Refilling the Temperature Gauge

Here is a bit on how to refill tired temperature gauges on the pushrod engines. Lots of old cars have mechanical thermometers. Mechanical thermometers include those which push a fluid up a narrow tube because the fluid expands in volume when its temperature rises. Other mechanical thermometers rely on changes in vapor pressure of a fluid when heated.

Many cars come with a dual gauge instrument; one part reads oil pressure and one part reads water temperature. Since a gauge reads oil pressure, one may suspect that the gauge maker would use the same gauge type for both oil pressure and water temperature. This would make manufacturing easier than if different gauges were needed in the instrument. How would this be possible to have water temperature and oil pressure read from the same type of gauge? Note that the oil pressure gauge reads from 0 – 100 pounds per square inch (psi). Is there a fluid which is inexpensive, has relatively small vapor pressure at room temperature yet has around 100 psi at 100 degrees Centigrade (212 Fahrenheit), and would have been known to automotive engineers in 1920? Sure enough, ethyl ether fits all these criteria. Since only about 2-3 cc of ether (the volume of a cherry) is needed, if you have 10-20 cc of ether; that is plenty even if you fail the first attempt at the refill.

If there are leaks in the thermometer, the ether volume in the thermometer will diminish with time. For a while that will not matter. As long as there is enough ether that some of it remains liquid across the whole temperature range (up to 100 C), then the vapor pressure can accurately reflect the temperature of the cooling system. When the ether level drops so that all of it is vaporized at some temperature below 100 C then the thermometer reading will not report the coolant temperature accurately. When the ether is slightly low, the thermometer reading can under-report the coolant temperature. For example, one might see the gauge reading 75 C when the coolant is boiling in the block. Thus, in addition to noting the temperature gauge reading, one should have familiarity with the expected reading for the circumstances; judge whether the gauge is right. When the ether is substantially gone, the temperature gauge will read low quite clearly or not even move off the minimum.

It is good on occasion to calibrate your gauge though you think it is sufficiently full. This can be done without removing the sending bulb from the thermostat housing, merely put a handheld thermometer in good contact on the outside of the thermostat housing near the bulb. If your dash gauge is working well, the handheld thermometer will read the same temperature as the dash if you have good contact at the thermostat. The handheld thermometer should read lower than the dash reading if your contact is not so great. Just about any handheld thermometer will work well, but I have learned that infrared-measuring units work easiest (race car folks use these for tire temperatures and they are widely used in science and engineering applications, cost can be less than $100).

Another way to test your gauge is to remove the sender bulb from the thermostat housing. If the handheld thermometer indicated trouble, it is good to do this next step for confirmation that your gauge is not reading correctly. If this next step indicates the gauge is working fine, then you made an error in the handheld thermometer testing but do not have to remove the instrument from the dash. Redundancy in testing can save some time. Once removed from the thermostat housing, this next step is to immerse the bulb in a simmering pot of water. Obviously a reading of near 100 C should be found at the dash if the gauge is full of ether and working correctly. A pot of simmering water at the sender can be achieved by using a hot plate carefully placed there or by using a propane torch to maintain simmering of a pot heated on the stove. Of course, the boiling water could be provided by boiling the coolant in the block. In this case, the testing is easier since the bulb need not be removed.

Examine the surface of the bulb sender while it is totally immersed in the simmering water. If the bulb is leaking, there should be some bubbles coming out as it begins to be heated. As the temperature inside rises, the heated air inside the bulb may vent the excess pressure through a leak (just like seeing bubbles under water when a leaky tire inner tube is tested). Note that simmering can cause bubbles to form on the outside of the bulb that are not from leaks, so be sure there is a leak.

If the gauge reads low (say, by more than 5 degrees when a thermometer is used in the simmering water in which the bulb is totally immersed), remove the entire gauge from the car. The bulb and copper tube will pass through the bulkhead. The bulb-sealing nut may prove irritating to get through the hole. Various solutions abound, including patience or pulling the oil pressure line first. Also, do not let the tube kink; the gauge requires vapor communication from the bulb to the dash gauge head. The twisted wire (some units have this, some don't) around the copper tube helps keep it from kinking and from engine vibration wearing a hole in the tube. On reassembly, be sure to use the rubber grommet going through the bulkhead to keep exhaust fumes down and to avoid vibration cutting a hole in the tubing. The oil pressure line is unscrewed from the rear of the gauge, while the temperature unit is soldered onto the back.

In all the following steps, use adequate ventilation and caution when handling ether, it is flammable (a bit more than pure alcohols). A one inch flame of ether vapor at the gauge end is not worrisome (just blow it out) but do not put flame heat to the bulb end when ether is present. And remember to keep solder out of the copper tube insides.

Remove the protecting crimped shield where the copper tube enters the gauge. Check again for leaks using the simmering water. Now also use some liquid soap around the tube/gauge union to look for leaks there. It is possible to have no visible leaks yet the ether is gone. This method of leak checking does not examine the inside of the gauge.

Clean off the soap and unsolder the tube from the gauge using a propane torch or similar. If a leaky bulb was observed, now submerge bulb in boiling water to vaporize any remaining ether and expel the vapor through the tube. Then use the propane torch to disassemble the bulb unit, clean it up, and resolder it together and to the copper tube.

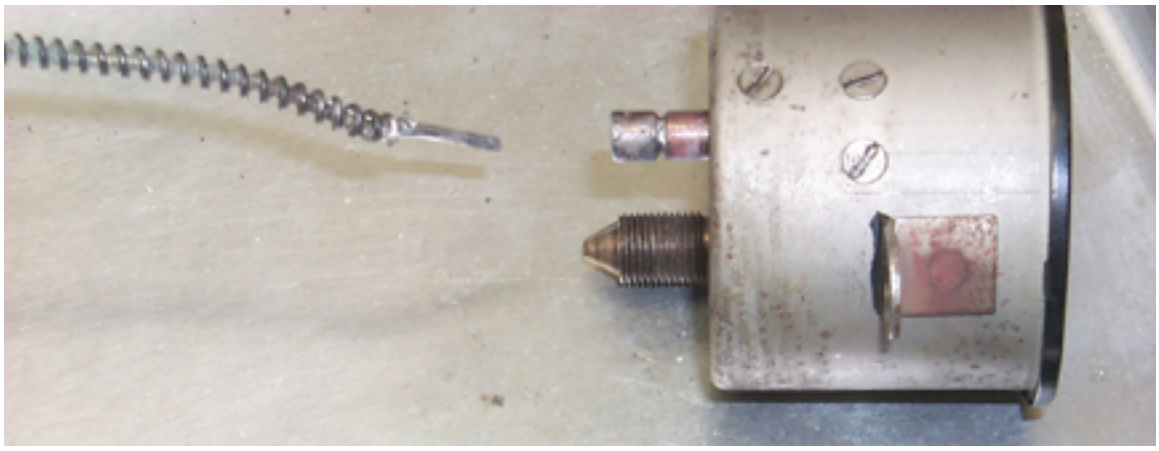
To refill with ether, first immerse the bulb in simmering water for about 30 seconds while the copper tube is held under the surface of the ether supply. This will expel about one third of the air inside the bulb. While keeping the gauge-end of the copper tube in ether, put the bulb into an ice-water bath or dry ice. The cooling of the air inside the bulb will draw ether into the bulb. About 2-3 cc of ether will be drawn into the bulb (about one third full). After about 30 seconds, withdraw the copper tube from the ether and insert it into the gauge while maintaining the bulb in the cold bath.

Resolder the tube to the gauge (including the end of the fitting and the little hole on the side) still keeping the bulb in the cold bath. Be sure the bulb/thermostat screw cap is on the copper tube pointed in the right direction before resoldering. All the soldering is done with a propane torch or similar, but the heat load on the gauge must be minded. Keeping the gauge cold enough to hold the outside of the case by bare hand should not cause heat damage to the gauge. Allow to cool.

After placing some liquid soap all around the soldered joint at the gauge, place the bulb in a pot of water. A thermometer in the pot should agree with the reading on the gauge within a few degrees. Heat the water and check all the way to boiling. Also check the bulb and the gauge joint for bubbling leaks as the bulb is heated. And smell for ether also. Leave the unit overnight and do the temperature, smell, and bubble leak checks again. You may find a need to do some of the work over again if the seals are not perfect. Then reinstall.

Figures

Putting ether into thermometer bulb sitting in icebath.



Ready to resolder tube to gauge. Solder tube into gauge and hole in groove on side of gauge fitting.

Checking the results before reinstalling.