SYMBOL OF SW EXCELLENCE

SERVICE INSTRUCTIONS

ELECTRIC GAUGES

STEWART SER 4601 WARNER

GENERAL

Electric gauge installations primarily consist of a gauge and sender in combination. The gauge is mounted in or on the vehicle panel while the sender is installed in the engine block, transmission, differential, or fuel tank, as required. Gauge and sender are connected by a single wire (No. 18 AWG, stranded). All gauges are grounded through their mounting unless panel is of nonconductive material, (wood, plastic, fiberglass, etc.) in which case the gauge must be wired to a ground common to battery ground. All senders are grounded by installation.

IMPORTANT: *Excessive use of sealant or pipe thread compound should be avoided due to the possibility of losing sender ground.*

NOTE: *Fuel tanks are generally grounded to the vehicle frame, which provides the ground for the fuel gauge sender, however, when this is not the case, a separate wire must be connected from the fuel gauge sender flange to a ground common to battery ground.*

Electric gauges and senders are not repairable in the field. In case of failure, they must be replaced. Gauge failures are often caused by defective wiring or loose ground connections. Therefore, the first step in locating the cause should be a complete inspection of all wiring and connections. If wiring is secured to chassis by clamps, the insulation should be checked for breaks causing unintentional grounding of the wire.

Model T-321092 Electric Tachometer and Gauge Checker may be used to test whether or not the gauge is operable. This tester will not check calibration of the gauge.

Model 650-J-918239 Electric Tachometer and Gauge Tester will test both operation and calibration of tachometers and gauges.

DESCRIPTION

Stewart-Warner manufactures three types of electric gauge mechanisms. They are Thermal, Magnetic, and Bi-Torque which are all operated in conjunction with senders. A sender is basically a variable resistor wired in series between the gauge and the vehicles ground.

NOTE: *Voltmeters and Ammeters do not require a sender.*

The Thermal type mechanism consists basically of a wire wound heat actuated Bi-metallic strip, mechanical linkage and pointer assembly. The Bi-metallic strip is composed of two dissimilar metals bound together which will expand at different rates as more current is applied causing the strip to bend and in turn move the pointer up scale.

The Magnetic mechanism consists of a butterfly shaped magnetic material on a pivot shaft with a pointer which is located between the holding and actuating coils. As more current is supplied to the actuating coil due to the sender resistance decreasing, the pointer will move up scale.

The Bi-Torque mechanism is a magnetic type gauge and operates similarly to that of the standard magnetic mechanism. The difference between the two is that the Bi-Torque has a round permanent magnet on the pivot shaft which is inserted between two coils that are wound at right angles to each other on the same plastic frame. Bi-Torque gauges can be distinguished from other Stewart-Warner gauges by four posts on the rear of the case, slightly more weight, and a longer case. They will give an instantaneous indication when energized and when de-energized the pointer may come to rest at any position, (it does not return to zero).

NOTE: *Ammeters and Voltmeters must return to zero when de-energized. Two types of Ammeters are available from Stewart-Warner, a standard Ammeter and a Remote Shunt Ammeter. The Remote Shunt Ammeter is most commonly used where the ammeter must be mounted at a greater distance away from the engine. This simplifies installation by allowing the use of smaller rather than larger gauge wire to the ammeter.*

An ammeter will indicate the current flow between the generator or alternator, load (lights, radio, etc.) and the battery. Under normal conditions, the ammeter should read in the "charge" range. A prolonged reading in the "discharge" range will soon cause the battery to run down or become dead. For an accurate indication of current flow, ammeter must be connected between all the electrical apparatus (except the starting motor) and battery.

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STEWART-WARNER CORPORATION
1826 W. Diversey Parkway
Chicago, Illinois 60614

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DESCRIPTION (Cont'd)

Voltmeters can be used on engines having an electrical system with a generator, alternator or battery only. Voltage rating of Voltmeter must be same as voltage rating of battery in electrical system.

The primary purpose of a Voltmeter is to show the condition of the battery. It also shows the level of regulated voltage being produced by the generator or alternator while engine is running.

Actual battery voltage is read before or after operating engine. A constant reading in red segments on face dial indicates a need for a check of either battery or generating system.

The vehicles voltage regulator is compensated to permit the generating system (generator or alternator) to produce more charging voltage during cold weather. Therefore, the Voltmeter will show higher readings during cold weather than it will in warm weather.

The bi-metallic heat actuated voltmeters require a few minutes for "warm-up" time.

The Bi-Torque Magnetic Voltmeters give an instantaneous indication only when energized.

WIRING

ELECTRIC PRESSURE & TEMPERATURE GAUGES

It is recommended that No. 18 AWG wire and eyelet type terminals with insulated shanks, be used to wire terminal studs on back of gauge to avoid the possibility of shorting the mechanism of electric gauges. There are three types of gauge wiring procedures:

1. If gauge has THREE TERMINALS; (A) for wire to ignition, (B) for wire to sending unit, (C) for wire to ground (and for lighting kit 366-CH bracket, if lighting is desired). FIGURE 1

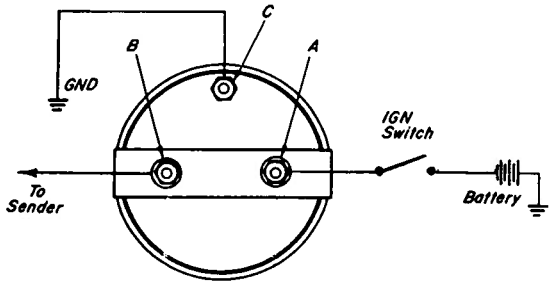


FIGURE 1

2. If gauge has FOUR TERMINALS; (A) for wire to ignition, (B) for wire to sending unit, (C) and (D) either stud may be used for wire to ground (and for lighting kit 366-CH bracket, if lighting is desired). FIGURE 2

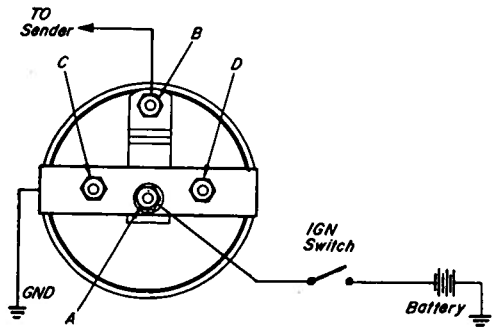


FIGURE 2

3. If gauge has FOUR TERMINALS; (A) for wire to ignition, (B) for wire to sending unit, (C) and (D) for mounting bracket and ground wire. FIGURE 3

NOTE: *Some magnetic gauges do not provide a terminal for connecting a ground wire. These gauges are grounded through the mounting bracket, grounding spring. If application is for other than metallic panel (with ground common to that of battery), secure a wire between the mounting bracket, grounding spring and case to a common ground.*

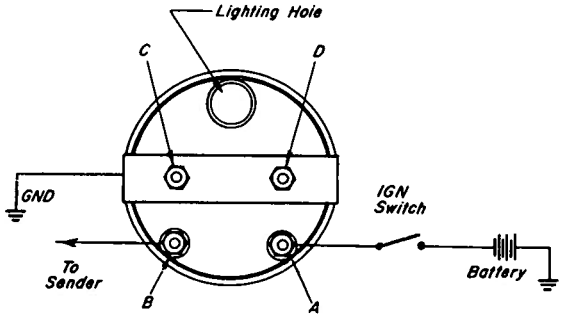


FIGURE 3

If more than one gauge is being used, their ground posts may be connected to each other and grounded as one by connecting one of their posts to chassis.

IMPORTANT: *Some gauges can be used for either 24 or 32 volt systems by wiring a resistor in series between the ignition lead and the "IGN" terminal of the gauge. See chart and wiring diagram for correct application. FIGURE 4*

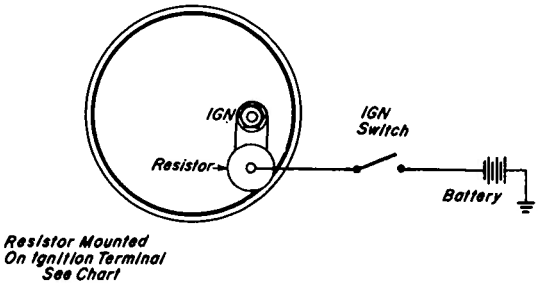
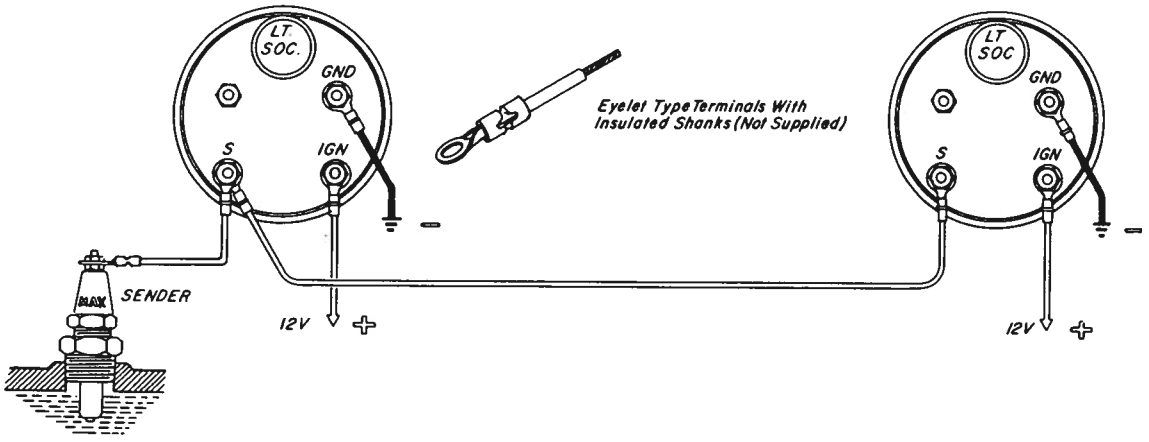


FIGURE 4

RESISTOR CHART

Magnetic	Bi-Torque
12V to 24V Use SW No. 829525-6 to 32V Use SW No. 829525-3	12V to 24V Use SW No. 829525-2 to 32V Use SW No. 821988

Dual Temperature and/or Pressure Gauge installation may be accomplised with the use of a Stewart-Warner sender designed for this purpose.



AMMETERS AND VOLTMETERS

IMPORTANT: *Use No. 10 AWG, stranded (minimum) to prevent overloading of wiring for ammeter and No. 18 AWG, stranded for voltmeters.*

Because there are many different circuit arrangements, it is impractical to provide one simple method for wiring ammeters or voltmeters. See installation instructions sheet for particular gauge in question. All wiring should incorporate the use of insulated, eyelet type terminals.

IMPORTANT: *Make certain full voltage of vehicles 12 volt system is supplied. Do not connect where a resistor has reduced voltage. When it is not possible to connect marine voltmeter to a source controlled by the ignition switch, a separate on-off switch is necessary. This will allow voltmeter to be de-energized, which will prevent battery drain during extended periods when engine is not operated.*

Do not use automotive gauges for marine applications.

TESTING PROCEDURE

IN-VEHICLE TEST for pressure, temperature and fuel gauges and their sending units.

1. First step in testing Electric Bi-Torque Gauges is a complete inspection of all wiring to gauge and sending unit. Make sure that all terminal connections are tight and wires are free from breaks in wire or insulation.

2. Use a test light to check for power to gauge. If no power to gauge, check for a blown fuse, bad connection, defective switch, etc.

   NOTE: *Vehicle's ignition must be in "ON" position or power switched, on during this test.*

3. If gauge has power to it, disconnect the wire to sending unit, at sending unit. Ground the wire to frame or chassis of vehicle, this should give the gauge a full scale indication. If not, replace the gauge, it is defective.

4. If full scale indication is present, check the sending unit for excessive sealant or rust on threads or screws. If rust or sealant is present, remove it and try sending unit again.

5. If no indication, replace the sending unit, it is defective.

OUT-OF-VEHICLE TEST for pressure gauge and sending unit.

1. Remove gauge and sending unit from vehicle. A pressure regulator with gauge and 12 volt negative ground power source are required for this test.

2. Connect the pressure sending unit to a regulated air supply and connect gauge and sending unit as per wiring instructions, to a 12 volt negative ground power source.

   NOTE: *If gauge and sending unit application is for 24 or 32 volt system, remove the resistor before testing units. If at this time the gauge and sending unit operate satisfactorily with resistor removed, replace the resistor with a new one. Use only a 12 volt negative ground system with resistor removed. Both gauge and sending unit must have a common ground to provide accurate indications.*

3. Slowly apply air pressure to sending unit. The gauge being tested should show the same indication as the gauge on the pressure regulator.

   CAUTION: *Do not apply pressure that exceeds the scale of the gauge being tested. Permanent damage to sending unit may result.*

4. If gauge does not indicate accordingly, replace the sending unit with one known to be correct. Repeat steps 2 and 3.

5. If the gauge still does not indicate properly, replace the gauge, it is defective.

6. If the gauge indicates correctly, replace sending unit that was removed from vehicle. The sending unit is defective.

7. Re-install gauge, sending unit and resistor if used.

OUT-OF-VEHICLE TEST for temperature gauge and sending unit.

1. Remove gauge and sending unit from vehicle.

2. Connect gauge and sending unit to a 12 volt negative ground power source, as per wiring instructions.

   NOTE: *If gauge and sending unit application is for 24 or 32 volt system, remove the resistor before testing units. If at this time the gauge and sending unit operate satisfactorily with resistor removed, replace the resistor with a new one. Use only a 12 volt system with resistor removed. Gauge and sending unit must have a common ground to provide accurate indications.*

3. Place the sending unit in a container of agitated water of known temperature. Use a thermometer in the water to help insure accuracy. The temperature of the water must be within the scale of the gauge.

   NOTE: *Variations of ± 5° are common on most thermometers. Before determining if a gauge is malfunctioning adjust readings with a ± 5° tolerance.*

4. Wait a few minutes for the sending unit to come up to temperature of water.

5. If gauge does not indicate the same reading as the temperature of water, replace sending unit with one known to be correct.

6. Repeat steps 3 and 4.

7. If gauge indicates the same reading as temperature of water, use this sending unit to replace the sending unit that was removed from vehicle.

8. If indications on the gauge do not correspond to the indications of the thermometer, replace the gauge.

9. Re-install gauge, sending unit and resistor if used.

OUT-OF-VEHICLE TEST for fuel gauge and sending unit.

1. Remove gauge and sending unit from vehicle.

2. Connect gauge and sending unit to a 12 volt negative ground power source, as per wiring instructions.

   NOTE: *If gauge and sending unit application is for 24 or 32 volt system, remove resistor before testing units. If at this time gauge and sending unit operate satisfactorily with resistor removed, replace the resistor with a new one. Use only 12 volt system with resistor removed. Gauge and sending unit must have common ground to provide accurate indications.*

3. Slowly move float arm up and down. The gauge should indicate correctly in relation to position of float arm (down - empty, up - full).

4. If gauge does not indicate correctly, replace the sending unit with one known to be correct. Repeat steps 2 and 3.

5. If gauge now indicates correctly, the sending unit removed from vehicle is defective and must be replaced.

6. If gauge does not indicate correctly in relation to the movement of float arm, the gauge is defective and must be replaced.

7. Re-install gauge, sending unit and resistor if used.

TESTING PROCEDURE FOR AMMETERS

First, thoroughly inspect all electrical wiring to the ammeter. Check for loose or broken wires, loose connections or incorrect wiring. If there are no defects in wiring, replace the ammeter with one known to be correct. If normal indications result, replace the original ammeter. If abnormal indications result, a complete inspection of the electrical system is necessary.

If ammeter is used with a remote shunt, replace the original shunt with one known to be correct. If normal indication results, the original shunt is defective and must be replaced. If abnormal indications result, this warrants a complete inspection of the electrical system.

See Service Check Chart for other symptoms.

TESTING PROCEDURE FOR VOLTMETER

CAUTION: *Do not exceed the voltage scale of gauge. Permanent damage to gauge may result.*

Using a negative ground, variable direct current voltage supply, connect the voltmeter as per wiring instructions. Slowly increase the voltage. If voltmeter indicates accordingly to the gauge on the variable voltage supply, it is operative. If the voltmeter does not indicate accordingly, it is defective and should be replaced. If the voltmeter is operative, a complete inspection of the vehicle's electrical system is necessary.

SERVICE CHECK CHART

FUEL, PRESSURE, TEMPERATURE, AMMETER AND VOLTMETER		
SYMPTOM	**POSSIBLE CAUSE**	**CORRECTIVE ACTION**
No gauge indication	1. Empty fuel tank. (F)	1. Fill tank.
	2. No power to gauge. (F,P,T,A,V)	2. Loose or broken wire from power source. Replace or tighten.
	3. Broken wire between gauge and sending unit. (F,P,T)	3. Replace wire.
	4. Sending unit not grounded. (T,P,F)	4. Check for rust on mounting screws.
	5. Defective pump. (P)	5. Repair or replace.
	6. Insufficient amount of fluid in Rsvr.(F,P)	6. Add fluid to reservoir.
	7. Clogged fluid gallery. (F,P)	7. Remove foreign material from gallery.
	8. Engine not sufficiently warm. (T)	8. Let engine idle a few minutes.
	9. Defective sending unit. (F,P,T)	9. Replace the sending unit.
	10. Defective gauge. (F,P,T,A,V)	10. Replace gauge.
	11. Dead battery. (A,V)	11. Recharge or replace battery.
	12. Blown fuse. (F,P,T,A,V)	12. Replace fuse.
	13. Loose or broken fan belt. (V,A)	13. Tighten or replace fan belt.

SERVICE CHECK CHART (Cont'd.)

FUEL, PRESSURE, TEMPERATURE, AMMETER AND VOLTMETER		
SYMPTOM	**POSSIBLE CAUSE**	**CORRECTIVE ACTION**
No gauge indication (cont'd)	14. Defective regulator . (A,V)	14. Replace regulator.
	15. Defective alternator (diodes burned out). (A,V)	15. Replace or repair alternator.
	16. Defective resistor or shunt. (F,P,T,A)	16. Replace resistor or shunt.
Excessive pointer fluctuation.	1. Loose wire connections. (F,P,T,A,V)	1. Check and tighten all wiring.
	2. Defective pump. (F,P)	2. Replace or repair.
	3. Restricted fluid gallery. (F,P)	3. Remove restriction.
	4. Clogged filter. (F,P)	4. Replace filter.
	5. Defective regulator. (A,V)	5. Replace regulator.
	6. Loose fan belt. (A,V)	6. Tighten fan belt.
	7. Defective sending unit. (F,P,T)	7. Replace sending unit.
	8. Defective gauge. (F,P,T,A,V)	8. Replace gauge.
Full scale indication at all time	1. Wire to sending unit grounded. (F,P,T)	1. Check and tighten all wiring connections.
	2. Improper connections at posts on rear of gauge. (F,P,T)	2. Refer to Wiring Instructions for proper connections.
	3. Gauges not properly grounded. (F,P,T)	3. Refer to Wiring Instructions for proper connections.
	4. Defective regulator. (A,V)	4. Replace regulator.
	5. Defective sending unit. (F,P,T)	5. Replace sending unit.
	6. Defective gauge. (F,P,T,A,V)	6. Replace gauge.
Indicating inaccuracy	1. Loose connections. (F,P,T,A,V)	1. Tighten all wiring connections.
	2. Improper resistor. (F,P,T)	2. Check part number and replace.
	3. Improper shunt. (A)	3. Check part number and replace.
	4. Improper sending unit. (F,P,T)	4. Replace with proper sending unit.
	5. Defective sending unit. (F,P,T)	5. Replace sending unit.
	6. Defective gauge. (F,P,T,A,V)	6. Replace gauge.

LETTERING CODE:

T = Temperature Gauge **F = Fuel Gauge** **P = Pressure Gauge**

A = Ammeter **V = Voltmeter**

FUEL SENDER - QUICK IN-TANK CHECK FOR

STEWART WARNER INSTRUMENT

240 OHM SYSTEM

1. Remove wire lead from sender terminal
2. Connect ohmmeter across sender terminal and mounting flange
3. Estimate amount of fuel in the tank
4. Ohmmeter should read the following values:

   a) Full tank = about 20 to 50 OHMS

   b) 1/2 tank = 80 to 120 OHMS

   c) Empty tank = 220 to 260 OHMS

5. If the above value (s) is (are) not obtained the sender is defective

MECHANICAL SPEEDOMETERS AND TACHOMETERS

Using a known speed rotating device (e.g. an electric drill that turns in the proper direction to cause the speedometer or tachometer to indicate) attach it to the drive end of the flexible shaft. Turn on the rotating device. The speedometer or tachometer should register. If it does not register, it is likely that the core of the flexible shaft is broken. Replace the core (or entire shaft assembly) and repeat the exercise. If the speedometer or tachometer registers, function has been ascertained.

ACCURACY CHECK - SPEEDOMETERS

Most mechanical speedometers are calibrated to register 60 MPH (100 KPH) when the input speed to the instrument is 1000 R.P.M.

NOTE: No ratio adapters are used in this test.

The known speed rotating device should cause the speedometer to indicate in relation to this ratio. EXAMPLE: If the drive R.P.M. is 1000, the speedometer should indicate 60 MPH; if the drive R.P.M. is 500, the speedometer should indicate 30 MPH; if the drive R.P.M. is 1200, the speedometer should indicate 72 MPH.

The odometer should register one (1) mile at 60 MPH indication in one (1) minute.

ACCURACY CHECK - TACHOMETERS

Most mechanical tachometers are calibrated to register twice the input R.P.M. (2:1 ratio). When a known speed rotating device (e.g. an electric drill that rotates in the direction to cause the tachometer to indicate) is attached to the drive end of the flexible shaft, an input speed of 500 R.P.M. should register 1000 R.P.M. on the face dial. This ratio applies to other input speeds, e.g. 1000 input R.P.M. will register 2000 on the face dial.

NOTE: No ratio adapters are used in this test.

As with speedometers, look for possible flexible shaft core breakage if the instruments does not function correctly. Also determine that if a ratio adapter is used in the system it must be checked for function independently.

GENERAL - SPEEDOMETERS AND TACHOMETERS

A speedometer or tachometer that is seized (cannot be rotated) at its input end is caused by excessive pressure of the flexible shaft core pressing against the magnet shaft. This is revealed by a flaring of the magnet shaft hole and is not the fault of the instrument. To avoid this condition use a shorter core or a flexible shaft which employs a compensating tip at the lower (drive) end. The latter design enables the core to " float" in the casing.

MECHANICAL PRESSURE GAUGES

Mechanical pressure gauges may be checked by applying air pressure with a pressure regulator equipped with a gauge and comparing the reading of the gauge in question to that of the regulator gauge. They should be comparable. If they are comparable look for a broken, leaking or constricted pressure line, or for leaking thread connections. If the readings are not comparable the gauge is defective.

MECHANICAL TEMPERATURE GAUGES

Mechanical temperature gauges may be checked by placing the bulb end of the capillary tube in a container of engine coolant or oil of known temperature. Use a thermometer in the water to help insure accuracy and continuously stir the liquid. Wait at least 10 minutes for the bulb temperature to equalize with that of the thermometer. If the indications on the gauge do not correspond to the indications of the thermometer the gauge is defective.

TEMPERATURE SWITCHES

ENGINE OFF-COLD ENGINE

Temperature switches may be checked with a battery powered test light or multimeter set on resistance setting. Remove the wire from the switch terminal. On a normally open circuit switch the test light should not illuminate or the multimeter indicating an open circuit, high resistance when one lead is touching the switch terminal and the other lead is touching a metal portion of the switch body. If the test light illuminates, the switch is defective.

FUNCTION AND ACCURACY

To check function and accuracy remove the switch and place the bulb end in a container of hot radiator coolant. Use a thermometer to insure accuracy. Allow 10 minutes to stabilize temperatures of the switch to that of the thermometer. (It may be necessary to continuously heat the coolant, depending upon the temperature switch setting which is stamped on the hex of the switch and the coolant must be continuously stirred.) With a 12 volt D.C. test light or multimeter, attach one lead to the switch terminal and the other lead to the metal switch body. The test light should illuminate and the multimeter indicate less than 3 OHMS when the thermometer reaches the switch temperature setting.

If the multimeter or the test light indicates significantly below or above the switch setting temperature, the switch is defective.

PRESSURE SWITCHES

ENGINE OFF

Pressure switches may be checked using a battery powered test light or multimeter. Remove the wire from the switch terminal. The test light should function or multimeter indicates less than 3 OHMS on the resistance setting on a normally closed switch when one lead is touching the switch terminal and the other lead touches the metal portion of the body. If the test light does not illuminate, or the multimeter indicates a high resistance, the switch is defective.

ENGINE ON

With the engine turned on and the multimeter or test light leads hooked up as described above, the test light should not illuminate or the multimeter should indicate a high resistance. Be certain that engine pressure exceeds the pressure setting of the switch. The pressure setting is stamped on the hex of the switch in PSI. If the test light illuminates or the multimeter indicates less than 3 OHMS, the switch is defective.