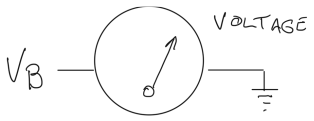
# Gauges

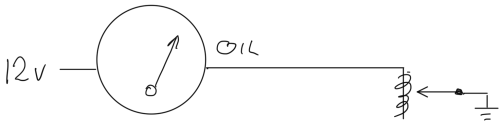
## And a Winter Project...

Having read the recent articles on gauges, I thought it might be interesting to submit something about the classic Jaguar gauges. They have an 'interesting' design, some mysteries, and one or two simple upgrades that can improve them significantly. The following is based on a series 2 E-Type but is relevant to most classic Jags.

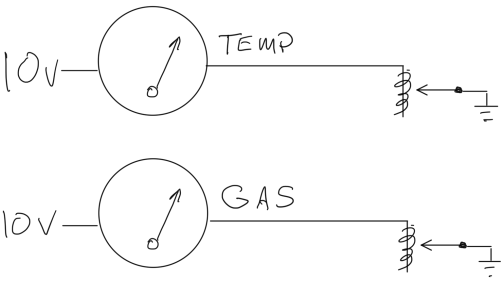
This is an adaptation from the wiring diagram. All of the gauges are simple voltage meters.




The voltage meter is wired between the positive voltage from the battery directly to ground.




The other meters expect to have a specific, fixed, voltage input (either 12V or 10V). They are then wired to a variable resistance, and finally to ground. Each gauge pointer moves between its low point (0 voltage flowing) to its high point (10 or 12 volts flowing). The markings on the gauge face are arranged to represent the desired measure (for example from empty to full).

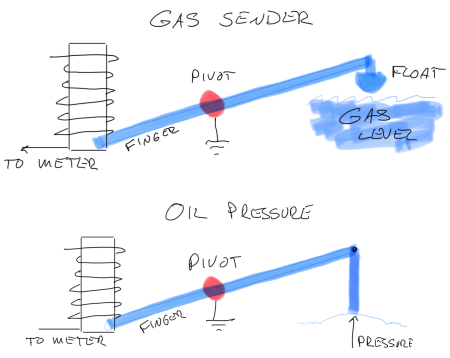



The variable resistance is provided in what is usually called the sender unit. Each sender is similar to an old fashioned volume control. A metal finger moves across a coil of wire. The more of the coil that is in the circuit, the higher the resistance. At one end, there is no wire and the meter is connected directly to ground. At the other end, there is high resistance and the circuit has nearly no connection.

The senders look something like this:

Each has some mechanical mechanism to move the finger from one end to the other of the resistance wire.

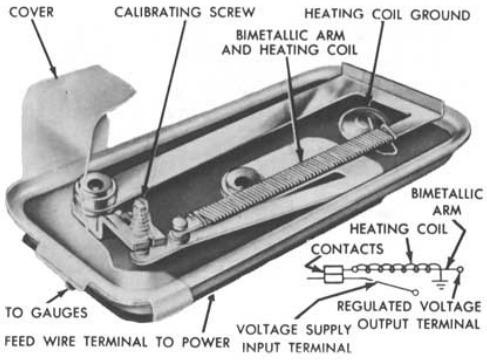
For the gas sender, a float rises or falls on the surface of the fuel. For the oil pressure, pressure presses up a membrane to move the lever. In the case of temperature, a bimetallic strip bends as it is heated.



Obviously these devices are open to wear and failure, but there is a more fundamental problem: Where do the 10 and 12 volt inputs come from?

By looking at your battery gauge, you can see that the battery voltage is close to 12V but varies both up and down as the battery voltage changes while charging or as load discharges it.

The other gauges get their input either directly at battery level (the oil gauge) or from a voltage regulator, shown here in an image from Wikipedia.




It is a mystery to me why Jaguar chose to use the battery level to drive the oil gauge. One result of this is that the displayed oil pressure will change (along with the battery gauge) as the voltage varies from 12V.

More interesting is how the voltage 'regulator' manages to provide 10V: It doesn't. The voltage 'regulator' provides either battery voltage or 0 voltage in a proportion that hopes to average to 10V. It works by heating a bimetallic strip which then bends to open the contact to the output to the remaining gauges. If the input actually IS 12V, the contact would be closed 5/6ths of the time and the output would be a square wave averaging 10V. As the input goes up, the strip heats faster and the contact is closed less time. As the input goes down, the contact is closed more of the time. If it goes down to 10V, the contact stays closed.

When working, and at the same ambient temperature that was present when the calibrating screw is set, the output is:

- either 0V alternating with battery voltage to average to 10V,
- or a steady voltage of 10 or less.

In winter you magically get more gas and better oil pressure (just kidding - but it looks that way until the regulator heats up). When it fails either the gauges fall to 0 or you always have ¼ tank of gas (just kidding again).

The good news is also your easy and cheap winter project: Update the regulator to something a bit more modern.

## Your New Regulator

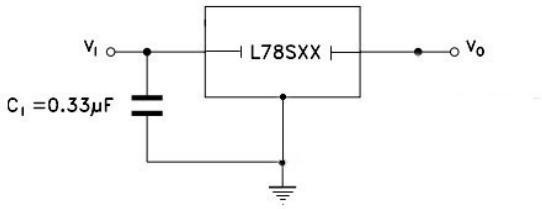
Seriously: this job is easy and you can put the parts inside the original housing. You can buy the parts through many sources one of which is mouser.ca.

Any of these 10V regulators will work: https://www.mouser.ca/Semiconductors/Power-Management-ICs/Voltage-Regulators-Voltage-Controllers/Linear-Voltage-Regulators/_/N-5cg9g?keyword=7810

Here is the data sheet for the Texas Instrument chip: https://www.ti.com/lit/ds/symlink/ua78.pdf

You need one more part, a capacitor, which can also be found at mouser (or many other places).

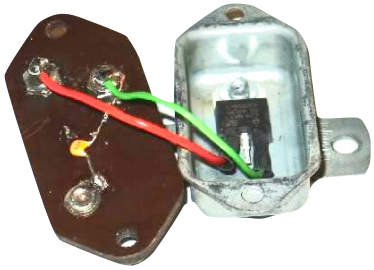
Here is a simplified circuit diagram from the data sheet, but omitting the output capacitor. You can add the second capacitor if you wish, but given the fact that the original device simply switched from 10 to 12V it really isn't necessary to worry about spikes in the output.




To complete the project:

- Take the existing regulator out of the car, open it, and remove all the components.
- Connect the V1 input to the original input and add the capacitor between V1 and ground.
- Connect V0 to the 10V output.

When you are done it will look like the picture to the right.



Here is another discussion of the process (with more pictures) from the Jag Lover's Forum: https://forums.jag-lovers.com/t/s1-4-2-temperature-question/377934/16

That solves the 10V gauges, but what about my oil gauge??

As an undergraduate I noticed that lecturers left some tasks "to the student as an exercise"; here is an exercise for you.

Make another regulator for 12V. The process is almost the same as above except using this chip https://www.mouser.ca/ProductDetail/STMicroelectronics/LM217T-DG?qs=UOUhb9503hGQo4HwxJhENg%3D%3D

The data sheet is here: https://www.mouser.ca/datasheet/2/389/lm217-1849593.pdf. Figure 7 (on page 10) shows the full circuit for a variable regulator. By making a variable voltage regulator instead of a fixed one you can adjust the voltage sent to the gauge . This will have the effect of shifting the gauge's reading either up of down. This allows you to calibrate the gauge to match a

temperature measured with a thermometer. That said, there are simpler versions further down in the sheet.