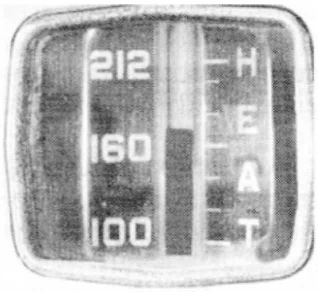
INTRODUCTION TO TEMPERATURE GAUGES

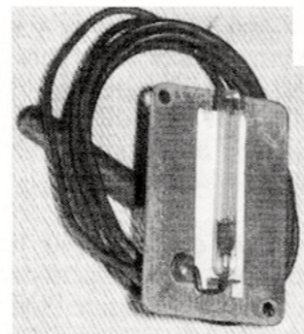
Back in the mid-1980s, *Skinned Knuckles* presented an article on repairing temperature gauges. The article was intended to address the Radimeter. Before the Radimeter, a thermometer sat is a housing above the radiator fill tube and indicated the temperature to the driver. It was known as the Motometer. The Radimeter was a rather sophisticated system utilizing a low boiling point liquid and a Bourdon tube indicator gauge. As the fluid boiled it expanded, tending to straighten the bourdon tube and running gears and pinions so that an indicator needle gave the (approximate) temperature of the coolant in the block. It is about that type of gauge that the following article, plus a sequel in next month's issue, refers.

But there was yet another type of temperature gauge manufactured by the King-Seeley Company - yes, the same company that made the hydrostatic gas gauge.

The King-Seeley gauge used a high boiling point liquid which expanded as the temperature of the coolant/block rose. But instead of terminating at the instrument panel in a Bourdon tube indicator gauge, a clear sight glass, similar to the K-S gas gauge, was calibrated in degrees.A bulb and tube fit into the the water jacket of the block, much like the Radimeter, and the tube was connected to the sight glass at the dash. As the liquid expanded, the level in the sight tube also rose. I doubt that the liquid was ether, because as the temperature reached operating temperature the fluid did not boil in the sight glass. Oh, one additional thing: the fluid, like that in the K-S gas gauge, loses its color when exposed to light, especially noticeable in an open car.



King-Seeley made, besides their famous gas gauge, a sight-glass temperature gauge. The 'fluid' in the photo was enhanced for illustrative purposes.


An extremely rare King-Seeley temperature gauge replacement sight tube and capillary line with the bulb attached.

Other than that, I know virtually nothing about the King-Seeley temperature gauge. My research resulted in - - - naught!

If any of our readers can add anything, anything at all, to the mystery of the King-Seeley temperature gauge, I would welcome it.

Please let me know. Thanks.

Editor

Part I

Repairing Vapor Pressure-Type TEMPERATURE GAUGES

- by Bill Cannon

By the mid-twenties many car makers had adopted temperature gauges mounted on the instrument panel to advise the motorist of the temperature of his coolant. Prior to that time, you either had to guess at the water temperature or buy the popular accessory device called the Motometer.

One of the most widely used coolant temperature devices in this era was the Radimeter. Although it is quite simple in operation, it was never intended to be repaired, adjusted, or tampered with in any way. If it became inoperative or was damaged, it was supposed to be replaced as a complete unit. Shop manuals and service manuals don't waste much space on items which are not supposed to be repaired or adjusted, so you won't find much information on the Radimeter in the usual sources. Today NOS replacements are virtually unobtainable at any price, so if your temperature gauge is inoperative, and probably nine out of ten are, you are out of luck. Or are you? Not necessarily. The purpose of this article is to explain how I fixed mine, and you can do the same with very little trouble or expense.

How the Radimeter Works

Before going into its repair, let us first consider how the thing operates. The Radimeter is a device which technically is known as a vapor pressure thermometer. It. utilizes the measurement of pressure in a closed system which is filled with a low boiling liquid to tell us what the temperature of that closed system is. Every pure liquid exerts a vapor pressure which is uniquely determined by the temperature of the liquid. When a liquid is confined at a temperature somewhat above its boiling point, the pressure increases by a relatively large amount for even a small change in temperature. The vapor pressure thermometer is, therefore. in principle a fairly accurate method of measuring temperature over a limited range since pressures can be measured with ease and accuracy.

The Radimeter, or vapor pressure thermometer, is, therefore, simply a bulb filled with the appropriate liquid which is connected to a pressure gauge. When we heat the bulb, the vapor pressure of the liquid increases and the gauge responds to the pressure. Unlike the thermometer, which requires calibration for each instrument made, the vapor pressure thermometer requires no calibration since we know from prior experience what pressure will be exerted by the liquid at any given temperature.

No specific volume of liquid is necessary in a vapor pressure thermometer - only enough to ensure that when the connecting tube and gauge are filled with the liquid under pressure, there is still enough left in the bulb to maintain the correct. liquid-vapor equilibrium. For that reason, the units are designed with thin connecting tubing so that most of the liquid remains in the bulb.

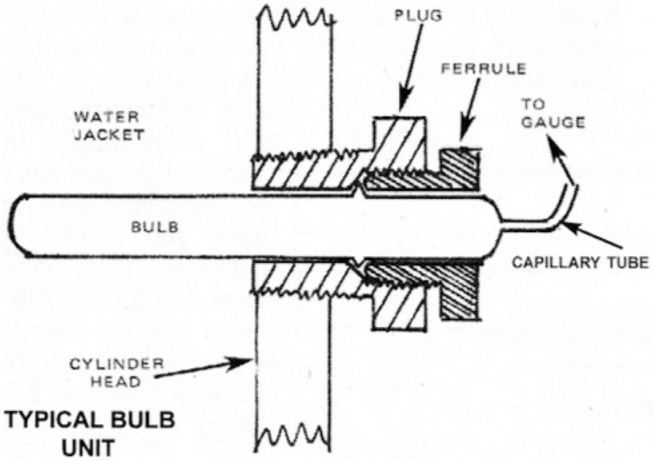
What it Looks Like

So much for the theory of operation, What does the thing look like, you may ask? First we find that there is a cylindrical bulb (this holds the sensing liquid), which is held in the cylinder head by a threaded ferrule which, in turn, is screwed into a plug which fits a tapped hole in the head. This plug is usually threaded on the outside with a 1/2 inch pipe thread. When the ferrule is screwed down onto the ring around the bulb, the latter is locked in place and sealed against water leakage.

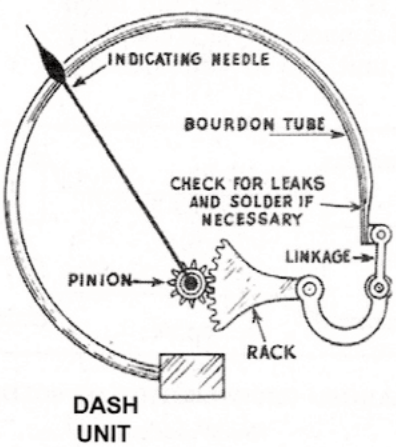
Extending from the bulb to the dash unit is a thin capillary tube (usually copper). The inside diameter is extremely small - something like 0.010 inch or less - and great care should be taken not to kink or bend the tube sharply. At the dash end of this tube is a pressure gauge. It will almost invariably be a simple Bourdon type pressure gauge unit. For those readers who may not be familiar with the principle of the Bourdon gauge, it is simply a flattened tube bent in the form of a coil or arc. Internal pressure in the tube will tend to cause it to straighten out, and if one end of the tube is fixed and the other end is free to move, it can indicate pressure inside the tube by connecting the free end to a suitable pointer through linkages or gears. Practically all industrial pressure measuring devices make use of the Bourdon tube principle.

The Sensing Liquid

As far as I have been able to find out, all of the automotive temperature gauges of this type use ether (diethyl ether) as the sensing liquid. This material, which is well known from its use as an anesthetic, is an ideal liquid for the purpose as its boiling point (94 F.) is just about at the point where we want to start measuring water temperature in an automotive cooling system, and at any higher temperatures the vapor pressure will go up pretty fast. Its vapor pressure is about 25 psi at130 F. and 90 psi at. 212 F., so that's a convenient to way to measure pressure with a small, inexpensive Bourdon gauge. Moreover, ether is stable (when kept out of contact with air), inexpensive, and doesn't corrode or attack metals. It is, of course, highly flammable, but since there is scarcely more than a teaspoonful in our system, and it is sealed, there isn't much of a fire hazard, if any.



TYPICAL BULB UNIT



DASH UNIT

Depending on which model of car you have, your dash unit may be calibrated to read in degrees Fahrenheit, or it may simply read Cold-Driving Range-Hot.

Chances are about nine in ten that any car you are restoring today will have a faulty or broken temperature gauge. Probably in years past, some mechanic couldn't get. the bulb out when removing the cylinder head or engine and ended up twisting it off or kinking it, or he may have cut the tube off with pliers. If the gauge unit or instrument cluster has been replaced in recent years, probably someone has whacked off the capillary in that vicinity of the dash unit. Either way, your gauge is out of commission.

If you are fortunate enough to have an operative gauge on the car you are restoring, try to keep it that way. If you have to remove the bulb to get the cylinder head off, for example, douse the ferrule with plenty of penetrating oil before attempting to unscrew it. If you get the ferrule out, you are still not home free. You will probably find that the bulb is stuck inside the pipe plug with rust. Try to work it free, but it is very difficult with nothing to get hold of. If you try to unscrew the plug before the bulb is free, you will, of course, twist off the capillary and ruin the unit.

Attaching a New Bulb and Capillary

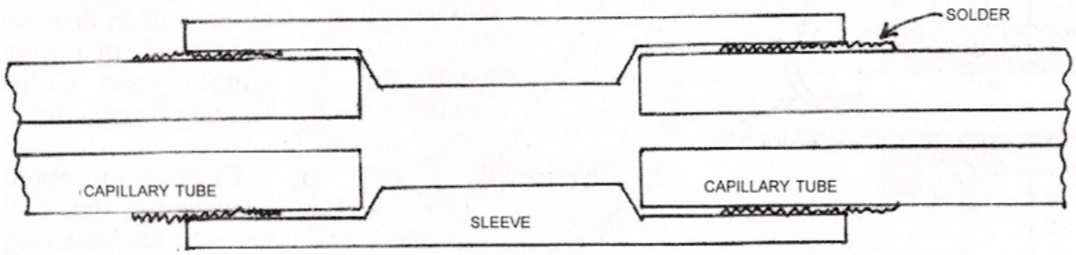
Let's assume that you are about as lucky as I am and find that the capillary has been cut or twisted off or the bulb is ruined. Chances are still good that the dash unit is OK - Bourdon tubes don't often go bad unless over-pressured. Take the unit out of the dash, open up the capillary tube if it has been cut or crushed, hook it up to a source of air pressure and test it. If it shows an indication of about 130 F. at 25 psi - that might be about 1/3 the way up the driving range - it is probably working all right. Check the linkage and pointer to determine that everything is working all right and not binding. a source.

If the gauge head is working satisfactorily, all you have to do is affix a new bulb filled with sensing fluid and connect it via a capillary tube to the old gauge unit. Go to your friendly parts supply house and buy a new universal type replacement gauge. They used to cost about five bucks, but the last one I bought set me back $12.95, so inflation has caught up with the replacement gauge market, same as everything else. You may be able to find NOS units at swap meets for less. Don't pay too much attention to the gauge end as we are going to cut that off and discard it anyway.

Cut off the old original capillary tube anywhere from an inch or so to ten inches away from the dash unit. File the end square and deburr it so you are sure the tube is open. Take your soldering iron and tin the tube just above the open end, leaving about 1/16 of an inch untinned. I'll explain why later.

Now tin a portion of the capillary on the new replacement gauge so that when the tubes are joined later at that point, the total length of the capillary will be about the same as original. This length isn't critical, and if the tube is too long the excess can be coiled up behind the dash. It's better to have it too long than too short.

First cool the bulb of the replacement gauge in ice water to ensure that the ether it contains is pulled back into the bulb section. Place the replacement gauge with its capillary and bulb in the freezing compartment of your refrigerator - and the colder the better. While the gauge is cooling, go out to the shop and make a sleeve to join the two capillary tubes. I use a piece of round brass stock 1/8 inch in diameter and about an inch long. Chuck the brass rod in a lathe and bore through from end to end with a No. 60 drill. Then counter bore each end to a depth of 1/4 inch with another drill to provide sufficient clearance to insert the ends of the capillary tubes. Most of the tubes are 0.075 inch outside diameter, so a No. 47 or 48 drill is about right. The tubes may vary in diameter, however, so it is a good idea to mic them beforehand and drill accordingly. In case you do not have the necessary tools to make the sleeve, I understand that hobby shops stock brass tubing in various diameters, so you might check this source. Do not try for a press fit



ENLARGED CROSS-SECTION OF SOLDERED JOINT

Vertical scale is exaggerated

of the tubes in the sleeve - allow a couple of thousandths clearance for effective sweat soldering.

After the replacement gauge has thoroughly chilled down (several hours in the freezer), take it out and cut the capillary just past the tinned spot. File the end square and de burr it and make sure it is open just like you did with the capillary on the dash end. Slide both tubes into the sleeve and sweat solder together, keeping the heat on the ends of the sleeve so that the solder does not run down to the ends of the tubes and plug them. By leaving the extreme ends of the tubes untinned, as suggested above, there is less tendency for the solder to run to the ends of the tubes. You can also wrap a strip of damp tissue paper (about 1/4 inch wide) around the center of the sleeve before soldering. It helps keep the heat off the ends of the capillaries and may prevent the solder from running where you don't want it.

Testing the Gauge

Now you are ready to see how good a job you did. Immerse the bulb in a pan of water on the kitchen stove. Use a thermometer (a candy thermometer works fine) to check the temperature of the water as it warms up. If you smell ether at the solder joint, you have a leaker, and you may be able to salvage the operation by getting the thing back into the freezer without delay. If the gauge shows no response at all, you have probably plugged one or both tubes with solder. Refreeze the whole assembly and cut and resolder, only be more careful this time.

Most of the time you will find that your restored gauge will read with reasonable accuracy. If it proves to be a little off at the boiling point of the water, try to remember where that point is on the gauge dial since it is important to recognize if your car starts to boil.

When installing the gauge in the car, first screw in the pipe plug using pipe dope so that you can remove it some day if necessary. Route the tube so that it will not be damaged or kinked in the future. Also apply pipe dope to the ferrule threads.

Now on your next tour, sit back and watch the old bus overheat without guessing about it.

NOTES ADDED IN PROOF: I have never had any trouble finishing the soldering job before the bulb warmed up significantly. If you are worried about it, freeze the bulb in a small receptacle (paper cup) of water. The additional mass of the frozen water will keep the bulb and its contents cold for a prolonged period of time. If you have access to dry ice, the bulb can be chilled in it before the cutting and soldering operation, and some time will be saved.

Thanks to the late Henry Miller, San Gabriel, California, who first taught me how to repair temperature gauges. *Bill Cannon*

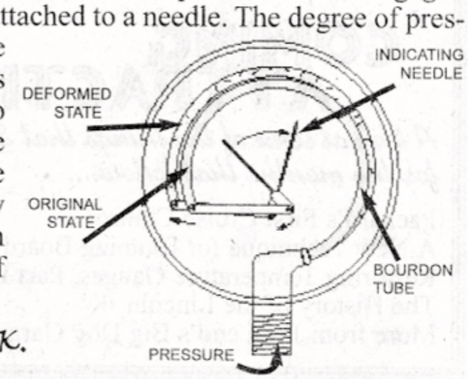
S.K.

Next month we will follow an actual repair of the Radimeter temperature gauge. Longtime subscriber to SK, *Tod Fitch, makes the repairs to his temperature gauge in a step-by-step photo essay. Obviously, profusely and clearly illustrated, it is must reading before you attempt the actual repair. Does the repair work? We'll see next month.*

WHAT IS A BOURDON TUBE?

We have referred numerous times in the preceding article, to a Bourdon tube. If you are familiar with this device, you found no difficulty in understanding the principle. But if not, well, let's describe a Bourdon tube and a Bourdon tube-gauge.

A Bourdon tube is a system by which pressure alters the curvature of a loop of tubing causing a series of gears to move a needle. The Bourdon tube is open at the input end, and sealed at the gear end. It is shaped like a circle, with either a single loop, or sometimes with concentric loops of tubing and is slightly flattened. As pressure is introduced into the open end, the tube tends to 'straighten out.' The closed end will move a pinion which is engaged with a gear attached to a needle. The degree of pressure to move the tube is calibrated so that the results are indicated by the needle on the face of the gauge.



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