Remobilisation of a 1937 Morris 8 Sports
Episode 3: Fixing the fuel gauge - what I did to stop it reading backwards

Hi, my name is Alister (Al) Gardiner. This is another episode in the trials and tribulations of our Morris 8 "remobilisation". I hope readers might find something of interest amongst the content. My apologies if it is all a bit ho-hum to the more accomplished of you. For feedback I can be contacted on 0279222242, or at grannybigal@xtra.co.nz.

Topics

The topic of this instalment is the strange case (or not as strange as it turns out) of a fuel gauge reading backwards. Future articles will highlight just some of my further solutions to the rebuild challenges, such as:

- installing some front shocks – there was nothing in the box of bits
- starter motor nightmare - did these things ever work at 6V? additional instrumentation and electrics - LEDs, turn indicators and 12V
- upholstery trim - a bit of individuality on the door pockets starting issues - how can some things so simple be so difficult?
- my car battery – a custom solution using the ubiquitous 18650 lithium ion cell

These will still take a few months to compose and deliver. I suggest that if anything is of immediate interest to you; get in touch with me or the editor to see if it can be prioritised. See earlier issues for other topics.

The Problem

I started out attempting to get the engine running with only a few litres in the fuel tank. Strangely, the petrol gauge read full. I immediately suspected a wiring error somewhere since I had carried out all the instrument panel wiring and added quite a few features – more about that in a future instalment.

So I pulled the instrument panel out again. I rechecked the wires to the gauge and then tried reversing them. There is also a third connection inside the gauge to the chassis which biases the pointer position in some way. But to no avail - all seemed OK. The fuel tank level measurement system is electromechanical. Basically a float in the tank operates on a resistive element via slider fingers to vary the resistance as the fuel level changes. The resulting current electromagnetically positions the fuel tank gauge pointer.

I then jumped on-line to find out anything I could about the Morris 8 sender unit characteristics, rather than clamber under the car and pull the whole thing out – to find out what?

And here is what I found out on-line from the comfort of an arm chair - as the more knowledgeable of you are probably already aware of. There were two different models of Smiths 6V sender unit produced, which required different gauges. One system reads full on low resistance, and yes - the other reads <u>empty</u> on low resistance. Apparently replacement earlier type sender units (Smiths G33, which our type should be) are like hens teeth i.e. almost impossible to find. I can only assume that in the past our car sender was replaced with the later type (Smiths G35). The previous owner(s) must have had to adjust to reading the tank in reverse. Not impossible but I imagine a bit unnerving until you get used to it!

The technical article from the URL next page explains in more detail why it is not possible to mix these different versions. .

Basically the pre-war system (G33) tank sender provides near zero resistance when the tank is full, while the later (G35) system is the reverse of this (near zero when empty).

See: http://www.morris8cars.66ghz.com/Pictures/TechPics/Gauge1.pdf for a full explanation and a second article describing how to determine the physical differences in the units at: http://www.morris8cars.66ghz.com/Pictures/TechPics/Gauge2.pdf?i=1

Some Tests and Measurements

With a small amount of fuel in the tank (~2litres), the gauge was reading **FULL**. Disconnecting the wire from the sender unit to the gauge (open circuit or high resistance) made the gauge read **EMPTY.** This more or less confirmed the case. With a variable resistor connected between the wire to the gauge and ground, the gauge gave the following approximate indications:

Gauge Reading	Resistor Box Value (Ohms)
Full	0 *
3/4	2.9
1/2	7.0
1/4	10
Empty	25

* ~1 ohm was measured with about 2-3 litres in the tank.
This proves that the gauge expects a variable resistance ranging from very low for a FULL reading to a high resistance of about 25 Ohms for an EMPTY reading (i.e. it must be a G33 unit).

Note that the gauge scale is non-linear, with the higher scale range spread out, e.g. 1/2 is much closer to Empty than to Full.

I measured the unmodified sender unit at about 1.6 Ohms with the float fully down (i.e. EMPTY), 32 Ohms fully up (i.e. FULL), and 16 Ohms with it about half way. These readings were somewhat intermittent, which suggested an open circuit in the element winding, or corroded/worn/weak slider fingers.

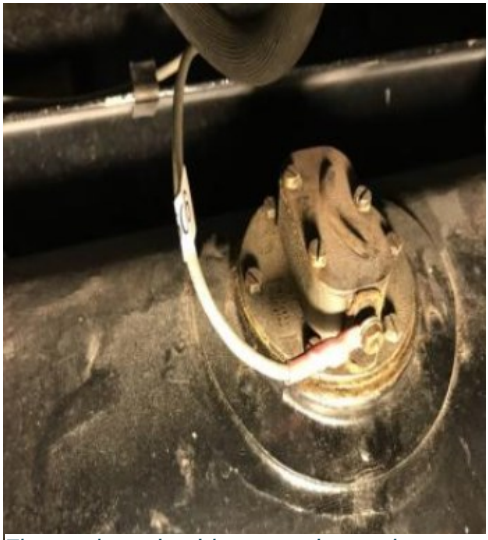
They do however correspond with the required resistance expectation of the gauge but in reverse.

By inspection, based on the above reference and confirmed by the measurements, our car tank sender is therefore a G35. I assume that the gauge is a G33, and that the original tank sender was at some stage replaced with a G35.

The photo shows the G35 sender unit mounted on the front of the tank with the connected cable linking it to the gauge. The return circuit relies on a good electrical connection from the sender body to the tank and then to the chassis. If you are having fuel gauge problems, checking the continuity of this earth connection should be one of the first tests. Because of the low operating voltage and resistances it doesn't take much corrosion or just a slightly loose connection to reduce the current flow sufficiently to give false gauge readings.

The Adopted Solution

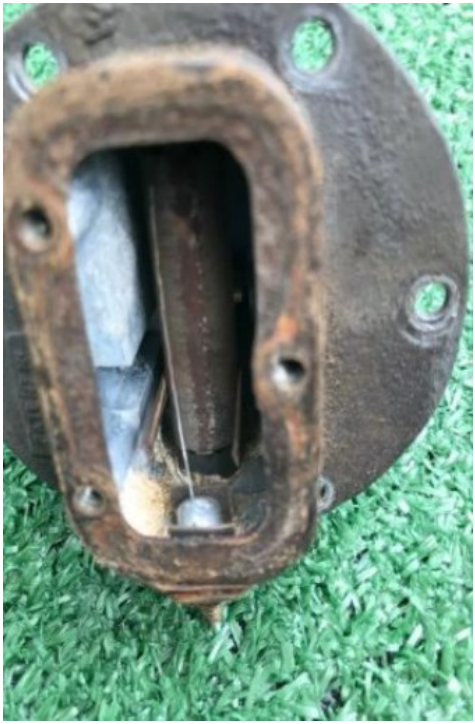
So what to do? With not much chance of finding a replacement I wondered if I could reverse the internal wiring at one end to get the pointer to move in the opposite (right) direction. I decided to attack the tank sender end since it seemed simpler to pull apart than the gauge. So out it came. Often a real problem because at least one of the lightweight flange screws usually shears off. For once I was in luck, and with liberal use of CRC the unit came off without incident.



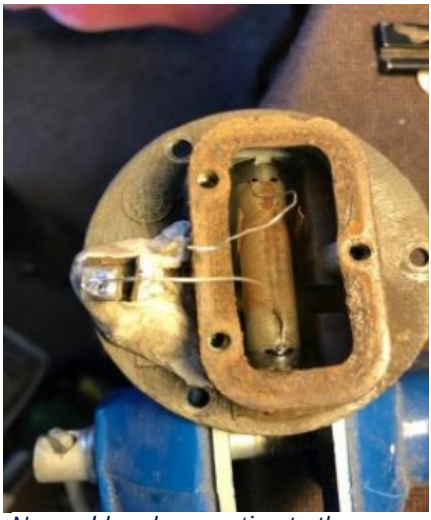
The sender unit with connection to the gauge.

As it turned out, modifying it wasn't easy, but also not too difficult.

I unscrewed the cap on the sender unit (4 screws, see photo above) to see if the resistor element could be reversed to get it to deliver high resistance when the tank is empty, and ~ zero Ohms when it is full. On examination, I found that the external terminal at the bottom is connected internally to the top of the wound resistance wire element (see thin straight wire running vertically from the solder blob in the photo opposite). The variable resistance is the dark coloured vertical element behind this wire. The pair of slider fingers can just be discerned one either side, positioned at the bottom in this photo (float is as high as it can go, i.e. max. resistance). The fingers were quite worn, but I could find no way of adjusting or replacing them, so expect to have to put up with a bit of jitter on the gauge. The top end of the resistance element is left open circuit. There appeared to be no means of removing the element to reverse it, so after some deliberation I decided to unsolder this wire from the terminal blob, leave it open, and solder a new lead to the bottom few turns of the element. See photo opposite, where the terminal has been removed from the bottom of the housing

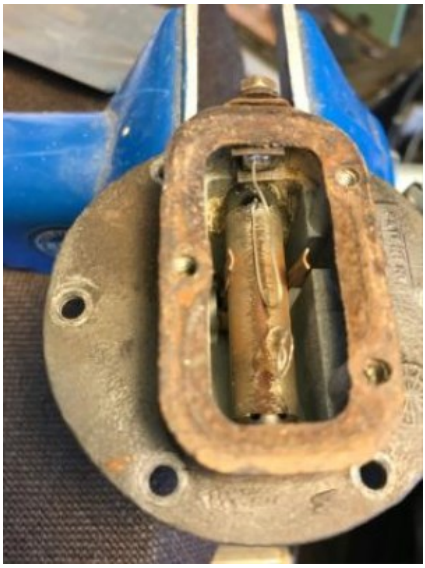


Sender unit with cap removed



New soldered connection to the resistance element at the bottom

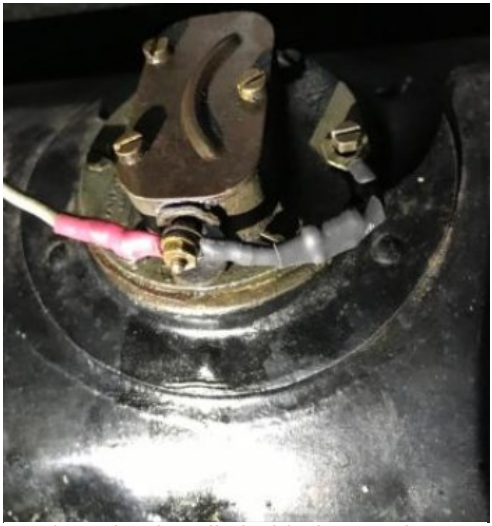
and stuck out to the side with a chunk of Bluetack for convenience. This photo shows the new soldered connection between the terminal and the resistance element. The unsoldered original wire can be seen loose at the top. I left the old wire end "scrunched" up on top of the element when reassembled, in case I need to reconnect at some time in the future. See photo opposite, which is now presented "upside down" (in case you are confused), to more clearly show the new wire connection and screw terminal in position (now at the top).
The modified system was reinstalled and tested. It appears to work well.



New wire terminated and old connection left loose

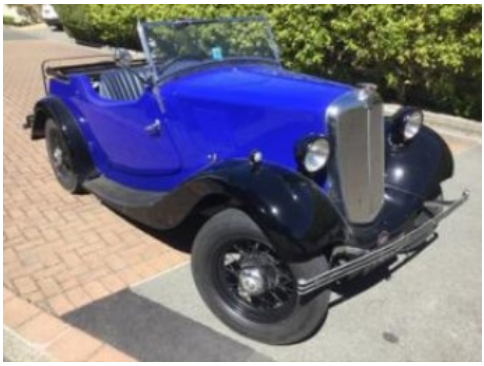
Fine Tuning

To improve accuracy at low fuel levels, I speculated that a shunt resistor of about 100 Ohms could be connected between the sender unit terminal and ground. This would reduce the effective sender resistance as the tank approaches empty, and shift the gauge pointer up a bit from the hard off position to align with EMPTY on the scale. This value would reduce the combined resistance from around 32 Ohms for the sender alone to about 25 Ohms).



Sender unit reinstalled with shunt resistors

It does not noticeably affect the higher scale readings. After testing with a variable resistance box I eventually settled for 40 Ohms (rather than 100), made up of 3 x 120 Ohms 1/2W resistors in parallel. This lower value set the gauge pointer at a little above EMPTY with about 3 litres in the tank, still providing a small reserve when registering EMPTY. A terminal was soldered to each end of the 3-resistor assembly, which was then enclosed in heat shrink tubing and connected between the sender terminal and a mounting screw, i.e. to chassis. The photo shows the sender unit with the sheathed external shunt resistors connected between the terminal at the bottom and a mounting screw to the right.



Does it now read correctly? Yes. I have not had the car on the road for any distance yet to be able fill the tank to the top, but I am confident it will be accurate enough for classic car outings.

So if you do happen to be faced with this situation, making a modification to a tank sender unit is well within the capabilities of a car nut who can handle a soldering iron.

That's it for this this instalment -more next time.