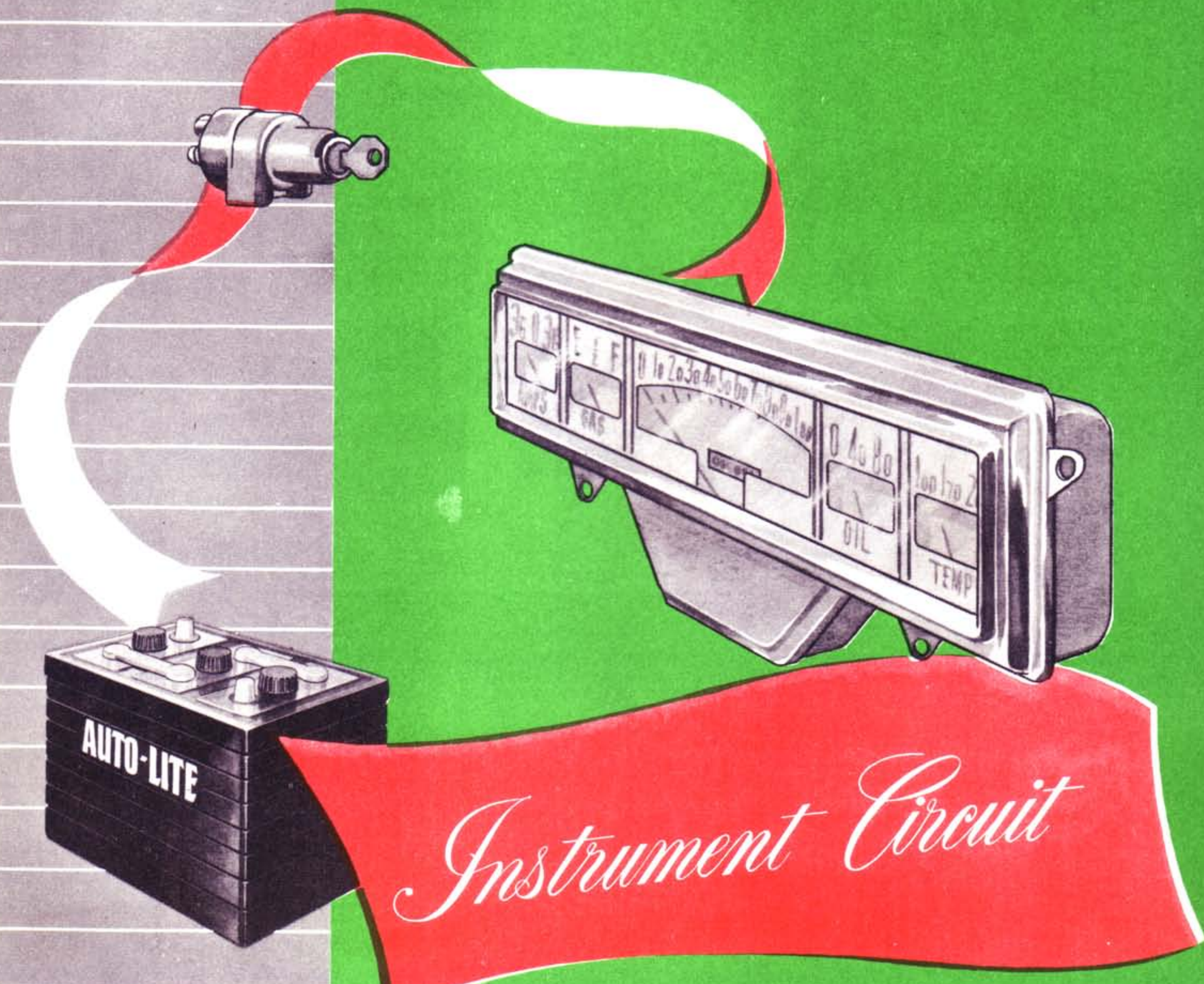

Instrument Circuit

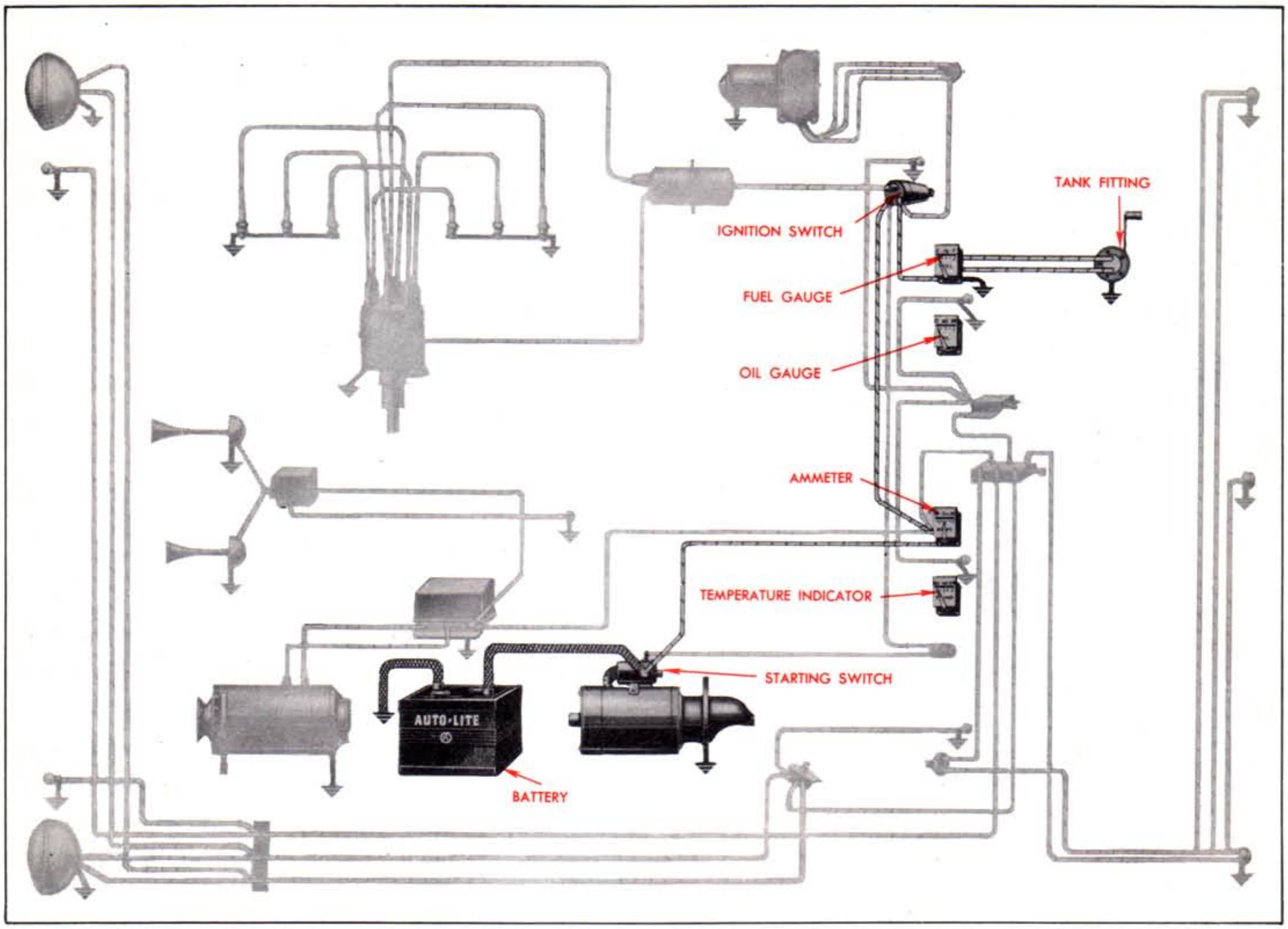

FIGURE 200—THE INSTRUMENT CIRCUIT. This illustration shows the instruments used on the complete car wiring diagram in figure 1. It will be noted that the ammeter and fuel gauges are electric while the heat indicator and oil pressure gauges are the Bourdon type and have no electrical connections. Other illustrations in this chapter show variations of the fuel gauge circuit and also typical circuits for electrically operated oil gauges and heat indicators.

CHAPTER 7 THE INSTRUMENT CIRCUIT

Most internal combustion engines have a number of instruments or gauges mounted on the control panel. These gauges tell the operator how the engine and some of the accessories are operating and warn him when some of the more damaging failures occur or approach. They do not tell the complete story of any one condition; for instance, the oil gauge tells the pressure of the lubricating oil as it leaves the pump, but it does not tell the condition or amount of oil or whether some of the lines have been plugged.

Automotive type gauges give only an approximate indication as exact values are not needed for normal operating observation. *Panel gauges are not accurate enough for making adjustments or tests, and special test instruments should be connected in the circuit when any tests or adjustments are made.* In general, the temperature indicator and oil pressure gauge are more accurate than the ammeter or fuel gauge. However, automotive type ammeters do indicate the correct direction of current flow and correctly tell whether current is flowing into or out of the battery.

The usual control panel includes an oil pressure gauge, temperature indicator, ammeter and fuel gauge. These units are included in the wiring diagram shown in figure 200. Many also have a speedometer or tachometer which tells the engine or car speed. Maintenance of the first four of these units is covered in this chapter. Tachometers and speedometers are not included as they require special tools and extreme care when making repairs and adjustments and only an experienced speedometer mechanic should attempt such servicing.

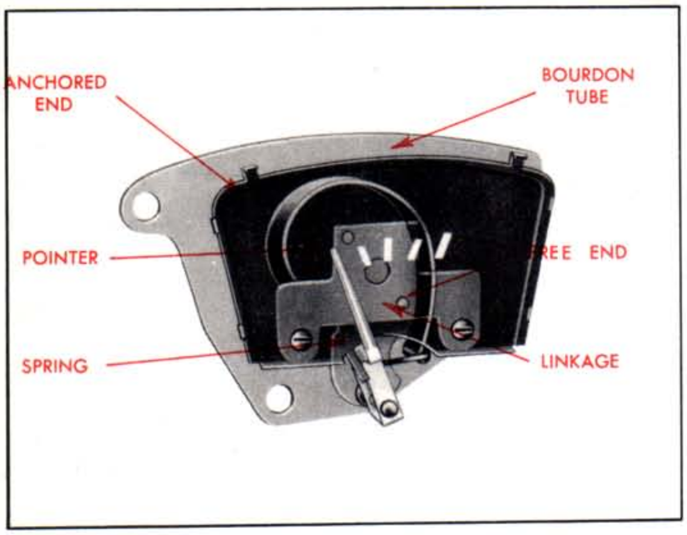

FIGURE 201—BOURDON TYPE OIL PRESSURE GAUGE. This type gauge is connected by a tube to the oil line and the oil pressure causes the Bourdon tube in the gauge to straighten. The straightening of the tube moves the pointer.

THE OIL PRESSURE GAUGE

The oil pressure gauge indicates the pressure of the engine lubricating oil. The most common type is connected by a tube to the oil line leading from the oil pump. Oil pressure from the pump is carried by the tube to the head where it causes a Bourdon tube to straighten out slightly. This straightening of the Bourdon tube causes the pointer movement. Electric oil gauges have a sending unit with a variable resistance which is actuated by the oil pressure, and a dash or receiving unit which translates the impulse from the sending unit into terms of pressure.

BOURDON TYPE OIL GAUGES

The Bourdon tube (see figure 201) is an oval tube, bent in a circular shape and closed except for the connection to the oil pump. When oil pressure is applied to the flat Bourdon tube, it tends to expand to make a circular cross section, and in so doing straightens out slightly. The amount of expansion and straightening depends upon the amount of pressure applied to the tube. One end of the Bourdon tube is fixed while the other is linked to the pointer. While no spring is necessary to return the pointer to zero, a spring is often used to keep a slight tension on the pointer and to take up any slack in the linkage thus reducing vibration or fluctuation of the pointer.

If the oil gauge is inoperative, disconnect the tube from the back of the gauge. Check for possible plugging of the tube by holding the end of the tube over a receptacle and starting the engine. The oil should flow from the tube at a steady rate. If it does not, check the oil pump operation and check the tube for kinks, leaks and plugging.

If the previous inspection shows that oil pressure is reaching the gauge, remove the gauge from the panel. Inspect to see if the small hole leading into the Bourdon tube is open and clean out with a pin. Make sure there is no binding on the pointer or other parts. Connect the unit to the oil line and check its operation. If the unit is still inoperative it should be replaced. When mounting the oil gauge in the panel, have any dust gaskets properly placed and check for any possible binding or interference due to a distorted mounting.

If the gauge operates but does not give a reasonably close indication of the oil pressure, check its readings by comparing with a similar gauge known to be in good condition or with a test gauge that can be connected to the oil line. Make this comparison test under the same conditions of temperature and engine speed so that a true gauge comparison can be obtained.

Minor adjustments can be made in the gauge indications by bending the wire linking the Bourdon tube to the pointer. Bending the wire link towards the pivot increases the spread and will increase the readings after the zero point has been reset. Be sure to check the indications and compare them with a master meter before reinstalling the oil gauge in the panel.

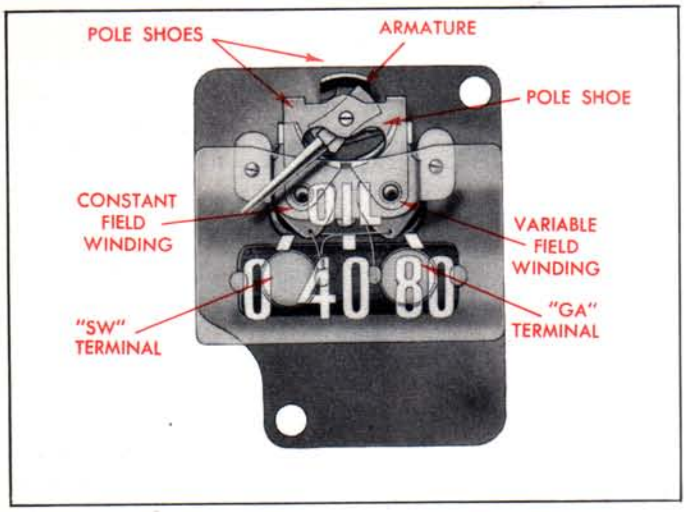

FIGURE 202—ELECTRIC TYPE OIL PRESSURE GAUGE (DASH UNIT). The electric oil pressure gauge has three magnetic poles, two of which have windings. The pointer assembly has a soft iron armature which is attracted by these poles and assumes a position between them depending upon their relative strength. The two windings are wound in the same direction so that the two lower magnetic poles have the same polarity while the upper pole has the opposite polarity and completes the magnetic circuit.

ELECTRIC OIL GAUGES

The electric or magnetic oil pressure gauge includes two units. The dash unit (figure 202) has three magnetic poles, two of which have windings. One of these windings is connected to the ignition switch and to ground and creates a steady magnetic pull towards the "zero" position whenever the ignition switch is turned on. The other winding is also connected to the ignition switch but it is grounded by the sending unit. It creates a magnetic pull toward the maximum pressure position, the strength of which is dependent upon the amount of resistance inserted in the circuit by the sending unit. The sending unit (figure 203) has a resistance with a sliding contact which is actuated by the oil pressure. When pressure is applied to the diaphragm in the sending unit, resistance is shorted out. The internal connections and hookup of these units is shown in figure 204.

The pointer is mounted on a magnetic vane which is attracted by the two lower magnetic poles and assumes a position between them depending upon the combined magnetic field. A counterweight is mounted on the pointer assembly to bring the reading back to zero whenever the ignition is turned off.

Periodically inspect the wiring from the ignition switch to the dash unit and between the dash and engine units for loose connections frayed insulation and breaks or grounds. If the gauge does not properly indicate the oil pressure whenever the engine is operating, stop the engine and check to make sure the oil pump is operating correctly and that no oil lines are broken. Also make sure there is sufficient oil to cover the pump intake.

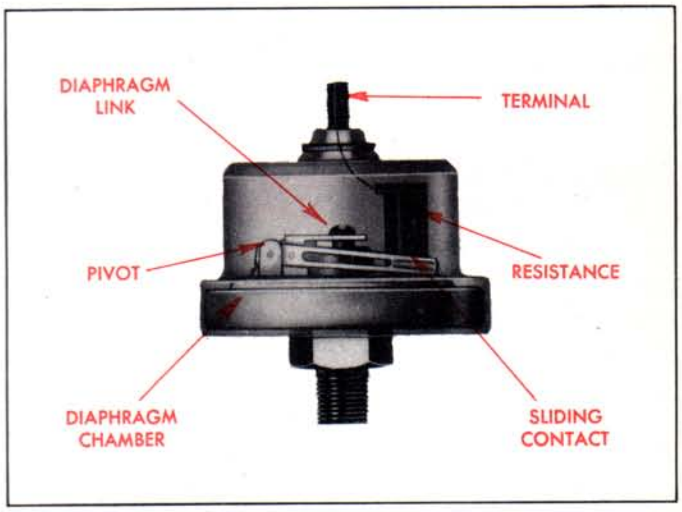

FIGURE 203—ELECTRIC OIL PRESSURE GAUGE (ENGINE UNIT). Oil pressure from the pump acts on the diaphragm to push upward on the link and raise the sliding contacts. This reduces the resistance in the variable field circuit and increases its strength.

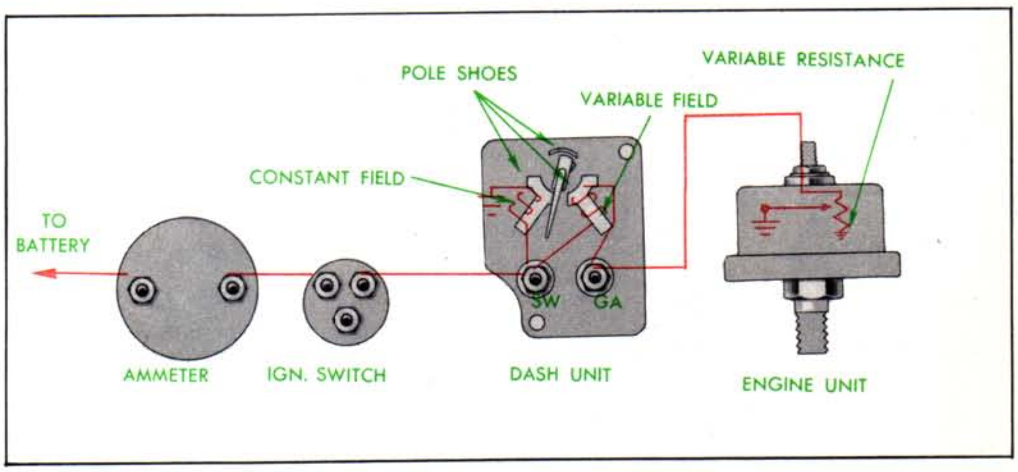

FIGURE 204—WIRING CIRCUIT OF THE ELECTRIC OIL PRESSURE GAUGE. This illustration shows the relation and wiring hookup between the various parts of the circuit and helps to understand how an increase in oil pressure reduces the resistance in the variable field circuit thereby increasing its strength and moving the pointer toward the right.

With the ignition turned on, connect a test lamp from the "SW" terminal on the dash unit to a ground on the car frame. If the lamp does not light it indicates no power is reaching the gauge and the ignition switch, ammeter and wiring should be thoroughly inspected.

ELECTRIC OIL GAUGE TESTS

To test a gauge which does not give true indications of the oil pressure make sure electricity is reaching the dash unit by the test lamp check above. Disconnect the lead from the engine unit and again turn on the ignition. The pointer should stay against the left stop pin. Ground the engine unit lead to the chassis and the pointer should stay against the right stop pin. The various conditions with the possible causes are listed below so that the results of this test can be interpreted.

Original Operation	*Test Result*	*Cause*
Gauge reads zero at all times	Gauge reads zero for both tests	Open lead from dash to engine unit or open variable field winding in dash unit. Check lead by repeating the above test by disconnecting the lead from, then grounding the dash unit "GA" terminal.
Gauge reads zero at all times	Gauge reads properly as described above	Faulty engine unit. Check by substituting an engine unit known to be in good condition and observing the operation when the engine is running.
Gauge reads maximum at all times	Gauge reads maximum for both tests	Grounded lead from dash to engine unit, ground in dash unit variable field winding or open constant field winding. Check lead by repeating the above test by disconnecting the lead from, then grounding the dash unit "GA" terminal.
Gauge reads maximum at all times	Gauge reads properly as described above	Faulty engine unit. Check by substituting an engine unit known to be in good condition and observing the operation when the engine is running.
Gauge reads maximum except at very low speeds	Gauge reads properly as described above	Faulty engine unit or incorrect calibration. Install new engine unit and observe operation when engine is running. Calibrate dash unit. Replace dash unit if it cannot be calibrated.
Gauge reads too low or too high	Gauge reads properly as described above	Faulty engine unit or incorrect calibration. Install new engine unit and observe operation when engine is running. Calibrate dash unit.
Pointer will not move		Damaged dash unit or incorrect installation. Remove and inspect.

To calibrate a dash unit connect the "SW" terminal to a battery of rated voltage and connect a lead from the "GA" terminal to an engine unit known to be in good condition and which is mounted on a controlled source of oil pressure. Ground both the dash and engine unit cases to the second battery terminal. The engine itself can be used for the source of oil pressure if the pressure is known for a certain engine speed.

With the gauges connected as above, operate the engine or adjust the pressure to a known value that will give

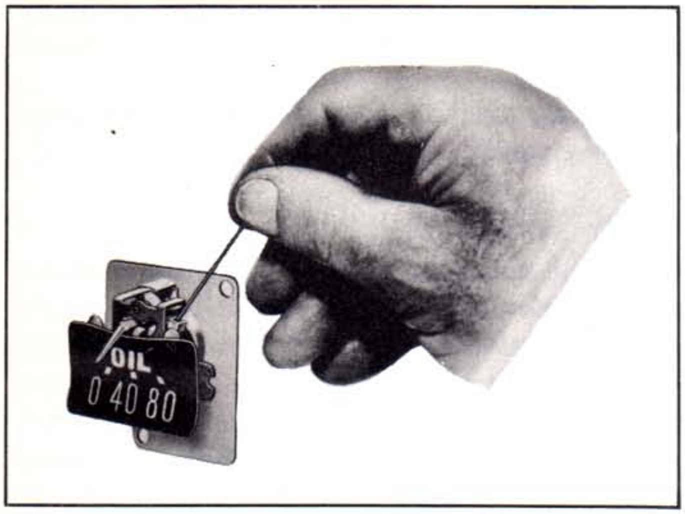

FIGURE 205—ADJUSTING THE ELECTRIC OIL GAUGE. A stiff wire placed in the "U" shaped bracket at the top of the pole shoes can be used to move the poles toward or away from the armature and increase or decrease the effect of the winding on the armature.

at least 50% of full scale reading. With a stiff wire turn the right hand pole shoe as shown in figure 205 until the gauge indicates correctly. Stop the engine or turn off the oil pressure and adjust the left hand pole shoe to bring the indication to zero. Recheck with pressure on and off making minor readjustments until correct calibration is obtained.

In some instances it may be necessary to increase or decrease the spread of the indicator movement. This is done by bending the auxiliary pole to increase or decrease the air gap between the pole and armature.

After all adjustments of the poles are completed apply one drop of air drying varnish to the pole shoes to prevent slipping.

THE TEMPERATURE INDICATOR

The temperature indicator is a remotely controlled thermometer which tells the temperature of the engine coolant. Bourdon type gauges (figure 206) have a capillary tube and bulb attached to the unit. This tube and bulb are filled with a liquid and sealed. When the bulb is heated by the engine coolant, the confined liquid generates vapor pressure which is transmitted through the capillary tube to the Bourdon tube in the gauge. This

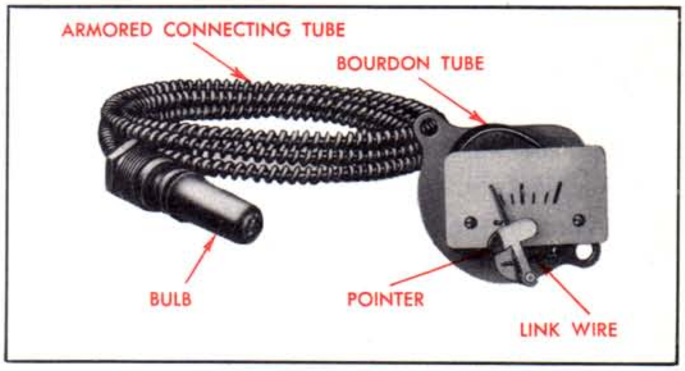

FIGURE 206—BOURDON TYPE TEMPERATURE GAUGE. This gauge is similar in construction to the Bourdon type oil gauge shown in figure 201; however, on the heat indicator the capillary tube is included with the unit and connects to a bulb on the lower end. The bulb and tube are filled with a fluid which expands with heat and creates a pressure which acts on the Bourdon tube to cause it to straighten slightly.

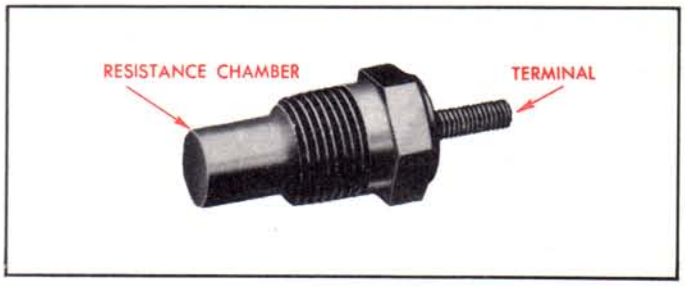

FIGURE 207—ELECTRIC TEMPERATURE GAUGE (ENGINE UNIT). A thermistor is used in this unit which decreases in resistance as its temperature rises. It is connected from the terminal to ground and controls the current flowing in the variable field circuit.

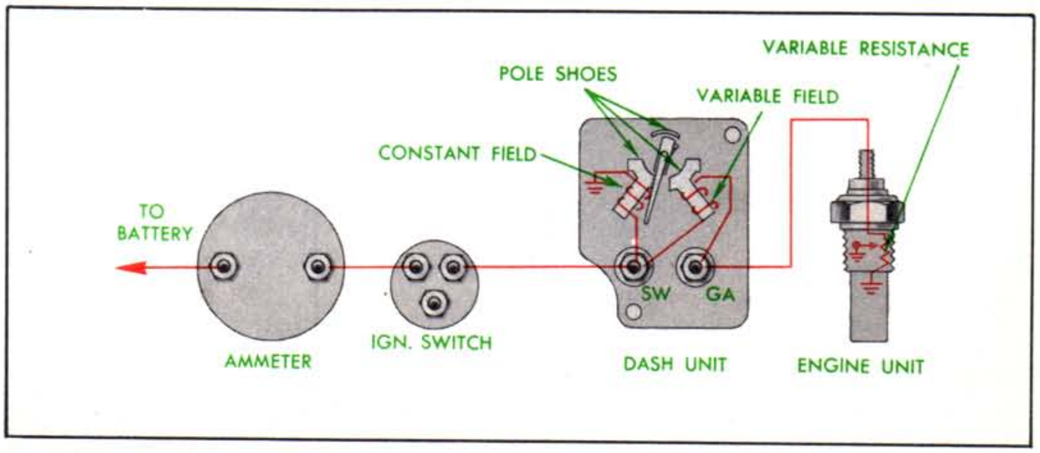

FIGURE 208—WIRING CIRCUIT OF THE ELECTRIC TEMPERATURE GAUGE. This circuit is similar to the oil gauge circuit shown in figure 204. The only difference is in the engine or sending unit and in the values of the resistances of the various parts.

Bourdon tube is similar to that described for the oil pressure gauge and is linked to a pointer in the same manner. The complete gauge is calibrated to read directly in degrees.

Electric temperature indicators are constructed in the same manner as the electric oil gauge previously described. The main difference is in the sending unit which is installed in the engine water jacket. This sending unit has a thermal resistance unit that varies with the water temperature. This affects the dash unit variable field winding in the same manner as described for the oil gauge. Figure 207 illustrates the temperature gauge sending unit while figure 208 shows the internal connections and hookup of the circuit.

BOURDON TYPE TEMPERATURE INDICATORS

If the temperature gauge does not give a reasonably accurate indication of the coolant temperature, remove the unit from the engine and panel. Inspect the bulb, capillary tube and indicating head for a damaged or distorted condition. Replace the unit if any of these conditions are found.

Automotive type heat indicators are calibrated at normal engine temperature and at the boiling point and the lower part of the scale is only approximate. To check the indication, place the bulb in a pan of boiling water and allow time for the gauge to come to its indication. If this point is correct and if the pointer returns to the left stop pin at room temperature, the unit is functioning correctly and can be reinstalled. If the gauge does not indicate correctly at the boiling point, adjustments can be made by slightly bending the wire linking the Bourdon tube to the pointer lever. Bending the wire toward the pointer pivot increases the spread of the indication, while straightening or bending the wire changes its length and changes the reading at any one point. Be sure the link wire moves freely on the pointer lever and that it does not apply a twisting or thrust force.

After adjustments are completed insert the bulb in boiling water and observe the pointer while it moves over the scale. Check the indication then remove the bulb and observe the pointer while the unit cools. If the pointer movement is erratic it may be due to sticking of the link wire at the pointer lever which should be corrected.

Replace the gauge if it cannot be adjusted to give satisfactory performance.

ELECTRIC TEMPERATURE GAUGES

The electric or magnetic temperature gauge is similar to the electric oil gauge; however, it is calibrated in degrees and the sending unit is actuated thermally without moving parts. The resistance unit used in the temperature gauge sending unit is made of special metal oxides in the form of a flat disc that changes resistance as its temperature varies. When it is hot, the resistance inserted in the variable field circuit is reduced and the pointer is attracted toward the right or "Hot" indication.

Inspect, test, and adjust the electric temperature gauge as described previously for the oil gauge except when adjusting, insert the engine unit in boiling water and water at room temperature to set the maximum and minimum points.

THE AMMETER

The ammeter enters into most of the electrical circuits used on the car or engine. It tells whether current is flowing into or out of the battery and gives an approximate indication of the rate of current flow. Usually intermittant loads of high current values, such as the starting motor or dual horns, are taken directly from

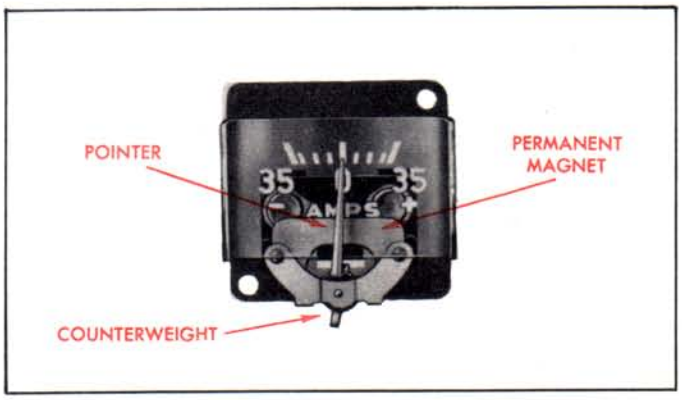

FIGURE 209—AUTOMOTIVE TYPE AMMETER. The ammeter has a soft iron armature which is mounted on the pointer shaft. A permanent magnet attracts this armature to hold the pointer at the "zero" position. Current flowing through the meter creates a second magnetic field which turns the armature to the right or left depending upon the direction of current flow.

the battery and are not routed through the ammeter; however, most small loads come from the battery through the ammeter to the unit. The ammeter tells whether the battery is being charged or discharged and from an analysis of the ammeter indications a warning is received whenever one of the other circuits develops an open or ground. Under normal conditions with the engine stopped, the ammeter should show a discharge when one of the electrical circuits is turned on. The amount will vary depending upon the size of the load, but if the ammeter moves all the way to the discharge side, it indicates a ground or short which should be located and corrected. Consult the trouble shooting chart in Chapter 9 and refer to the chapter covering the particular circuit which causes no or too much ammeter movement.

A typical automotive type ammeter is shown in figure 209. A soft iron armature is mounted on the pointer shaft. This armature is positioned by two magnetic fields. One, produced by the horseshoe shaped permanent magnet located above the armature, holds the armature in the cross position and the pointer on zero. The other magnetic field is produced by the current flowing through the brass plate or "coil" which bridges the terminals. The flux from this current is localized by the soft iron pole face placed on the center of the coil, adjacent to the armature. This flux causes the armature and pointer to rotate from the zero position by an amount and direction proportional to the amount and direction of the current flowing through the coil. When no current is flowing through the instrument, the permanent magnet returns the pointer to the zero position. A counter-balance is mounted on the armature assembly opposite the pointer to balance the assembly and assist the permanent magnet in returning the pointer to zero. A non-magnetic disc is also mounted on the pointer shaft near the permanent magnet. Eddy currents, induced in this disc by the armature movement, cause a counter-magnetic field which has a slight damping effect and helps stabilize the meter.

If the ammeter does not operate, remove it from the panel being careful not to ground the battery lead. Inspect the pointer and armature assembly. Make sure it moves freely and has a slight amount of end play in the shaft. After adjusting the end play, apply a drop of air drying varnish to the bearing to prevent turning. Some of the later production ammeters have a silicone damping fluid on the bearing screw end of the pivot. This fluid should not be removed or the damping effect will be lost. Hold the ammeter in the same position as it would be mounted in the panel and check the zero position. Hold the counter-weight and apply a slight pressure to the pointer to bring the "at rest" position exactly to zero.

Connect the panel ammeter, a test ammeter, and carbon pile rheostat in series with a battery. Adjust the current to various values and compare the two ammeters. Reverse the connections to the panel ammeter and check the indications on the discharge side. If the meter indicates the direction of current flow correctly and gives an approximately correct reading it can be replaced in the panel.

Inspect the ammeter for correct mounting, seeing that the gasket is in place and that there is no interference with the ammeter operation. Connect the leads to the meter making sure the terminals are tight. Turn on the lights or some other accessory and observe if the ammeter moves to the "discharge" side; if it shows a charge under these conditions it indicates that either the leads on the ammeter terminals or battery have

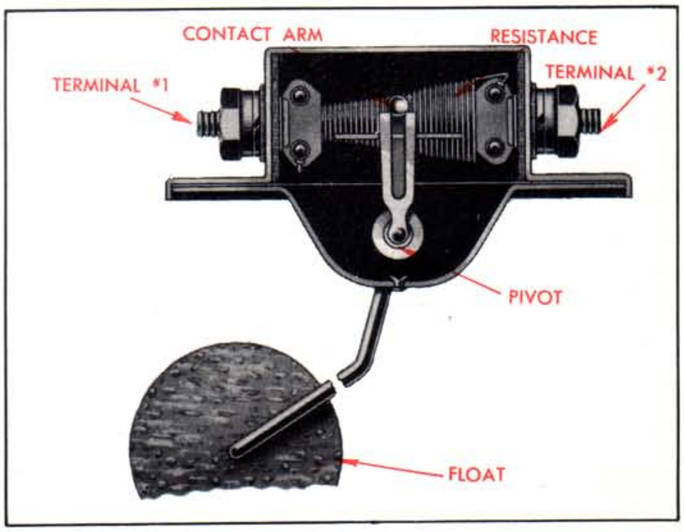

FIGURE 210—FUEL GAUGE TANK UNIT. The unit illustrated is used with a thermal type dash unit as both ends of the resistance are connected to terminals while the sliding contact grounds the resistor. The resistance between each terminal and ground varies with the position of the float and sliding contact.
Other tank units may have only one terminal which is connected to one end of the resistance. The sliding contact is connected to ground and varies the amount of resistance in the circuit.

been interchanged. Check the battery ground polarity according to the specifications for that particular installation. Reversed ammeter readings may also be caused by reversing the permanent magnet when the ammeter was assembled.

THE FUEL GAUGE

The fuel gauge is an electrically operated instrument for measuring the amount of fuel in the tank. Two units are used; one mounted on the control panel is called the dash unit, while the other is mounted within the fuel tank.

THE TANK UNIT

The tank unit consists of a resistance with a sliding contact which is actuated by a float. This resistance is connected to the dash unit and varies the current in the dash unit windings to give the meter indications. Tank units may have one or two terminals and have different circuits and characteristics that are designed for use with a particular dash unit and tank shape or size.

See figure 210 for a sectional view of a typical 2 terminal type. The tank unit must be grounded to complete the circuit and for ungrounded or 2 wire systems a lead must be installed from the tank unit case to the dash unit frame. On bayonet type mountings with clamp ring and ring seal, care should be taken that a good ground connection exists between the clamp and tank. Usually terminals are provided for this ground circuit when the units are designed for a two wire system.

The length of the float arm and the angle of movement are designed for certain sizes of tanks while the form of the insulating block, on which the resistor is wound, depends upon the shape of the tank. The angle of float movement is not always proportional to the amount of fuel in the tank and the resistor shape is designed to offset the variations to give a definite change in resistance for each like change in fuel amount.

MAGNETIC TYPE DASH UNIT

Two types of dash units have been built. The magnetic type is illustrated in figure 211 and the thermal type is illustrated in figure 212. The magnetic type has three magnetic poles two of which have windings. One of these windings is connected to the ignition switch and ground and creates a steady magnetic pull towards the "empty" position whenever the ignition switch is

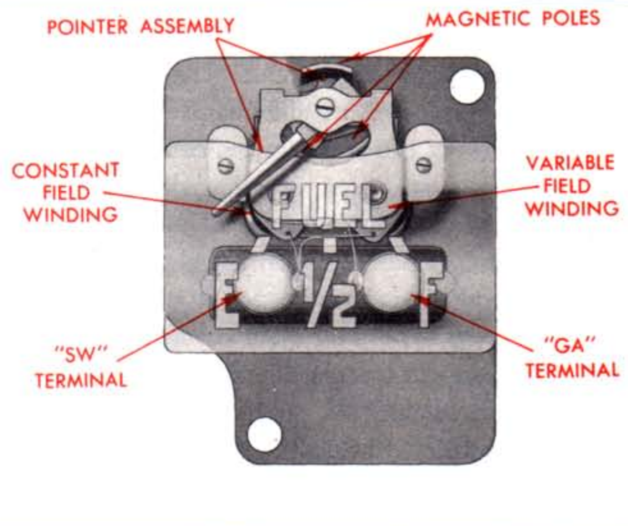

FIGURE 211—MAGNETIC TYPE FUEL GAUGE. The magnetic fuel gauge is like the electric oil gauge in appearance and operation with the main difference being in the method of operating the sliding contact in the sending unit.

turned on. The other winding is also connected to the ignition switch, but it is grounded by the tank unit. It creates a magnetic pull toward the "full" position, the strength of which is dependent upon the amount of resistance inserted in the circuit by the tank unit. The circuit of this type gas gauge is shown in figure 213. With the float in the "empty" position, resistance is inserted in the variable field circuit; while with the float in the "full" position, most of the resistance is grounded out. The pointer is mounted on a magnetic vane which is attracted by the two lower magnetic poles and assumes a position between them depending upon the combined magnetic field. A counter-weight is mounted on the pointer assembly to bring the reading back to "empty" whenever the ignition is turned off.

If the gauge does not give an accurate indication of the amount of fuel in the tank, check to locate the trouble as follows: Disconnect the lead from the "GA" terminal on the back of the dash unit. Turn on the ignition and the pointer should stay against the left stop pin. Ground the "GA" terminal and the pointer should move to the right stop pin. Check the wiring from the ignition switch to the "SW" terminal and replace the dash unit if it does not act as described. Reconnect the lead to the "GA" terminal and disconnect the lead from the tank unit. The gauge should stay against the left stop pin when the ignition is turned on. If it indicates "full" look for a ground in the wiring between the dash and tank units. Ground the lead at the tank unit. If the gauge does not move to the right stop pin look for an open in the wiring.

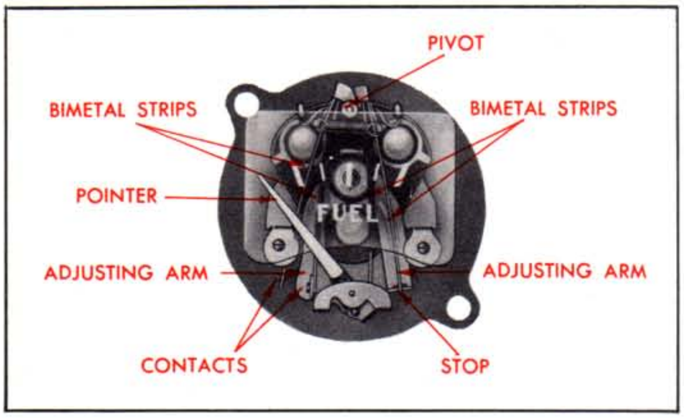

FIGURE 212—THERMAL TYPE FUEL GAUGE. The thermal type fuel gauge requires a short period to heat up when the ignition is turned on or when a change occurs in the amount of fuel. This feature explains the absence of pointer vibration whenever the fuel sloshes from side to side.

The above tests checked for faults in the dash unit variable field winding and for opens or grounds in the connecting wires, but did not check the constant field winding or tank unit. To test these parts connect a tank unit, known to be in good condition, to the "GA" terminal on the dash unit and ground the tank unit case. Operate the float arm manually and observe the readings. If the dash unit indications are incorrect, remove and calibrate the dash unit; while, if the dash unit indicates correctly replace the tank unit. If no spare tank unit is available to make this check, remove the tank unit and use it for the above check. If the dash unit constant field winding is open the gauge will read "full" over a large part of the float arm movement, while if the tank unit is faulty, the gauge will be erratic or will not operate at all.

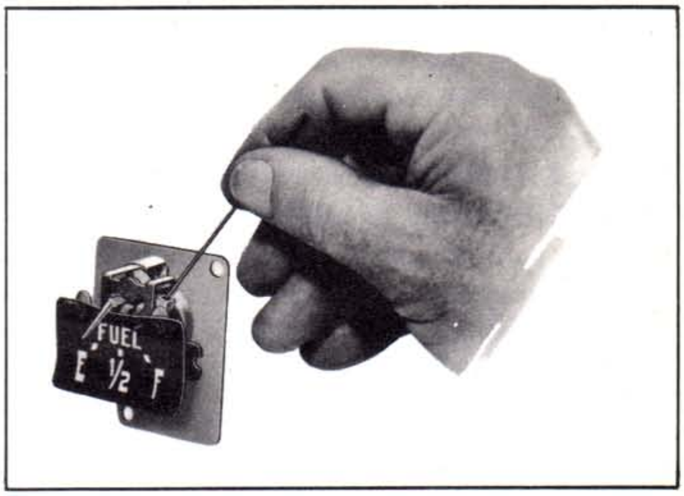

FIGURE 214—ADJUSTING THE MAGNETIC FUEL GAUGE. Moving the pole shoe toward the armature increases its effect. For instance, decreasing the gap between the armature and variable field pole increases the readings over the entire range while decreasing the gap at the constant field decreases the indications, and decreasing the gap at the upper pole reduces the amount of pointer movement. Proper calibration is obtained by adjusting all three poles to give correct readings over the entire scale.

If the operation of the gauge is erratic it may indicate that there is interference with the pointer movement. Remove the dash unit and inspect the pointer and armature assembly. Straighten the pointer if it has been bent and rubs against the dial and frame. Check to make sure there is a slight amount of end play in the shaft and that the bearing plates have not been bent out of alignment. Make sure bearings are clean. If the adjustable bearing is loose, or after adjusting the end play, apply a drop of air drying varnish to prevent the bearing turning. Later gauges do not have this adjustable bearing screw, the

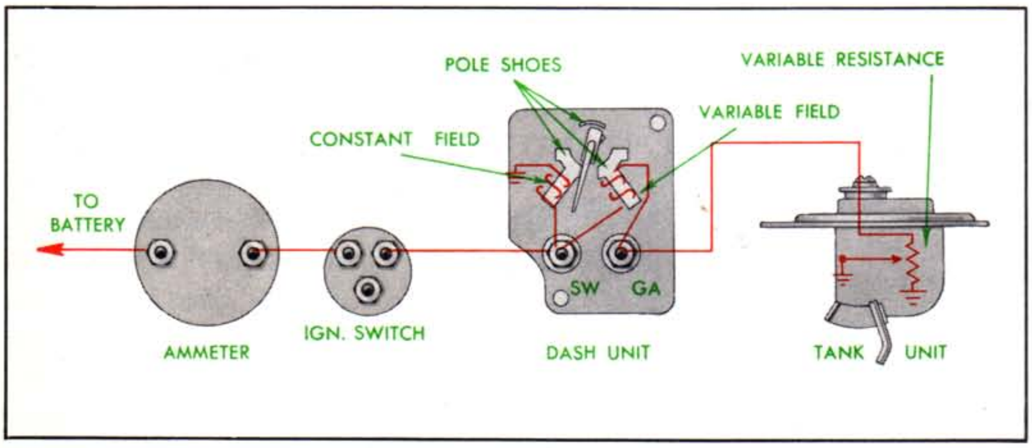

FIGURE 213—WIRING CIRCUIT OF THE MAGNETIC FUEL GAUGE. Note the similarity between this diagram and those in figures 204 and 208. In each, a variable resistance in the sending unit controls the current flowing through the variable field coil and controls the relative magnetism between the two coils which act on the pointer.

shaft being held in position between the bearing plates, the upper one being loose and held in place by the dial screws. In no case should varnish be applied to this type bearing and adjustment is not necessary.

To calibrate the dash unit, remove it from the panel and mount it in the same position. Check to make sure the pointer turns easily and returns to the left hand stop from any position. The pointer should return promptly and have a very slight bank against the stop.

Connect the "SW" terminal on the dash unit to one battery terminal and ground the dash unit frame to the other battery terminal. Connect the tank unit to the "GA" terminal and connect the tank unit case to the battery ground terminal. Place the float arm in the "full" position (against the upper stop) and turn the right hand pole shoe so that the pointer just indicates "full". Place the float in the "empty" position (against the lower stop) and turn the left hand pole shoe to give the correct indication. Repeat this process at the "full" and "empty" positions until no change is necessary. To rotate the pole shoes pry on the "U" shaped lug on the top edge of the shoe as shown in figure 214. Check the indications at the "full", "½ full" and "empty" positions. When calibrating, it may be necessary to spread or reduce the indicator movement. This is done by bending the upper pole shoe to increase or decrease the air gap between the pole and armature. After all adjustments are completed apply a drop of air drying varnish to each pole shoe to prevent slipping.

When installing the gauges in the panel or tank be sure not to bend the pointer or arm. Have all gaskets in place and check for possible binding caused by a distorted panel or by improper assembly.

THERMAL TYPE DASH UNIT

The termal type dash unit is illustrated in figure 212. It has two bimetal strips that are wound with heating coils and two bimetal strips without coils that compensate the unit for external temperature and also protect the coils from overheating. The heating coils are wound around the strips that actuate the pointer and are welded to the strip at the lower end. The other ends of the coils are connected to the terminals marked "1" and "2" respectively. The left bimetal strip has a set of contact points at its lower end which are held together by the coil spring just below the hinge pivot. The right hand bimetal strip is held stationary at its lower end by an insulating stop.

The internal and external connections of the thermal type fuel gauge with its corresponding tank unit are shown in figure 215. This type tank unit has two terminals that are marked "1" and "2" and are connected to the terminals on the dash unit which have the same markings. Both ends of the resistance are insulated while the ground connection is made through the sliding contact. Movement of the float arm varies the resistance and therefore the current in the two heater circuits. The amount of bending of the two bimetal strips depends upon the current in the heating coils. This bending causes the lower end of the strips to grip the pointer and move it into position.

The two outer bimetal strips are assembled so that any ex-

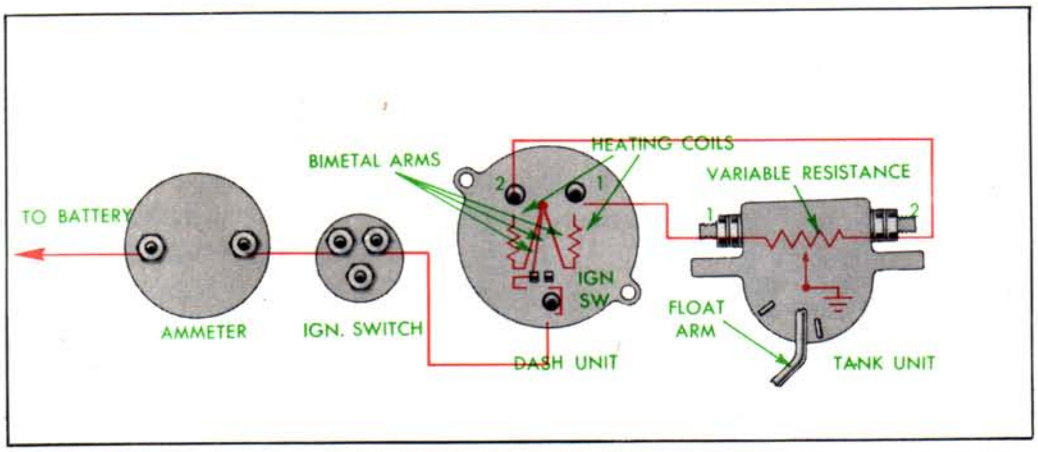

FIGURE 215—WIRING CIRCUIT OF THE THERMAL FUEL GAUGE. In this schematic diagram the circuit can be followed from the battery to the dash unit, through the contacts where it divides with each half passing through a heater coil and part of the tank unit resistance then to ground through the sliding contact.

ternal temperature change causes the hinges to rotate slightly and move the strips that actuate the pointer so that the pointer is held stationary. As the coils are heated the bending of the bimetal strips creates a pressure which rotates the left hand hinge slightly and opens the contact points. Cooling begins immediately and the coil spring closes the contacts, causing only a very slight movement of the pointer.

With the thermal type gauge it is sometimes necessary to add a radio resistance unit assembly so that radio interference due to operation of the gauge contact points is eliminated. This resistance fits over the gauge terminal studs and is installed before the wiring terminals are in place.

If the gauge does not give an accurate indication of the amount of fuel in the tank, check to locate the trouble as follows: Disconnect the leads from the No. 1 and No. 2 terminals on the dash unit and turn on the ignition. Ground the No. 2 terminal and allow approximately one minute for the gauge to reach its indication which should be above the "full" position. Ground both the No. 1 and No. 2 terminals and the gauge should return slowly to the "½ full" position. If the dash unit does not operate correctly remove it for a complete check and adjustment. If the dash unit operates correctly reconnect the leads to the terminals and disconnect the leads from the tank unit. Repeat the above test by grounding first the lead that was connected to the No. 2 terminal on the tank unit then by grounding both leads. If the indications are not as described it indicates a grounded or open lead which should be repaired. By elimination, if the gauge operates correctly in the above two tests, the tank unit can be regarded as the cause of the original inoperation. When reconnecting the leads to the dash or tank units be careful not to interchange them as this would reverse the indications.

Erratic or incorrect indications may be caused by a loose connection or ground in the wiring or terminals while a fluctuating pointer is usually caused by dirty contacts in the dash unit. Sticking pointers may be caused by a bent pointer or frame or by interference between the gauge and panel. Remove the gauge from the panel and inspect for a bent pointer or pointer bearings. Check to see that there is a slight amount of end play in the pointer shaft and that the pointer turns freely. Clean the contacts by drawing a strip of clean bond paper between them.

To calibrate the dash unit place the gauge on the bench in the same position as it was mounted in the panel. Shield the unit from air currents that would cause uneven cooling of the bimetal blades. Connect the "IGN SW" terminal to the battery, connect the No. 1 and No. 2 terminals to a tank unit known to be in good condition and ground the tank unit case to the other battery terminal.

Set the float arm in the "empty" position and allow time for the pointer to reach its indication. Adjust the pointer position by moving the arm carrying the stationary contact point. This arm is pivoted at its upper end and can be moved out or in with a slight pressure. Set the float arm in the "full" position and allow time for the pointer to come to rest. Adjust the pointer position by moving the arm carrying the insulating stop in the same manner as that just described for the left hand arm.

Repeat the adjustments at the "empty" and "full" positions until no more change is necessary.