

ELECTRIC FUEL GAUGES

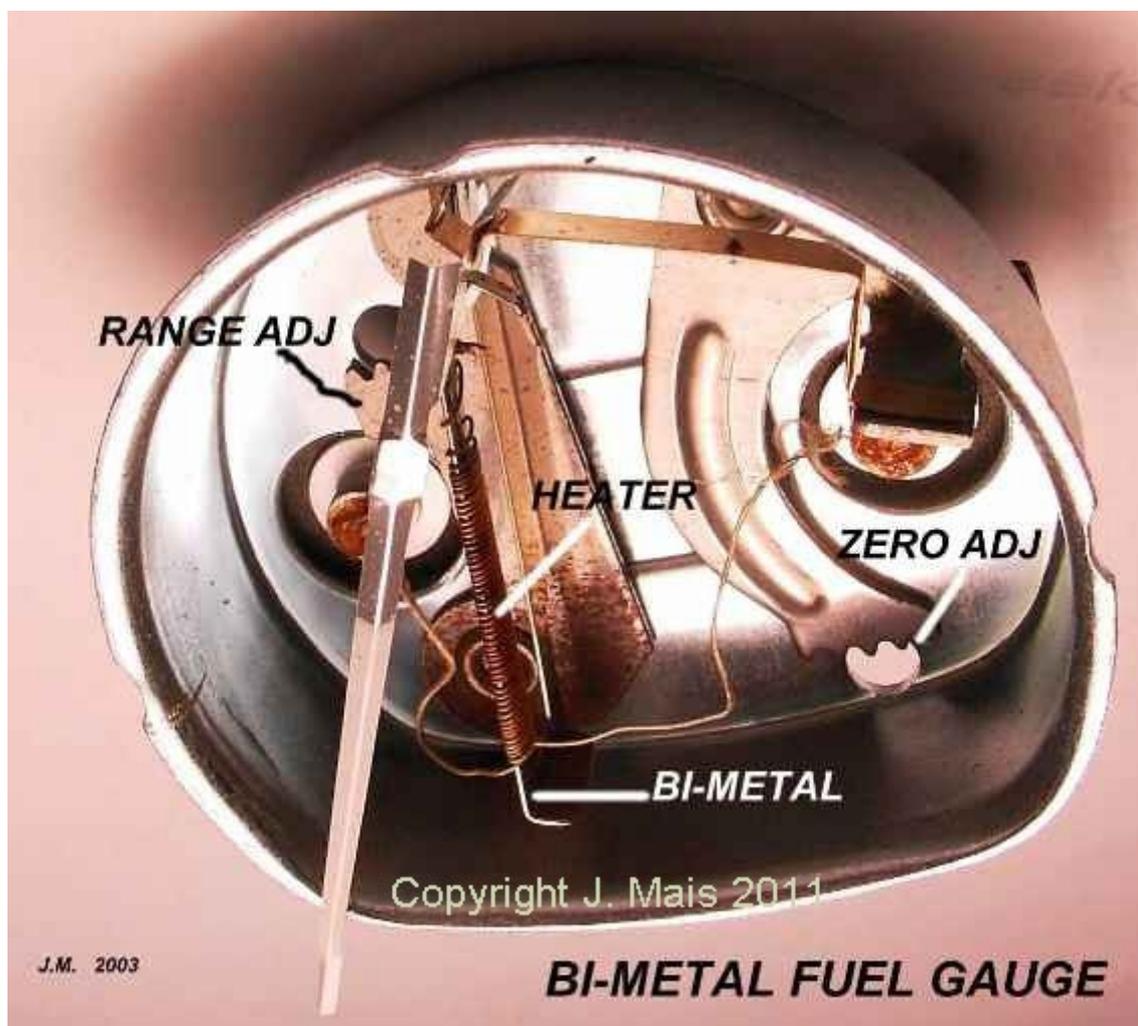
TESTING A GAUGE [Click to jump to this section.](#)

THERMAL-TYPE GAUGE

Beetles were first sold with electric fuel gauges beginning with the 1968 model year. Karmann Ghias and Buses had them even before this.

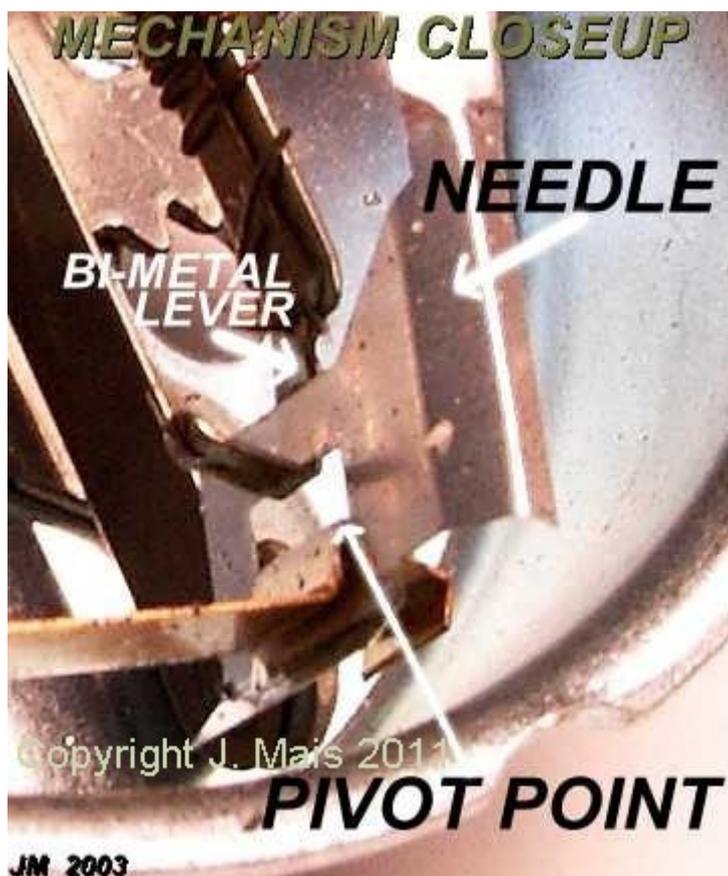
The gauge used on the Beetle from '68 onward is a thermally-actuated design. It is not a new concept; Ford used gauges similar to this as early as the 1930's and it probably goes back even further.

Here's the basic concept: the float in the fuel tank drives a rheostat (variable resistance). The rheostat varies the current flowing into the fuel gauge on the dash. Inside the gauge, a tiny heating element responds to the rheostat current. When fuel level is high, current is at a maximum and the heater gets hottest. The heater is wound around a small bi-metal strip; as the heater warms up, the strip bends or "warps".



The picture above shows the gauge as it is mounted in the speedo housing. The lower end of the bi-metal strip is fixed. The upper end will move left or right, depending on the heater temperature.

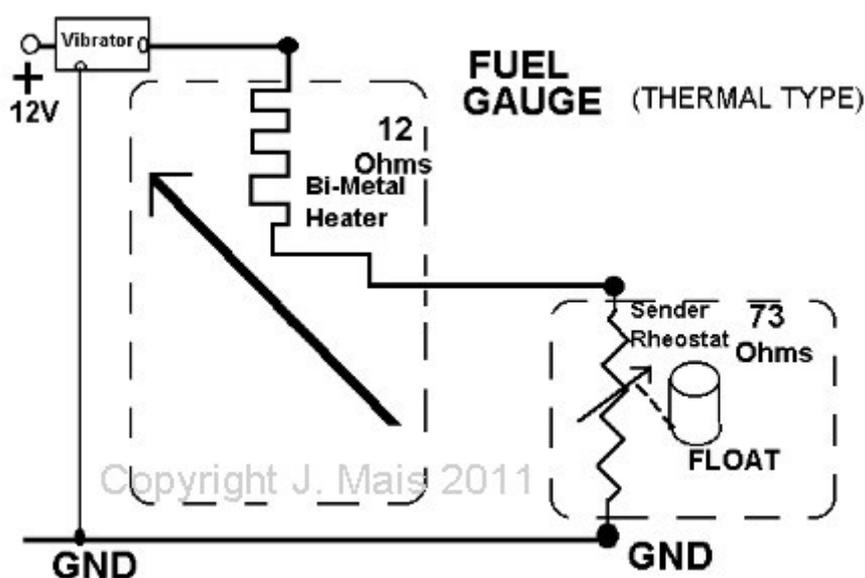
The photo shows 2 geartooth adjustments. These were for factory calibration. A tiny toothed pinion tool is inserted from the rear to turn the adjuster. Re-calibration in the field is rarely required and strongly advised against. The adjustment is extremely critical and the gauge is easily ruined.



This photo was taken with the gauge "upside-down". The pivot point is where the needle is attached. The bi-metal lever has a "hook" which pushes or pulls the needle. Because of the short distance between the hook and the anchor point for the needle, a small movement of the bi-metal strip results in a very big travel of the needle.

Shown below is the circuit diagram. When the tank is Empty, the rheostat has roughly 73 Ohms resistance. Only a small current flows through the heater as a result. This is just enough to keep the needle at the lowest mark on the dial. As the float rises, more and more current flows, driving the needle upward. When Full, the rheostat has approximately 10 Ohms resistance and

maximum current flows to the gauge.



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DAMPING- This type of gauge is inherently heavily damped. During cornering, fuel sloshes about and the float bobs up and down, varying the current to the gauge. But it takes a fairly long time for the bi-metal to respond to the current change (1 or 2 seconds). This delay averages out the variations due to float bobbing.

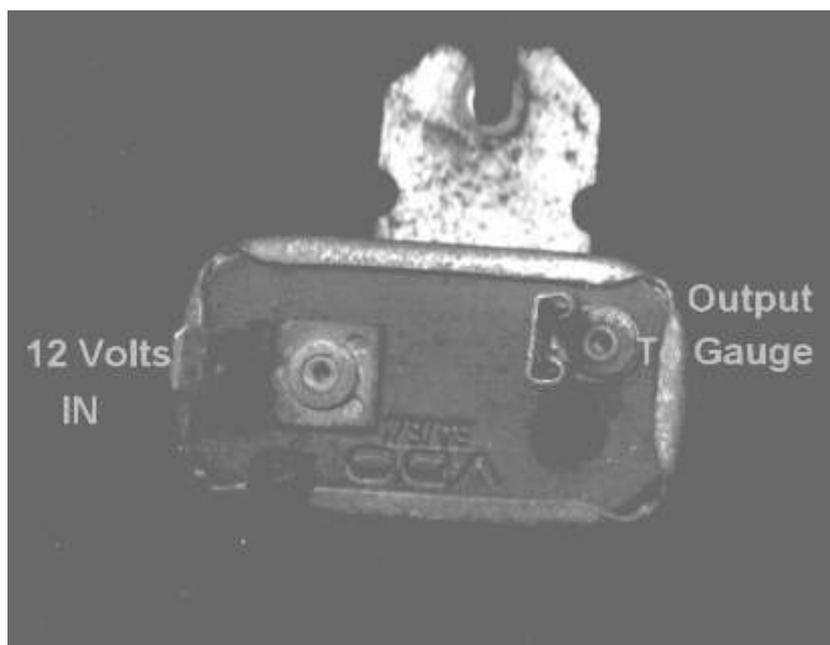
FLOATS- Below are the 2 styles of floats used on Beetles.

Due to the odd tank configuration on Super Beetles, 2 floats are used to move the rheostat at different rates during the transition in shape.



VOLTAGE REGULATION

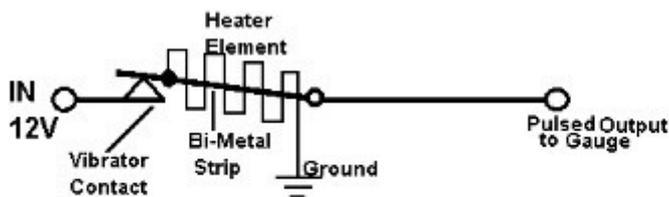
Because of the sensitivity of the heater/bi-metal design, it is very important that the input voltage to the gauge be constant. Voltage regulation is accomplished by a very simple, yet effective, design. Shown below are the exterior and interior views of the voltage stabilizer or "vibrator", as it is often called.



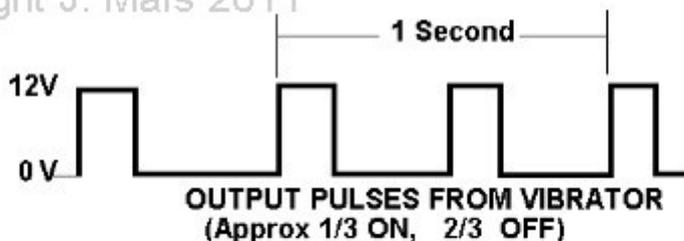
The vibrator is screwed to the back of the speedo housing. It is very important that this screw connection is well grounded or else the vibrator won't operate properly. The connection from the vibrator output may be made to either side of the gauge, depending on how the vibrator is mounted.



The design incorporates the same type of bi-metal strip and heater as found inside the gauge. But here it has a different purpose. 12V from the battery heats up the heater element and warms the strip. The thermal mass is small and the strip responds very rapidly. As soon as it begins to move, the strip causes the contact points to open. This breaks the circuit and the current ceases. Now, the strip begins to cool off and bends back to its original shape, closing the contact. This repeats, over and over. The result is a series of pulses, each with a voltage of 12V. When the pulses are fed to the gauge, the heater element in the gauge averages the pulses out.



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FUEL GAUGE "VIBRATOR" (Voltage Stabilizer)

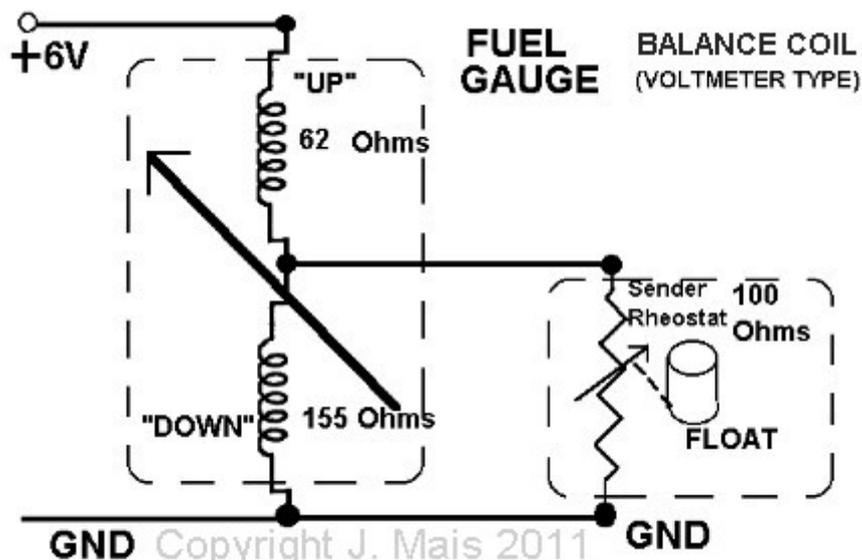
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The closer the pulses are together or of longer duration, the hotter the heater in the gauge will get. By accurately controlling the pulses, the stabilizer has the effect of regulating the voltage (here, we're talking about RMS or "effective" voltage). Suppose that battery voltage goes up (as when the generator increases output). The heater in the stabilizer will heat up more rapidly and open the contact points sooner. The result will be shorter pulses of 12V sent to the gauge. The opposite happens when the battery voltage goes lower.

It all sounds quite crude and un-reliable but, in fact, it does work rather well and at low cost.

BALANCE COIL GAUGE

No heaters or bi-metal in this type of gauge. Rather a meter movement, like that in a voltmeter or ammeter is used to detect the current from the sending unit rheostat. A small permanent magnet sets up a field which interacts with magnetism produced by coil windings inside the meter. A voltmeter usually only has one such winding; our fuel gauge has 2 windings as shown schematically below.



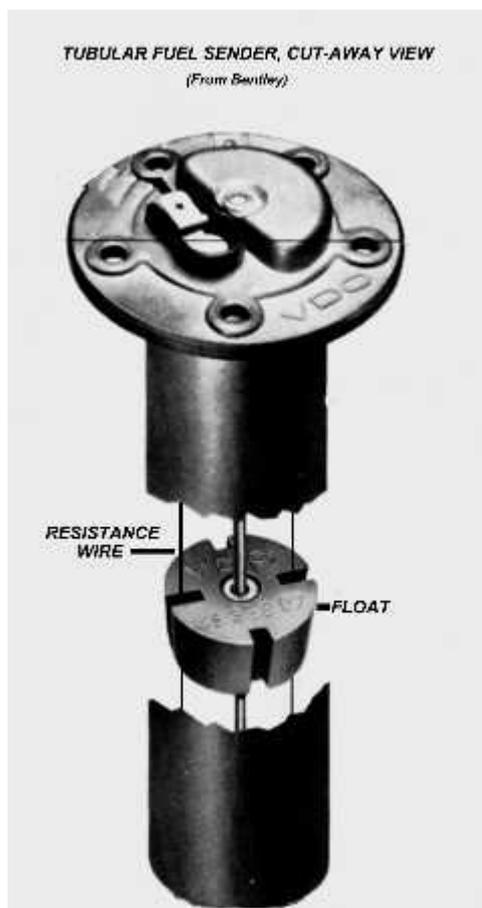
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NOTE: Resistance values shown are for 6V gauges

The coil winding resistances and sender resistance are set so that when the float is at the bottom of its travel, the magnetism from one coil perfectly balances out the other.

Now, as the float moves upward, resistance decreases and more current is pulled through the "UP" coil. At the same time, current is "robbed" away from the "DOWN" coil. The net effect is to cause the needle to move upscale.

No voltage regulation is required with this type of gauge because of the cancelling effect of the 2 coils. For example, a rise in input voltage will cause more current to flow in the "UP" coil, but it will also cause more current in the "DOWN" coil. The 2 cancel each other. This gauge is quite stable over a reasonable voltage swing.



This tubular sender is the type commonly used with the balance-coil gauge. The 2 thin wires are made of resistance material wire. As the float moves up and down, it makes contact between the 2 wires. Upward movement means less resistance in the circuit.

DAMPING- This gauge is not inherently damped since it has no thermal mass to rely on. Without damping of some kind, the needle would fluctuate wildly as the car rounded corners and fuel sloshed about. To overcome this, small holes are drilled in the outer tube. If tank level suddenly changes, it takes several seconds for the fuel to flow in and out of the holes and for the float to respond.

- The Balance Coil type of gauge was used on Buses up until the '73 models (thru VIN 2132138900). Late '73 and later Buses used the thermal type of gauge with a bayonet mount sender (single float).

Karmann Ghias used Balance Coil gauges until late in the '73 model year (VIN 1432621518), then they switched to thermal type until the end of production.

All Type 3 cars (fastback/squareback) used the Balance Coil gauge.

● **TESTING THE GAUGE** Often it is hard to determine whether the gauge or the sender is the cause of problems. Do these 2 easy tests:

Pull the wire off the sender. The gauge should go to EMPTY.

Take the sender wire and ground it (Ground it to chassis, not the tank). The gauge should go to FULL.

If it passes both these tests, the gauge is good and any problems are in the sender.

NOTE: Later senders have 2 wires; one is the wire to the gauge, the other is a ground wire. On these senders, ground is always Brown; the sender wire may be either Black or Yellow (or even Green). Make sure that the Brown wire actually goes to a grounding stab somewhere on the chassis.

There is no absolute test for the vibrator (thermal gauges), but a pretty good check can be made by connecting a voltmeter (old fashioned analog type) or a small 12V test lamp from ground to the vibrator output terminal (where it connects to the gauge). The voltmeter should bob up and down several times a second. If it does, the vibrator is probably good. They rarely go bad and failure is usually complete.

If a gauge is intermittent, check the tightness of the 2 hex nuts on the back of the gauge; they have a habit of loosening on the thermal gauges. Intermittent gauge operation can also be caused by poor contact at the fuse supplying this circuit.

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