

BMW E39 Expansion Tank Failure Analysis

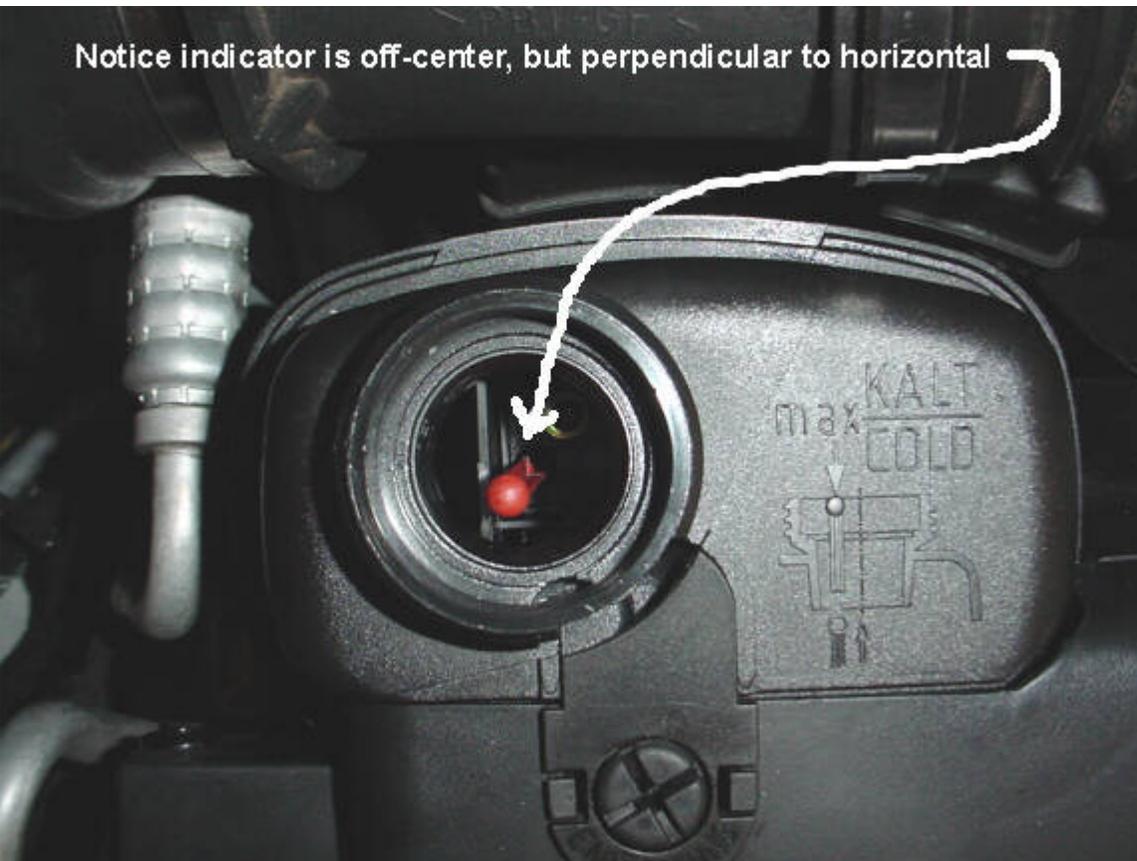
Recently (1/16/03) the water pump in my 540 failed at 52k miles. Coolant was leaking from the shaft seal behind the pulley, but only when the motor was running. After replacing the pump, thermostat/housing, hoses and belts, I noticed a new problem had crept in - coolant was slowly leaking from the bottom of the expansion tank, where the sensor plugs in. The coolant was traveling along the wires coming off the sensor, eventually dripping down onto the underbody pan and onto the ground.

The (plastic) expansion tank is a sealed unit - the top and bottom halves are welded together, making repair or non-destructive inspection impossible. The design uses four fittings - one for the filler cap (top of tank), one for the main inlet/outlet hose (2/3rds down on tank), one for the coolant overflow hose (top of tank), and one snap connector for the sensor (bottom of tank). The two hose fittings have brass inserts inside the hose barbs to keep the hose clamps from crushing the barbs, which I think is a nice design feature. Too bad the guy who put those in didn't design the coolant level detection system.

I've seen many posts on RoadFly regarding failure of this tank, so after replacing the tank with a new one (list is ~ \$70, I paid \$60.58 including tax), I put an old blade in the table saw and ran the leaking tank through it, severing the tank just below the factory join line. After looking inside, I think I now understand how these tanks fail in this mode.

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Notice indicator is off-center, but perpendicular to horizontal



Here's the new tank with the cap (not included) removed. As you know, the red indicator should be even with the top of the tank when the motor is cold.

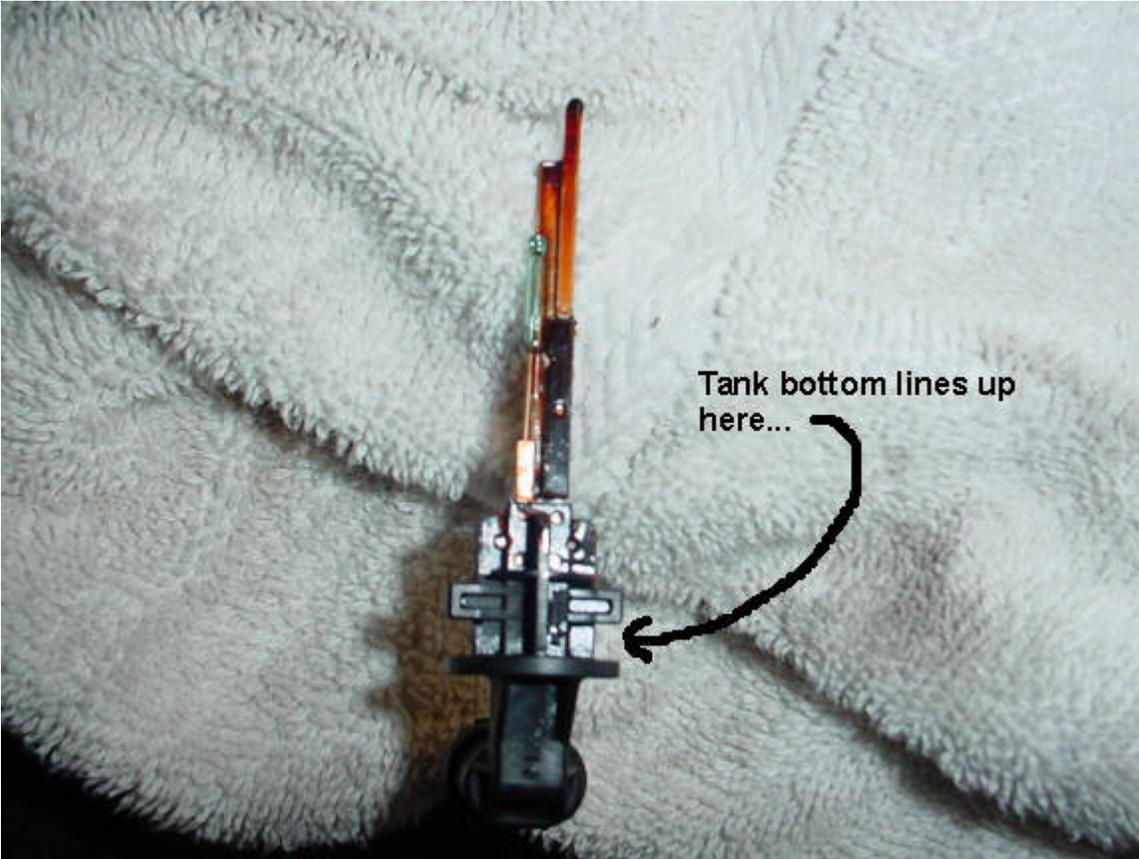
Although it is off-center in the opening, it should be sticking STRAIGHT up. Mine has always sort of leaned over to this side or that, and I just assumed the float was tilted - no big deal, right?

WRONG!!!

Here's a picture of the sensor which is installed in the bottom of the tank. The "inside" portion of the sensor is about 1-1/2 inches long. When I discovered the leak, I assumed this to be a wet sensor, and couldn't figure out how it was supposed to seal against the bottom of the tank.

As it turns out, this is *not* a wet sensor - it fits into a cavity molded into the tank bottom, which in turn protrudes up into the tank proper. This cavity is sealed from the coolant, and is supposed to be dry.

I am fairly sure this sensor works as follows: the coolant level float in the tank contains a metallic "donut", and this sensor must use this (via magnetic field, Hall Effect or ???) to determine the proximity of the float to the sensor. When the coolant level gets low, the float gets closer and closer to the sensor, until the low-coolant alert is triggered...

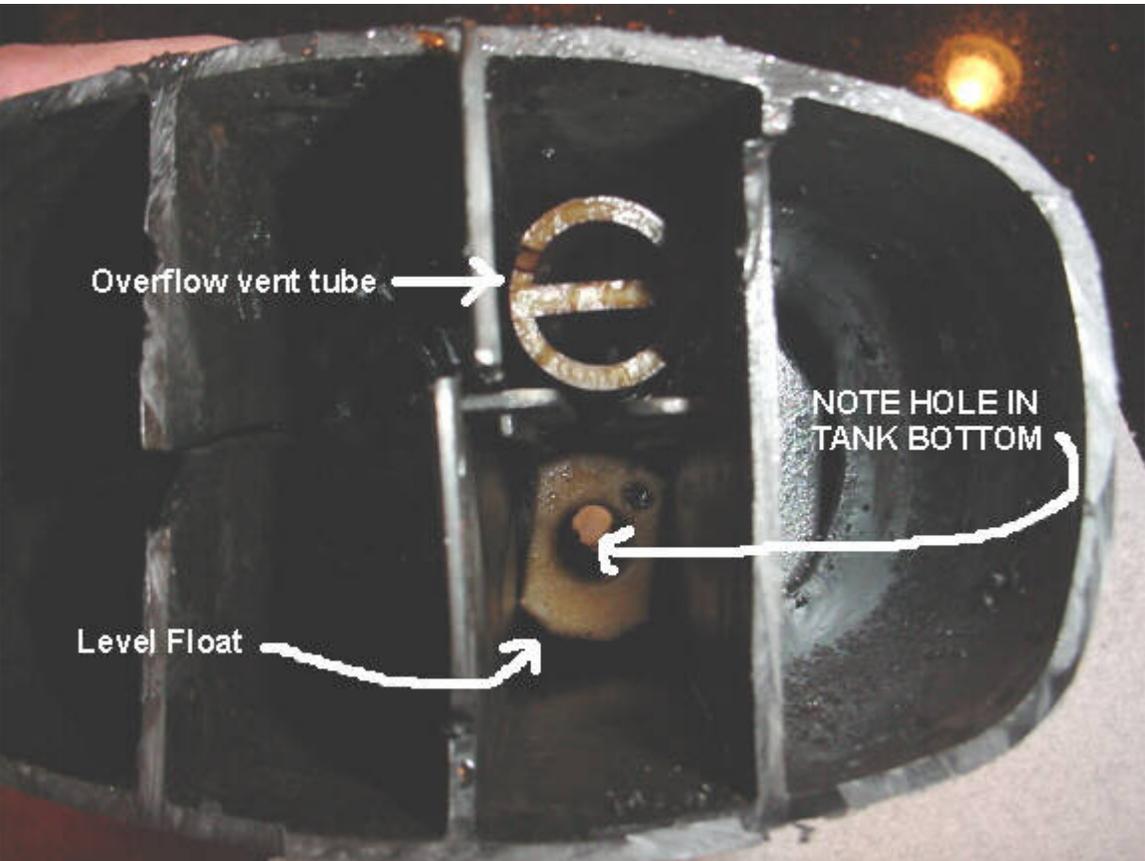




Here's the inside of the top of the expansion tank. Not too much going on here, and in fact none of this piece has anything to do with the failure.

But in case you've ever wondered what it looks like, here you are... :)

That pipe at the bottom with the o-ring on one end gets inserted into the overflow vent - it carries coolant up from the bottom of the tank out the hose (and back into the radiator). It was a tablesaw casualty.



Ok, now it gets (a little) interesting. There's the other half of the overflow tube at the top-center of the pic. See that hole in the bottom center? That's the TOP of the sensor cavity. If the sensor hadn't been plugged in, partially blocking its path, coolant would rush out this hole.

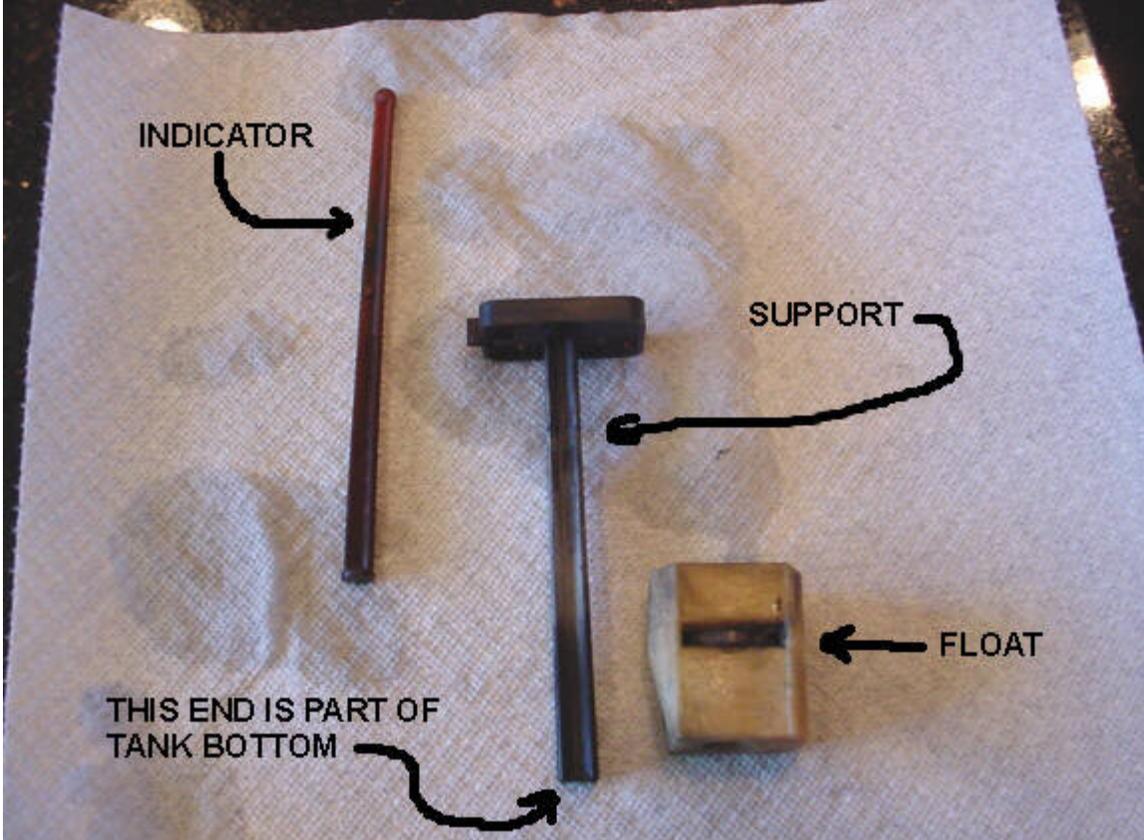
The white-ish thing marked "level float" is just that - the float. If you look carefully at the upper right corner of the float, you'll see a dimple in the plastic. This is where the red indicator "stick" should be attached. Mine was broken off, and had been for some time...



Here's the other side of the tank - looking at the bottom from the outside. You can see the sensor cavity molded into the tank, and the hole at the top (same hole as in previous pic).

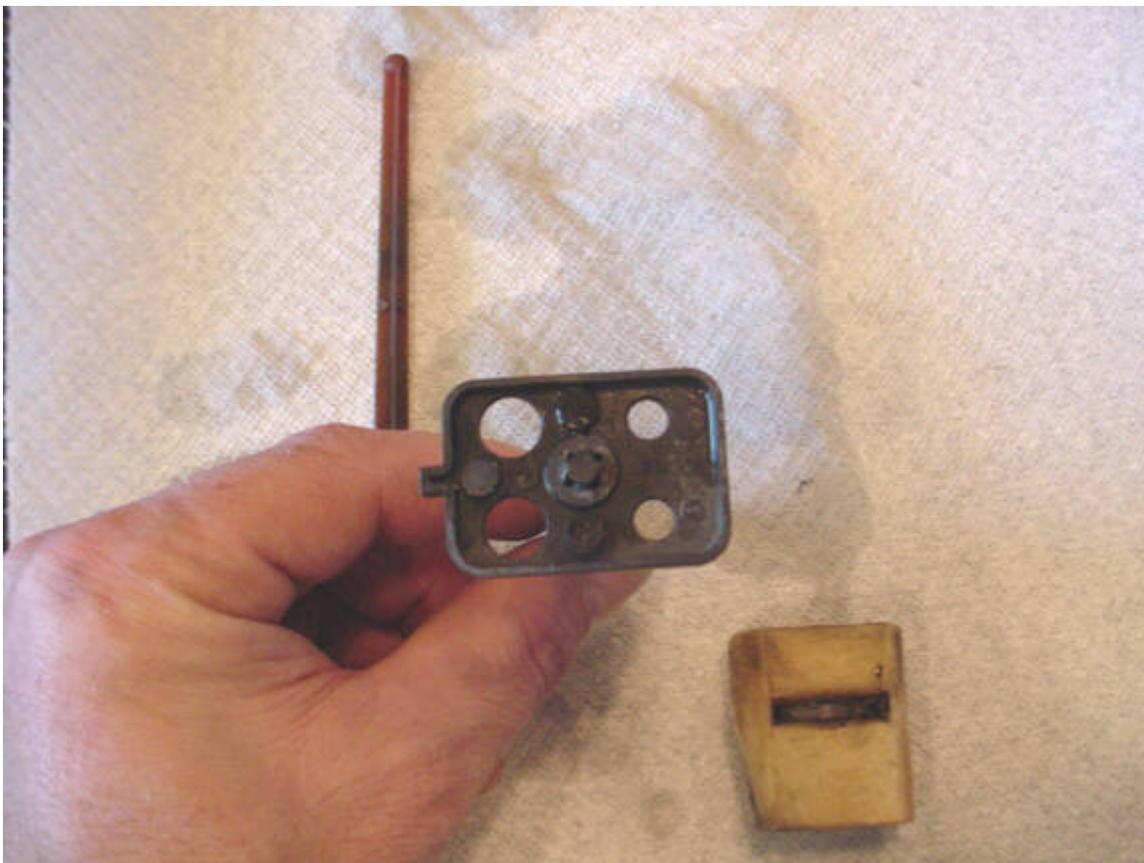


Just another view of the bottom of the tank - you can see how the sensor snaps in much like a polarized light bulb.



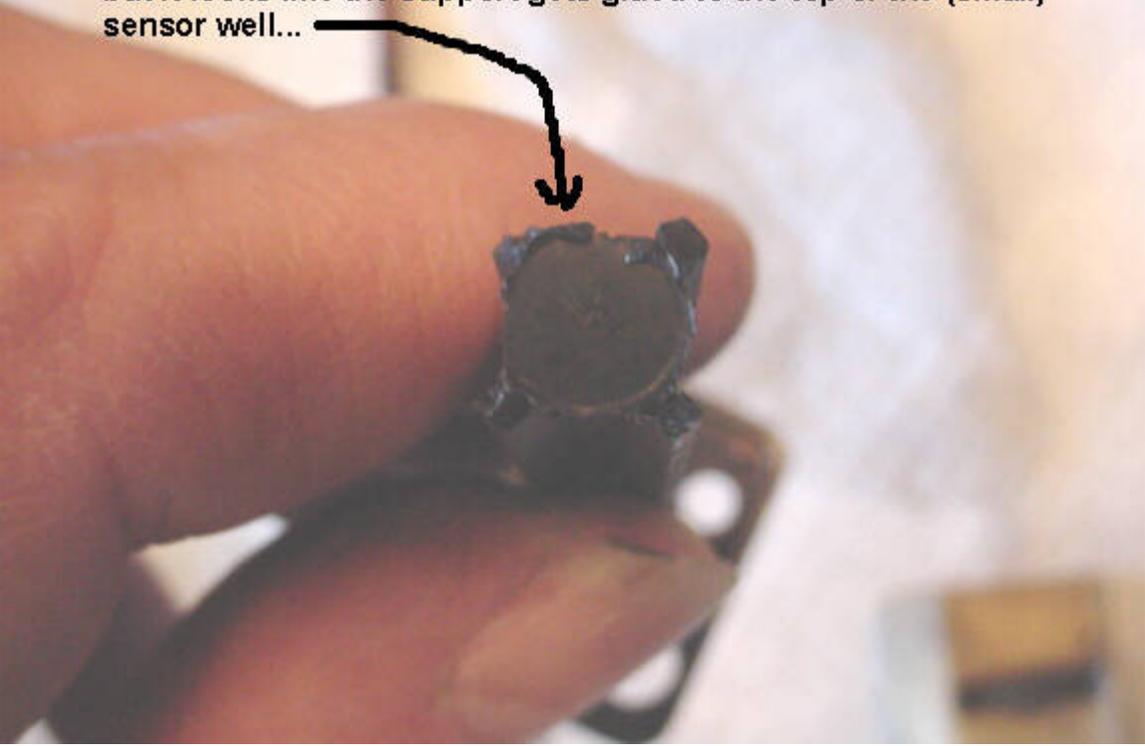
Here's how the float assembly came out after cutting open the tank. Note that the act of cutting the tank did nothing to these pieces.

Looking at the "T" shaped support, you can see that it basically forms a large moment arm acting on the very small portion of tank it gets glued to.



Here's the top of the support, which you can see when you look down inside your expansion tank. The red indicator sticks up through one of these holes. This rectangular platform sits down in the tank, held in place by guides molded into the tank.

This is actually part of the bottom of the tank! I can't tell for sure, but it looks like the support gets glued to the top of the (small) sensor well...



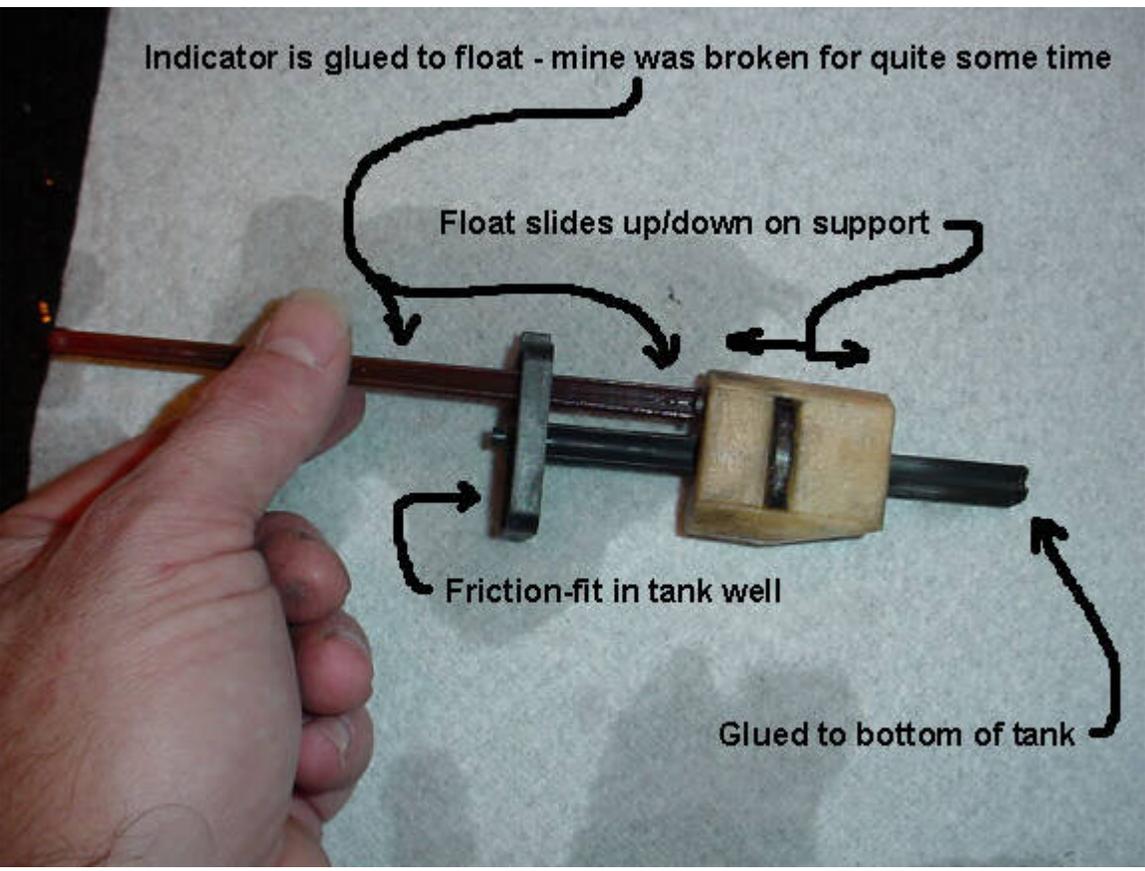
The other end of the support. you can see how small the section is that gets attached to (and forms part of!) the tank floor.

Indicator is glued to float - mine was broken for quite some time

Float slides up/down on support

Friction-fit in tank well

Glued to bottom of tank



Now we get to my theory. This shows how the float assembly should look. The float and indicator are supposed to be one piece. The float slides up and down on the support. Note the metallic piece embedded in the float.

But, if you happen to replace the expansion tank cap in such a way that the indicator is cocked to one side (instead of carefully placing it straight down on the indicator), over time it can (and does) break off and separate from the float. Now you have an even longer lever arm working against that small section at the bottom of the tank.

Eventually the bottom of the tank fatigues and develops a crack, and coolant is then free to leak past the sensor. On my tank, the support had broken completely away. Bad design, Hans...

