Design of Test Bench for Automotive Gauges

Sayali Chati[1], Archana Waghela[2], Shraddha Arekar[3]
[1, 2, 3] Department of Instrumentation
[1, 2, 3] Savitribai Phule Pune University, Pune, Maharshtra, India-411001

Abstract- *A test bench for automotive gauges is designed to check for the accuracy, detection of any fault in the gauges. Gauges are widely used in the automobiles. We have chosen four specific gauges; temperature gauge, pressure gauge, fuel gauge and speedometer. We will study each gauge and as per their working principle, we will design simulation circuits. The simulation circuits will be the inputs for our test bench and the gauges to be tested will be connected at the output side of our test bench.*

Keywords-test bench, automotive gauges

I. INTRODUCTION

Automotive gauges display vital functions of a vehicle. If there are no gauges in the vehicle, the vehicle will still function but the user will not get current information about the various parameters like fuel, level, temperature, oil pressure, speed, etc. If the gauges are not employed in the vehicle, the user will never know at how much speed the vehicle is running, the level of the fuel inside a tank, warming of the engine, etc. It is required to represent correct information by the gauges in the vehicle. Thus, we have designed a test bench that will check the accuracy of the gauges and where the fault has occurred like, in the sending unit, or the wiring inside or the gauge itself. The various application areas for a test bench will also include checking of the gauges of Gensets (engine generator), Agricultural pumps, locomotive engines.

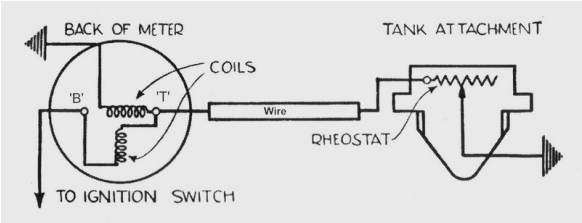
II. DESCRIPTION OF EXISTING SYSTEM

A. Working Principle of a Gauge

The working principle of a gauge is similar to that of a moving coil galvanometer. When a current carrying coil is placed in a magnetic field of a permanent magnet, it experiences a force and moves. This motion is translated into the movement of the pointer on the dial. In case of automotive gauges instead of the coil, a magnetic wafer is placed. The movement of the wafer is calibrated to represent change in pressure, temperature, level and speed.[2] (2)

B. Construction of a gauge

An automotive gauge consists of two coils placed at 90° with respect to each other. There are three terminals provided on the gauge: Battery (B), Ground(G) and Tank(T).The two coils are mounted in such a way that one coil is placed between B to G terminals and the other between T to G terminals. The B to G connection goes to the battery, while that between T to G goes to the sender unit. The B to G coil carries fixed amount of current, since it is connected to the battery, but the flow of current for the coil between T to G varies, since it is connected to the sender unit. As the resistance of the sender unit varies, the current flow in the coil varies. (4)



C. Temperature gauge

A temperature gauge displays the temperature of coolant inside the engine in °C. For example, a temperature gauge is representing the temperature from 40°C to 120°C. So, with the temperature gauge on the dash the driver can see any increase or decrease in the temperature of coolant.

Fuel gauge

A fuel gauge displays the level of fuel inside a tank. If the tank level of a car is full, the pointer on the dial displays “F” (Full). If the tank level is empty, the pointer displays “E” (End).

D. Pressure gauge

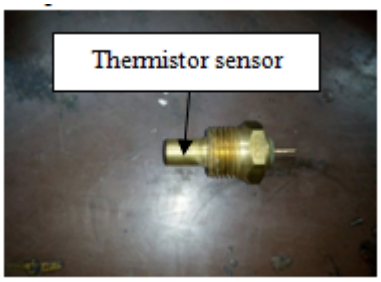
A pressure gauge displays the oil pressure inside the engine in ‘bar’. For example, an oil pressure gauge is displaying the pressure from 0 bar to 10 bar.

E. Speedometer

A speedometer displays the speed of a vehicle in km/hr. It not only indicates the current speed but also alerts the driver if the speed limit is crossed.

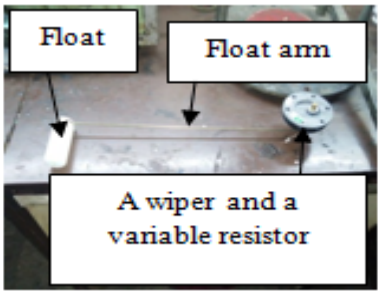
F. Senders

Temperature sender



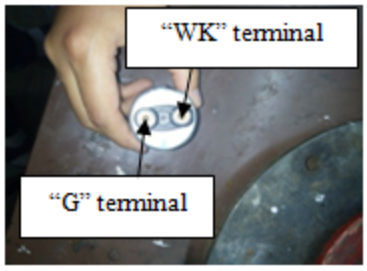
The above picture shows a temperature sending unit. A thermistor is placed inside this sender unit. The thermistor measures the instantaneous change in the temperature of the coolant by changing its resistance. As shown in the picture, the part of the sending unit where the thermistor lies is in contact with the coolant inside the engine. Thermistor has high resolution and greater precision compared to RTD and Thermocouple. Therefore it is implemented in the temperature sending unit.[1]

Fuel sender



A fuel sending unit contains a float, a float arm, a wiper and a variable resistor. The whole assembly is placed inside the tank. The float rises or falls as per the level of the fuel in the tank. This motion of the float is translated to move the pointer on the dial. This is achieved through sliding of the wiper over the variable resistor.(1)

Pressure sender



The above picture is rear view of the pressure gauge sending unit. It consists of two terminals marked as "G" terminal and "WK" terminal. The "G" terminal is connected to the gauge, whereas the "WK" terminal is connected to the warning light on the dash. In case if there is less oil pressure inside the engine, the lamp lits.

The above picture shows a small port present on the front side of the pressure gauge sending unit. This portion of the sending unit is in contact with the oil inside the engine. Through this port, oil pressure enters in the sending unit.(3)

Speed sender unit

An electronic speedometer displays the information sent by a vehicle speed sensor (VSS). The VSS is mounted on drive shaft. It consists of a toothed metal disc and a magnetic coil which is stationary. As the disc rotates passing over the coil, the teeth cut the magnetic field, thus producing a frequency of pulses. These frequencies are fed to the speedometer, due to which the pointer moves on the dial. More the frequency, more will be number of pulses produced, more will be the deflection of pointer on the dial.

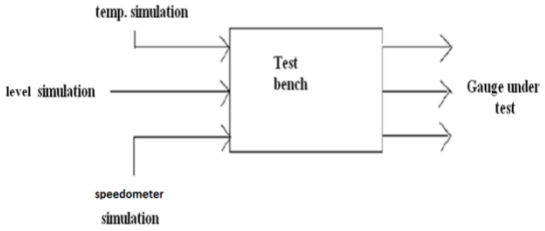
III. DESIGN OF A TEST BENCH

Till now, we have studied four different gauges. Those are used by all automobile vehicles. We also overviewed four different types of senders respective to the four gauges. From the information, we come to know that, the working principle of temperature, pressure and level gauges is based on resistance and the working of speedometer gauge is based on frequency pulses.

Therefore, for temperature, pressure and fuel gauges we have used a potentiometer varying between 0 Ω to 500 Ω (based on the observations obtained while checking the respective senders) and for speedometer we have built a 555 timer circuit in a-stable mode, which delivers square wave pulses of 100 Hz frequency. [1] Another feature provided by our test bench is that it can check the gauge and the respective sender unit at a time. So, while checking the gauge along with the sender unit, any simulation input is not required. For

example, while checking a fuel gauge, both the sender and the gauge are connected to the test bench. While testing, by moving the float manually, we can see the movement of the pointer on the dial.

A. Block diagram



Our test bench design can be categorized into two stages:

1. Input stage:

It contains the input variable simulation circuits such as; frequency simulation, pressure simulation, temperature and level simulations, etc.

Here, we are providing temperature, level and pressure simulations by using potentiometer and frequency simulation by using a 555 timer circuit in a-stable mode.

2. Output stage:

At the output, gauges to be tested are connected like; temperature gauge, fuel gauge, pressure and speedometer gauge, etc.

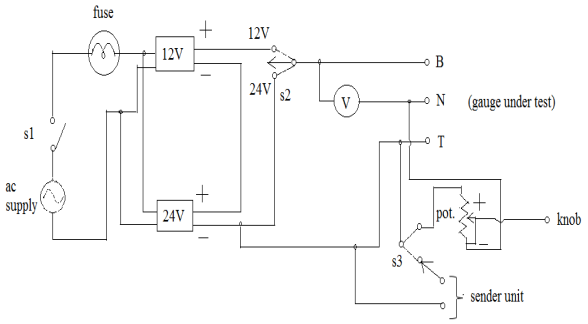
B. Checking of gauges

1. Connect the gauge to be tested at the output side.
2. Switch on the supply.
3. According to the voltage rating of the gauge, select 12V or 24V (provided on the rear side of the gauge).
4. Select the simulation input with help of a manual switch provided on the panel.
5. If the gauge to be tested is any of the temperature, fuel or pressure gauge; then use the potentiometer knob to move the pointer on dial.
6. If the gauge to be tested is a speedometer, then it is interfaced with the timer circuit to move the pointer on dial.
7. Accuracy of the gauge is decided by comparing the results obtained with the standard calibration chart (provided by the manufacturers of the gauge).
8. If the results obtained match with those provided in the standard calibration charts, then the gauge is accurate.
9. If not, then it requires maintenance.
10. Similar testing procedure is applied while checking the senders along with the respective gauges.
11. By using a manual switch, we can disconnect the internal simulation circuitry while checking the sender units.

C. Standard calibration chart

Level		Pressure		Temperature	
Cm	Ω	Bar	Ω	°C	Ω
1.5	192	0	10 ± 2	60	207
3	165	2	52 ± 4	70	170
4.5	143	4	97 ± 3	80	145
6	124	6	124 ± 5	90	106
7.5	105	8	160	98	75 ± 6
9	80	10	191	120	38.4 ± 3
10.5	56				
12	38				
13.5	20				
15	12				

D. Circuit diagram



The circuit diagram of our test bench is as shown above. The s/w s1 is a mains switch. The two power supplies 12 V and 24 V deliver respective voltages. The switch s2 selects either of the two supply, according to voltage rating of the gauge connected at output side. The voltmeter displays either 12 V or 24V. The terminals B, N and T are provided as the output terminals, to which the gauge under test is connected. The knob is provided on the panel which varies the resistance of the potentiometer. The s/w s3 connects to the potentiometer only when the gauge testing is done and when the gauge and the sender both are connected then it switches the position and gets connected to the sender unit terminals as shown in the diagram.

ADVANTAGES

1. We can make it more versatile for checking other parameters in the vehicle like;
   - Left and right indicators
   - Battery charging
   - Seat belt on / off
   - Center locking
   - Air bag
2. It is not based on any software, so even a mechanic can operate without doubt.
3. Our test bench has flexibility to test the gauges of any device.
4. This device is cost effective as it is cheap, without any software clumsiness; so no one has to fear about its failure rate and eventually arising maintenance cost.
5. By implementing these tests, one can save the unnecessary expenses on costly maintenance, which are usually advised to the customers at any service stations.

IV. CONCLUSION

With a test bench, we can check the gauges of a vehicle. The accuracy of gauge is based on the standards defined by the manufacturers. If, the gauge or sender unit is not accurate, it requires further maintenance.

ACKNOWLEDGMENT

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