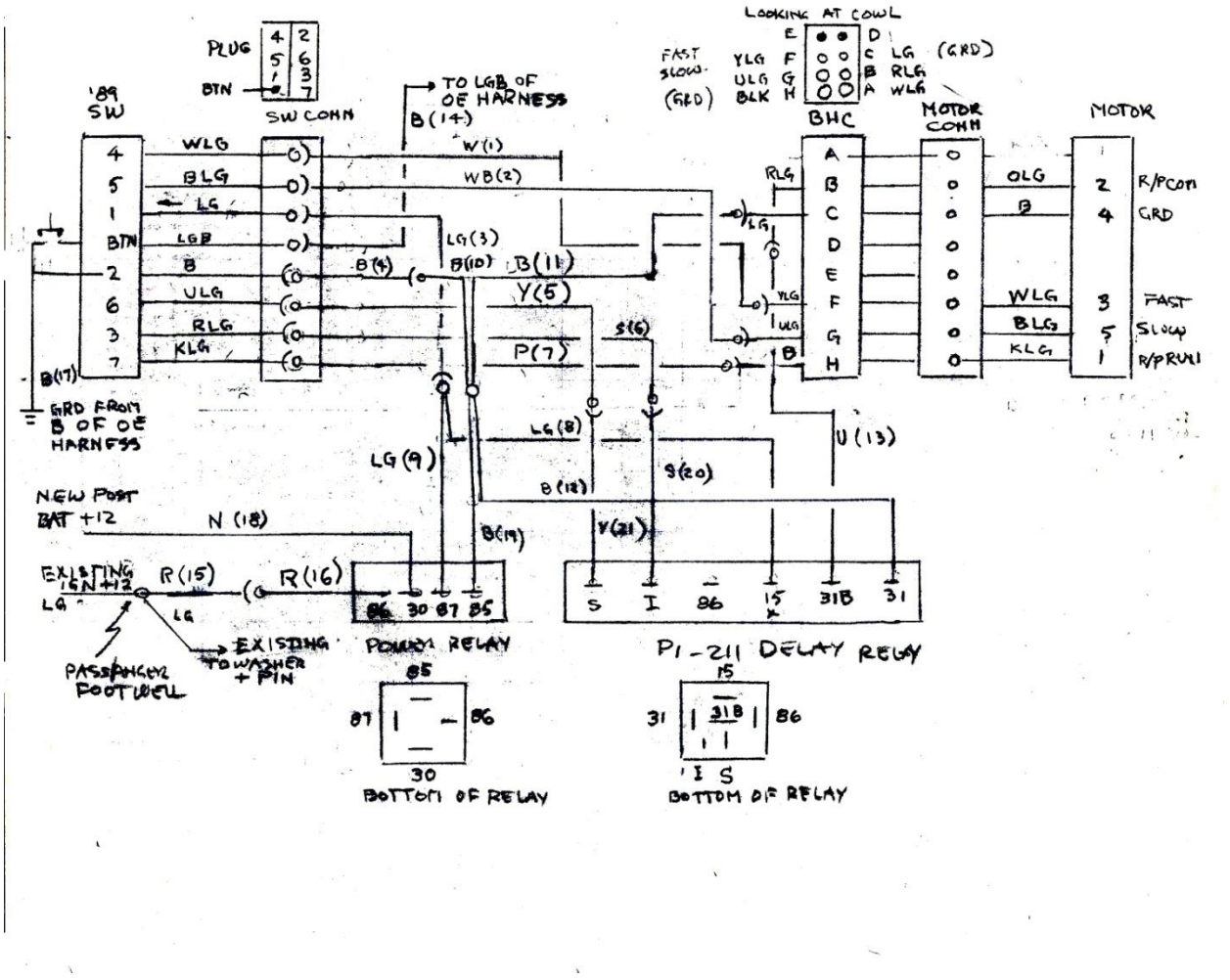

Figure 21 Wiring harness diagram for new wiper system using the aftermarket Volvo intermittent relay.

You might notice that Figure 21 provides little help in understanding how the system works. This is because it includes no information on connections *inside* the components. Consequently, this diagram allows you to build the harness, but would not of much help in diagnosing problems that might arise. For that, you need a *circuit diagram*, such as shown in Figure 22. With this presentation of components, their internal structure, and connections between pins, it's easy to trace the current path when the wiper switch is in some position. For example, the highlighting shows that when the wiper switch is in the Slow position, current flows from the Ignition +12V to Pin 1 of the switch, out Pin 5, to Pin 5 of the motor/gearbox, through the armature, and to ground completing the circuit. Among other things, this makes it clear that if the wipers aren't working in Slow, you shouldn't be thinking it's a bad intermittent relay. It's either the switch, the motor, or a bad connection.

Note that Figure 22 is based on the one in the Jaguar service documents for the '89-'92 XJ-S fitted with the Electrolux wiper system. However, the diagram for an aftermarket Volvo intermittent relay (P1-211)

and a power relay (PR) have been pasted in. In the Appendix, six versions of this diagram are shown and discussed, covering all modes of operation.[20]

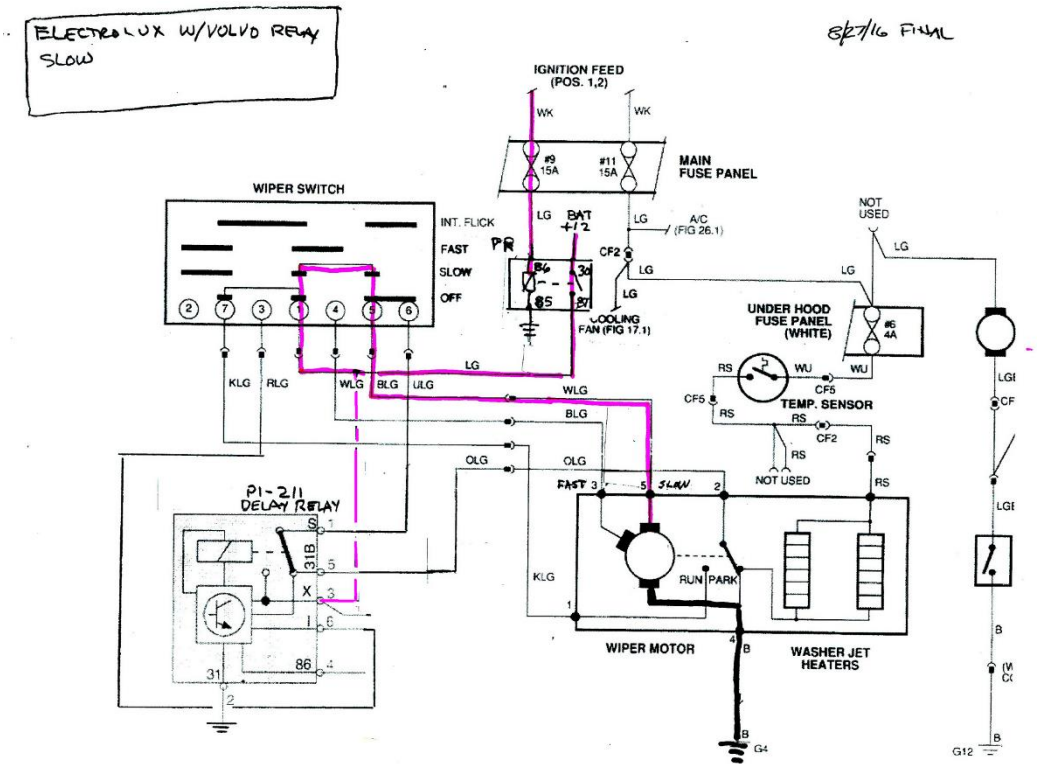

Figure 22 Circuit diagram for '89-'92 XJ-S Electrolux system (Figure 15.2 in the XJ-S MY 1989 Electrical Guide) with Volvo Relay.

The New Harness

First, let's go over the conventions and symbols used in the diagram Figure 21.

The color of each wire is indicated with the same letters used in the Jaguar manuals:

- B=Black
- W=white
- U=Blue
- R=Red
- Y=Yellow
- K=Pink
- P=Purple
- LG= Light Green

Two or three letters are used for striped wires, e.g., WLG means White with Light Green stripe.

[20] There are six modes because the Park microswitch in the motor/gearbox results in two different states for the Off and Intermittent switch positions.

Numbers in parentheses after the color refer to wire numbers in Table 2 Harness Wire Schedule.

The major components are represented by rectangles with connection points (Pins) identified by numbers or letters. If the pins are marked on the physical component, those numbers are used in the diagram. In the case of the bulkhead connector, which has no markings, I've adopted a lettering used by Richard Dowling in his study of the early Lucas wiper.

Small circles represent inline junctions, to be implemented with butt connectors or the like. A small circle together with a mating arc, -o)-, represents a bullet connector with the circle representing the male side and the arc the female side. Note that the bullet connector symbol is shown *within* the SW CONN plug, meaning the left half (male or female) is molded into the plug, while the other is crimped to the mating wire. On the other hand, note that for the bulkhead connector (BHC) both halves of the bullet connector are crimped inline because the mating plug from the OE harness is reused.[21]

At the left side of the diagram we see the new wiper switch (SW) and its harness connector plug (SW CONN). Above SW CONN is a face view of the connector plug with corresponding SW pin numbers shown. Note that the lower left pin of the is not numbered because it connects to the washer button wire rather than a pin molded into the switch body. Between the SW and SW CONN we see the switch harness wires with the indicated colors.

The new power relay and the intermittent (delay) relay are shown at the bottom of the diagram. These components will be installed above the passenger side footwell.

The diagram also shows the motor and its connector for completeness, although these connections are part of the motor/gearbox assembly and *are not changed*. The lines between BHC and MOTOR CONN are just the connector pins themselves, and those between MOTOR CONN and MOTOR are the Electrolux system harness.

Most of the wires in the diagram will be bundled with shrink-wrap tube and passed through the center console to the other side. However, there are a two that *aren't included in this bundle*, namely the wiper motor ground (Black) and washer pump ground (Black Light Green). Instead, I took advantage of the original under-dash harness for these connections. The black wire in this harness is connected to some (well hidden) chassis grounding point up under the dash, which needs to be connected to Pin 2 of the SW. From SW, this ground is passed on to the bulkhead connector and eventually the motor.[22] Similarly, the under-dash harness Black/Light Green wire connects the wiper switch washer button ground to the washer motor negative pin. However, instead of going through the bulkhead connector to the cowl, this ground goes through a different bulkhead connector to the right of the passenger footwell and on into the engine compartment where the pump is mounted. I saw no reason to change either of these paths

[21] The pins in the BHC are non-standard, so mating bullet connectors are not available. Therefore, the mating connector plug must be cut off the OE harness and reused.

[22] For the OE Lucas system, the ground *had to go through the switch* because motor ground needs to be switched for the parking mode. For the Electrolux system, motor ground doesn't *need* to go to the switch because it's fixed, but it is convenient to just pass it on through the switch since that path is already established.

since the same connections are needed in the new system. However, I did splice into the Light Green (Ignition switched +12v) wire, as will be described later.

Ignition-controlled +12v power must be provided to Pin 1 of SW. In the OE configuration, it is picked up from some hidden connection to the under-dash harness, probably on the driver's side. This voltage is carried on the LG wire to Pin 1 of SW, and from there gets switched to one or more of the other pins as dictated by the switch position. However, in the new configuration I wanted to provide wiper power *directly from the battery* through a new power relay that is switched on by Ignition +12V.[23] Since this relay is to be on the *passenger side,* that's where a source for ignition +12 is needed. Fortunately, the LG wire carrying +12v for the washer pump goes through the bulkhead connecter on the *right side of the passenger footwell*, providing a place a splice (using Red wire) to Pin 86 of the nearby power relay.[24] The relay output Pin, 87, then feeds clean +12 battery power to a LG wire that (curiously) *goes through the new harness bundle back to the driver's side* where it connects to Pin 1 of the wiper switch. A splice in that wire also provides the same voltage to Pin 15 of the new intermittent relay mounted beside the power relay.

> **Note:** You will notice that the diagram shows bullet connectors in all wires that go between the driver's side and passenger side of the vehicle. The reason for this is historical. I originally tried to reuse the original wiper harness that runs under the dash up near the lower edge of the windscreen. Had this effort succeed, the new harness would be almost entirely on the passenger, with a single new wire passed through center console under the radio. Based on that thinking, I initially built the passenger side part of the harness. Unfortunately, problems emerged that caused me to abandon that approach and instead build a complete new harness. The easiest way to do this was to keep the already built passenger side portion and connect it to an "extension" harness going to the driver's side using bullet connectors. However, there is no compelling reason why you couldn't omit these connectors, making the harness all one piece. It would eliminate about 7 bullet connectors, i.e., 14 crimped joints. If I had it to do over again, that's what I'd do.

The photo in Figure 23 shows the new harness built according to the diagram and set up for bench testing.

[23] Kirby Palm later told me he didn't see the need for this since there's never been any problems reported for the Ignition Protection relay.

[24] It's I tight place to get to with the crimper, but it can be done.

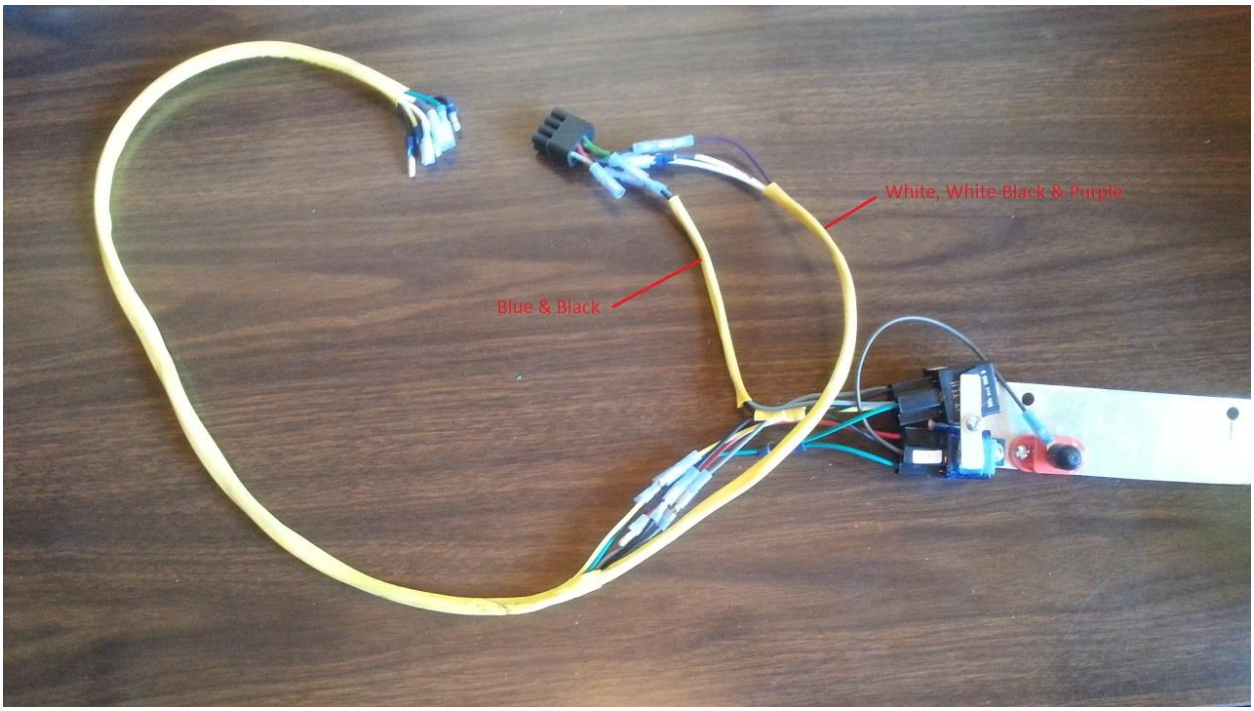

Figure 23 Bench test using new harness.

Table 2 Harness Wire Schedule

Wire number	Function	From	To	Color	Length (inches)[25]
1	Fast	SW Connector	Bulkhead connector	W	35
2	Slow	SW Connector	Bulkhead connector	WB	35
3	+12V to SW	3-way bullet connector	SW connector	LG	25
4	System ground	SW Connector	Inline bullet connector	B	25
5	Slow power in intermittent & off	SW Connector	Inline bullet connector	Y	25
6	Intermittent relay power in intermittent & off	SW Connector	Inline bullet connector	S	25
7	Wiper power during Off/parking & intermittent	SW Connector	BHC	P	35
8	+12V to delay relay	3-way bullet connector	Delay relay	LG	Short
9	+12V from power relay	Power relay	3-way bullet connector	LG	Short
10	System grounds	Inline bullet connector	Butt splice	B	Short
11	Wiper motor ground	Butt splice	Relay harness	B	12
12	Delay relay ground	Butt splice	Delay relay	B	Short
13	Wiper power during Off/parking & intermittent	Delay relay	BHC	U	12
14	Ground path for washer pump	SW Connector	LGB pin of OE harness (drivers side)	B	Short
15	Ignition +12V to control power relay	Inline bullet to Power relay	Power relay		
16	Ignition +12V to control power relay	2-1 butt splice (passenger footwell)	Inline bullet to Power relay	R	Short
17	Wiper System ground	Pin for Black wire in OE harness (driver's side)	3-way bullet ground connector on wiper switch.	B	Short
18	Battery +12v	Right firewall power post	Power relay	B	15
19	Power relay ground	Butt splice	Power relay	B	Short
20	Intermittent relay power in intermittent & off	Inline bullet connector	Delay relay	S	Short
21	Slow power in intermittent & off	Inline bullet connector	Delay relay	Y	Short

Building and Installing the Electricals

Wires, Connectors, and bundles

Before anything else, get all the electrical parts as shown in Parts Required above. You'll be doing a lot of stripping and crimping, so be sure to also get a ratcheting crimper, and a good wire stripper. These

[25] Lengths are approximate. Cut longer & trim for best fit.

tools will ensure good crimps, and will be much easier to use than cheap ones. This might take a couple weeks since you won't be able to get everything locally.

As you prepare to do the "cutting and crimping," study the wiring diagram Figure 21, and the harness photo in Figure 23, very carefully. The wiring diagram shows where the various connections need to be made, the type of connector to use, and which sides of the joints get the male and female connectors. From it you can also see which wires should be bundled together. For example, you will see that the backbone is a bundle that connects to the wiper switch and runs to the passenger side of the vehicle. There, some of the wires (W, WB, & P) run directly to the bulkhead connector, while others go to the delay and power relays. That means the main bundle extends through the console, then splits into two. Then, there's a separate harness that connects the relays together, connects to the main bundle, and to the bulkhead connector. To get an idea of what the overall harness looks like, see Figure 27. Observe the details, like five wires connect to the bulkhead connector, three directly from the wiper switch, and two from the relays. The sixth connector on the plug is not used.

After having studied the harness photo and diagram, there are a couple other things you might want to think about before cutting and crimping. First, before crimping connectors at both ends of a bundle, be sure to feed the wires through the shrink-wrap tubing. Also, you might want to double check everything, and perhaps even do bench testing *before* putting the heat gun to the shrink-wrap, just in case something needs to be changed. Cutting it off after shrinking, without damaging the wires, can be difficult.

Cutting & Crimping

Finally, after all the preparations, you are ready to actually build the harnesses. There are two pieces, the long piece that goes through the center console, and the smaller one that connects it to the relays and bulkhead connector.

When cutting the wires, note that the lengths shown in Table 2 Harness Wire Schedule are approximate. For the longer piece, if you want the best fit consider removing the under-dash trim pieces so you can feed a few wires through the center console and to their destination to get the proper length. When doing this, be aware that where the bundle passes through the center console doesn't line up with where it needs to go. On both sides, it must bend toward the firewall to clear the inboard trim piece (the one that the vent comes through), then routed to the mating wires. This bend adds to the required length of the harness. You might want to make the long run a little longer just to be safe, but be aware that too much length can cause grief later because the space under the dash is crowded, especially on the driver's side.

Another challenge is making splices and attaching connecters. To get tight joints, be sure to use the correct connector size for the wire. At places where a three-way splice is called for, use connectors made for this purpose if you can. Otherwise, use a connector big enough for two wires, then on the end that gets the single wire, strip the end longer and fold it before slipping it into the connector.

The challenge for the relay harness is connecting to the relay sockets. If you have gotten the ones with loose contacts (as I recommend) instead of pigtails, you must crimp the contacts to the harness wires,

Figure 24. The problem, though, is the heavy duty ratcheting crimper that works well for crimping bullets do a terrible job of crimping these more delicate connectors, Figure 25. Unfortunately, crimpers designed for this task are very expensive. I recommend using needle nosed pliers to do the best job you can in bending the tabs over the stripped wire, then get out the iron and flow solder into the joint. The pliers can also be used to do a fair job of crimping the second pair of tabs over the insulation. Then, before slipping the contact into back of socket, *check and double check to be sure you're putting it into the correct slot*.

Figure 24 Relay socket & contacts

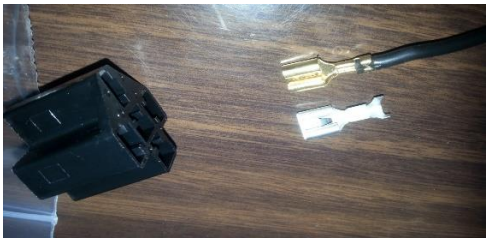

Figure 25 Contact crimping

If you do make a mistake you will have to remove the contact from the plug. There are special tools for this, but you can do it with tools you already have.

To remove a contact, you must push something into the rectangular opening behind the contact at the front of the plug. What the tool is supposed to do is bend down the little tab you see on the back of the tab, shown in Figure 24. There are many videos on YouTube showing how to do this with various tools, and I've tried several with mixed results. What works best for me is a small Allen wrench (1/16" works well). Technique is important though. *Do not hold the block while pushing. Most often, that will jamb the tab end into the plastic, and pushing harder tends to fold it up, locking it into place even more firmly. Once that happens you might have to cut the socket off and throw it away.* Instead, *hold the wire*, as shown in the photo. If you've used the right size of Allen, it doesn't require a lot of force. Just wiggle while pushing gently and you'll feel it when it slips in, depressing the tab. Then a gentle tug on the wire while holding the plug pops it out.

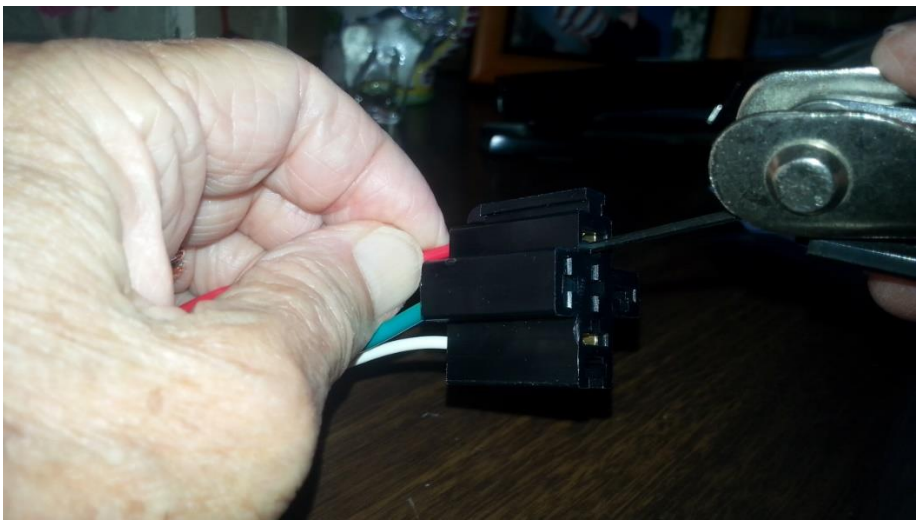

Figure 26 Removing relay socket contact.

By the way, my objection to the sockets with pigtails is the wires nearly are always too large a gauge for the expected current. Thick wires are harder to push around to where you want them to be. And then they must be crimped to a smaller wire, which means one end of the connector or the other will be the wrong size for the wire. It's easier and better to just attach the socket connector pins directly to your harness.

After you've done all the cutting, and have crimped the connectors to *one end* of the various bundles, slip them into the shrink tubing, and then crimp on the remaining connectors. Your harness is basically finished at this point, but before you can do the bench test you need to mount the relays on the mounting plate (but not in the car).

Relay mounting

If you haven't already done so, **disconnect the battery before doing this step**.

Remove the trim panels above and to the right of the passenger footwell. For best access, also remove the glove box.

Make up a relay mounting plate to be bolted onto the blower housing, Figure 27. I used 1/16" aluminum plate cut wide enough to accommodate the two relays (about 1 ¾") and long enough to allow attachment to the AC blower housing with the two existing bolts (about 10"). Drill 5/16" about ½" from the top and separated by the distance between the two studs on the blower housing. Also drill and tap holes for mounting the auxiliary power post. [26]

The delay relay (upper one in the photo) doesn't have a mounting tab, but you can make one out of thin (1/32") aluminum and use JB Weld to attach it to the relay. Drill the new tab ¼" so it can be attached along with the mounting plate to the blower housing.

Figure 27 Relay mounting

Auxiliary Power Posts

Battery power for the wiper system is picked up from the post on the firewall above the passenger footwell, Figure 28. It's a tight place to work, but can get at it with along needle-nosed pliers. First, pull off the rubber cap, which will probably crumble away. Make up a lead with heavy brown wire long enough to reach the relay mounting plate and fit it with a ¼" ring connector. Remove the nut to attach

[26] There's insufficient space behind the plate for nut and washer when it's bolted to the blower housing.

the lead to the post. Bending the connector not quite 90^{o} will make it easier to push it onto the post with the pliers while replacing the nut. For safety, you can cover the post and nut with a rubber vacuum cap from AutoZone. The new lead goes to a battery post on the relay plate, Figure 27, also covered with a vacuum cap.

As can be seen in Figure 27, there are two brown wires attached to the auxiliary post. The smaller gauge one goes to Pin 86 of the power relay. The heavy gauge one goes across to the driver's side and attaches to another auxiliary power post. It's an easy thing to do, and it might come in handy sometime.

Figure 28 Firewall Power Post

Ignition +12V Splice

The new power relay, Figure 27, needs a source of Ignition +12V. For want of a better source, I choose to pick it up from the washer pump power wire (LG) that can be found in the cavity to the right of the passenger footwell.

Splicing into this wire is a bit difficult because it's in a tight place to work, and there's no significant slack in the wire. Here's one way to do it. Cut the wire and crimp bullet connectors to both sides of the cut, male on one side and female on the other. Then make up a small "Y harness," with two short branches (about 2-3 inches) fitted with male and female bullets to mate with the cut wire, and the third branch long enough to reach Pin 86 of the power relay. I used Red wire for this, but any color will do.

Salvage Bulkhead Connector Mating Harness Connector

To do the bench testing of the entire system, you will need a connector block that fits the bottom side of the bulkhead connector. The quick and easy way of getting one is to salvage the one from the OE harness that runs under the dash up near the windscreen. To gain access to it remove the two screws that secure the bulkhead connector to the cowl. Pull it up as far as you can and cut the wires, leaving enough length to crimp bullet connectors. Crimp on the connectors that will mate with the new harness. See Figure 23.

Test Wiper Switch and modify its harness

Jaguar Service Bulletin JD 03 / 89, Item: 18, indicates that the wiper switch harness requires a slight modification to work with the Electrolux system. The modification is simply snipping the black wire that is connected to Pin 2 of the switch. *I strongly recommend testing the switch first since these switches are notorious for failures*. I bought three before getting one that was serviceable, and even the third one wasn't perfect. After cutting the wire I discovered that the Flick (single wipe) didn't work. I couldn't return it with the cut wire, so I decided to use it. It's not that much more difficult to do Off/Slow/Off.

Testing the switch is not difficult. Just put the lever in each of the positions and check for continuity as indicated in Figure 22. For example, in the Slow position Pins 1 and 5 should be shorted. To check the Flick function, have a helper put the lever in the Off position and lift and hold it while you verify that Pins 5 and 6 are shorted, and Pins 7, 3, and 1 are shorted.

Bench Test of Entire System

This is the final test of the entire electrical hook-up before installing in the car. If you've correctly connected every exactly as shown in the diagrams, you will be able to set the wiper motor/gearbox to Slow, Fast, Intermittent, and Off. When it is switch to Off, it will stop only at the Park position. You will also be able to change the delay time when it's in Intermittent mode. It's a very rewarding experience!

Or, if it fails to do something correctly, it will be easy to track down the problem using a DVM and the circuit diagrams shown in the Appendix.

To do the bench test, place the wiper switch, harnesses, relay assembly, and motor/gearbox on your workbench or desk. Connect the various elements as shown in Figure 23.

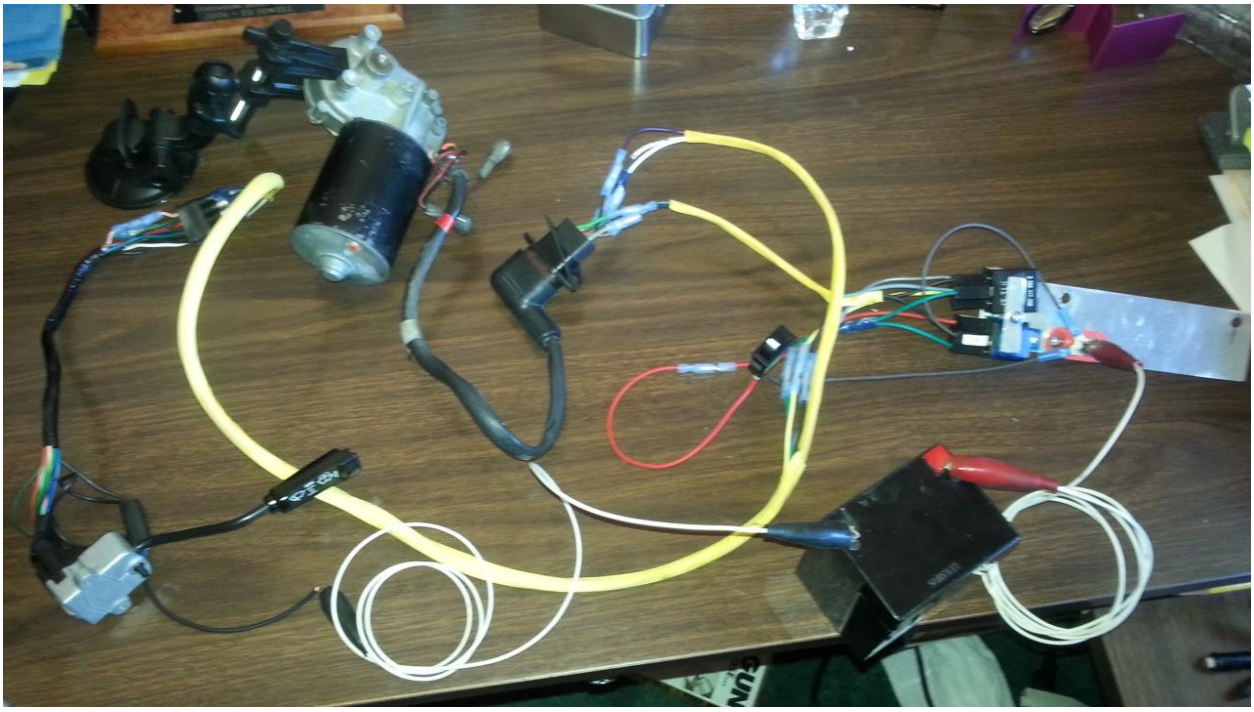

Figure 29 Bench Test

I clamped the motor/gearbox in a project vice to keep it from jumping around when starting and stopping.

You will need a source of +12V power. I used a computer backup power supply battery. Use jumper wires to connect the negative terminal to the black wire connector at the wiper switch. Connect the +12V terminal to the auxiliary power post on the relay mounting plate. To simulate the ignition switch,

connect the battery +12V one terminal of an on/off switch of some kind. Set the switch to the Off position, then connect its second terminal to the red wire going to Pin 86 of the power relay.

Set the Wiper switch to Off, then flip the simulated ignition switch. The motor/gearbox should now respond to the wiper switch. You might want to put a piece of tape on the motor shaft and mark it pointing to one of the gearbox mounting posts so you can verify that it always stops at the same place. Try the various modes. To test the adjustable delay period, see Setting the Intermittent Delay below.

There is a video of my bench tests in the online photo album for the project at www.efsowell.us.

Setting the Intermittent Delay

The IDP P1-122 Intermittent relay allows the delay between wipes to be adjusted. To set the delay period to, for example, 5 seconds, move the wiper switch arm from Off to Intermittent and then back to Off. Slowly count to 5, then move the arm back to Intermittent. The motor/gearbox will do a wipe every 5 seconds. After a while, turn the wipers off. In subsequent usage, the Intermittent mode will exhibit the 5 second delay until it is reset with the same procedure.

Electrical Installation

Be sure the battery is disconnected.

Note: Some of these steps may have already been done during bench testing.

1. Remove the trim panels above both footwells, and the inboard trim pieces that hold the AC vents. Also, remove the plastic clamshell enclosing the wiper and turn indicator switches.
2. Attach the relay mounting plate to the right AC blower housing. Make up and install a 14 or 12 AWG, brown wire with ¼" ring connectors going from the firewall battery power post to the auxiliary power post on the relay mounting plate.
3. Connect the Red "Y-harness" from the Ignition +12V source to the right of the passenger footwell to power relay Pin 86.
4. Connect the relay harness to the relay assembly, and to the long harness.
5. Connect the long harness and the relay harness to the to the connector block that mates with the bulkhead connector. Working outside the car, use a coat hanger or the like to fish the latter up to the cowl and connect it to the bulkhead connector. Reattach the latter to the body. Be sure to use a gasket and/or sealant to prevent water leakage.
6. Now, you must route the long harness through the center console. I removed the radio, but you might be able to avoid that. First, fashion a fishing tool from a coat hanger or the like. Work it through from the driver's side. In its path are the two 2" diameter plastic AC air ducts going to rear compartment. Go over or under, which ever you find easiest. If the radio is out, you can help it along by reaching through the opening. Once through, attach it tightly to the end of the harness with tape. Wrap the tape into a cone around the connectors so there are no sharp corners to hang up on wires and other things that will be in its path. Pull gently from the other side. Again, if the radio is out you can help it along through the opening.
7. Swap the old wiper switch for the new one and connect the new harness. Consulting the wiring diagram for colors, Figure 21, make sure to get each harness wire to the correct wiper harness connector pin. Also make two jumpers with bullet connectors and connect the Black wiper

switch ground wires the Black/Green washer ground wire, to the OE under-dash harness connector.

8. Connect the new harness to the bulkhead connector plug. Pull the latter up into the cowl cavity, plug it into the bulkhead connector, and reattach the bulkhead connector to the cowl.
9. Check all connections carefully before reconnecting the battery.
10. Test the electrical connections by checking voltages at each pin of the bulkhead connector. For example, put the wiper switch in the Slow position. From the Figure 21, we see that Pin G of the BHC connects to the motor/gearbox Slow, so that pin should be at +12V. Do this for all the positions of the switch.

    You should also check the washer pump wiring. To do this, first turn the Ignition switch to Run and check for +12V at the wire that connects to the pump + pin. Then, set your DVM to Continuity and connect the leads to body ground and the wire that goes to the pump – pin. It should indicate no continuity. Then have an assistant press the button on the end of the wiper switch arm. The meter should indicate continuity.
11. If you confidence level is high, reinstall trim panels. Otherwise, you might want to delay this until the grille/wiper assembly is installed.

Install Grille/Wiper Assembly

The Electrolux grille/wiper assembly is very easy to install. Unlike the OE Lucas assembly, nothing protrudes beyond the edge of the grille, so it just drops smartly into place. Before doing that, however, you must connect the motor/gearbox harness connector to the bulkhead connector, and connect the washer fluid feed hose to tee fitting that distributes it to the jets.

Both are easy if you've positioned the tee correctly. Place some wood blocks or the like on the cowl to hold the grille high enough to get your hands under it and make the connections.

Before dropping the assembly into place, you should check the washer system for leaks. Put some fluid in the washer fluid reservoir, turn the Ignition to Run, and press the wiper switch arm button. The jets should spray, but all the hose joints should remain dry.

Install Wiper Arms and Blades.

The only issues here are what arms and blades to use, and how to install them on the car. Regarding the arms, you could continue to use the ones from the OE Lucas system. Alternatively, you could switch to those specified for the Electrolux system. I chose to go all Electrolux. The differences are:

- Color. The OE arms and blades for the early XJ-S were brushed stainless steel. For the Electrolux system, they are flat black.
- Arm bend. The bend at the end of the arms, referred to as "crank" in the Service Bulletin, are different.
- Blade attachment. The OE Lucas arms had a pin that fit into a hole in the blade, whereas the the Electrolux arms are folded at the end to form a hook that slips into the blade. Aftermarket blades usually have the parts necessary to attach to either style of arm.

Mounting the the wiper arms on the posts is complicated by the need to get them at the correct angle. What you want is an angle that leaves as little space as possible between the lower ends of the blades the windscreen molding, but not hitting the molding. This should be approximately 20-25^{o} above the molding. But, it's a bit tricky getting them that way, and to tell the truth, I'm not very good at it. I flip the arm up relative to the part that fits over the post, do my best to eyeball when it's going to wind up when it's flipped down, fit it onto the post and tighten the nut. If it looks too high or too low, I take it off and try again. I generally wind up with them a little higher than they should be, but that's better than them hitting the molding.

Alternatives and Other Applications

One of the main choices made in this retrofit was selecting an Intermittent relay. The easiest choice, had it been available, would have been to use the part used when Jaguar offered the Electrolux wiper system as a replacement for the later Lucas system, the so called Green relay. It was plug compatible with the later Lucas system relay socket. Although it was not plug compatible with my car (which had no Intermittent mode and therefore n relay at all), if I had been able to find one it would have saved me a lot of time, since presumably I could have worked directly from the Jaguar wiring diagrams. However, they are no longer available from Jaguar, and any floating around are hard to find and therefore pricy. So, I searched widely for aftermarket "delay relays," as they are generally called. I found three that looked promising:

1. The Volvo aftermarket relay P1-122 from IPD
2. A generic delay relay from Nagares, S.A., TLFS4 (available with 4 or 12 second delay)
3. A kit with delay adjustment knob

I bought all three, and benched tested the P1-122 and TLFS4. I settled upon the P1-122 and still believe it is the best. However, last time I checked at www.ipdusa.com this item was out of stock and had been on back order for months. If someone wants to do this conversion and can't get the P1-122, I'd be glad to send them the TLFS4 and tell them how to make it work. I didn't do anything with the kit, but I'd be glad to send it to anyone who wants to play with it.

I also want to mention that I believe it would not be too difficult to build a small harness that would allow the P1-122 to be plugged into the Jaguar relay socket. In other words, it could be used as a replacement for the Jaguar part. If anyone is interested, let me know.

Appendix: How it works

The main body of this project write-up is about *how to do the conversion* from the early XJ-S Lucas wiper system to the '89-'91 Electrolux system. This Appendix is about *how it works*, i.e., how the wiper switch interacts with the intermittent relay to control the motor/gearbox.

The best way to explain how the system works is with *circuit diagrams.* The ones shown here are based on the one provided Jaguar publication XJ-S 1989 Electrical Guide, Figure 15.2, VIN 154404-156988[27], presented earlier as Figure 22. Now, we will switch to what is basically the same diagram, but with changes made to accommodate the aftermarket Volvo intermittent relay, IDP part number 103226. We will examine the wiper system in six (yes, 6!) different modes of wiper operation:

- Slow
- Fast
- Intermittent: During pulse from the intermittent relay
- Intermittent: After pulse and before the motor/gearbox microswitch to the Park position
- Off- Run: Wiper switch is in off position but motor/gearbox microswitch is in the Run position
- Off- Park: Wiper switch is in off position but motor/gearbox microswitch is in the Park position

Before describing the operation of these modes, let's go over some conventions used in the diagram. Please refer to Figure 30.

First, in all diagrams the wiper switch shows four sets of horizontal bars, each labeled at the right with switch positions: Off, Slow, Fast, and Int. Flick. Note that some of these bars are *thick* and extendes across 2 or 3 numbered Pins. This means all Pins covered by the bar are shorted together internally by a solid, brass contact plate. For example, in the Off position Pins 5 and 6 are shorted, and in Int. Flick Pins 1, 3, and 7 are shorted. On the other hand, for some positions there are *short,* thick bars connected by a *thin* line. This means *only the pins with short think bars connected by a thin line are shorted internally*. For example, in the Slow position Pins 1 and 5 are shorted together, but not Pin 3.

Now, let's go over the several Modes of operation.

[27] The Jaguar figure is labeled "Wiring diagram." I prefer to call it a *circuit diagram* because, unlike the wiring harness diagrams, it reveals the actual electrical current paths, i.e., circuits, including those parts that are internal to the components.

Slow

Slow is the simplest of the six modes. As seen in Figure 30, current flows from the Power relay to Pin 1 of the wiper switch, passes through an internal path to Pin 5, through the wiring harnesses to Pin 5 of the motor/gearbox, through the armature to Pin 4 of the motor/gearbox, and to ground.[28] Wipers operate at Slow speed. Note that while +12v is applied to Pin X of the intermittent relay, no circuit is formed due to the relay switch being in normal position. In other words, the relay is not involved at all in this mode.

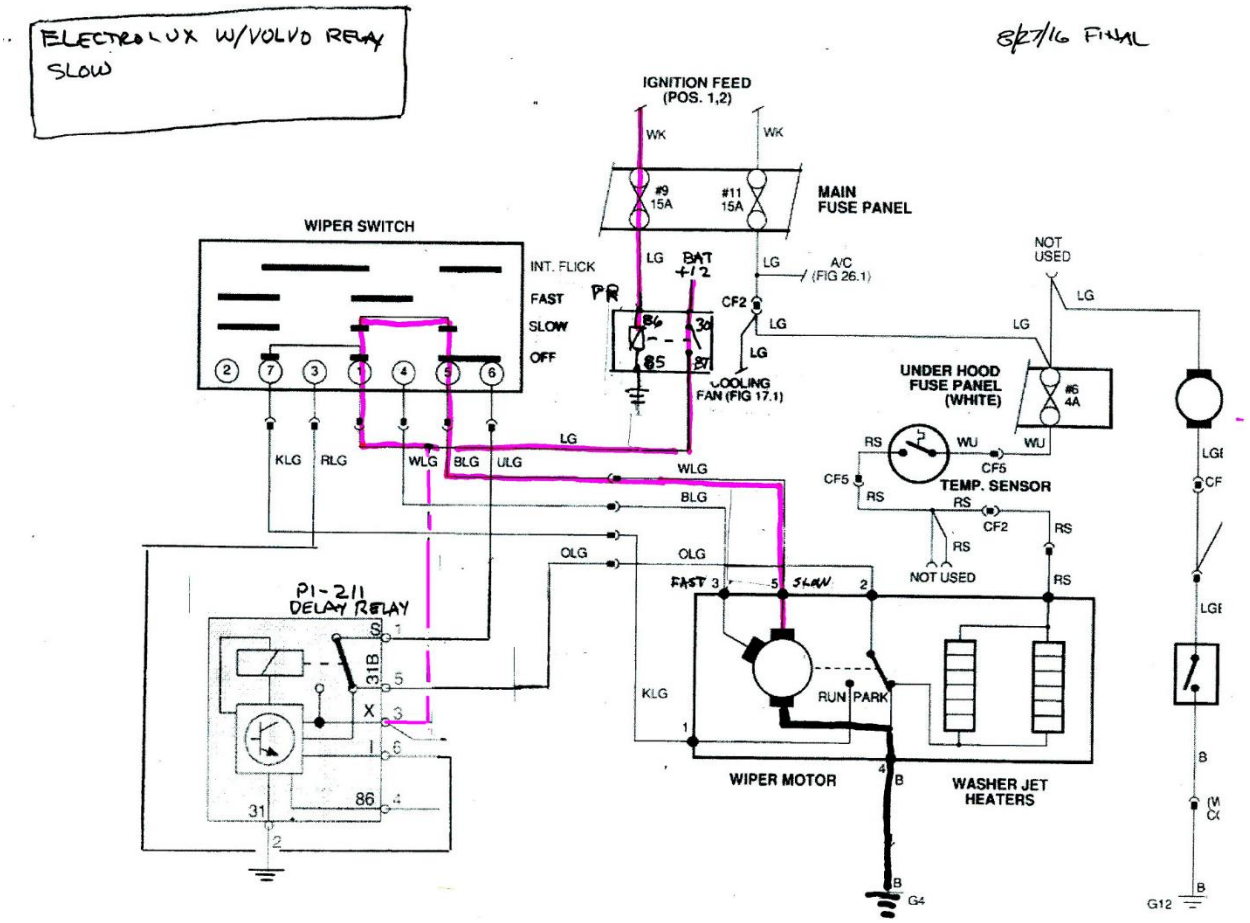

Figure 30 Slow Mode

[28] The path from ground to +12v through the battery is omitted in these diagrams.

Fast

Much like the Slow mode, in the Fast mode current flows from the power relay to Pin 1 of the wiper switch, passes through an internal path to Pin 4, through the wiring harnesses to Pin 3 of the motor/gearbox, through the armature to Pin 4 of the motor/gearbox, and to Ground. Wiper operates at Fast speed.

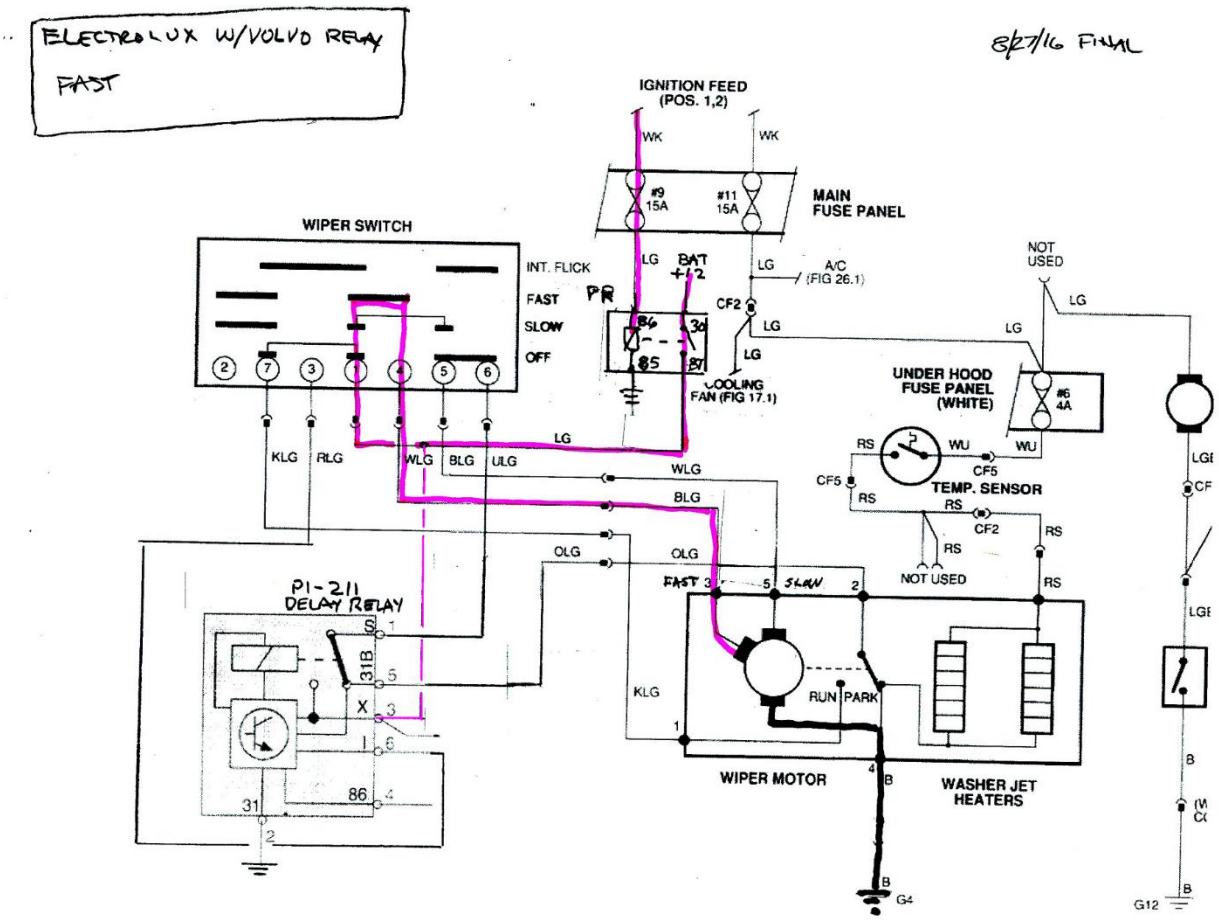

Figure 31 Fast Mode

Off - Run

This mode deals with the "parking" issue, i.e., making sure the wipers are rotated close to the bottom of the windscreen when off.

When the wiper switch is changed from any other position to Off, it's very likely that the motor/gearbox microswitch is in the Run position and the intermittent relay is in the normal position, as shown in Figure 32. The intermittent relay has +12v to Pin X, but nothing to Pin I, so it allows the highlighted circuit. Note that the switch connects Pins 1 and 7 internally, thus applying +12v to the motor/gearbox Pin 1. Then, due to the microswitch being in the Run position, the current passes through the intermittent relay, then through the wiper switch a second time to get to Pin 5 of the motor/gearbox. The motor runs in Slow until the cam reaches the microswitch trigger, then stops when the microswitch flips to Park. The system is then in the Off-Park state, Figure 33.

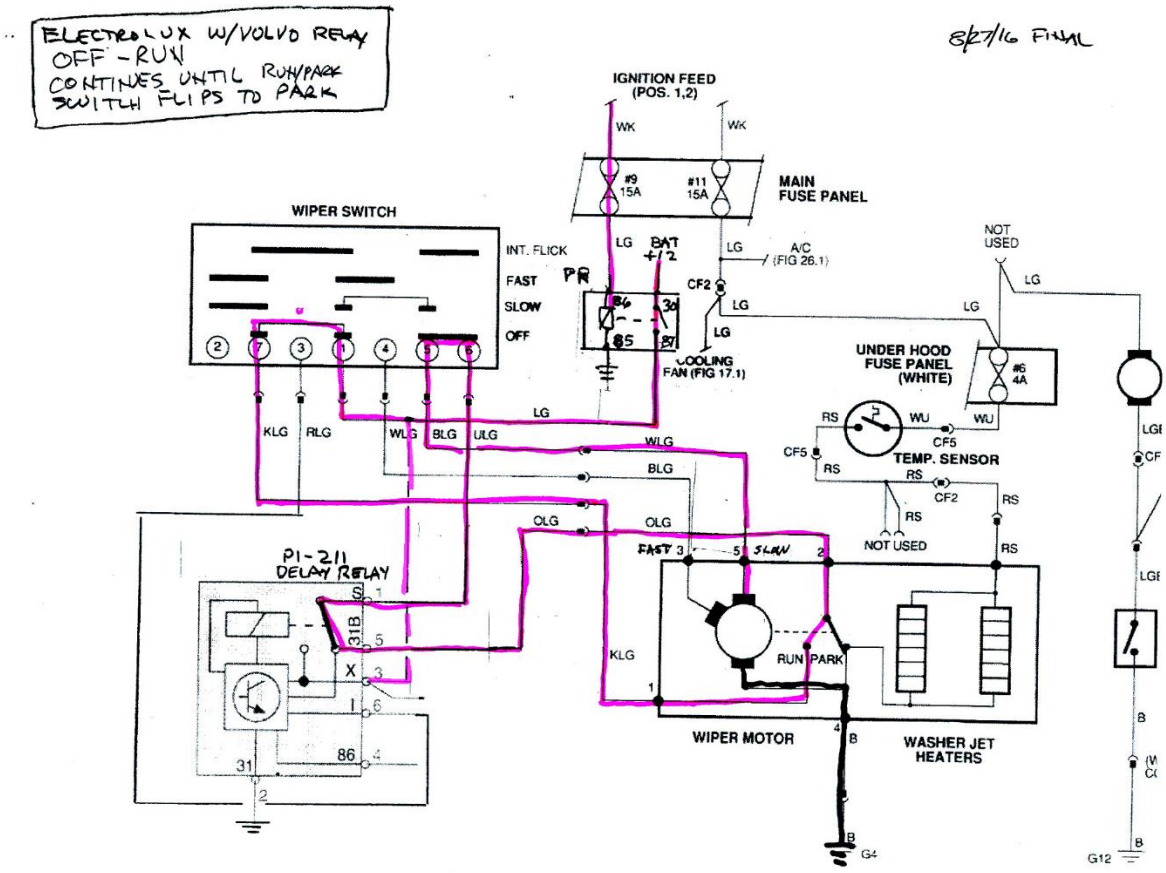

Figure 32 Off - Run Mode

Off - Park

Here we see the Off-Park mode, in which the wiper switch is in the Off position, the intermittent relay is is in the normal position, and the motor/gearbox microswitch is in the Park position. Although there is +12v to the intermittent relay and the motor/gearbox, Pin 5 of the motor/gearbox is grounded so the wipers are off.

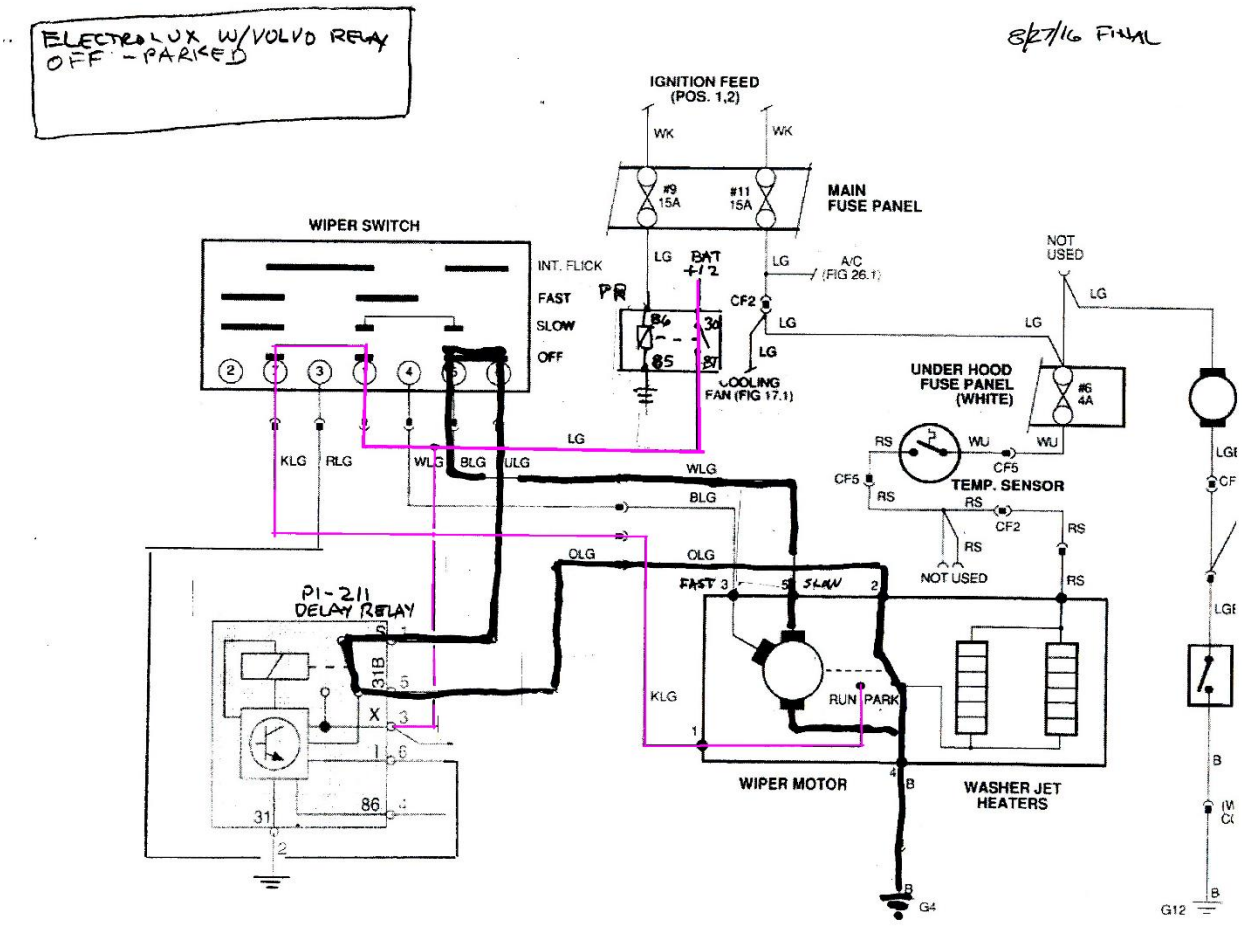

Figure 33 Off - Park mode

Intermittent - During pulse

The purpose of this rather complex mode is to start the motor/gearbox moving. It begins when the wiper switch is switched to the Intermittent position, and ends when the pulse ends. After the wipers have gone through one back-and-forth cycle and a preset delay, there is another pulse that begins the mode once more. This repeats until the wiper switch is moved to another position.

As can be seen in Figure 34, while in this mode +12v is applied to Pin 1 the intermittent relay, Pins I and X of the intermittent relay, and Pin 1 of the motor/gearbox. Due to the +12v at Pin I of the intermittent relay, the relay switch flips away from its normal position, thus providing a current path through wiper switch Pins 6 and 5 to Pin 5 of the motor/gearbox. Consequently, the motor begins turning. After a tiny movement, the motor/gearbox microswitch flips from Park to Run, providing *another* source of +12v to the motor. This marks the transition from Intermittent – During Pulse mode to Intermittent – After Pulse mode.

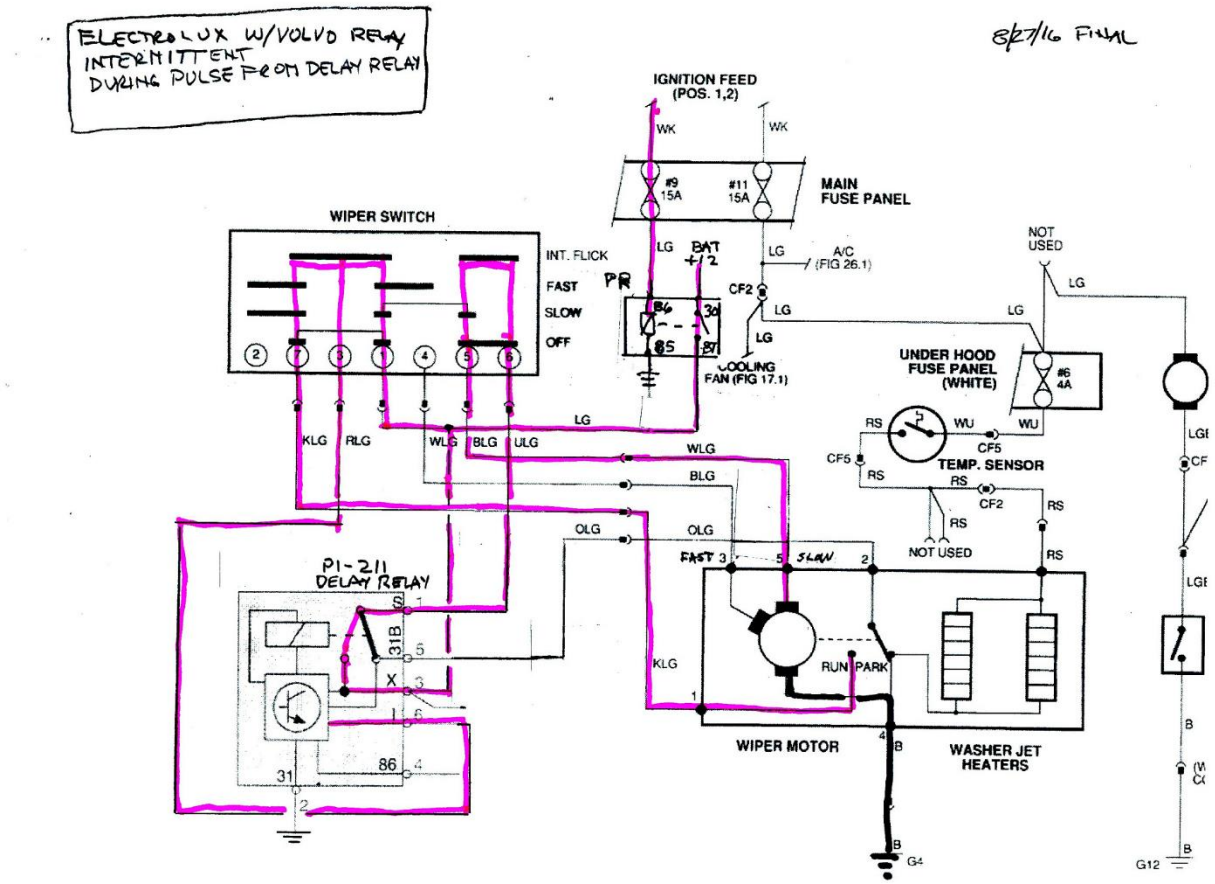

Figure 34 Intermittent during Pulse

Intermittent - After Pulse

In this mode, the wiper is still in the intermittent position, but the intermittent relay and motor/gearbox are in different states, causing different circuits to be active. Specifically, the intermittent relay now connects S and 31B rather than S and X, and the motor/gearbox microswitch is applying +12v to 31B instead of ground. The result is the motor/gearbox continues to run, and will continue to do so until the cam reaches the microswitch trigger, flipping it to the Park position. It will remain stopped until after the delay period when another pulse is generated, starting the process anew.

So, the upshot is the intermittent relay starts the wipers and the Run/Park switching mechanism in the motor/generator stops it.

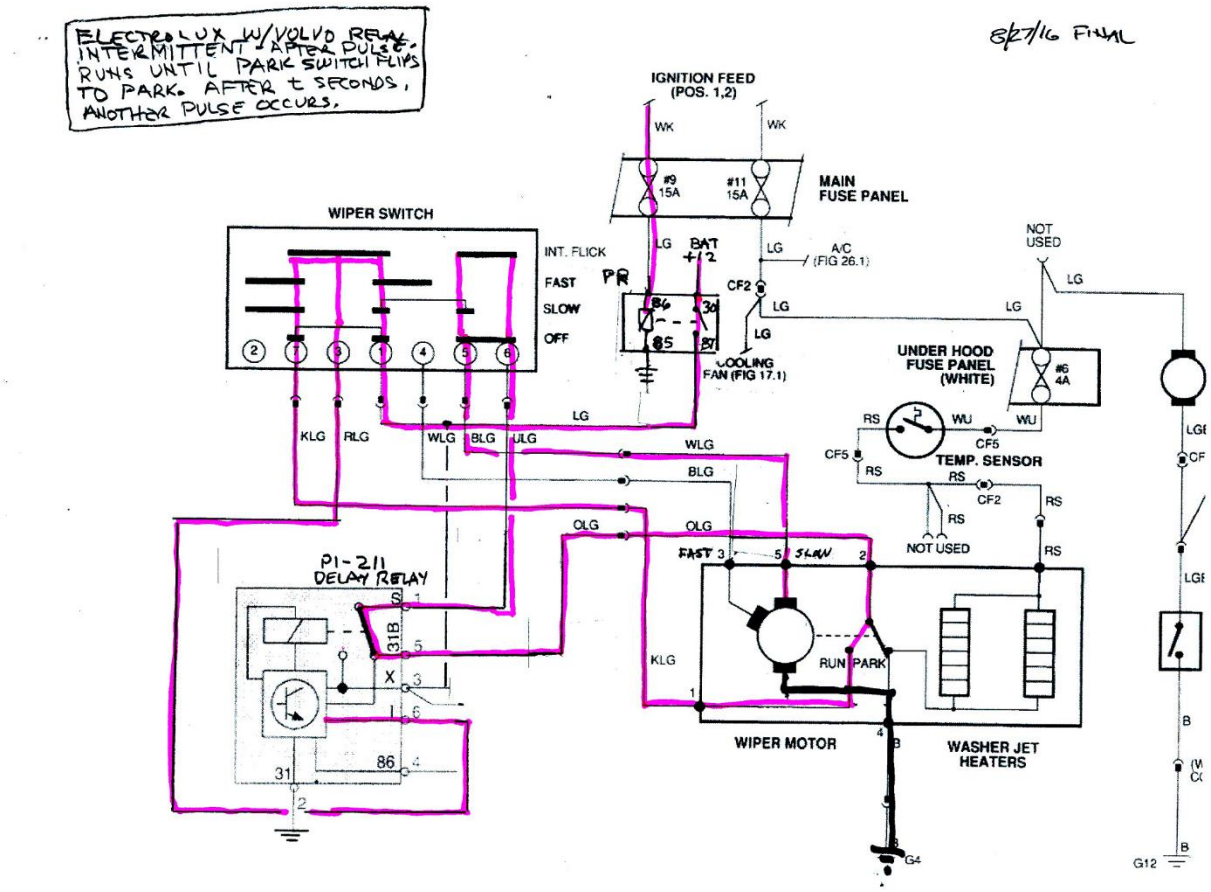

Figure 35 Intermittent after pulse

The astute reader might have noticed that in the above discussion of the two Intermittent modes it was assumed that the motor/gearbox microswitch was initially in the Park position. The question is then, "what if it wasn't?" The answer is simple: If it was instead in the Run position the motor/gearbox would continue to rotate until the cam lobe got to the microswitch trigger, whereupon it would switch to Park, putting the system into Intermittent – During Pulse mode. In other words, the whole Intermittent process can begin in either the During Pulse or After Pulse modes, and it doesn't really matter.

Design

Some readers might be interested in how I arrived at the circuit diagrams discussed above. The simple answer is “reverse engineering.” That is, I studied existing diagrams to fully understand how they worked. This included both Jaguar publication XJ-S 1989 Electrical Guide, Figure 15.2, VIN 154404-156988, and the equivalent diagram for the car for which the target intermittent relay, IDP part number 103226, was made, namely a mid 90’s Volvo 850.

First, I made several copies of the diagrams for both the Jaguar and the Volvo. Then for each switch position I used colored pens to trace the current paths from Ignition +12V to motor/gearbox ground, each on a different diagram copy. I quickly discovered that Slow and Fast were very simple modes because they didn’t involve the either the intermittent relay or the motor/gearbox microswitch. It also became clear that when the wiper switch is in Off or Intermittent, there are *two possible operational modes* depending on the state of the motor/gearbox microswitch. This meant there are six operational modes rather than two. After that discovery, I could easily see exactly how the system worked in every mode.

Afterwards, it was just a matter of matching up each pin on the Volvo relay with that with the same role on the Jaguar relay. One minor issue was the Volvo wiper switch has an Intermediate position and a Flick (single-wipe) position, and each has its own Pin for connection to the intermittent relay. In the Jaguar switch, these two functions conflated to a single position. This left me with a Pin 86 on the Volvo relay with nothing to connect to. I took a chance and just left it disconnected. Fortunately, when I did some bench testing everything worked! Apparently, Pin 86 and I on the Volvo relay are connected internally, whereas in the Jaguar system this connection is made in the wiper switch.

After the bench testing I could sketch the wiring diagram and build the harness.