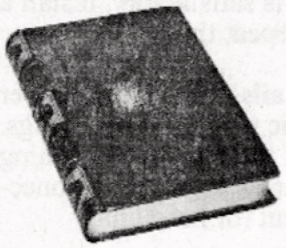

AUTOMOTIVE

Maintenance and Trouble Shooting

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American Technical Society, Chicago, IL
1954

This is a continuation of last month's article on Instruments. In the March issue we covered an introduction to Electrical Instruments and Non-electrical Instruments, Ammeters, Voltmeter (Charge Indicator). We continue this month with the Fuel Level Gauge, Oil Pressure Gauge, Temperature Gauge, Mechanical Speedometers and Electrical Speedometers and Tachometers.

INSTRUMENTS

V. Fuel Level Gauge .
VI. Oil Pressure Gauge
VII. Temperature Gauge
VIII. Mechanical Speedometers
IX. Electrical Speedometers and Tachometers

V. FUEL LEVEL GAUGE

This section contains trouble shooting procedures for electrical and non-electrical type fuel level gauges. The tests necessary to locate the cause of trouble are included in these procedures. Whatever trouble may be experienced with fuel level gauges, regardless of the exact nature, can be solved by following these tests. These procedures do not take into consideration the possibility that the instrument pointer might be stuck or bent, or that the float arm of the tank unit (sending unit) might be bent, causing an inaccurate reading. If there is doubt about these possible conditions, the old unit can be checked against a new one known to be good.

a. Electrical Type Fails to Register. Typical wiring circuits for electrical fuel level gauges are shown in Figs. 3, 4, and 12. The ignition switch is always connected in series with the fuel gauge to prevent discharge of the battery through the instrument when the engine is not operating.

If the gauge fails to register, it is necessary to determine whether the sending unit, the receiving unit, or the wiring which connects the two units is at fault. The tests necessary to locate the cause of the trouble may be performed in two ways. The first method requires the use of a spare sending unit known to be in good condition. The second method involves "shorting" the sending unit.

A fuel gauge sending unit can also be used as a testing device for electrically operated oil pressure gauges, or temperature gauges, as explained later in this chapter in Sections VI and VII.

(1) TESTING WITH SPARE SENDING UNIT (TANK UNIT). Select a fuel gauge sending unit known to be satisfactory for testing purposes.

NOTE: *If there is any doubt about the satisfactory operation of the sending unit selected, connect it in series with a receiving unit known to be satisfactory and a six-volt battery). Operate the sending unit float arm by hand. If the receiving unit reads "zero" with the float in its bottom position and "full" with the float in its top position, the spare sending unit can be considered as a satisfactory testing device.*

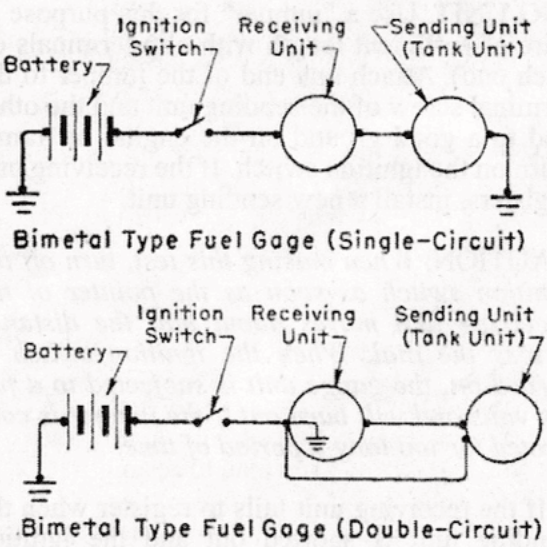


Fig. 12 Typical Wiring Circuits - Electric Fuel Level

Disconnect the sending unit being tested. In its place connect the sending unit selected for a tester. Use two ten-foot lengths of insulated wire equipped with clip terminals at each end to make this connection so that the test can be made sitting in the driver's seat where the operation of the receiving unit can be observed.

Turn on the ignition switch. With the float of the spare tank unit being used as a tester at the bottom position, the receiving unit should register at the bottom mark on the dial. By moving the float of the tester toward its top position, the receiving unit pointer should gradually move to the top mark on the dial. It is necessary to allow about one minute for the receiving unit to heat up.

If the receiving unit operates satisfactorily, inspect the sending unit on the vehicle to be sure that it is properly grounded. If the vehicle is equipped with a radio, a condenser is usually installed at the sending unit. If the condenser is shorted, the receiving unit will overread.

If the sending unit is properly grounded and the receiving unit registers properly, install a new sending unit.

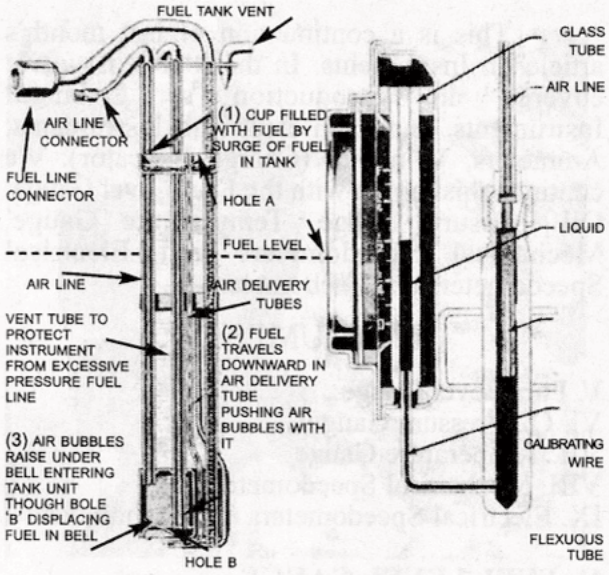
If the receiving unit does not operate or fails to indicate correctly, inspect the wiring between the two units for open circuits or grounds. If the wiring is satisfactory, install a new receiving unit.

(2) TESTING BY SHORTING OUT SENDING UNIT. Use a "jumper" for this purpose (a wire of sufficient length with clip terminals on each end). Attach one end of the jumper to the terminal screw of the sending unit and the other end to a good ground on the engine or frame. Turn on the ignition switch. If the receiving unit registers, install a new sending unit.

CAUTION: *When making this test, turn off the ignition switch as soon as the pointer of the receiving unit moves about half the distance across the dial. When the ignition switch is turned on, the gauge unit is subjected to a full six volts and will burn out if the jumper is connected for too long a period of time.*

If the receiving unit fails to register when the sending unit is shorted out and the ignition switch is turned on, inspect the wiring and connections between the two units for open circuits or grounds. If the wiring is satisfactory, install a new receiving unit and repeat the test.

b. Hydrostatic Type Fails to Register. Proper operation of the hydrostatic type fuel gauge (Figs. 13 and 14) depends upon the proper functioning of the sending unit (tank unit), the air line connections, and the receiving unit (or head unit).



Hydrostatic Fuel Gauge

Fig 13 Sending Unit ***Fig. 14 Receiving Unit***

(1) TESTING RECEIVING UNIT. The U tube receiving unit must hold liquid and read zero (0) when disconnected. To set the gauge reading exactly at the zero mark as required, remove or add liquid. Disconnect the air line from the brass tube (Fig. 14). To remove liquid, use a slender wooden stick, such as a toothpick, to absorb some of the liquid in the brass tube. To add liquid, use a small size medicine dropper. Inspect the receiving unit for evidence of dirt or flaws in the seat where the air line is connected. Look for evidence of leakage in the small flexuous tube between the brass tube and the glass tube.

NOTE: *The accuracy of the hydrostatic type fuel gauge is dependent on the specific gravity of the fluid used in the receiving unit. Use only fluid which is made specifically for this type of gauge.*

Test the receiving unit for leakage of air or liquid, or for obstructions. Pump the liquid up into the unit to a point on the gauge above the bottom line. To do this, move the thumb rapidly up

and down against the top end of the brass tube at the back of the unit. This action will cause the liquid to rise in the glass tube. Press the thumb against the top of the tube to hold the liquid at a given point. If the liquid will not rise or will not hold at a given point, there is an air leak, liquid leak, or an obstruction in the unit. It is not practical to attempt repairs if this condition exists, and a new receiving unit should be installed.

(2) TESTING AIR LINE. The air line (Fig. 14) which connects the sending and receiving units must be free from leaks and obstructions. The most common cause for obstruction is the accumulation of gasoline or water in the air lines. Any liquid obstruction in the air line will cause erratic gauge readings, particularly when the vehicle is accelerated or brought to a sudden stop.

Use a hand tire pump to blowout the air line. Install a connector (Fig. 15) on the gauge line at the receiving unit end and attach the tire pump to the connector. Operate the hand pump for at least fifty continuous full strokes to remove all moisture or gasoline. Then close the air line with a plug (Fig. 15) and suck on the other end of the line. Create as much suction in the line as possible and hold the vacuum thus created by pressing the tongue against the air line. If there are no leaks in the air line, the vacuum created should hold the tongue against the line for at least one minute. Check the receiving unit again to be sure that it registers at the zero mark. Reconnect the air line to the unit, making sure the connection is tight. Try the sending unit connection to be sure it is tight.

CAUTION: *Never use compressed air to blow out the air line. Compressed air usually contains water or moisture which will accumulate in the air line and cause the gauge to register incorrectly.*

(3) TESTING SENDING UNIT (TANK UNIT). The sending unit must supply air by the surging of the gasoline in the fuel tank. Stopping, starting, and turning corners will hasten this action. After the system is supplied with air, the gauge should not lose its reading unless it is disconnected. A quick method to fill the system with air is to disconnect the fuel line at the fuel pump and blow into it with the mouth (do not use compressed air). On vehicles having a fuel tank mounted under the driver's seat, drain the tank or drive the vehicle so that the fuel in the tank will surge sufficiently to fill the system with air.

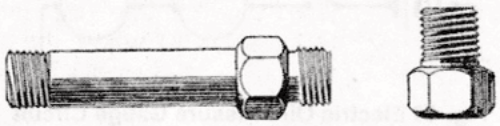


Fig. 15. Connector and Plug for Making Hydrostatic Fuel Gauge Tests

If a satisfactory reading can be obtained on the gauge but it will not remain accurate, inspect air line connections for dirt or flaws which could cause air leaks.

The sending unit (Fig. 13) seldom is the cause of trouble. If, however, it is known that the receiving unit, air line, and all connections are satisfactory and the gauge still fails to register properly, replace the sending unit, as it is not practical to attempt repairs.

VI. OIL PRESSURE GAUGE

Troubleshooting procedures in this section pertain to two types of oil pressure gauges commonly used on automotive vehicles. One type is operated electrically. This type gauge consists of a sending unit and a receiving unit connected by wiring. The other type oil pressure gauge operates on the pressure-expansion principle. This type gauge is made as one complete assembly consisting of bulb (sending unit), connecting line, and gauge.

a. Electrical Type Fails to Register. An oil pressure gauge of the electrical type (Fig. 16) operates on the same basic principle as an electrical type fuel level gauge which is more fully described in Section I in the March 2012 issue of *SK* under the heading, "Fuel Level, Temperature, and Oil Pressure Gauges."

Since the unit is basically the same in principle as the electrically operated fuel level gauge, the same tests may be used to locate trouble. These tests involve the use of a spare fuel gauge tank sending unit as a tester, as explained in Section V under "Testing with Spare Sending Unit." In addition, the gauge may be tested as described for the electrical type fuel level gauge in Section V under the heading "Testing by Shorting Out Sending Unit".

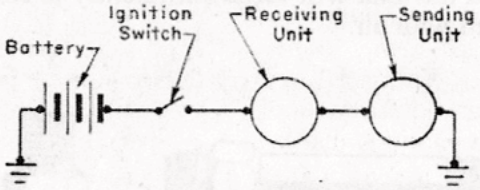


Fig. 16 Electric Oil Pressure Gauge Circuit

b. Pressure-Expansion Type Fails to Register. 'When the engine is idling, the oil pressure gauge should show a small amount of pressure. As the engine is speeded up, the gauge should register a higher pressure. On most vehicles, an engine speed equivalent to a car speed of 30 mph will cause the gauge to show its maximum pressure. A typical, pressure-expansion type, oil pressure gauge is illustrated in Fig. 8. (March 2012 issue of *SK*).

NOTE: *When an engine has seen considerable service clearance in the main and connecting rod bearings and in the camshaft bearings will cause a drop in oil pressure readings, particularly at idling speeds. If the oil pressure gauge shows no pressure at idling speed but indicates pressure as soon as the engine is speeded up, the gauge should not be considered faulty.*

If the gauge fails to register or the action of the pointer is sticky, jumpy, or uneven, replace the gauge as it is not practical to attempt repairs.

VII. TEMPERATURE GAUGE

The troubleshooting procedures in this section pertain to two types of temperature gauges commonly used on automotive vehicles. One type is operated electrically by a sending unit mounted on the engine.

On some V type engines, two sending units are employed (Figs. 6 [March 2012 issue of *SK*] and 17). The second unit registers boiling temperature in the second cylinder bank. Therefore, if the coolant reaches the boiling point (200-212° F) in either bank, the instrument panel gauge unit will indicate the temperature of the cylinder bank which is the hotter.

On other engines equipped with an electrically operated temperature gauge, the second sending unit shown in Figs. 6 and 17 is not required.

Another type of temperature indicator used on automotive vehicles is the vapor-pressure type, shown in Fig. 18.

a. Electrical Temperature Gauge Having Two Sending Units Fails to Operate. This type of gauge should read in the "hot" position when the ignition switch is turned off, regardless of the temperature of the engine. "When the ignition switch is turned on, the pointer of the instrument should move toward the "cold" position and register the temperature of the engine. If the gauge does not operate in this manner, there is a short or open circuit in the wiring (Fig. 17), or the sending units or the instrument itself is at fault.

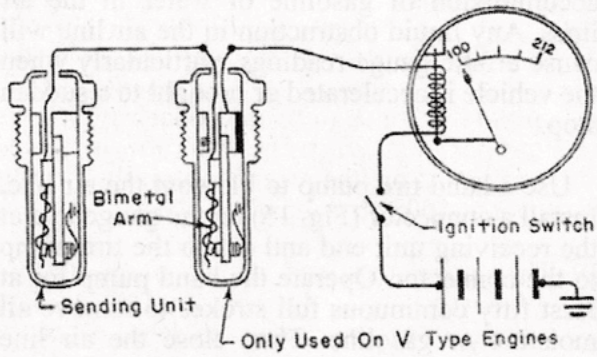


Fig. 17. Typical Temperature Gauge Circuit with Two Sending Units

(Courtesy Ford Motor Company)

If the wiring is grounded, the instrument will register in the "cold" position: when the ignition switch is turned on, regardless of the temperature of the engine. If there is an open circuit in the wiring, the instrument will register in the "hot" position when the ignition switch is turned on, regardless of the temperature of the engine.

To determine where trouble exists in the wiring, or whether the sending units or instrument is at fault, make the following test: (I) Turn on the ignition switch and leave it on during the test. (2) Ground the terminal of the sending unit which is farthest from the instrument. (3) If the pointer failed to move to the "cold" position, but now moves to "cold," when the terminals are shorted, the sending unit is at fault. (4) If the pointer stays at the "hot" position when the sending unit terminal is shorted, an "open" exists between the sending unit and the instrument. (5) To determine where the open is, short out in turn each terminal between the sending unit and the instrument until a "cold" reading is obtained. The wire or unit between the point where a "cold" reading is obtained, and the last point where a "cold" reading was not obtained is at fault.

b. Electrical Temperature Gauge with One Sending Unit Fails to Register. The electrical temperature gauge with a single sending unit operates on the same principle as an electrical fuel level gauge which is more fully described in Section I of this chapter.

The same tests used to locate trouble in the electrically operated fuel gauge may be used to locate trouble in this type gauge. These tests are made with a fuel gauge spare tank sending unit as explained on page 28.

Most electrically operated water temperature indicators register at about 212° F on the dial when the ignition switch is turned off. When testing this type temperature indicator, the receiving unit should register about 212° F when the fuel gauge tank unit float arm is at its bottom position. When the float arm is moved to its top position, the receiving unit should register about 100° on the dial.

The gauge may be tested more quickly by momentarily shorting the sending unit as described for the electrical fuel level gauge on page 29.

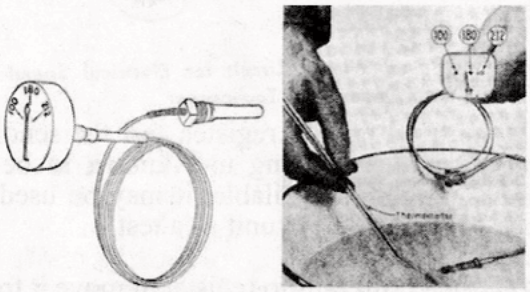


Fig. 18 Vapor Pressure Type Temperature Indicator and Method of Testing
(Courtesy AC Spark Plug Div. - General Motors Corp.)

c. Vapor-Pressure Temperature Gauge Fails to Register. The normal operating temperature of most liquid cooled internal-combustion engines is from 150 to 180° F. In localities where atmospheric temperatures rise higher than 100° F, the temperature gauge may register engine temperatures of 200° or higher.

If the gauge fails to register after the engine has reached normal operating temperature, or continues to register high temperatures when the engine is cold, drain the engine cooling system and remove the gauge bulb from the cylinder head.

Heat a pan of water and immerse the bulb of the gauge in the water. To check the gauge, immerse also a thermometer which registers up to 212° F (Fig. 18) or higher. Compare the reading on the thermometer with that on the gauge. If the gauge is inaccurate or will not register, it cannot be repaired. The entire unit must be replaced.

VIII. MECHANICAL SPEEDOMETERS

The troubles experienced with mechanically operated speedometers are that they (I) fail to show both speed and mileage, or that the pointers fluctuate; (2) fail to show either speed or mileage, or the pointers will not return to zero; or that they give an inaccurate reading.

a. Fails to Show both Speed and Mileage, or Pointer Fluctuates. Fluctuation of the speedometer pointer, or failure to indicate speed and mileage, is usually caused by a kinked or broken drive cable or casing. Remove and inspect the speedometer cable; if broken or kinked, install a new assembly. When the speedometer cable is installed, it should be positioned so that there are no sharp kinks or bends in the cable housing. A typical speedometer drive cable and casing is shown in Fig. 19.

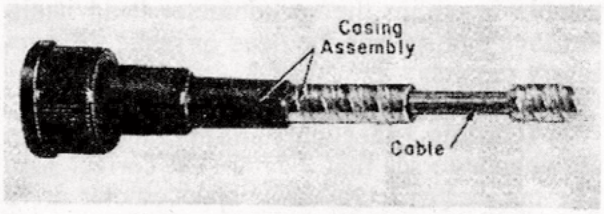


Fig. 19. Speedometer Drive Cable and Casing
(Courtesy AC Spark Plug Div.—General Motors Corp.)

To test for a kink in the cable, hold the two ends of the cable in the hands with the cable looped down (Fig. 20). Turn the cable slowly. If kinked, the looped end of the cable will "flop."

NOTE: *Breakage of the speedometer cable sometimes results from the use of a cable assembly which is too long. When a cable is replaced, be sure the new cable is exactly the same over-all length.*

If the drive cable is satisfactory, test the speedometer head for binding (Fig. 20). This can be done by using a short piece of speedometer cable (about 3 to 4 in. long) with a tip to fit

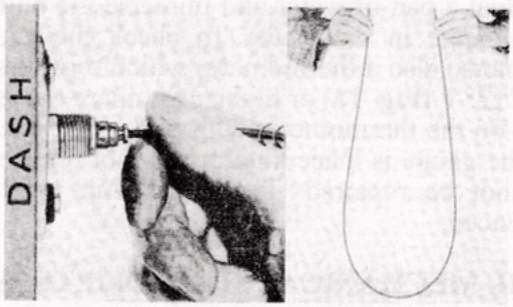


Fig. 20 Testing Speedometer Head and Drive Cable
(Courtesy AC Spark Plug Div. - General Motors Corp.)

the speedometer on which the test is being made. With the speedometer drive cable disconnected, insert the tip end of the short piece of cable in the speedometer socket. Spin the cable between the thumb and forefinger in the proper direction to cause the pointer to indicate speed on the speedometer dial. If there is any tendency for the speedometer to bind, remove the head for the necessary repairs. If the test indicates that there is no binding when the cable is spun, the speedometer head may be considered satisfactory.

b. Fails to Show Either Speed or Mileage, or the Pointer Will Not Return to Zero. If the speedometer pointer fails to return to zero or fails to indicate either speed or mileage, the trouble is within the speedometer head itself. Remove and replace the head or make the necessary repairs.

c. Reading Inaccurate. Inspect the tires on the vehicle to see that they are the correct size. The number of teeth in the speedometer drive gears in the transmission (or transfer case used on four-wheel drive vehicles) depends on the size of the tires and the gear ratio of the rear axle with which the vehicle was originally equipped. Any change in tire size or axle ratio will cause the speedometer to register either too slow or too fast. If the tire size is correct (same size as original equipment tires) remove the speedometer head for the necessary repairs.

IX. ELECTRICAL SPEEDOMETERS AND TACHOMETERS

The following trouble shooting procedures for the electrical type speedometer or tachometer are intended to correct such faults as failure to register, violent pointer fluctuation, and inaccurate reading.

a. Failure to Register. If the pointer of an electrical speedometer or tachometer stays at zero, check first for loose terminal connections in the wiring circuit (Fig. 21). Be sure the three connections on the head and the three on the sending unit are clean and tight. Jack up a rear wheel of the vehicle and run the engine with the transmission in high gear. Observe the speed indication.

If the head fails to register, remove the sending unit to make sure the flexible shaft or clutch which drives the sending unit is not broken or defective. Carefully inspect for binding in the drive joint. Remove the drive joint. 'With a rear wheel jacked up, operate the vehicle with the transmission in high gear to see that the driven gear in the transmission is operating properly.

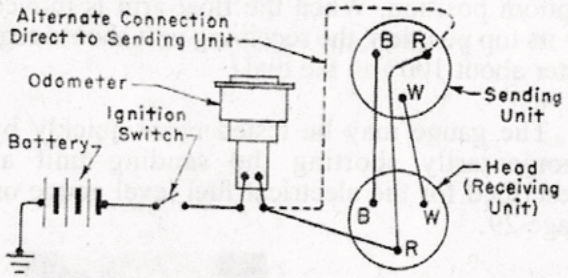


Fig. 21. Typical Wiring Circuit for Electrical Speedometer or Tachometer

If the head fails to register, test the sending unit. If another sending unit known to be in good condition is available, it may be used in place of the suspected unit as a test.

If the head still fails to register, remove it from the vehicle for testing on a special calibrating machine. If such equipment is not available,

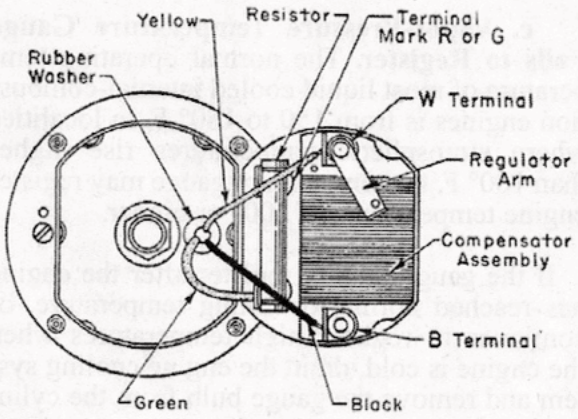


Fig. 22. Typical Wiring of Electrical Speedometer and Tachometer Heads
(Courtesy Stewart-Warner Corporation)

another head may be substituted for testing purposes. To determine whether or not there are any grounded connections inside the head, test for grounds as described under "Test Procedures" in this section. A typical wiring diagram of a speedometer and tachometer head is illustrated in Fig. 22.

Before replacing the head, always check all lead wires for possible grounds by the same method used to check for grounds within the head itself.

b. Pointer Fluctuates Violently. Remove the sending unit, inspect the flexible drive shaft or clutch to be sure that the drive units are operating properly. Inspect for binding in the drive joint and be sure the drive clutch is properly installed.

Test the sending unit or substitute another unit known to be in good condition as a test. If the pointer still fluctuates, inspect for grounds in the head (Fig. 22) or in one of the lead wires as described under "Test Procedures" in this section.

c. Reading Inaccurate. Remove the head from the vehicle and test on a special calibrating machine or substitute another head and run the vehicle with the transmission in gear. If another head is not available, test for grounded or open circuits.

If the head is found to be in satisfactory operating condition, remove the sending unit so as to test it on a special calibrating machine, or substitute another unit and run the vehicle with the transmission in gear. If another unit is not available, test sending unit as described under "Test Procedures." Inspect lead wire to head to be sure that it is not broken.

If head, sending unit, and wiring are satisfactory, and unit still registers incorrectly, it can be assumed that the ratio of the speedometer drive gears is incorrect for the axle ratio and tire size.

d. Test Procedure. To locate causes of troubles in electrically operated speedometers or tachometer, three tests will establish whether the wiring, sending unit, or head is at fault.

(1) TEST FOR OPEN OR GROUNDED CIRCUIT. Use a six volt head light or tail light bulb to test for grounded or broken wires in the circuit of an electrical tachometer or speedometer.

CAUTION: *The lead wires must be disconnected from the sending unit when making these tests) as current from the battery will ruin the magnet in the sending unit.*

With all three leads disconnected from the sending unit, connect one of the test light bulb terminals in series with one of the lead wires, and the other terminal of the bulb in a live battery terminal. If there are no grounds to the head or lead wires, the test light bulb will not light.

If the bulb does light, there is a ground in one or more, or both, of the lead wires or in the speedometer or tachometer head. Disconnect all three lead wires from the speedometer or tachometer head and make the following tests:

(a) TEST LEAD WIRES FOR GROUND. Connect a terminal of the test light bulb to one of the lead wires at the sending unit end of the wire, and the other bulb terminal to a live battery terminal. If the bulb lights, a ground is indicated, and the lead wire should be repaired or replaced. Repeat this same test for the other lead wires. If any grounds are found in the lead wires, repeat the test for grounds after repairs or replacements are made.

(b) TEST HEAD UNIT FOR GROUND. Leave all the lead wires disconnected at the sending unit and connect all of them to the head unit. Repeat the tests for grounds as outlined previously. If the test light bulb now lights, there is a ground in the head unit and it must be removed and repaired.

(c) TEST LEAD WIRES FOR OPENS. Test all lead wires for open circuit. This can be done by grounding the three lead wires where they are connected to the head unit, by connecting a jumper from the terminals on the head unit to any good ground on the vehicle.

CAUTION: *Make sure all lead wires are disconnected from the sending unit to prevent battery current from reaching the sending unit magnet.*

Connect one terminal of the test light to one of the wire terminal connections at the sending unit end, and the other terminal of the test light bulb to a live battery terminal. The test light bulb should light, indicating a complete circuit. If the test light does not light, an open circuit is indicated, and the lead wire probably is broken.

(2) SENDING UNIT TESTS. A regular flashlight bulb as used in a two-cell flashlight may be used as a test light to test the sending unit of an electrical speedometer or tachometer. The tests should be made in a dimly lighted room where it is possible to observe the brilliance of the test light while the tests are being made.

Remove the sending unit cover and disconnect all three lead wires.

If a calibrating machine is available, the sending unit should be removed from the vehicle. The test may also be made without removing the sending unit, however, by jacking up a rear wheel of the vehicle, placing the transmission in high gear, and running the engine at a speed equal to 30 to 40 mph.

Connect the flashlight bulb in series with terminals Band R (Fig. 21) of the sending unit and check for the following conditions: (1) If the bulb does not light, there is a broken wire in the circuit. (2) If the bulb alternately gets dim and bright about every two seconds or goes on and off, there is a ground in the sending unit.

Repeat the test by connecting the bulb between terminals Band R, and next between terminals B and HI (Fig. 21). The sending unit is satisfactory if the bulb burns steadily but slightly brighter when connected between terminals Band W than when connected between terminals Band R.

In the wiring circuit diagram (Fig. 21), an alternate connection for the odometer is illustrated. When tests are being made between terminals Band R with this type of equipment, the test light bulb should alternately get dim and bright since it is grounded through the odometer switch.

If the bulb reacts unfavorably, the lead wires within the sending unit are grounded or open-circuited, or the armature itself is defective and should be replaced.

(3) HEAD TESTS. Two tests may be made to check the operation of an electrical speedometer or tachometer head. The compensator and resistor assembly shown in Fig. 22 may be tested as one unit. The armature may be tested for grounded or open circuit.

(a) COMPENSATOR AND RESISTOR ASSEMBLY. A regular flashlight bulb used with a two-cell flashlight may be used in conjunction with a six volt battery to test the compensator and resistor assembly.

Remove the head from the vehicle and disassemble the compensator and resistor assembly. Connect the flashlight bulb in series between one terminal of the battery and terminal W (Fig. 21). Connect another lead wire between the other battery terminal and terminal B (Fig. 21). If the wires and the compensator are not broken and the regulator has a good contact, the bulb will light. As the regulator arm is moved clockwise, the bulb should burn more brightly and should be dimmer than when the arm is moved counterclockwise.

If the compensator and resistor assembly is inoperative it should be replaced.

(b) ARMATURE. A regular six-volt head light or taillight bulb may be used to test the armature. Remove the head from the vehicle and unsolder the lead wires on the back plate. Connect the bulb in series with one of the lead wires unsoldered from the back plate. Connect another lead wire from the battery to anyone of the other lead wires (yellow, green, or black) on the back plate (Fig. 22).

Move the two test leads so that all combination of the yellow, green, and black wires are tested. For example, if the two test leads are first connected to the yellow and green wires, the next step would be to connect the test wires to the green and black wires, and finally to the black and yellow wires. The test bulb should burn with equal brilliance when it is connected to anyone of the three possible combinations. If the bulb burns brighter on anyone combination, it can be assumed that there is a short in the armature. If the test light bulb does not burn at all, it can be assumed that there is an open circuit (broken or loose connection) in the armature. In any case of trouble within the armature itself, it should be replaced.

S.K.