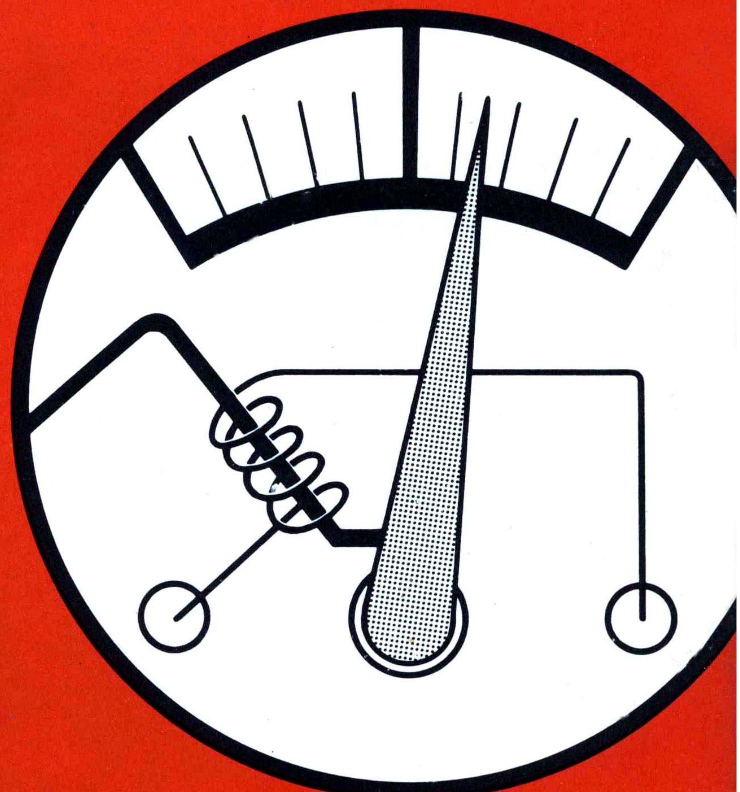
MASTER TECHNICIANS SERVICE CONFERENCE 66-10

REFERENCE BOOK

THERMAL-ELECTRIC GAUGES



CHRYSLER CORPORATION

PLYMOUTH • DODGE
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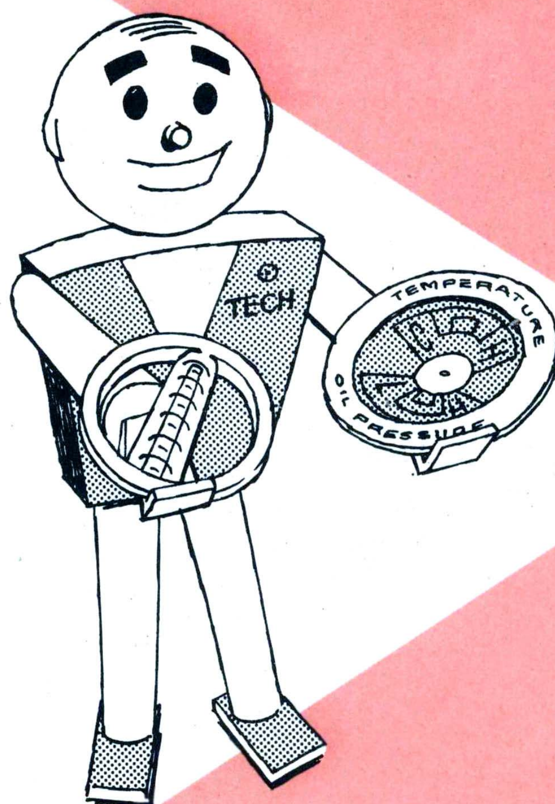
Back in the old days, a shiny, nickel-plated Motometer out on the radiator cap was the last word in temperature gauges. Today, our indicating equipment is more sophisticated and does a much better job than the old-time gadgets could ever do.

It's true that today's gauges and indicator systems are a bit more complicated than the Motometer's simple thermometer tube, but not to the extent that servicing is difficult. A close look shows that they're only simple electrical systems which any good technician can understand when their operation is explained.

The first sections of this book do just that. They explain in detail how our gauge and indicator systems work so you'll find it easy to relate cause and effect when you're diagnosing trouble. In the final section you'll find some practical trouble-shooting and adjustment tips to help you in servicing this equipment.

So, make a special effort to read through this reference book from cover to cover. You'll find that this information will add to your understanding of gauges and indicators so you'll be able to breeze through instrument panel jobs with ease. Be sure to put this book in your service file so it'll be handy for future reference.



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THERMAL-ELECTRIC GAUGE OPERATION

INTRODUCTION

The thermal-electric gauges used in Chrysler Corporation cars are simple dial and pointer indicators, operated by the heating effect of electricity. The same basic mechanism is used in fuel, temperature, and oil pressure gauges—only the dials are different.

Except for dial markings, these gauges also look much like the magnetic-type ammeter used to indicate alternator output. However, compared with the ammeter, thermal gauge pointer movement is relatively slow.

This slow, smooth pointer movement is one of the main advantages of the thermal-electric gauges. For instance, there's no flickering pointer to distract the driver when fuel sloshes around in a partly filled tank. And, probably more important, gauge indication accuracy is not affected by changes in alternator output or varying electrical system loads because gauge input voltage is closely regulated.

GET THE BIG PICTURE

Actually, the gauge only indicates what other parts of the circuit are doing. So, if you want to understand the thermal-electric gauge story from start to finish, you'll have to consider the complete circuit—gauge, sending unit, voltage limiter, and circuit wiring.

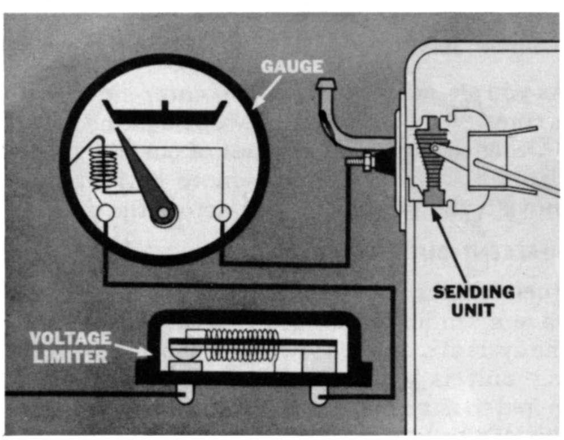


Fig. 1—Typical thermal-electric gauge circuit

GAUGE OPERATION

Because the thermal gauge works by heat instead of magnetism, its mechanism differs from the familiar magnet and moving coil in the voltmeter or ammeter you use for testing. If you looked inside a thermal gauge housing, you'd see that the indicating pointer is linked to the free arm of a "U"-shaped bimetal strip. This arm has a resistance wire winding which is connected to the gauge terminal posts.

The bimetal arm with its heater coil is the heart of the thermal-electric gauge—the "motor" that moves the pointer. Gauge operation is simplicity itself. When current flows through the resistance coil, it heats the bimetal, causes the arm to bend, and the pointer moves across the gauge dial.

HOTTER READS HIGHER

The amount that the bimetal bends is proportional to the heat produced by the current flowing through the resistance coil. In other words, when the current is small, the heating effect and pointer movement are slight. With more current, the added heat deflects the bimetal arm farther and moves the pointer to a higher-reading position.

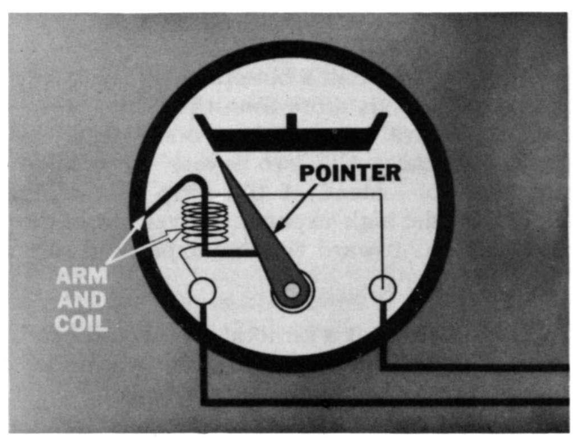


Fig. 2—Bimetal moves gauge pointer

The opposite effect occurs when current is reduced. As the heating effect lessens with lower current, the pointer moves back toward the lower end of the dial. Finally, when gauge input current is shut off by turning the ignition switch off, the bimetal strip moves the pointer off scale below the first dial marking at the left.

WHAT MAKES IT BEND?

The fact that the bimetal strip bends when heated and straightens out as it cools is common knowledge. However, the reason why this happens seems puzzling to some, so a brief explanation may help clear up any confusion.

IT'S TWO-FACED

Although a bimetal strip may look like a solid piece of metal, it's actually two layers of different metals welded together to form a single piece. Simply explained, the strip bends because the two layers expand different amounts.

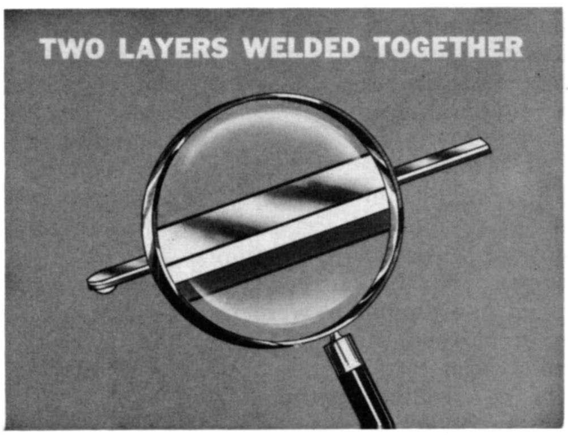


Fig. 3—Bimetal layers form single piece

In other words, when a bimetal strip is heated, one layer expands more than the other. However, this extra expansion on one side is restrained because the two layers are welded together. So, instead of the strip expanding uniformly, the high-expansion layer forces the strip to curve toward the low-expansion side.

COMPENSATION IS NEEDED

It's easy to see that a bimetal arm would bend farther than normal if outside heat was added to that produced by the gauge heating coil. And, if the gauges were cooled by low temperatures, the opposite reaction would cause the arm to bend less than normal. In either case, the gauge pointer would move farther or less than normal, so temperature compensation is needed to keep gauge indications accurate when weather or operating conditions change.

THE SHAPE DOES THE TRICK

Thermal-electric gauge temperature compensation is simple. The bimetal bending action is used to cancel outside temperature errors by making the bimetal strip in a special shape.

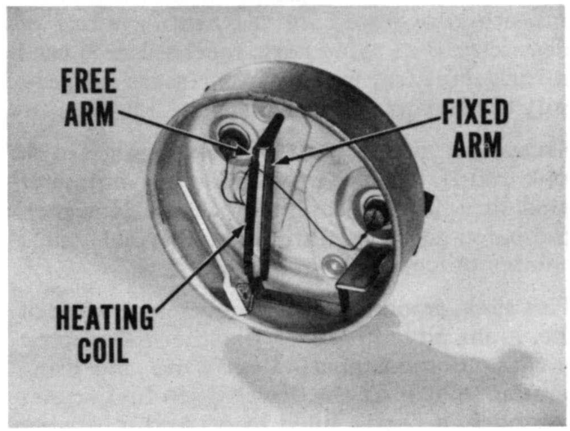


Fig. 4—Element cancels temperature errors

The gauge has a "U"-shaped bimetal element with one arm solidly attached to the gauge body, and the free arm linked to the pointer.

As you already know, when the free arm is heated it bends to move the pointer. So, when outside temperature bends the free arm, it also affects the other arm to the same degree. However, *the fixed arm bends in the opposite direction*, so the effect of outside temperature is cancelled out.

SENDING UNIT OPERATION

As you already know, gauge pointer movement is controlled by current flow through the gauge heating coil. A small amount of current giving slight pointer movement—more current flow moving the pointer farther across the dial.

DIFFERENT BUT SIMILAR

Fuel, temperature and oil pressure gauges each have a sending unit specially designed to suit the system's needs. However, each gauge sending unit is essentially a variable resistance linked to a sensing mechanism which varies the sender's resistance as changes occur in the system being measured.

FLOAT CHANGES RESISTANCE

For example, the fuel tank sending unit's resistance decreases as the float rises. This lower resistance causes the indicating current to increase, and the pointer moves toward the FULL mark. Then, as the tank empties, the falling float increases the resistance in the gauge circuit, lowers the current, and the gauge pointer moves toward EMPTY.

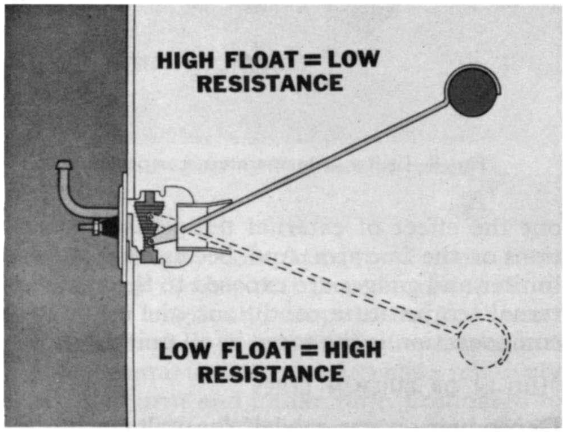


Fig. 5—Resistance change moves gauge pointer

The fuel tank sender and other sending units are explained in detail in a following section.

VOLTAGE LIMITER OPERATION

As mentioned earlier, thermal-electric gauge accuracy is not affected by changes in alternator output or electrical system loads because gauge input voltage is closely regulated.

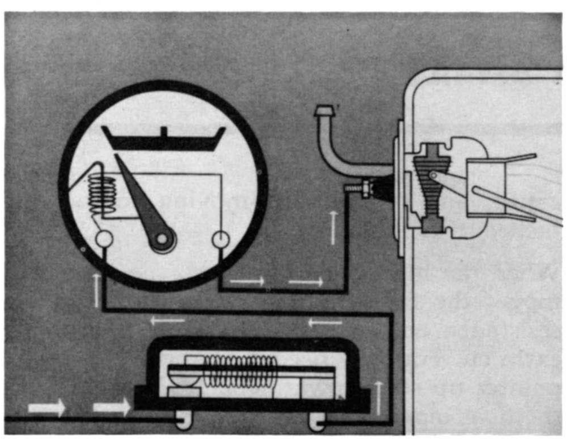


Fig. 6—Limiter reduces voltage effect

The input regulator for the gauges is called the voltage limiter. It's a sort of continuous-duty circuit breaker that automatically opens and closes to stabilize input voltage and protect the gauges against overloads.

FLOW IS INTERMITTENT

The voltage limiter's opening-closing action does not actually decrease the gauge input voltage. Instead, it causes an intermittent or pulsating current which produces the heating *effect* of five volts with steady current.

KEEPS POINTERS STEADY

The intermittent current flow maintains a steady heating effect at the gauges so the pointers will not fluctuate when the limiter opens and closes the circuit. This regulated input results in a steady, accurate gauge indication which is controlled by sending unit resistance changes only.

THAT BIMETAL ARM AGAIN

The control element of the voltage limiter is a bimetal arm with a heating coil, similar to the unit described earlier for the gauge. But here, instead of moving a pointer, the bimetal arm opens and closes a set of contact points to regulate current flow.

When the ignition switch is turned on, input current flows through the contact points and the bimetal arm to supply all the gauge circuits. At the same time, some current also flows through the heating coil to ground.

FIRST IT HEATS . . .

The current flowing through the coil heats the bimetal arm and causes the arm to bend. This bending movement opens the contacts and stops current flow through both the heating coil and the arm.

. . . THEN IT COOLS

When the heating coil cools, the bimetal arm straightens, closes the contacts and begins the cycle once more. This cycling action produces a pulsating current flow, which in effect, reduces the voltage at the gauges.

TIMING REGULATES THE CURRENT

You can see from the voltage limiter operating cycle that the *maximum* heating effect of current flow at the gauges is controlled basically by the length of time the contacts stay closed.

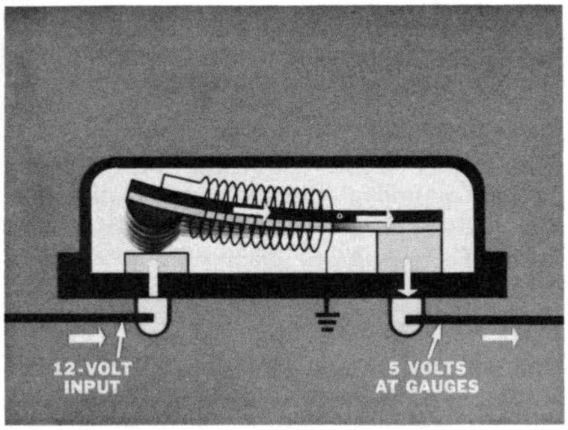


Fig. 7—Cycling produces pulsating current

So, to compensate for the normal load and charging variations of the car's electrical system, the limiter contacts open and close faster when input voltage increases—slower when the voltage decreases.

COMPENSATED FOR ACCURACY

Outside temperatures affect the bimetal element in the voltage limiter the same as they do in the gauges, so the limiter must also be temperature compensated to maintain accurate gauge current regulation.

The same compensating principle described for the gauges is used in the voltage limiter. The familiar "U"-shaped bimetal element in the limiter also has a fixed arm designed to cancel out the effect of external temperature variations on the free arm. And, because the voltage limiter and gauges are exposed to the same external temperature conditions, the amount of compensation is the same in all units.

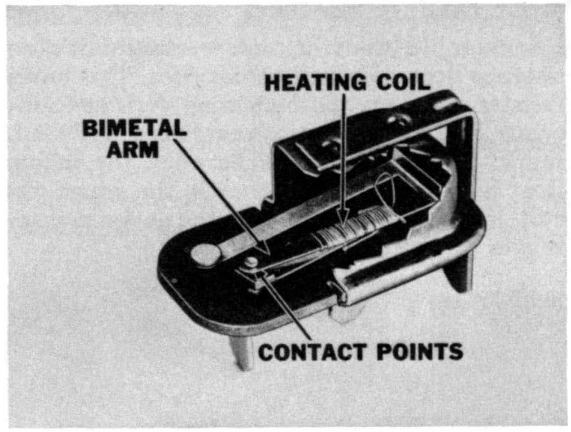


Fig. 8—Limiter is temperature compensated

PLUG-IN OR BUILT-IN TYPES

Depending on car model, the voltage limiter may be externally mounted on the circuit board behind the instrument cluster, or built into one of the gauges. Both types operate the same way and differ only in location.

The external, plug-in-type limiter can be replaced without tools by simply pulling out the limiter assembly and plugging in the replacement by hand. Built-in limiters, however, require removal of the instrument cluster.

SENDING UNIT DETAILS

FUEL TANK SENDING UNITS

As you know, float movement varies the resistance in the fuel tank sending unit to control the current in the gauge circuit.

THEY'RE ALL THE SAME . . .

Regardless of differences in appearance, the variable-resistance part of all our tank senders is basically the same. Each has an insulated resistance strip with one end connected to the gauge, and a grounded moving contact attached to the float arm.

When the float moves upward, the float arm moves the grounded contact toward the low resistance end of the strip. This allows the extra current flow needed to move the gauge pointer up-scale toward the FULL mark. As the float moves downward, the grounded contact now increases circuit resistance and the gauge pointer moves toward EMPTY.

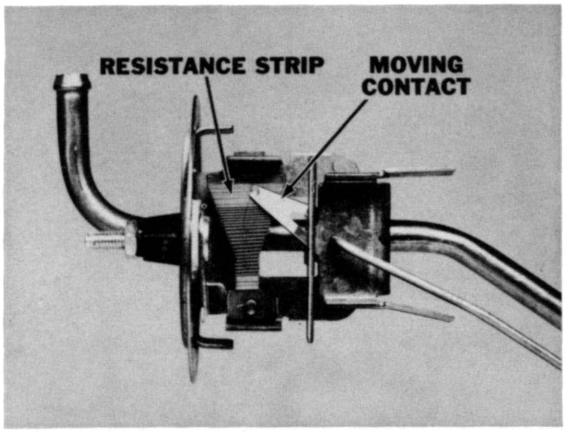


Fig. 9—Float moves resistance contact

. . . BUT SOME ARE DIFFERENT

You'll notice by comparing tank units from different car models that there is quite a variation in the length and shape of the float arms and intake tubes. For example, the sender in a flat, horizontal tank for a sedan has a relatively short float arm and intake tube. Compared to this, the sending unit for the deep, vertical tank used in some station wagon models has a long float arm and tube.

These are obviously extremes; however, some sending units are quite similar but not interchangeable. Always replace with the correct part number unit—don't make substitutions.

STOPS PREVENT FLOAT CONTACT

You'll also notice that each tank unit has stops which limit the up-and-down movement of the float arm. These stops are intended primarily to keep the float from contacting the tank at empty and full positions.

Float contact at these points is undesirable because the float may stick or be damaged. Constant rubbing contact can eventually wear through the thin walls of a metallic float and cause a buoyancy loss that will make fuel gauge readings inaccurate.

Float arm stops are also used to set the minimum and maximum resistance of the unit at the ends of the float travel range. You'll find more on checking these resistance settings in a later section of this book.

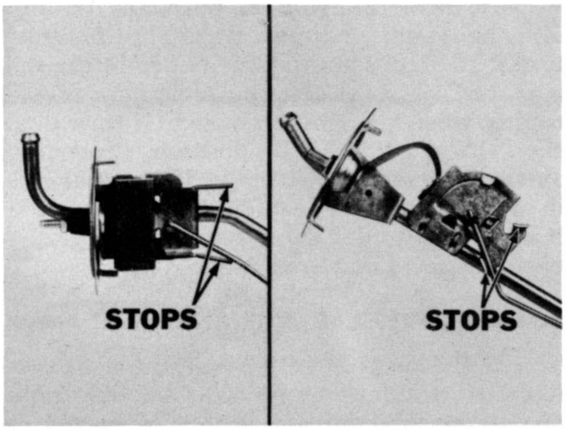


Fig. 10—Float arm stops are adjustable

TEMPERATURE SENDING UNIT

Like the fuel tank sender, the temperature sending unit is a variable-resistance device used to control gauge operation. In this case, the sender is a sealed unit located in the car's cooling system where it can sense changes in coolant temperature.

IT'S SELF-CONTAINED

The temperature sending unit is simply a sealed metal bulb which contains a special temperature-sensitive resistor element called a thermistor. One side of the thermistor connects to the gauge; the other is grounded through the bulb—there are no moving parts.

RESISTANCE IN REVERSE

The thermistor is simply a resistor that reacts to temperature changes. In other words, when engine coolant warms the sender, the sensitive element's resistance *decreases*.

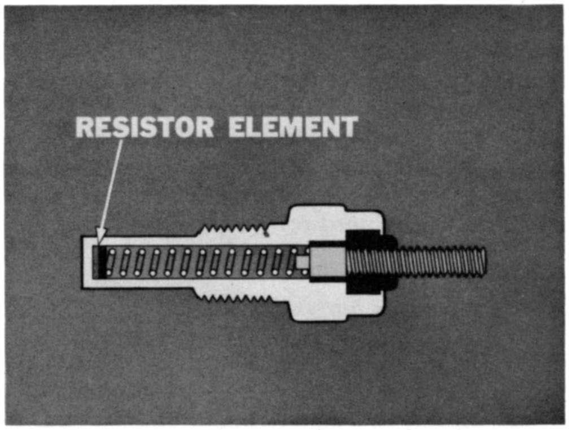


Fig. 11—Heat decreases element resistance

This means that more current flows in the circuit as engine temperature increases, so the gauge pointer moves toward the "hot" side of the dial. As the engine cools, the sender's resistance *increases* and the gauge pointer moves toward the dial's "cold" side.

OIL PRESSURE SENDER

Here again we have a variable-resistance device which changes gauge current to move the pointer across the gauge dial. The oil pressure sender is a sealed, self-contained unit connected to the engine's oil pressure system where it will react to pressure changes.

SIMILAR TO THE TANK UNIT

In general, the resistance part of the oil pressure sender is similar to that used in the fuel tank unit but smaller. Like the tank unit, the oil pressure sender has a built-in resistance strip with one end connected to the gauge and a grounded, moving contact to complete the circuit. However, in this case, the grounded contact is moved by an oil pressure diaphragm instead of a float arm.

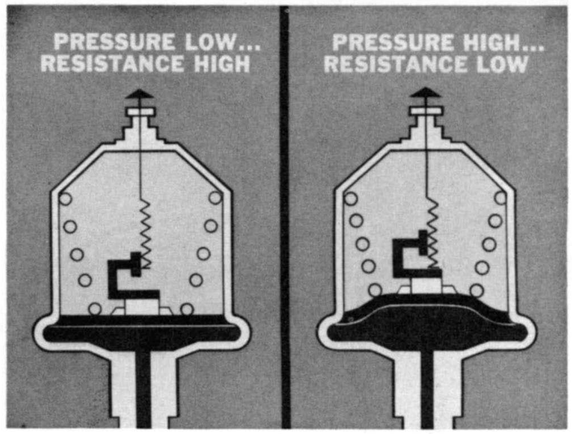


Fig. 12—Pressure diaphragm moves contact

PRESSURE LOWERS RESISTANCE

When engine oil pressure increases, the sender diaphragm moves the grounded contact toward the low resistance end of the resistance strip. Gauge current increases as the resistance goes down, and the gauge pointer moves toward the "H" mark on the dial. As pressure decreases, the sensing mechanism movement reverses and the pointer moves toward the "L" marking.

INDICATOR LIGHT SYSTEMS

Some Chrysler Corporation cars use warning lights as well as gauges to indicate engine and fuel tank conditions. These signal systems are essentially "On-Off" indicators which are much simpler than thermal-electric gauge circuits, both in design and in servicing requirements. An indicator light bulb is used instead of a gauge, and a sensing switch replaces the variable resistance sending unit. Since no gauge is used, there's no need for a voltage limiter.

LIGHTS TELL THE STORY

Here, instead of providing a moving-pointer indication of system conditions, the indicator bulb normally remains unlit as long as its system operates within the proper range. The bulb lights as a warning signal when a critical point is reached.

TESTING IS AUTOMATIC

Because indicator lights can burn out, like any other light bulbs, indicator circuits are designed to test the bulbs automatically before the engine starts. The indicator bulbs light for proof-testing when the ignition switch is turned to the "ON" or "START" position, depending on the car model application. If everything is in working order, the indicator bulb should burn brightly until its system reaches proper operating level, and then go out.

OIL PRESSURE WARNING LIGHT

This is the simplest of the warning light systems. It includes only an indicator light bulb on the panel, a pressure switch connected to the engine oiling system, and circuit wires.

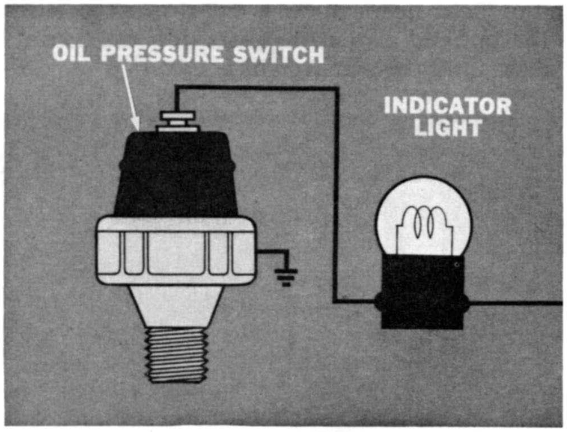


Fig. 13—Typical indicator light circuit

PRESSURE PUTS OUT THE LIGHT

Oil pressure switch contacts are normally closed when oil pressure is low or the engine's not running. So, when you turn the ignition switch on, the warning indicator bulb lights immediately. This arrangement not only warns of low oil pressure but also proof-tests the indicator bulb every time you turn on the ignition. As soon as engine oil pressure reaches safe operating level, the switch contacts open and the warning light goes out.

COOLANT TEMPERATURE INDICATOR

The engine temperature indicator light system used on current Chrysler models has two lights — red and green — to indicate cooling system conditions. Both lights are connected to a temperature-sensitive switch which reacts to changes in cooling system temperature.

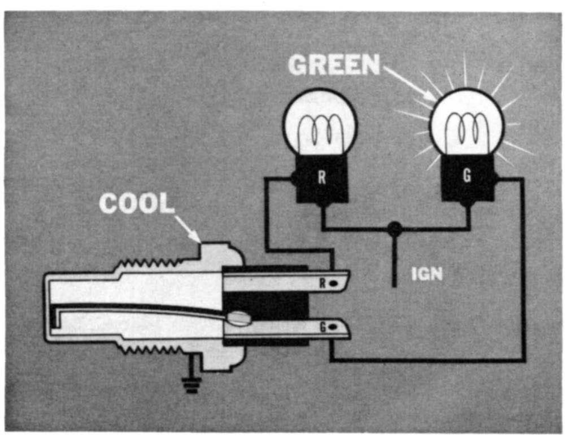


Fig. 14—Bimetal arm closes contacts

GREEN IS COOL

Temperature switch operation is simple. When the switch is cool, a bimetal arm in the switch bulb closes contacts in the green light circuit. This makes the green signal bulb light when the ignition switch is turned on, and keeps it lit until the coolant warms up.

When the coolant warms up, the bimetal arm bends and opens the green light contacts. The contacts remain open and both lights are unlit over the normal temperature range.

RED IS OVERHEATED

If coolant temperature rises higher than normal, the bimetal arm in the switch bends still farther, closes the red light contacts and lights the signal to warn of overheating.

You proof-test the red warning bulb each time the ignition switch is turned to the "START" position. A separate lead from the "ignition start" circuit provides current for this test.

SENTRY SIGNAL

Current Imperial models have a Sentry Signal light on the panel as well as three thermal-electric gauges. This warning light is a general alerting signal that lights to warn the driver of low fuel level, low oil pressure, or cooling system overheating. If the light goes on, a quick glance at the gauges will tell you which system is signalling.

ALL FOR ONE

The Sentry Signal circuit includes a low fuel level relay, oil pressure switch and coolant

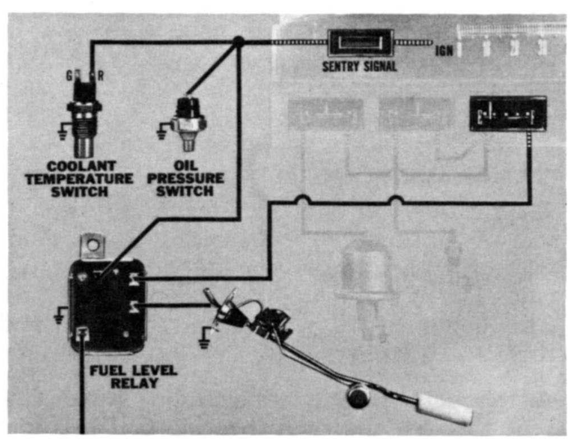


Fig. 15—Switches or relay light Sentry Signal bulb

temperature switch. These units all share a common connection to the Sentry indicator light so each can light the bulb.

The signal switches work the same as those used in the single-unit indicator systems, except that here, the green light terminal of the temperature switch is not used. The Sentry Signal light bulb is proof-tested through the oil pressure switch circuit when the ignition switch is switched on.

RELAY WORKS DIFFERENTLY

The low fuel level relay lights the signal bulb when fuel level nears one-eighth of a tankfull. The relay has warning light contacts like the other signal switches, but here the contacts are opened and closed electrically.

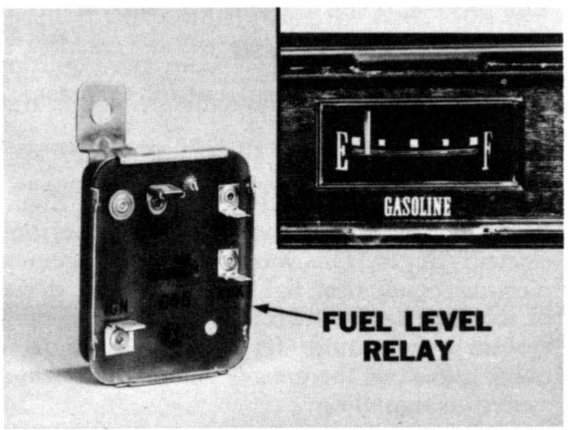


Fig. 16—Relay holds contacts open or closed

ANOTHER THERMAL-ELECTRIC UNIT

In general design, the fuel level relay is similar to the voltage limiter. However, in this case, the bimetal arm holds the contact points either open or closed instead of continually cycling as in the limiter.

PART OF SENDER CIRCUIT

The heating coil that operates the signal contacts is connected in series with the tank sending unit. When the float rises and sending circuit current is high, the bimetal arm bends. This holds the relay light contacts open and there's no warning signal.

As the fuel level drops, the sending circuit current through the relay heating coil becomes lower and the bimetal arm cools. When the tank unit float nears the one-eighth tank position, the bimetal arm straightens out, the contacts close, and the signal light goes on.

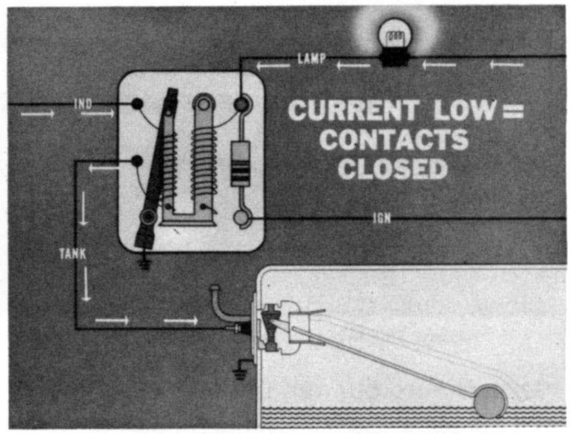


Fig. 17—Low fuel level closes signal contacts

HOLDING CIRCUIT PREVENTS FLICKER

When the contacts close to turn on the signal light, another part of the relay, called the holding circuit, also goes into action to keep the light from flickering.

A holding circuit is needed because normal up-and-down float movement could cause the signal contacts to open and close as fuel sloshed around in the nearly empty tank.

CONTACTS STAY CLOSED

To keep the contacts closed, the holding circuit has a separate heating coil which is wound on the anchored arm of the "U"-shaped bi-

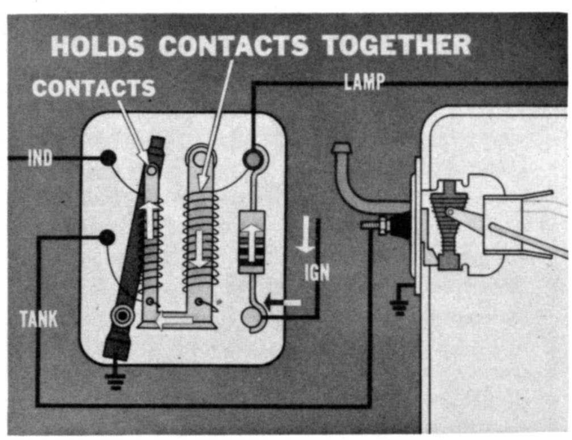


Fig. 18—Holding circuit keeps contacts closed

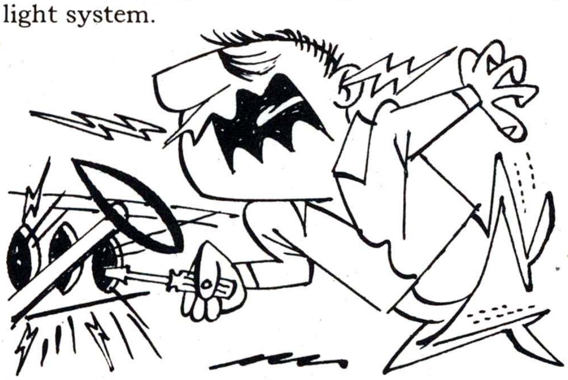
metal element. When the element's free arm closes the contacts, signal light current also flows through the holding circuit heating coil. This causes the anchored bimetal arm to bend and hold the contacts together until the ignition is switched off or fuel is added to the tank.

GAUGE AND INDICATOR LIGHT TROUBLESHOOTING

As in any car electrical system diagnosis, gauge or indicator light checking should begin with analysis of the symptoms so you can pinpoint the trouble as quickly and easily as possible.

Some cases of gauge troubleshooting are simpler than tracking down other electrical system troubles because gauge pointer movement —or lack of movement—gives you a direct indication of the cause. This makes it possible to narrow down trouble to sources which affect all the gauges, or only one gauge.

The procedure for troubleshooting indicator light systems is also simplified because the ignition switch light-testing feature can be used as the first step in checking out the warning light system.



CAUTION: Always disconnect the battery ground cable before you remove an instrument cluster or work with tools behind the instrument panel. An accidental short circuit can do costly damage to gauges, circuit boards, or other circuit parts. If the battery is needed for any reason after a gauge cluster is rolled out of the panel, connect a jumper wire between the metallic cluster housing and a good ground, and make sure that nothing is shorted before you reconnect the battery cable.

TROUBLE IN ALL GAUGES

Anything that goes wrong with voltage limiter operation affects all the thermal gauges at the same time because the limiter is the source of current for these gauges.

FULL-SCALE ACROSS THE BOARD

Where all the gauge pointers move beyond full-scale position after the ignition switch is turned on, you'll usually find the cause in the voltage limiter. An open heating coil circuit can keep the contacts from operating, or the contacts may be stuck closed. Either condition will expose the gauges to full battery voltage which can cause serious damage or gauge burnout.

A poor ground at the gauge cluster can also cause full scale movement of all the gauge pointers by making voltage limiter operation erratic. In some cases, you can correct a bad ground simply by tightening the cluster mounting screws.

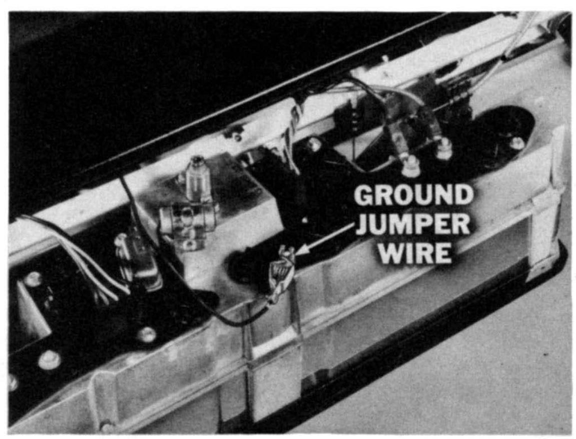


Fig. 19—Ground jumper protects gauges

NOTE: The voltage limiter is grounded through the gauge cluster attaching screws. When testing with the gauge cluster rolled out of the instrument panel, be sure to connect a temporary ground jumper between the metal cluster housing (not the plastic bezel!) and the panel before you turn on the ignition switch or you might burn out all the gauges.

DAMAGE MAY BE HIDDEN

Thermal gauges which have been exposed to higher than normal input voltage may be damaged internally, even though they still operate. Excessive voltage overheats and permanently distorts the bimetal strip and the gauge indication then becomes inaccurate.

CHECK POINTER POSITION

Where a gauge has been damaged by overheating, the pointer will not return to the normal off-scale position at the left side of the dial when switched off. If gauge damage is suspected, you can check the calibration with your C-3826 Thermal-Electric Gauge Tester.

BACK AND FORTH TOGETHER

Erratic movement of all the gauge pointers is also a symptom of voltage limiter trouble. Of course, there's always a possibility of loose connections. But, where all the gauge pointers temporarily move *down* scale from normal operating positions, it's usually the result of a voltage drop caused by dirty or burnt contacts in the voltage limiter.

On the other hand, if the gauge pointers all move *up* scale from steady positions, a poor ground is the usual cause. Here again, tightening cluster mounting screws may do the job.

THE TEST

When the ignition switch is turned on, a flashing test light or a fluctuating voltmeter tells you the voltage limiter is working okay. But, if the light burns steadily or the voltmeter indicates full system voltage, you've got an inoperative limiter or a poor limiter ground connection.

VOLTAGE LIMITER TESTING

Testing a voltage limiter on the car is easy. Simply connect a test light or voltmeter between the temperature sending unit terminal and ground, keeping the sender wire connected. Where the sender wire insulator interferes with the test connection, you can clip a jumper between the sender wire terminal and the sender post to keep the circuit connected.

On current Chrysler models, you'll have to make this test at the fuel gauge terminals behind the panel because the built-in voltage limiter connects only to the fuel gauge.

NO POINTER MOVEMENT

The final all-gauge trouble symptom is the complete absence of gauge pointer movement when the ignition is switched on. This condition is also related to the voltage limiter. It may be caused by open contacts in the limiter, or a break in the limiter input circuit.

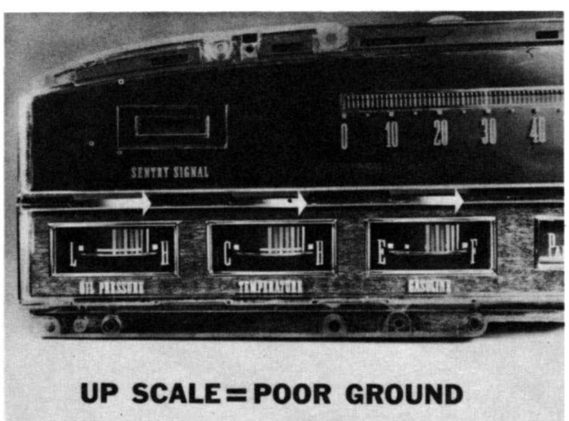


Fig. 20—Poor ground causes limiter trouble

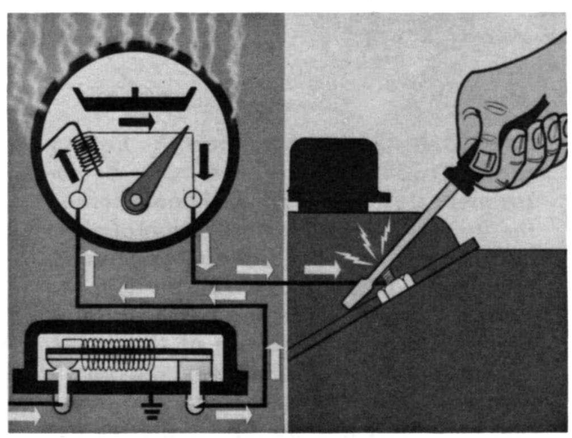


Fig. 21—Grounding sender can burn out gauge

CAUTION: When testing, do not short the sender terminal or wire to ground when the ignition switch is on. Grounding any gauge sender circuit allows higher than normal current flow which can damage or burn out the gauge.

IT TAKES PULL

Removing an external, plug-in-type voltage limiter for replacement is easy. You simply grasp the assembly firmly and pull it straight out of its circuit board receptacle. Be careful that you don't twist or force the limiter to get it off. You can break the circuit board and turn a simple replacement into a costly repair job.

OTHER LIMITER PRECAUTIONS

Remember the caution note about working with tools behind the instrument panel. Don't use a screwdriver to pry off the voltage limiter for replacement. If you forget and leave the ignition turned on, you can do plenty of damage.

A screwdriver short circuit between the input and output prongs of the limiter can burn out *all* the gauges. If the blade accidentally grounds the limiter input prong, you can burn out the circuit board.

Also be careful with built-in voltage limiters. If you accidentally apply full battery voltage to the "A" terminal (output to other gauges) or "S" terminal (to sending unit), you'll burn out the gauge and may damage the limiter. Grounding the "I" terminal (battery voltage) can burn out the circuit board—grounding the "A" terminal can burn out the limiter.

TROUBLE IN ONE GAUGE

Where only one of the thermal gauges does not work properly, the voltage limiter is probably okay, and you'll find the trouble in the gauge, the wiring, or the sending unit.

Testing to pinpoint single gauge circuit troubles follows the same pattern regardless of which gauge is acting up. You begin at the gauge sending unit and check out each section of the circuit back to the gauge to locate the trouble by process of elimination.

FUEL GAUGE CIRCUIT TESTS

Fuel gauge troubles are often caused by a poor ground connection at the tank sending unit, especially on older cars which have been exposed to road splash and corrosion.

The tank unit on Chrysler Corporation cars is directly grounded through the fuel line by the clip which attaches the line to the body. A clip-on-type ground strap connects the tank unit housing to the fuel line to bridge the flexible fuel hose at the sending unit.

Ground check: First, connect a jumper wire between the tank sending unit housing and a good body ground. Then, turn on the ignition switch and note the gauge indication. If the gauge now indicates properly, check the fuel line attaching clip and ground strap for poor connections.

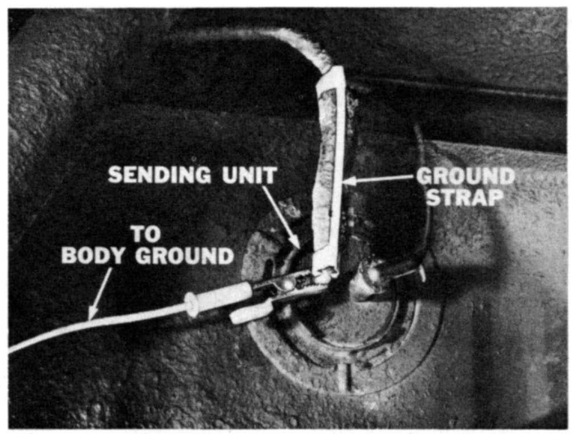


Fig. 22—Check ground connection condition

Sending unit check: Where the ground circuit checks out okay, the next step is to disconnect

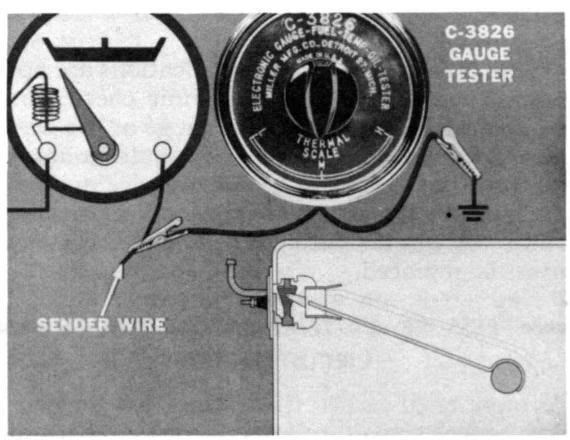


Fig. 23—Connect tester at tank

the sending unit wire, being careful that you don't ground the wire accidentally.

Next, clip the leads of a C-3826 Thermal-Electric Gauge Tester to the sender wire and a good ground at the tank unit housing or the body. If the gauge indication is now within specs, the tank sending unit or the Sentry Signal warning relay will require the additional tests described in your service manual.

> ***NOTE: On Imperial models, the total resistance of the series-connected tank sending unit and Sentry Signal warning relay equals the basic resistance of a standard tank sending unit. If the gauge tester is connected to the sender wire at the tank, the gauge will give a false, low reading because relay resistance is added to tester resistance. Therefore, the tester must be connected to the gauge wire disconnected from the "IND" terminal of the relay.***

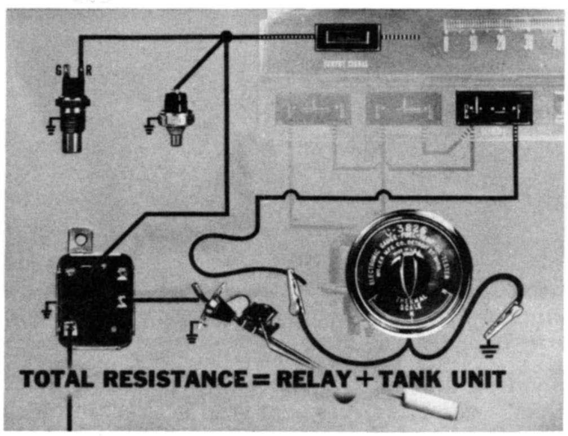


Fig. 24—Connect tester at relay

Gauge check: Where gauge indications are not within specs in the sending unit check, the trouble narrows down to the gauge or the wiring. To determine which is at fault, connect the tester as described in your service manual and recheck the gauge. If gauge indications are still incorrect, the wiring is okay and the gauge must be replaced.

PRESSURE OR TEMPERATURE GAUGE CIRCUIT TESTS

As mentioned earlier, the testing procedure for any gauge circuit follows the same pattern given for the fuel gauge circuit.

Actually, oil pressure and temperature gauge circuits differ from the standard fuel gauge system only in the design of their sending units. Here again, follow the test procedures given in your service manuals.

TANK UNIT PRECAUTIONS

As you know, rough handling can bend the sending unit float arm or the stops, and cause inaccurate gauge indications. Unless damage is obvious, there's no sure way of telling by appearance alone, whether the float arm stops have been disturbed. So, before installing a new tank unit, it's good practice to check the sender's resistance calibration.

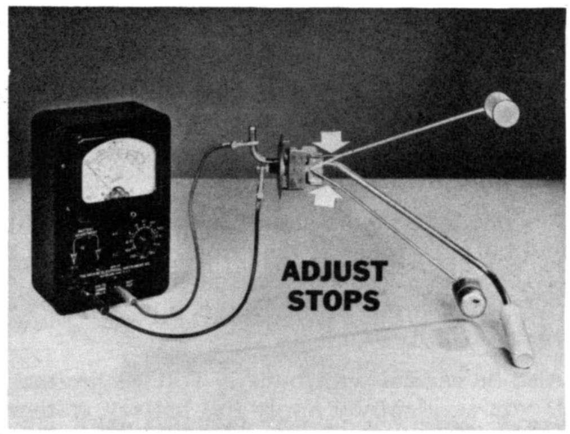


Fig. 25—Use accurate ohmmeter for testing

If sending unit resistance is not within specs with the float arm held against the stops, you can adjust the stops slightly to get the correct resistance settings. Where adjustment is needed, be careful that you don't bend the stops open too far or the sliding contact can run off the resistance strip and may jam, or twist out of shape.

> ***NOTE: Fuel tank sending unit resistance tests must be precise, especially in the high float position where tolerance is plus or minus one ohm. Your ohmmeter must be accurate for this test. Check it against a precision resistor at regular intervals.***

The tank sending unit intake tube is designed to locate the intake filter in contact with the tank bottom where it can pick up all the fuel. If the tube is bent upward by a tank bottom cave-in, it will stop drawing fuel when the level is below the tube end. This will cause the car to run out of fuel even though some gasoline remains in the tank.

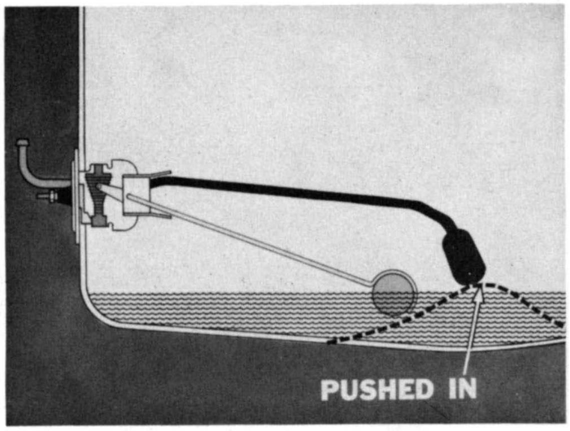


Fig. 26—Tank damage bends intake tube

Usually, the float operation of tank senders which have the resistance unit located on the sending unit housing is not permanently affected by tank cave-in damage. In most cases, the tank dent can be forced back out by compressed air and the fuel gauge will again indicate the correct level. However, the intake tube end remains off the tank bottom, so the car runs out of gas in spite of a part-full gauge reading.

On tank senders with the resistance unit and float arm stops mounted on the intake tube, both the tube and stops remain bent out of normal position after the tank bottom is forced out. Here, the car also runs out of fuel with a reserve remaining in the tank, but the gauge reads empty before this happens. As the tank is filled, the gauge pointer may not reach the full mark because float movement is stopped by contact with the tank top while the resistance unit is only in part-full position.

MAKE SURE IT BOTTOMS

When you install a new tank unit, you can "feel" for the tank bottom with the intake tube filter when installing the unit. If it touches bottom before you tighten the unit down, you can be sure it will be in proper position when the unit is in place.

CAUTION: Make sure the intake filter is pushed on all the way. A partly seated filter extends the intake tube and can bend the tube when the unit is tightened down. Tube distortion will also cause inaccurate gauge readings on some models.

Take special care in checking filter position of the new tank unit when you replace one which has a bent intake tube. The tank bottom may not have returned to its original shape when it was forced back out, so the new unit will not bottom correctly.

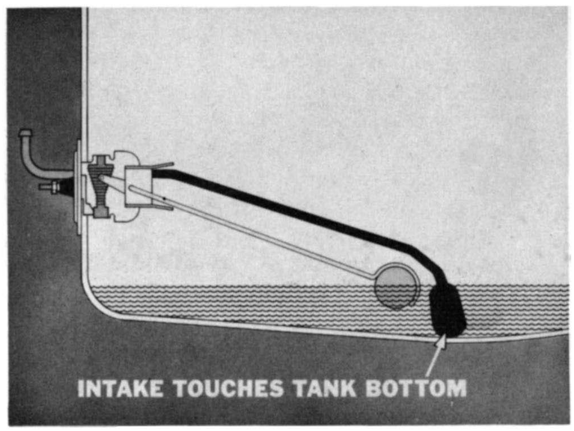


Fig. 27—Check intake filter position

INDICATOR LIGHT TESTING

Turning the ignition switch to "ON" or "START" normally lights the signal bulbs. However, if they do *not* light on this test, the cause could be a burnt-out bulb, a defective signal switch or an open in the wiring.

Procedures for tracking down indicator circuit trouble is described in your service manuals, but a few simple checks may help to speed up the process.

USE A TEST LIGHT

Where the signal bulb does not light on the proof test, disconnect the indicator wire from its switch in the engine compartment, and connect a test light between the wire and a good ground. The test light is now in series with the signal bulb, so if it glows dimly when the ignition switch is turned on, the signal switch is the trouble source. Double-check the switch with an ohmmeter.

No glow at the test light could be caused by an open in the circuit wiring, but probably means a burnt-out signal bulb.

Litho in U.S.A.