Blue Ribbon Service

GSS-1052-C

Testing and Servicing Electrical Equipment

on

Farm and Industrial Equipment

INTERNATIONAL HARVESTER COMPANY

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FOREWORD

The instructions and special tools shown in this Blue Ribbon Service Manual are for use by International Harvester Dealers and their factory trained servicemen.

The specifications as listed in this manual are current as of the printing date. Due to changes and improvements in our products, dealers are periodically issued service bulletins to keep this manual up-to-date. We suggest you refer to the most recent information when performing service work on this equipment.

International Harvester Factory Trained servicemen are best qualified to service IH equipment.

IMPORTANT NOTE

Always read each step in its entirety before starting to perform it. Necessarily, some vital information may come at the middle or end of the step. Much time can be saved, and damage to parts avoided, if procedures are studied before work begins.

LIBRARY FILING INFORMATION

1. File this Manual (GSS-1052-C) in Book 2 after Divider Tab GSS-1052. Destroy the GSS-1052 Manual.

2. Enter the following information in the Service Manual Index.

   Add the suffix letter "C" to the Form Number and change the description to read Testing and Servicing Electrical Equipment, on the following pages: 11, 31, 38, 44, 46 and 51.

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INTRODUCTION

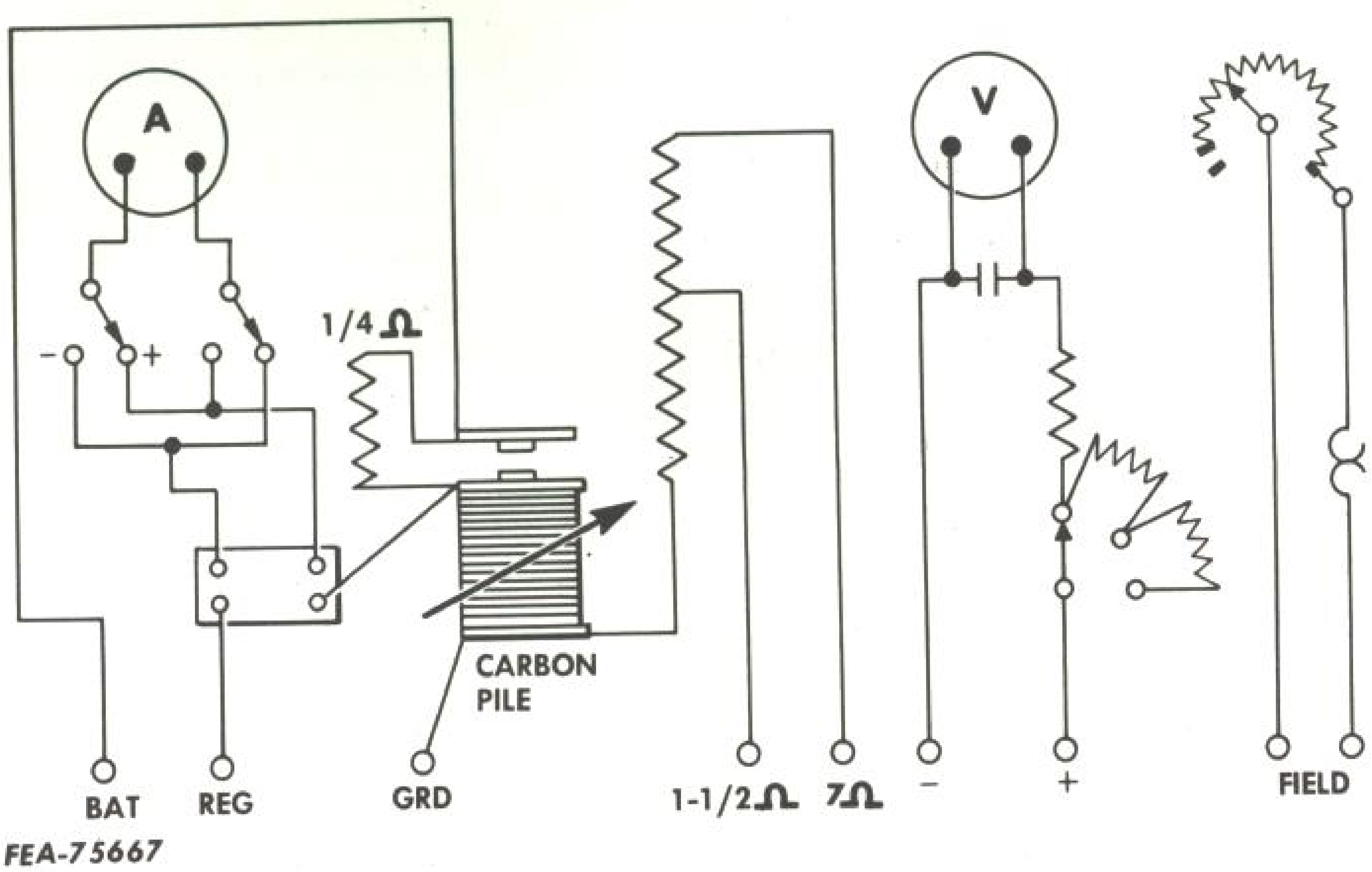
The purpose of this manual is to provide the serviceman with information on the testing and servicing of the electrical equipment used on International Harvester Farm and Industrial Equipment.

Proper use of the information contained in this manual requires that the serviceman be thoroughly familiar with the basic electrical principles described in Blue Ribbon Service Manual GSS-1310. Application of these basic principles is described in this manual.

For specifications and wiring diagrams pertaining to the equipment covered in this manual, refer to the Electrical Specifications Manual GSS-1308-C.

For analysis of spark plug, glow plug, distributor point and battery failures, consult the Service Analysis Manual GSS-1306.

EQUIPMENT REQUIRED FOR CIRCUIT TESTING



Illust. 1. Schematic wiring diagram of FES-63 Volt-Ampere Tester.

The only equipment required to completely check an electrical circuit is a volt-ampere tester such as our special tool FES 63. This tester is a combination voltmeter and ammeter in a single unit. The voltmeter is of the multi-range type to cover both 6 and 12 volt systems. It also gives readable indications below one volt for use in checking voltage drop in high circuit resistance. The ammeter may also be of the multi-range type.

In addition the voltmeter and ammeter, FES 63 tester incorporates 1/4, 1-1/2 and 7 ohm fixed resistors, a variable resistor and a carbon pile for loading a battery. An internal wiring diagram is shown in Illust. 1.

<u>CAUTION:</u> Whenever an unknown circuit is being tested, be sure that the carbon pile is connected into the circuit to prevent damage to the tester.

GENERAL INFORMATION

The systematic use of a volt-ampere tester (FES 63) in connection with an orderly sequence of visual inspection will disclose the causes of malfunction in the electrical circuits in the shortest possible time. It is not enough to know the general area of the fault. To save time and the needless replacement of parts, the actual point of failure must be located. This requires the use of accurate test equipment and a proper step-by-step procedure. Do not be satisfied if one of the inspections or tests discloses an irregular condition; there may be more. Continue the inspections and tests until all steps have been completed.

As an illustration, the current-voltage regulator may be believed defective due to continued low condition of charge in the storage battery. This condition may be caused by any one or a combination of the following factors:

Battery - a battery that is not in serviceable condition.

Wiring and connections. Faults in the wiring - such as poorly soldered terminals or dirty or loose connections causing high resistance in the circuit - will result in a low charging rate regardless of battery condition.

Generator. Dirty or out-of-round commutator, worn bearings, worn brushes, high commutator mica, poor internal connections, or loose or worn drive belts will reduce the normal output of the generator.

Regulator - oxidized regulator contact points, low range voltage adjustment, faulty regulator ground connection.

Operating condition - continuous loads in excess of generator capacity, such as frequent cranking demand in combination with too short an operating time to replace battery loss.

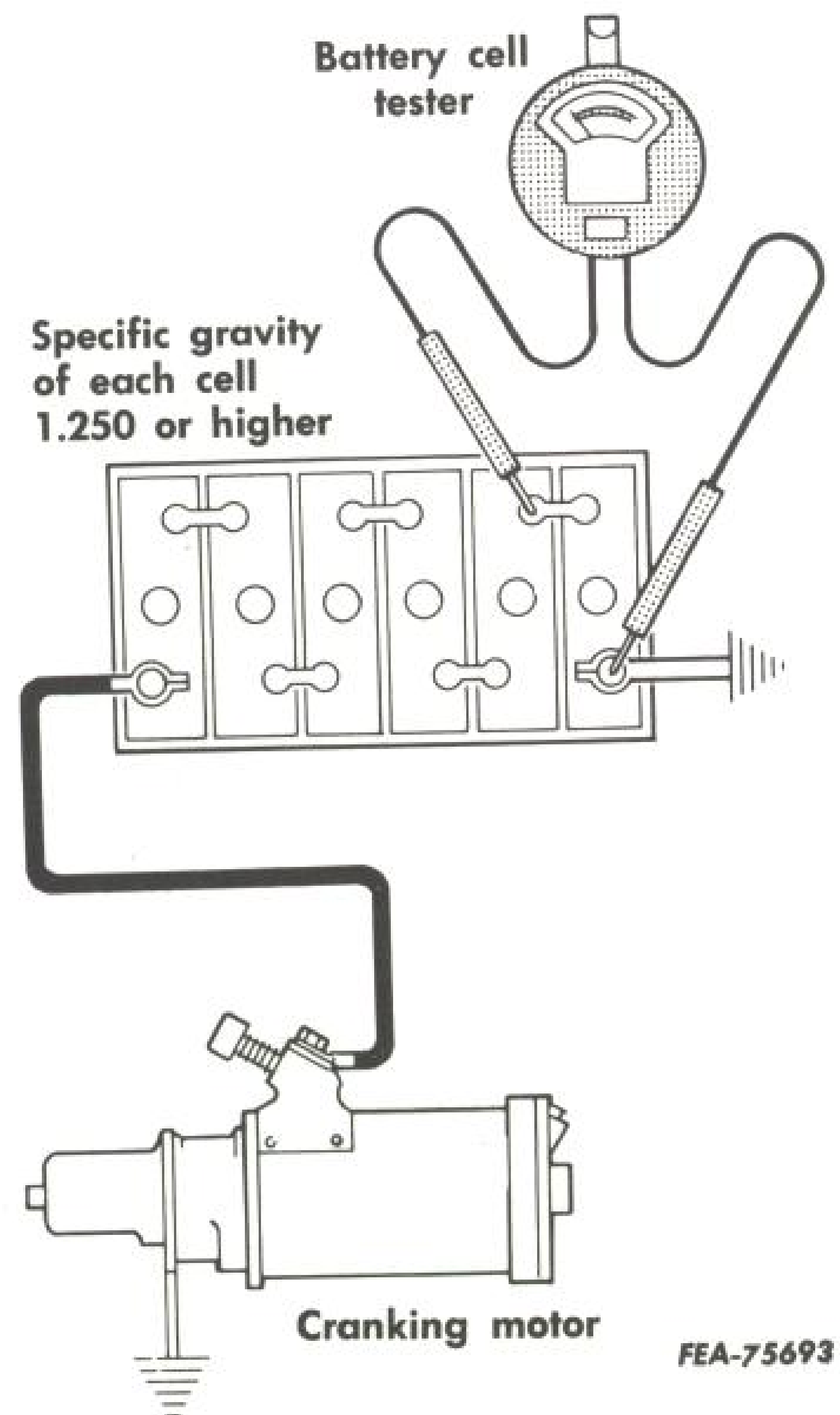
Only a complete test of the circuits in an orderly sequence will disclose all possibilities of electrical malfunction. After the test, the problem of operating conditions, if irregular, can be discussed with the operator.

CHARGING SYSTEM

TESTING THE DC CHARGING SYSTEM

Battery

The battery should be checked for state of charge and condition before any checks are made. Place a load on the battery by cranking or turning on all the lights and check the voltage of each cell. The voltage should not drop below 1.5 volts per cell and not vary more than .2 volt between cells. Illust. 2. Specific gravity should read at least 1.250 (corrected to 80°F) per cell.



Illust. 2. Checking battery cell voltage.

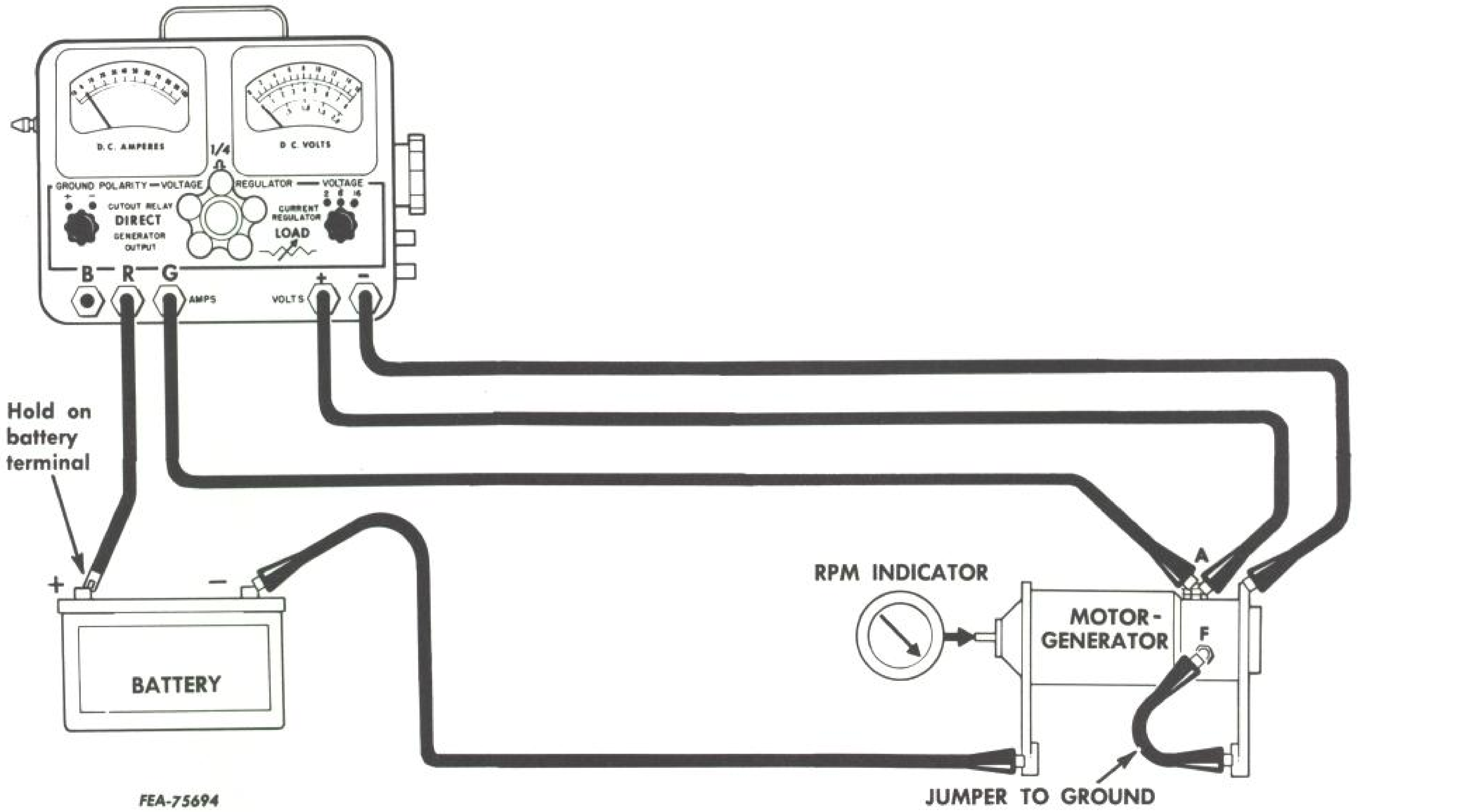
CAUTION: On carbureted engines, it will be necessary to disconnect the primary wire from its terminal on the distributor to prevent ignition during the cranking period.

Never operate the cranking motor for more than 30 seconds without allowing it to cool.

Motor-Generator

If the motor-generator fails to crank properly, inspect the entire cranking circuit for loose or badly corroded connections and damaged wiring. It may be desirable to perform a ground circuit and an insulated circuit resistance test as covered on pages 19 and 20. With the battery and wiring in good condition, close the motor switch. If the unit fails to crank, connect a jumper across the motor switch.

If the motor-generator operates, the motor switch is defective and should be replaced. If the motor fails to operate, trouble can be attributed to the engine or motor-generator. Excessive friction in the engine from tight bearings or pistons, or from heavy oil obviously makes the engine hard to crank.



Illust. 3. Motor-generator no-load test.

If the motor still fails to crank properly when the engine is known to be in good operating condition and the rest of the cranking circuit is satisfactory, the motor-generator should be removed for further checking.

With the motor-generator removed from the engine, the armature should be checked for freedom of operation by turning the shaft. Tight, dirty or worn bearings, a bent armature shaft or loose pole shoe screws may cause the armature to drag and fail to turn freely. If the armature does not turn freely, the motor must be disassembled.

However, if the armature does operate freely, the motor should be given a "no-load" test before disassembly. During this test, the motor is operated without the drive being connected to a load and the current draw and the armature speed noted.

Motor—No-Load Test

To perform this test, connect the tester as shown in Illust. 3.

CAUTION: A shorted field coil may draw excessive output which may damage the ammeter.

A tachometer or RPM indicator may be used to measure armature revolution per minute or free speed. While this test is performed, the motor should be held in a vise.

With the motor operating and the field grounded, measure the current draw and note the armature speed. Compare these readings with the specifications.

Results and Indications:

1. Low free speed and high current draw indicates:

a. Too much friction - tight, dirty or worn bearings, bent armature shaft or loose pole shoes allowing armature to drag.

b. Shorted armature. This can be further checked on a growler after disassembly.

c. Grounded armature or fields. Check further after disassembly.

2. Failure to operate with high current draw indicates:

a. A direct ground in the terminal or fields.

3. No current draw indicates:

a. Open field circuit. This can be checked after disassembly by inspecting internal connections and tracing circuit with a test lamp.

b. Open armature coils. Inspect the commutator for badly burned bars after disassembly.

c. Broken brush springs, worn brushes, high insulation between the commutator bars or other causes which would prevent good contact between the brushes and commutator.

4. Low no-load speed and low current draw indicates:

a. High internal resistance due to poor connections, defective leads, dirty commutators and causes listed under number 3.

5. High free speed and high current draw indicates:

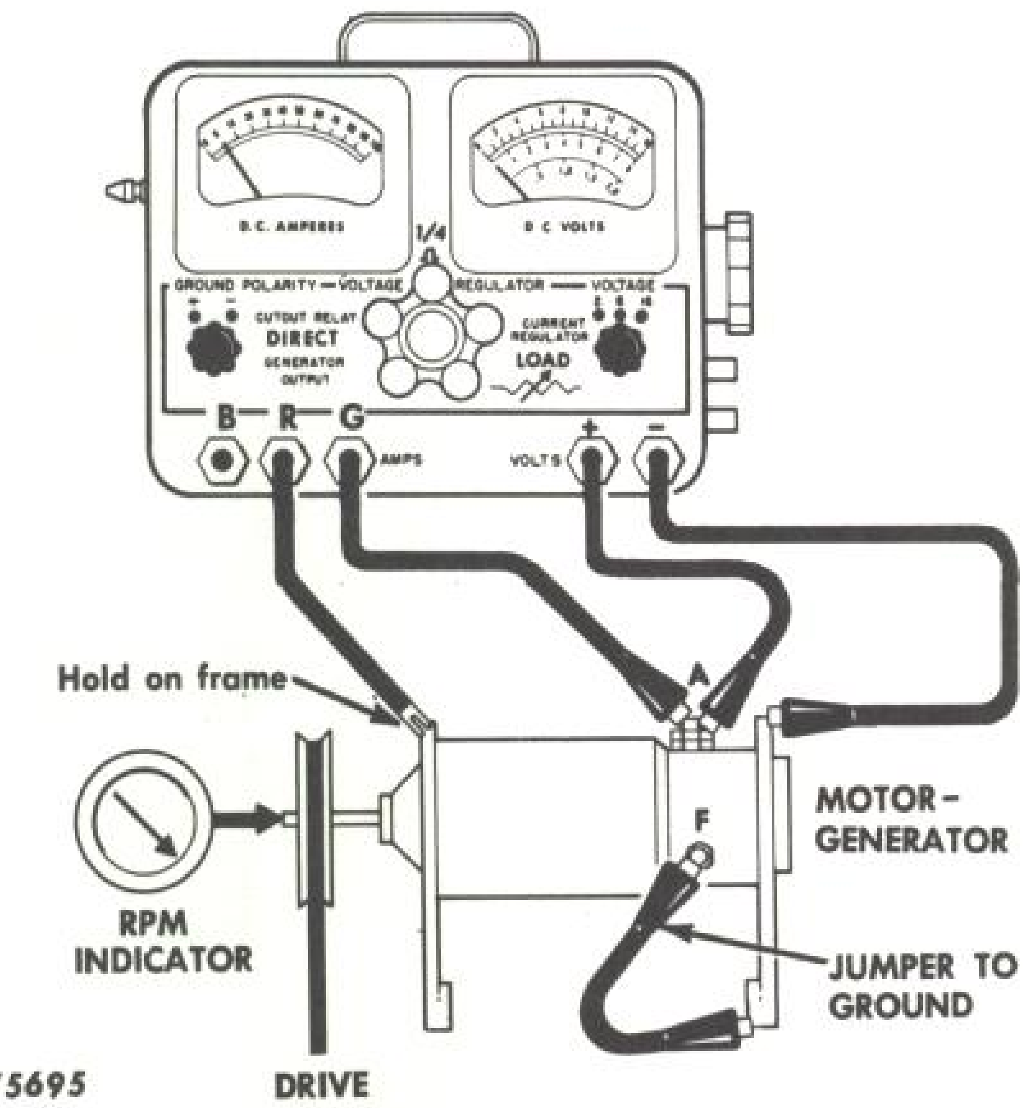
a. Shorted shunt or series field coil. A shorted shunt coil can be determined by following step number 1-c under Generator Output Test. If the shunt coil performs properly, replace the series coil.

6. High free speed and near normal current draw indicates:

a. An open shunt coil. Replace the coil and check for improved performance.

Generator—Output Test

If the motor-generator does not produce rated output during this test or produces excessive output, the unit should be checked further.

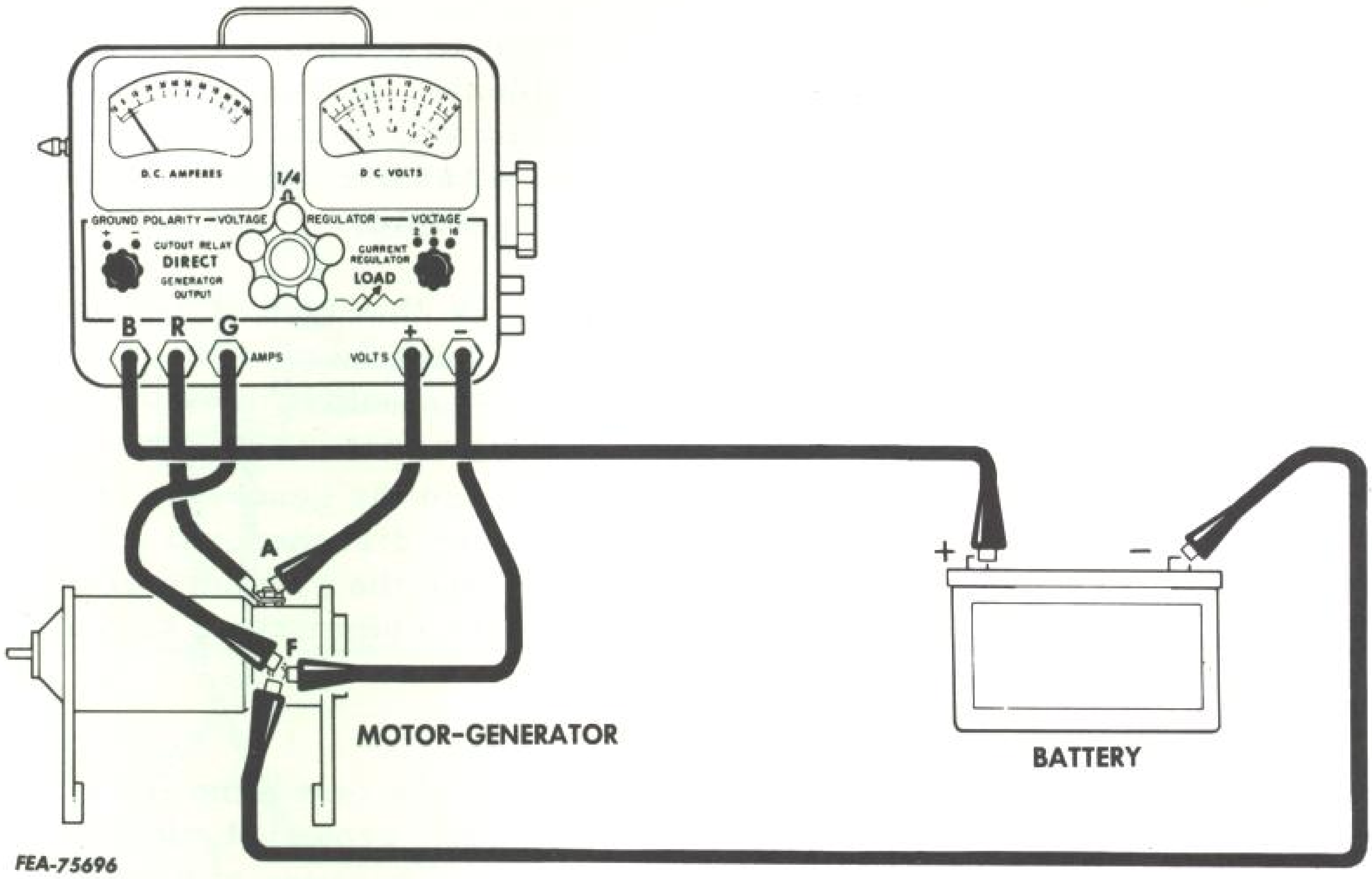


Illust. 4. Motor-generator output test.

To check the motor-generator output, some means of driving the generator is necessary. This can be done either on a test bench or by leaving it on the engine. Connect the tester as shown in Illust. 4. The field connection must be grounded with a jumper lead.

Drive the generator at specified rpm as indicated in specifications. Adjust the voltage by varying the resistor, and read the ammeter. The unit should function according to specifications. Use the following as a guide for the repair or replacement of parts as necessary.

1. NO-OUTPUT. If the generator will not produce any output, check for dirty commutator, sticky brushes, and poor internal connections. Solder thrown from the commutator riser bars indicate that the generator has been overheated from excessive output. Often this leads to an open circuit and burned commutator bars and consequently, no output.



Illust. 5. Checking for shorted field winding.

If the brushes are properly seated and are making good contact with the commutator, and the cause of trouble is not apparent, use a test lamp to locate the trouble as follows. (The leads must be disconnected from the motor-generator terminals.)

a. Raise the grounded brush from the commutator and insulate with a piece of paper. Check for grounds with test prods from the generator "F" terminal to the generator frame.

If the lamp lights, it indicates that the unit is internally grounded. Location of the ground can be found by disconnecing the field and brush leads from the insulated brush holder and checking the brush holders, armature and field separately. Replace or repair parts as required.

b. If the generator is not grounded, check for an open circuit with the test lamp. The lamp should light when one test prod is placed on the field terminal and the other is placed on the armature terminal. If it does not light, the circuit is open.

If the open is due to a broken lead or bad connection, it can be repaired, but if the open is inside the field coils, the damaged coil must be replaced.

c. If the field is not open, check for a short circuit in the field. Connect the tester as shown in Illust. 5. Proceed with caution, as a shorted field may draw excessive current which may damage the ammeter.

If the field current draw is not within specifications for the specified voltage, new field coils are required.

NOTE: If a shorted shunt field winding is found, check the regulator contact points, since a shorted field may have permitted excessive field current which would have caused the regulator contact points to burn. Clean points as necessary.

d. If the trouble has not yet been located, check the armature on a growler for open and short circuits. Open circuits in the armature are usually obvious since an arc will occur at the commutator bars connected to the open winding. This will occur every time they pass under the generator brushes.

If the commutator is not badly burned and the open circuit can be found and repaired, the armature can usually be saved. When this condition is found, the regulator should be checked and readjusted if necessary to bring the setting within specifications.

2. UNSTEADY OR LOW OUTPUT. If the generator produces a low or unsteady output, the following factors should be considered.

a. A loose drive belt that slips and therefore causes a low or unsteady output.

b. Brushes that stick in their holders, or low brush spring tension which will prevent good contact between the brushes and commutator resulting in low or unsteady output. This will also cause arcing and burning of the brushes and commutator.

c. A commutator that is dirty, out of round, or has high mica causes output to be low or unsteady. To correct these conditions, turn the commutator down in a lathe and undercut the mica. Burned commutator bars may indicate an open circuit condition in the armature as already stated in step "D" under "No Output."

3. EXCESSIVE OUTPUT. When a generator produces excessive voltage or current, disconnect the lead from the "F" terminal. If the generator output remains high with the "F" terminal lead disconnected, then the trouble is in the generator itself which must be further analyzed to locate the source of trouble.

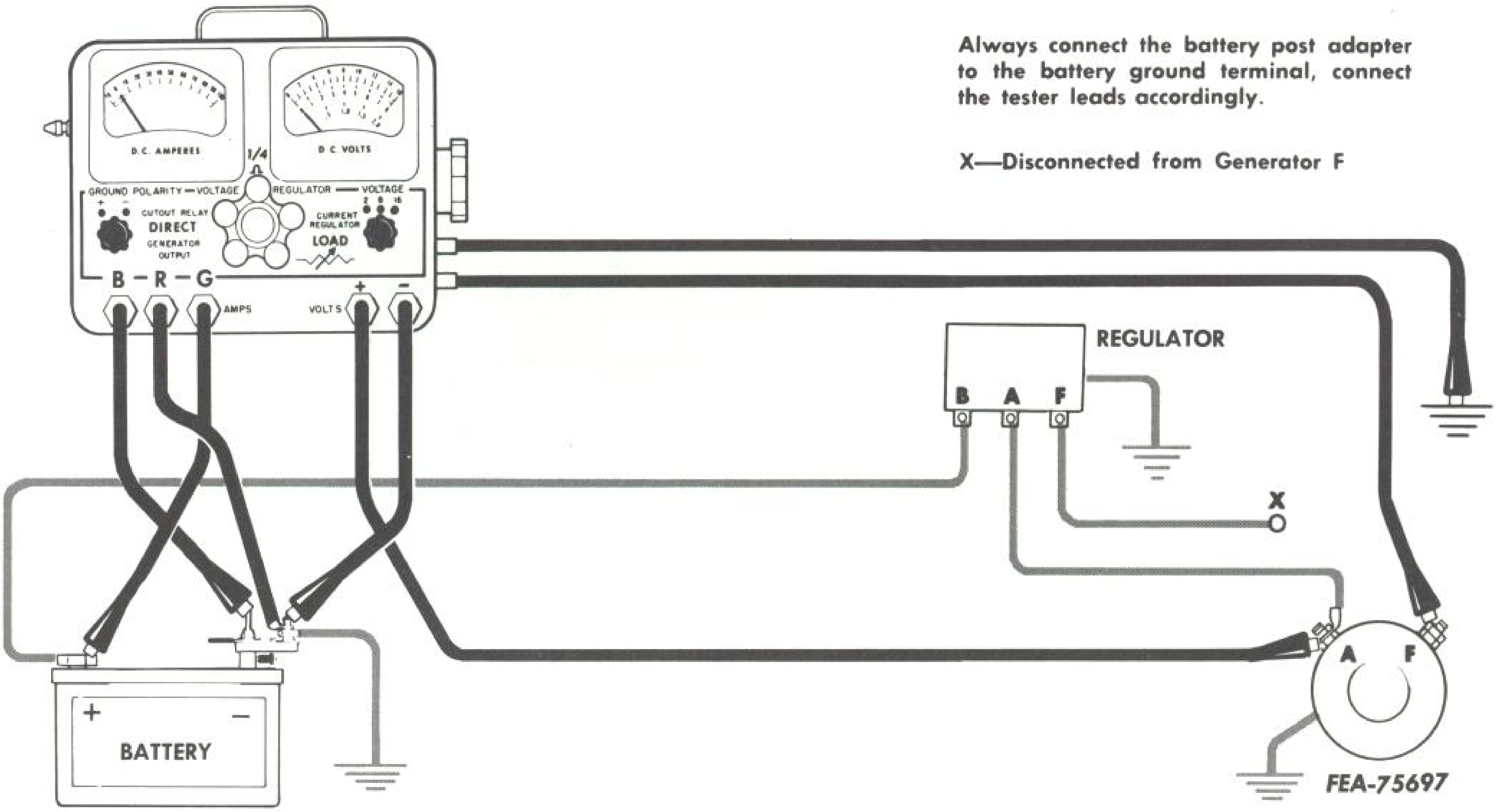
a. Since the motor-generator field circuit is grounded through the regulator, accidental internal grounding of the field circuit will prevent normal regulation so that excessive output will be produced by the generator.

On this type of unit, an internally grounded field circuit, which would cause excessive output, may be located by connecting a test lamp between the "F" terminal and the generator frame. All leads should be disconnected from the "F" terminal and the grounded brush insulated from the commutator with a piece of paper.

If the test lamp lights, the field is internally grounded. If the field has become grounded because of defective insulation on a field lead, repair can be made by reinsulating the lead. It is also possible to make repair when a ground occurs at the field pole shoes by removing the field coils and reinsulating them. A ground at the "F" terminal stud can be repaired by installing new insulating washers or bushings.

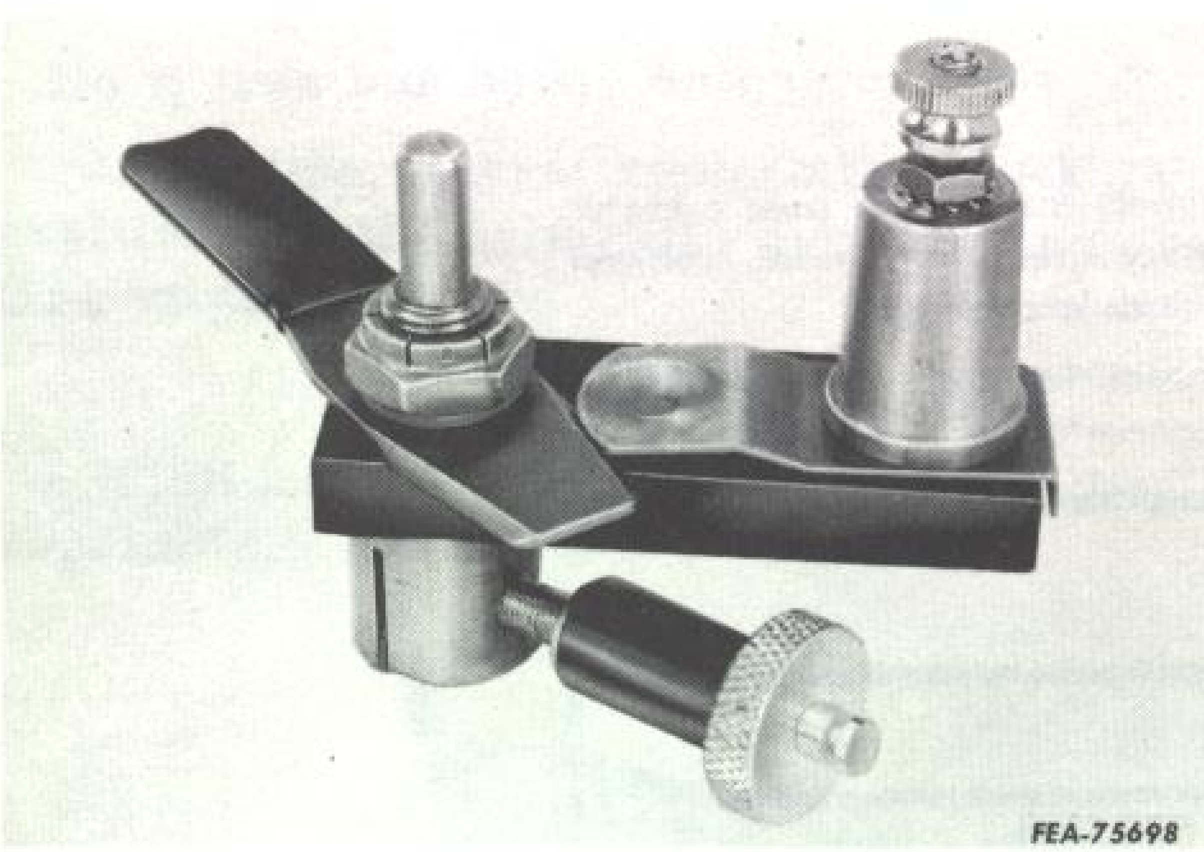
4. EXCESSIVE NOISE. Noise from a generator may be caused by a loose mounting or drive pulley. It can also be caused by worn or dirty bearings, or improperly seated brushes. Dirty bearings may sometimes be saved by cleaning and relubricating, but worn bearings should be replaced. Excessive noise may result if the brush holder is bent, resulting in improper seating of the brush. Such a brush holder should be replaced.

DC Generator



Illust. 6. Checking D.C. generator output or cut-out relay (3-unit regulator).

1. Connect the leads of the volt-ampere tester as shown in Illust. 6 to test generator output.



Illust. 7. Battery post adapter SE2057.

NOTE: The Battery Post Adapter SE2057 Illust. 7 is installed on the battery ground terminal to prevent dangerous arcing during connection of test leads. Due to this connection, the polarity of the tester must be reversed to obtain correct readings. The battery post adapter is used to ease tester connection to the circuit due to the inaccessability of the regulator on some models. If the battery post adapter is not used, follow the instructions furnished with the tester used and connect the leads to the battery terminals.

2. Bring the charging system components up to operating temperature before making any tests.

3. Set the tester as follows:

a. The control knob to DIRECT position.

b. The voltage switch to -16 volt position for 12 volt systems. -8 volt positions for 6 volt systems.

c. The generator field control (GFC) to OPEN position.

4. Close the battery post adapter (BPA) switch and start the engine.

5. Open the BPA switch and adjust the engine speed to the specified rpm for generator output.

6. Set the GFC to DIRECT position.

7. Observe the ammeter reading. The reading indicated should be equal to or more than rated output of the generator. Refer to specifications.

8. Set the GFC to OPEN position and shut off the engine.

Results and Indications:

1. If the output increases steadily as the GFC is turned to DIRECT position, but stops increasing before the DIRECT position is reached, the generator drive belt is loose or worn.

2. If the output is less than specified when the GFC is in the DIRECT position, there is a defective armature, shorted or grounded field coils, dirty commutator, poor brush contact, loose or defective field or armature wires, burned cutout relay contacts, low current regulator setting or damaged resistor on the regulator.

3. No output when the GFC is turned to the DIRECT position, there is a defective armature, open field coil, open field or armature wire or cutout relay contact failing to close.

Lucas DC Generator (British)

To check the output of the Lucas DC generator, connect the volt-ampere tester as shown in Illust. 8.

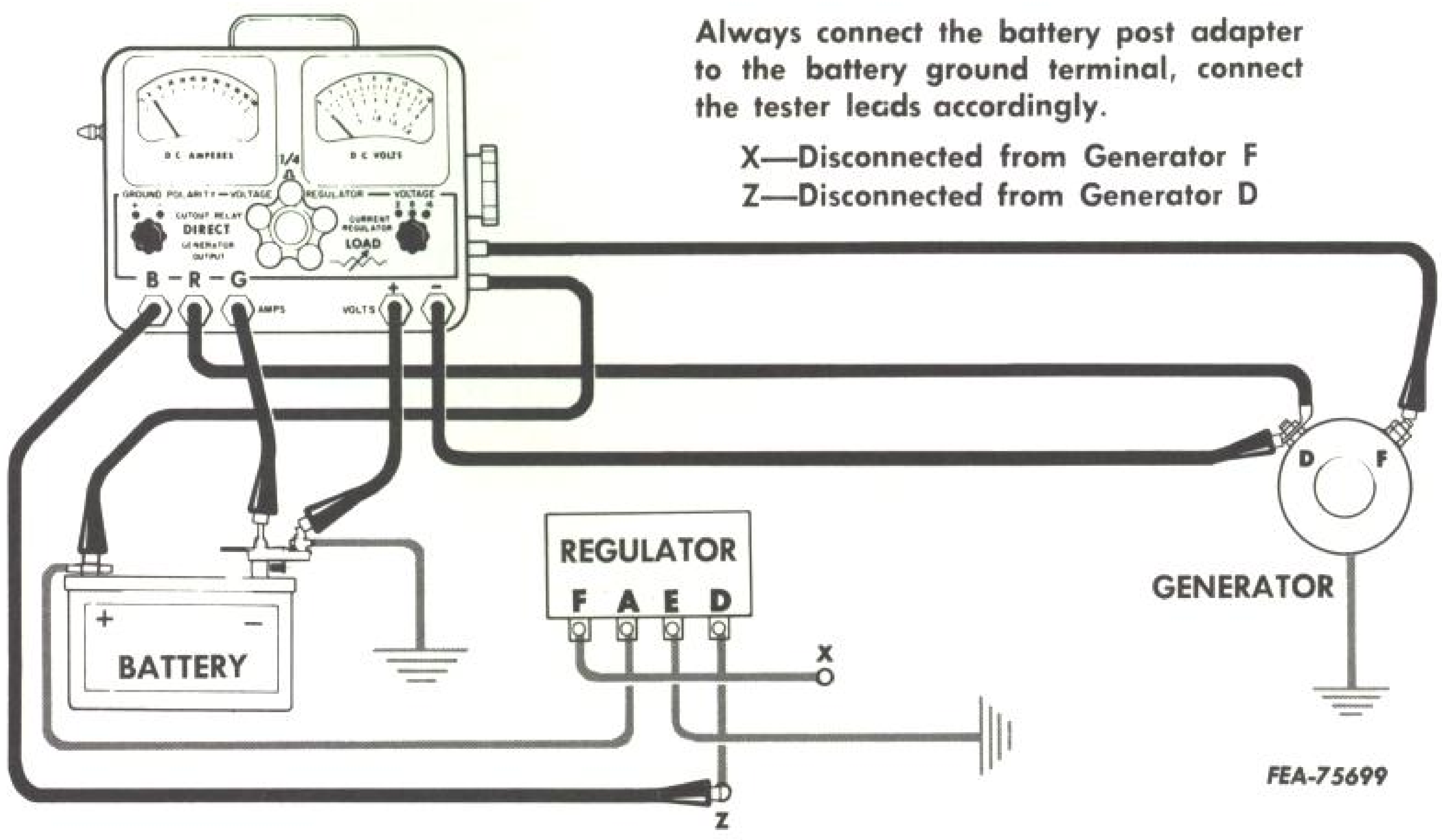
1. Turn the generator field control to the DIRECT position.

2. Start the engine and bring it up to operating temperature and speed specified for generator output.

CAUTION: Be sure to put a load on the system with the tester control to prevent the voltage output from exceeding the capacity of the tester.

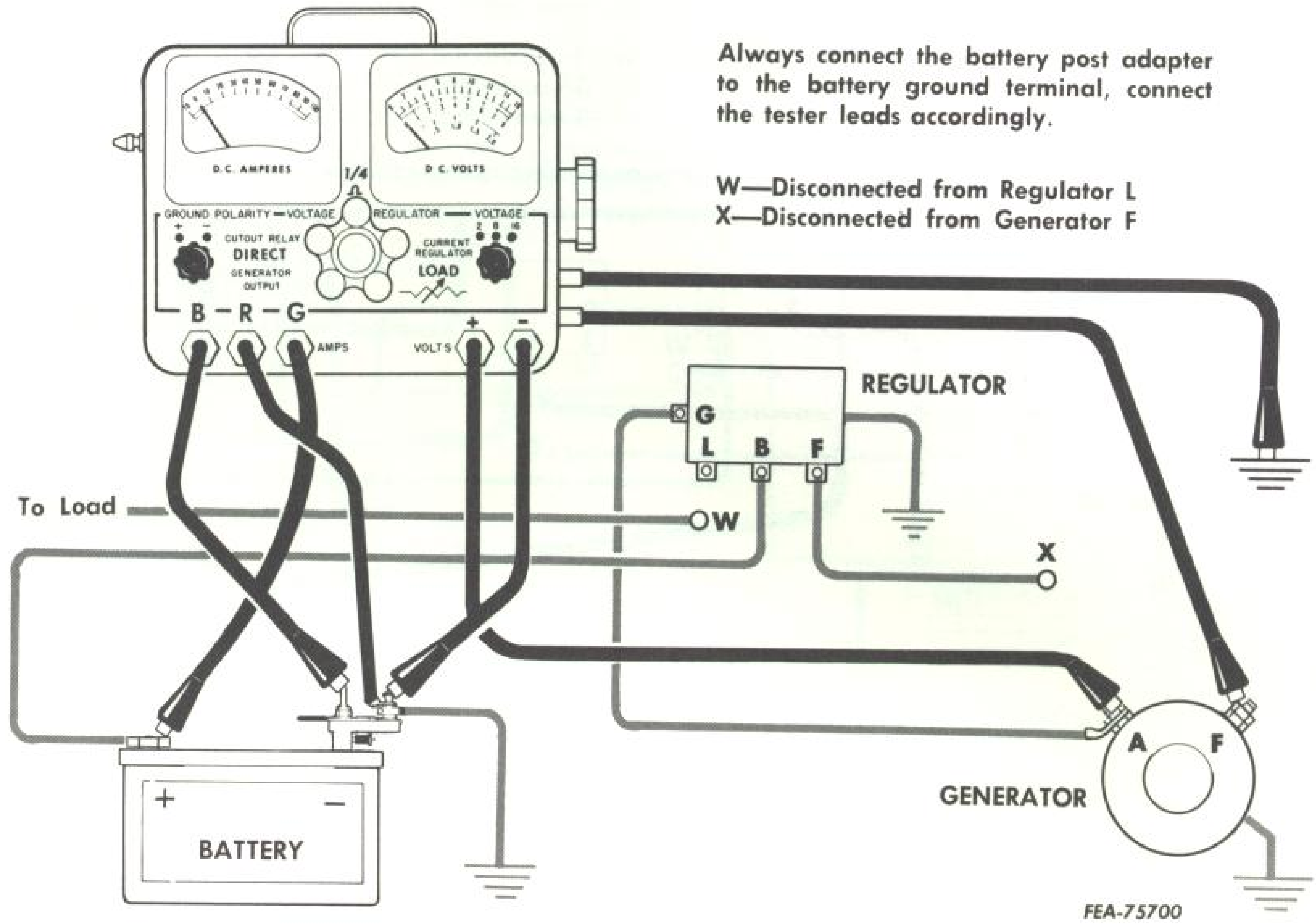
3. Set the load control to obtain system voltage. The ammeter will read generator output. The voltmeter will read voltage output when the load is removed.

4. Reduce engine speed and shut it off.



Illust. 8. Checking Lucas generator output.

Voltage Regulator Tests (2-Unit)



Illust. 9. Checking cut-out relay (2-unit regulator).

Cutout Relay Test

1. Connect the volt-ampere tester leads as shown in Illust. 9.

2. Set the control knob to the DIRECT position and the generator field control GFC to OPEN.

3. Disconnect the load wire from the regulator.

NOTE: On systems that carry the ignition on this "L" (load) circuit, a jumper is required from the hot battery terminal to the switch side of the ignition coil to furnish ignition current for the remainder of this test.

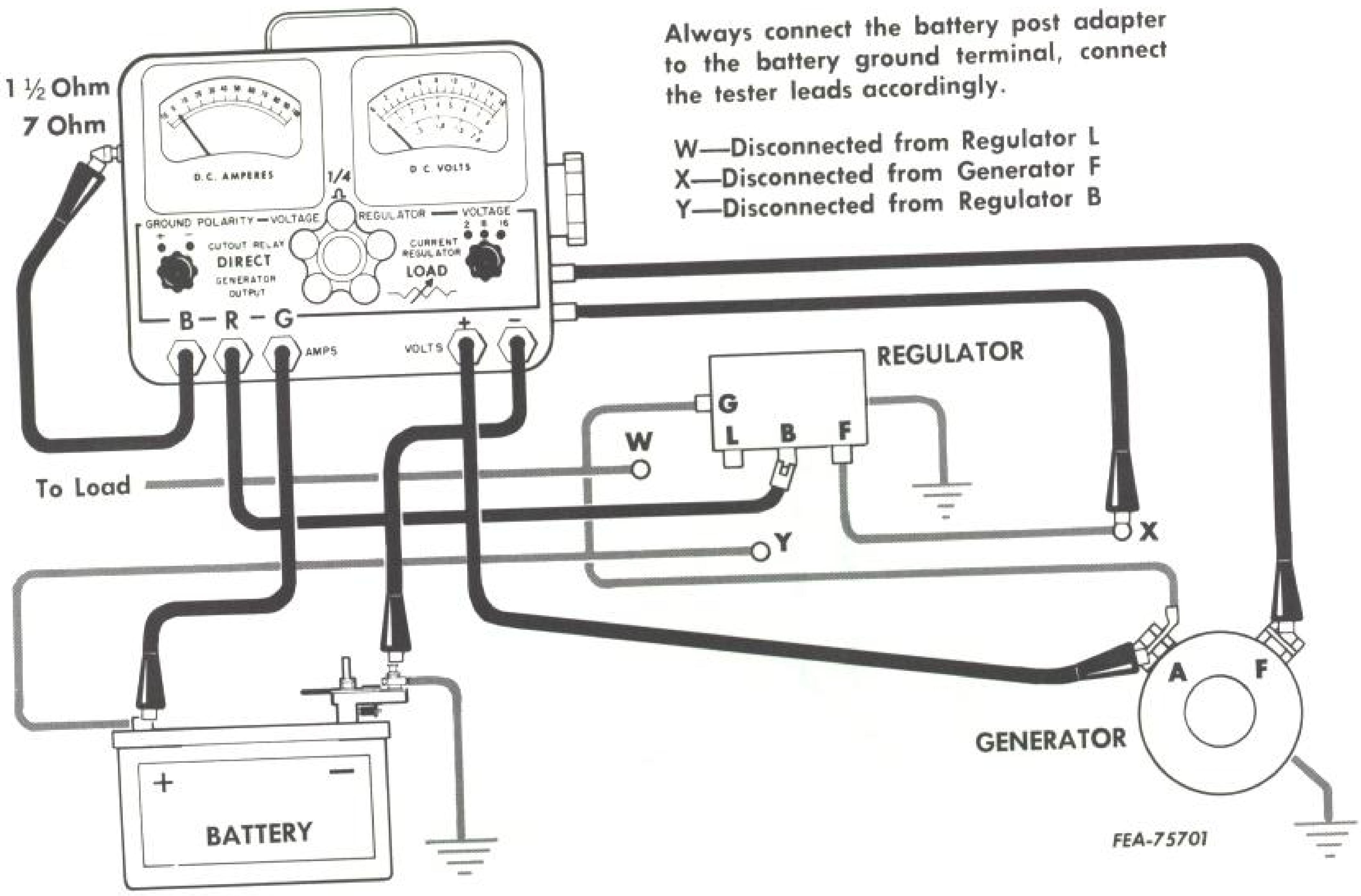
4. Start the engine and increase the speed to approximately 800 rpm.

5. Slowly rotate the GFC clockwise while observing both the voltmeter and ammeter.

6. Note the highest voltmeter reading just before the ammeter pointer begins to move. This reading indicates the closing voltage of the cutout relay and should be within specifications.

7. Continue to rotate the GFC clockwise until the ammeter reads approximately 5 amperes charge.

8. Slowly rotate the GFC counterclockwise while observing the ammeter for the greatest reading to the left of zero just before the pointer returns to zero. This indicates the opening amperage of the cutout relay and should be within specifications.



Illust. 10. Checking current-voltage regulator (2-unit regulator).

Voltage Regulator Test

1. Connect the volt-ampere tester leads as shown in Illust. 10. Connect the "Bat" lead of the ammeter to:

-1-1/2 ohm stud for 6 volt system
-7 ohm stud for 12 volt system

2. Rotate the generator field control (GFC) to the DIRECT position.

3. Increase engine speed to that specified for generator output.

4. Rotate the GFC counterclockwise to OPEN and then clockwise to DIRECT to cycle the regulator.

5. Note the voltmeter reading. This reading indicates the voltage regulator setting and should be within specifications.

Voltage Regulator Tests (3-Unit)

Cutout Relay Test. The cutout relay test is made to determine whether or not the cutout relay closes and opens properly with respect to generator voltage output and battery current. Unless the relay is operating within specifications, a discharged battery and, or damage to the charging system can result.

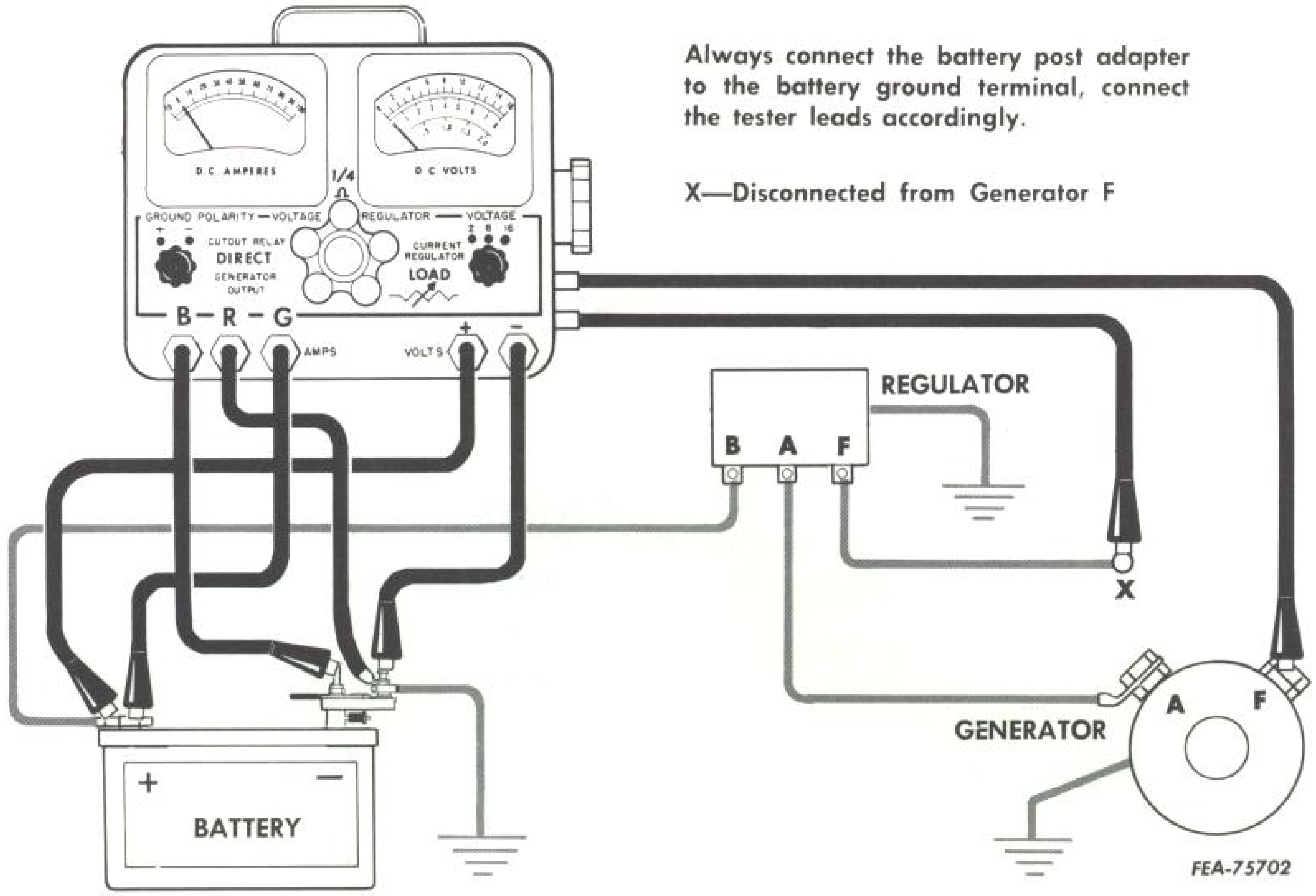
A relay which is not operating within specifications should be removed from the vehicle for further tests and adjustments as covered under voltage regulator servicing.

1. Connect the volt-ampere tester leads as shown in Illust. 6.

2. Start the engine and set at speed specified for generator output.

3. Slowly rotate the generator field control (GFC) clockwise while observing both voltmeter and ammeter.

4. Note the highest voltmeter reading just before the ammeter pointer begins to move. This voltmeter reading indicates the closing voltage of the cutout relay and should be within specifications.



Illust. 11. Checking voltage or current regulator (3-unit regulator).

5. Continue to rotate the GFC clockwise until the ammeter reads approximately 10 amperes charge.

6. Slowly rotate the GFC counterclockwise while observing the ammeter for the greatest reading to the left of zero just before the pointer returns to zero. This reading indicates the opening amperage of the cutout relay and should be within specifications.

Results and Indications:

1. If the cutout fails to close as noted by high voltage and no current, the voltage winding on the relay is open, the contacts are badly burned or the spring tension or air gap is excessive.

2. If the closing voltage is too high, check for excessive spring tension, air gap or point gap as covered under voltage regulator servicing.

3. If the closing voltage is too low, check for insufficient air gap, point gap or spring tension. Adjust as covered under voltage regulator servicing.

4. If the opening amperage is too low, check for excessive air gap, or spring tension or insufficient point gap.

Voltage Regulator Test

This test is made to determine if the voltage regulator is operating properly and within specifications. A regulator setting which is higher than specified can cause battery overcharge and damage to lights and accessories. A lower than specified setting can cause a discharged battery.

If the voltage regulator setting is not within the specified limits or is unstable or erratic, it should be removed from the vehicle for further tests, service and adjustments.

1. Connect the volt-ampere tester leads as shown in Illust. 11. Set the tester control knob to the 1/4 OHM position.

Single Contact Type Regulators:

1. Start the engine and increase the speed to that specified for generator output.

2. Rotate the generator field control (GFC) counterclockwise to the OPEN position and then clockwise to DIRECT position to cycle the regulator.

3. Observe the voltmeter reading. This reading indicated on the voltmeter is the voltage regulator setting and should be within specifications.

Double Contact Type Regulators:

1. Start the engine and increase the speed to that specified for generator output.

2. Rotate the generator field control (GFC) counterclockwise to the OPEN position and then clockwise to the DIRECT position to cycle the regulator.

3. Observe the voltmeter reading. The reading indicated on the voltmeter is the voltage setting of the regulator "shorting" contacts and should be within specifications.

4. Maintaining the engine speed, slowly rotate the GFC counterclockwise while observing the voltmeter. The voltmeter reading should drop off slightly and then remain steady. This indicates the voltage regulator setting of the "series" contacts. The voltage difference between the settings of the two contacts should be within specifications.

Results and Indications:

1. Regulator setting too high - check for excessive spring tension or armature air gap. Adjust as outlined under regulator servicing.

2. Regulator setting too low - check for insufficient spring tension or armature air gap. Adjust as outlined under regulator servicing.

3. Regulator setting erratic or unstable - check for burned or oxidized contacts, improper armature air gap or broken resistor on regulator back. Repair as outlined under voltage regulator servicing.

Current Regulator Test

The current regulator test is made to determine if the current regulator is operating properly and within specifications. A regulator setting which is higher than specified can allow the generator to exceed its rated output and consequently damage from overheating can result.

A regulator setting which is lower than specified will not allow the generator to produce the current demanded by the electrical system when loads are great and as a result the battery becomes discharged.

If the current regulator setting is not within the specified limits or is unstable or erratic, the regulator should be removed from the vehicle for further tests and adjustments.

1. Connect the volt-ampere tester leads as shown in Illust. 11.

2. Start the engine and adjust the speed to that specified for generator output. Rotate the generator field control (GFC) clockwise to DIRECT position.

3. Turn the volt-ampere tester control knob clockwise to LOAD position and adjust the knob until the voltmeter indicates system voltage.

4. The ammeter reading now indicates the current regulator setting and should be within specifications.

5. Turn the volt-ampere tester control knob counterclockwise to DIRECT.

6. Rotate the GFC to OPEN.

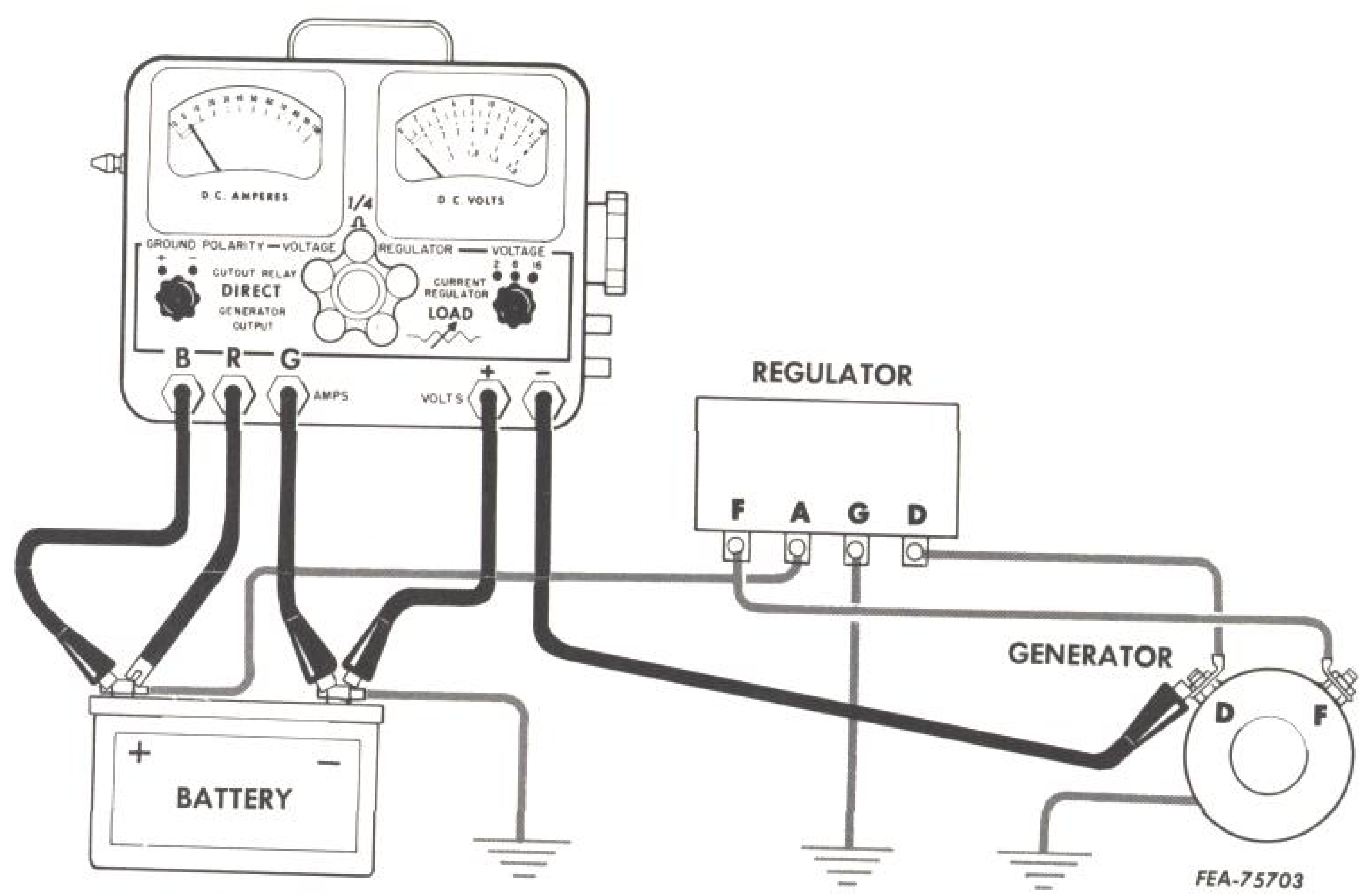
Results and Indications:

1. Regulator setting too high-check for excessive spring tension or armature air gap. Adjust as covered under voltage regulator servicing.

2. Regulator setting too low - check for insufficient spring tension or armature air gap. Adjust as covered under voltage regulator servicing.

3. Regulator setting erratic or unstable. Check for burned or oxidized regulator contacts, improper armature air gap or broken resistor on regulator back. Adjust and repair as covered under voltage regulator servicing.

Lucas DC Voltage Regulator Tests (British)



Illust. 12. Checking cut-out relay (Lucas regulator).

Cutout Relay Test

To test the cutout relay, connect the volt-ampere tester leads as shown in Illust. 12. Disconnect the battery cable from the negative post.

1. Start the engine and place a load on the system with the load control or by turning on the lights.

NOTE: It may be necessary to use a jumper wire from the negative post to the coil "SW" terminal for ignition on gasoline engines.

2. Slowly increase the engine speed until a "flick" is observed in the voltmeter reading. This indicates the closing voltage of the cutout relay and should be within specifications.

3. Reduce engine speed and remove the voltmeter lead from the generator "D" terminal. Connect this lead to the disconnected battery cable.

4. Run the engine at full throttle. Slowly decrease the speed while watching the voltmeter needle. The lowest reading before the needle drops to zero, is the opening voltage of the contacts. This should be within specifications.

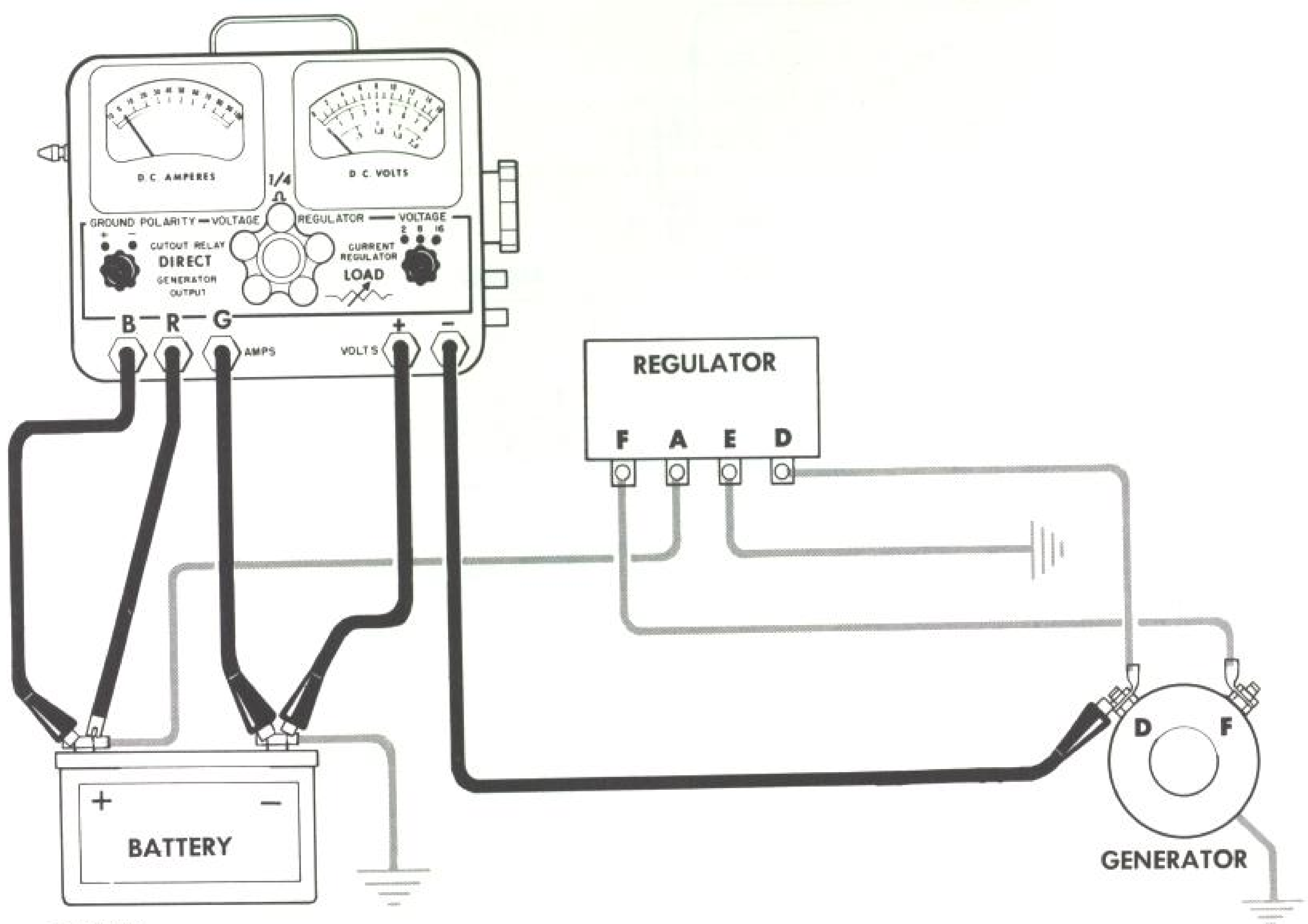
Voltage Regulator Test

1. Connect the leads of the volt-ampere tester as shown in Illust. 13.

2. Start the engine. Remove the battery cable if not already removed. See previous note.

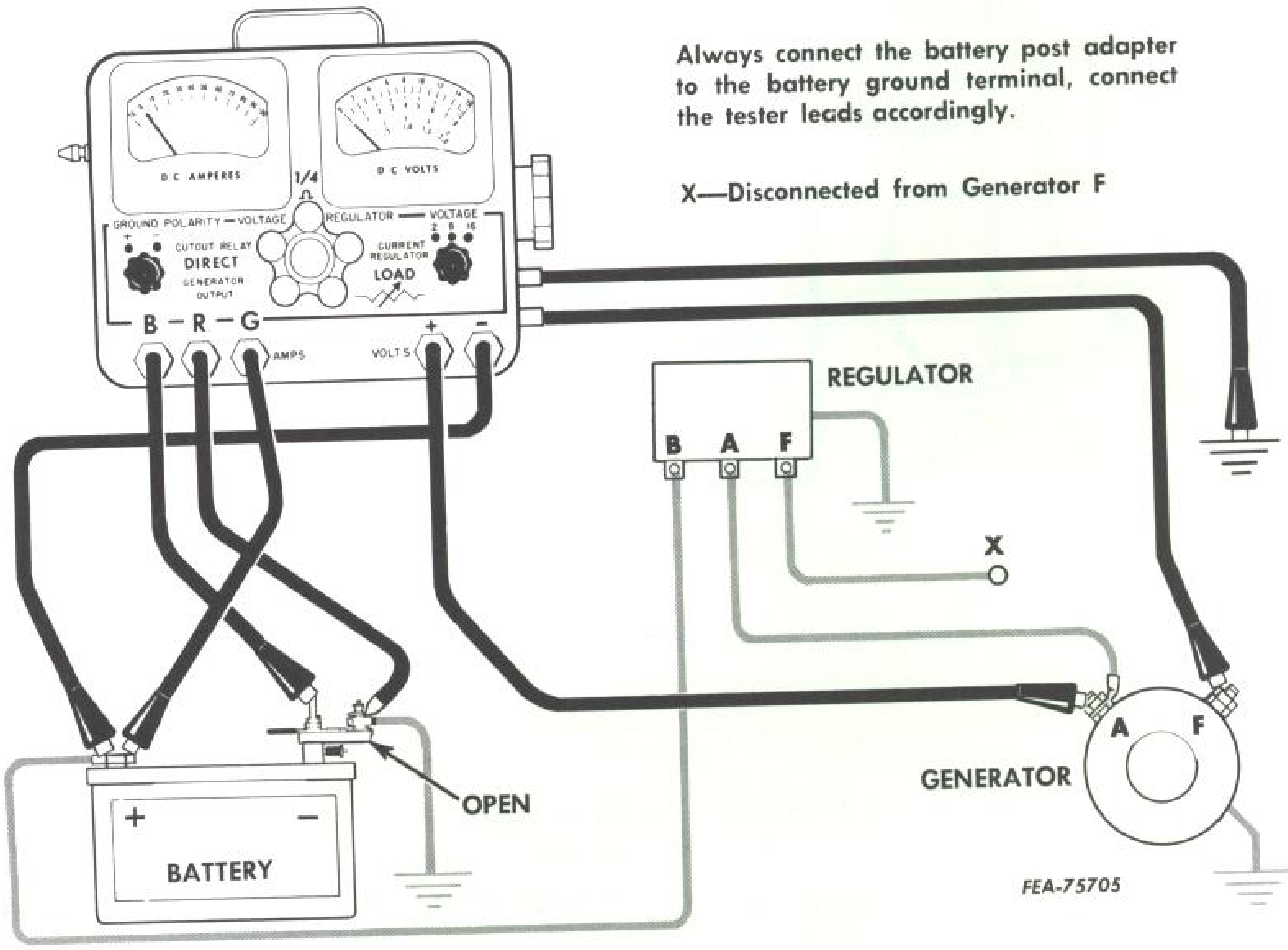
3. Slowly increase the engine speed until the voltmeter needle "flicks" then steadies. This should occur at a reading within the limits given in specifications.

4. Reduce the speed and shut off engine.



Illust. 13. Checking voltage regulator (Lucas regulator).

Insulated Circuit Resistance



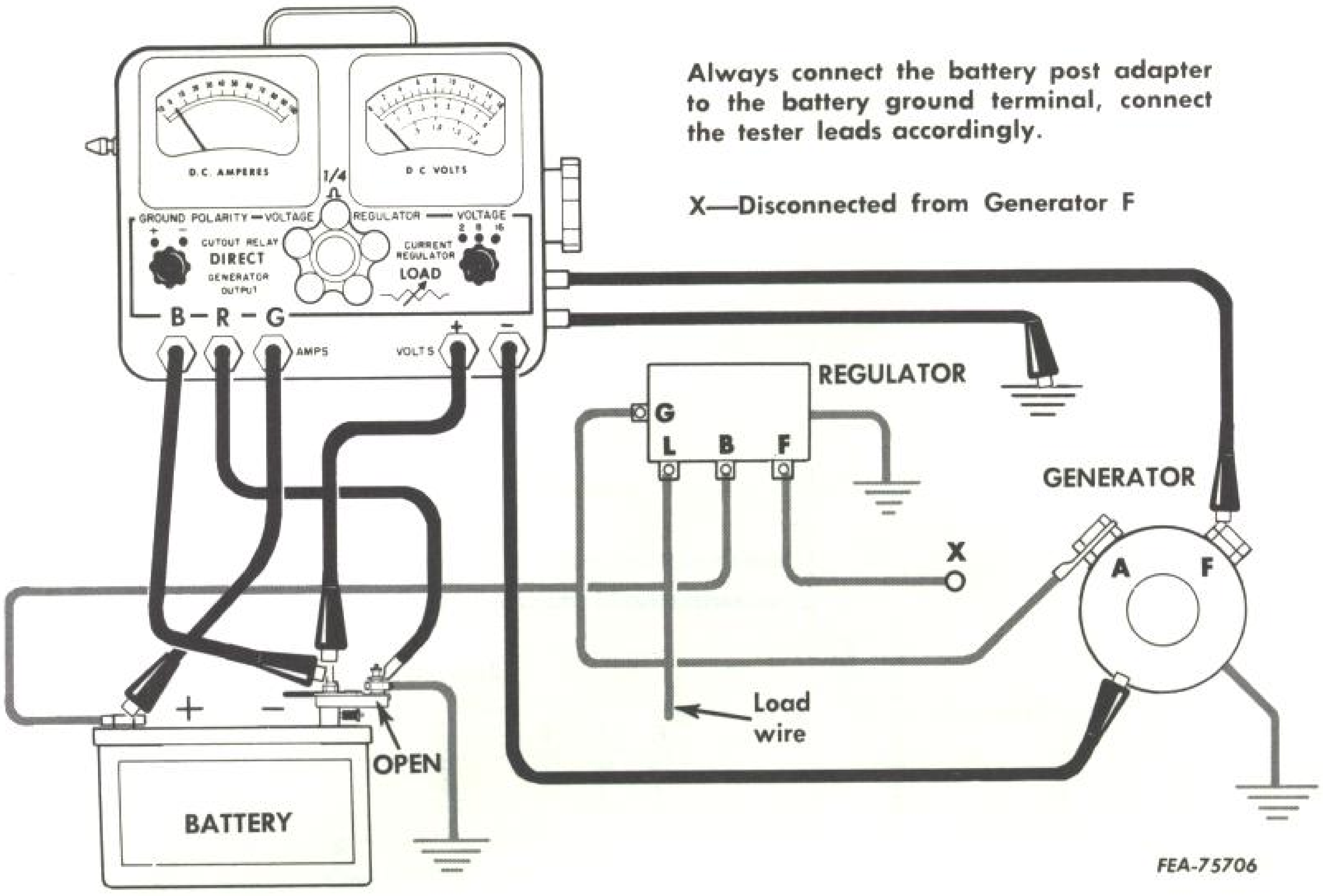
Illust. 14. Checking insulated circuit resistance.

1. With the volt-ampere tester connected as shown in Illust. 14, start the engine and set speed at approximately 1500 rpm.

2. Adjust the generator field control (GFC) until the ammeter reads 20 amperes.

3. With the voltmeter switch at the 2 volt position, observe the voltmeter reading. The reading should not exceed .6 volt. A higher reading indicates poor connections or broken strands in the wires which should be checked individually.

Ground Circuit Resistance



Illust. 15. Checking ground circuit resistance.

1. Connect the volt-ampere tester leads as shown in Illust. 15.

2. Start the engine and increase the speed to approximately 1500 rpm.

3. Adjust the field control until the ammeter reads 20 amps.

4. Observe the voltmeter. The reading should not exceed .1 volt.

Results and Indications:

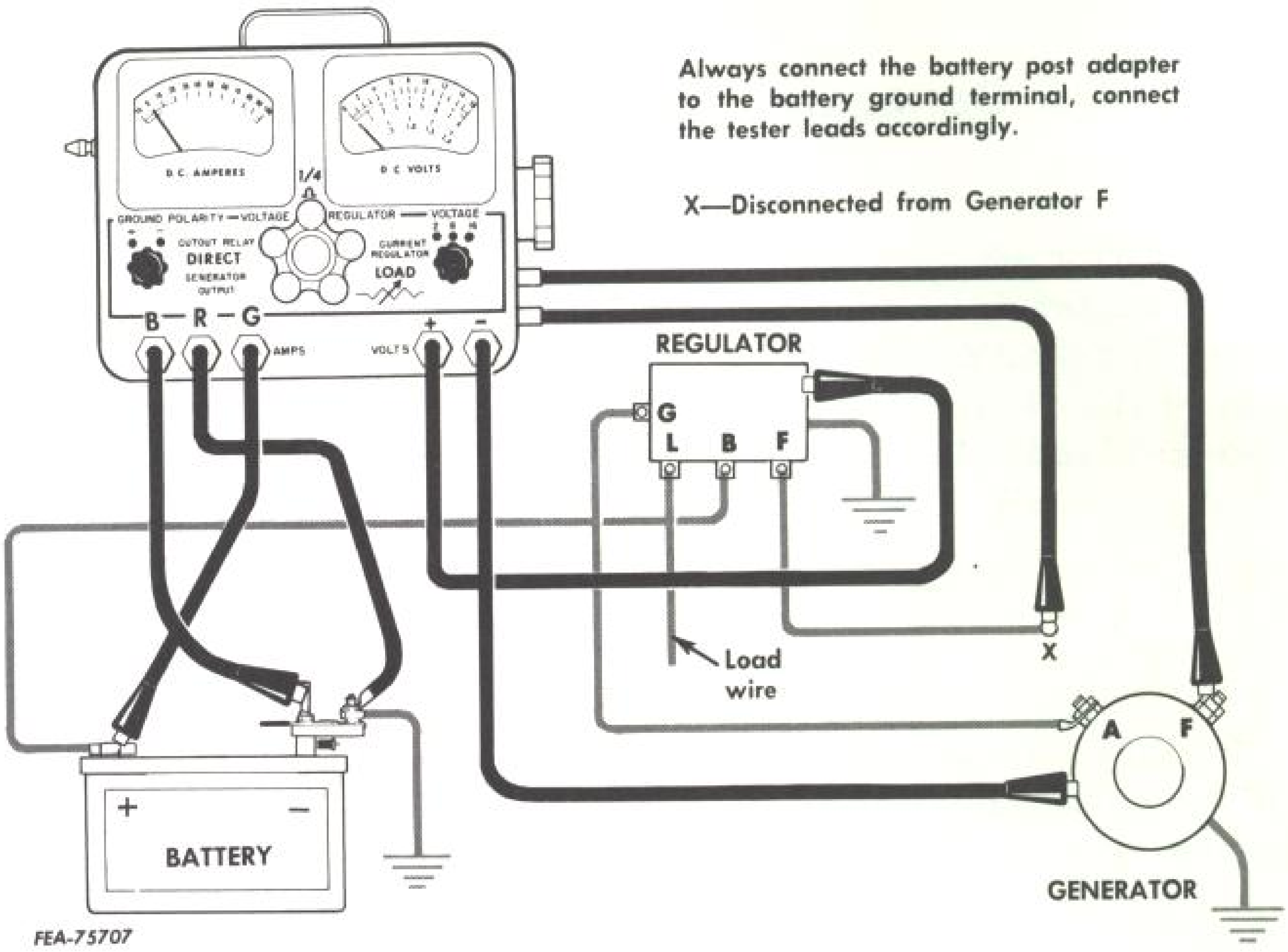
When the voltage loss exceeds the specified limit check for:

1. Loose or corroded connections at the armature terminal of generator, armature terminal of regulator, back of ammeter or tel-tale lamp, or battery terminal of starter solenoid by checking each connection with a voltmeter.

2. Faulty wiring from the generator to regulator armature terminal, battery terminal of regulator to charge indicator or charge indicator to starter solenoid.

3. Burned or oxidized cutout relay contacts, loose or corroded battery cable connections or a poor electrical connection between the generator and engine.

Regulator Ground Test



Illust. 16. Checking regulator ground resistance.

1. Connect the volt-ampere tester leads as shown in Illust. 16.

2. Start the engine and increase the speed to approximately 1500 rpm.

3. Set the generator field control (GFC) to the DIRECT position.

4. Turn the load control until a reading of 20 amperes is observed on the ammeter.

5. Observe the voltmeter for the highest reading. The reading indicates the voltage loss in the regulator ground circuit. This should not exceed .05 volts.

6. Turn the GFC to OPEN. Reduce the engine speed and shut off engine.

7. Disconnect all volt-ampere tester leads and make sure all wiring and connections are secure.

Results and Indications:

When the voltage loss exceeds the specified limit check for:

1. Regulator ground wire loose or defective.

2. Poor electrical connection between the regulator base and frame or between the frame and engine.

Repolarizing the Generator

After electrical tests requiring the opening of various circuits, the generator should be repolarized following the removal of meters and replacement of wires and cables in their normal operating positions.

Before the engine is started, momentarily connect a jumper lead between the "BAT" (battery) and "GEN" (generator) terminal of the regulator for "A" circuits. On Lucas generators, remove the field wire from the generator and momentarily connect a jumper lead from the "F" terminal of the generator to the insulated side of the battery. This allows a short surge of current from the battery to flow through the generator to correctly polarize it.

CAUTION: Avoid touching the jumper lead to the "F" terminal because this will damage the regulator.

Failure to repolarize could result in the generator building up its output in the wrong direction causing damage to the cutout relay and no charging current reaching the battery.

SERVICING THE DC CHARGING SYSTEM

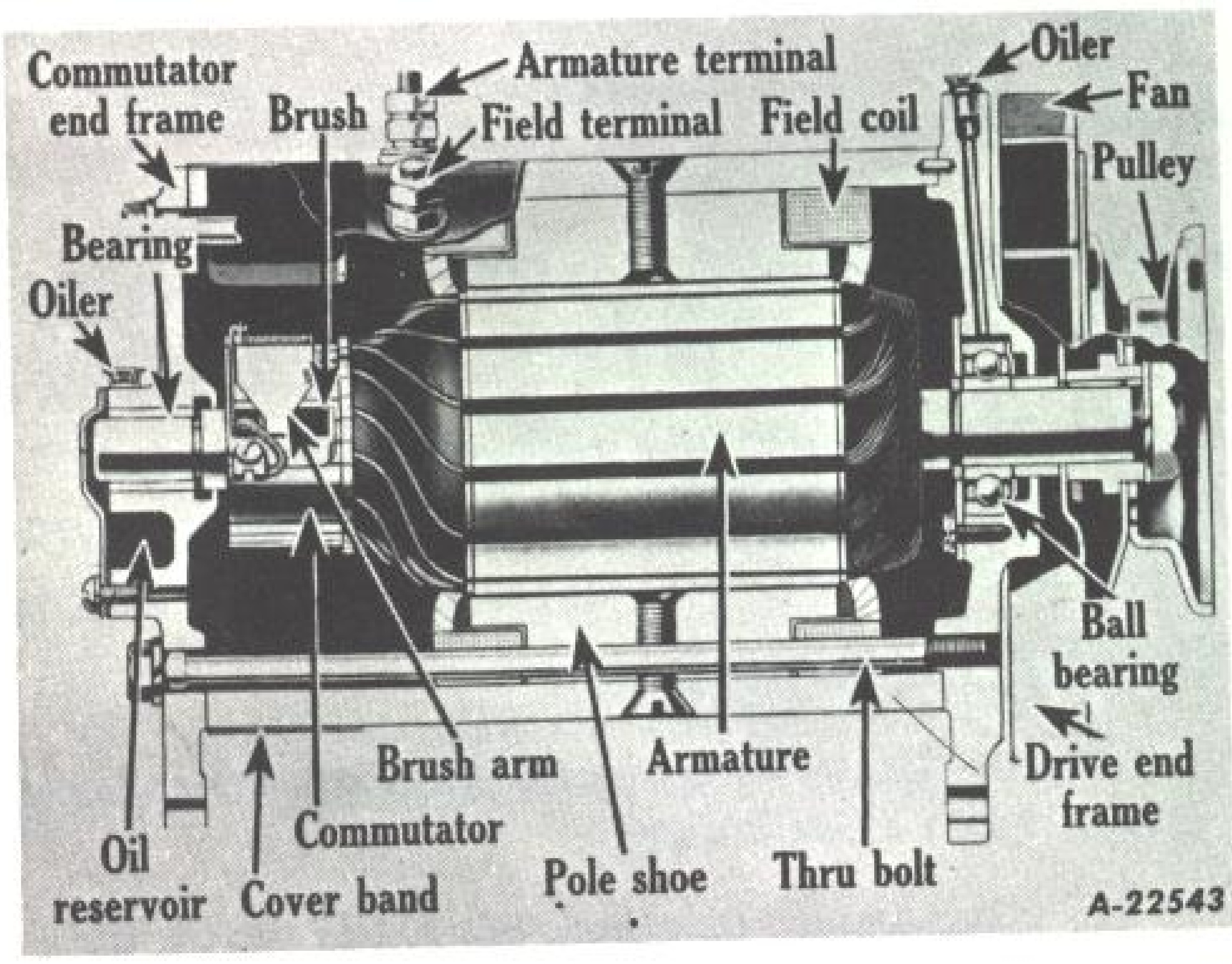
DC Generator and Motor-Generator

If you found the condition of the generator to be questionable during your testing procedure, it must be checked further to pinpoint the location of the trouble. Use the following procedures and information under the appropriate subhead. See Illusts. 17 and 18.

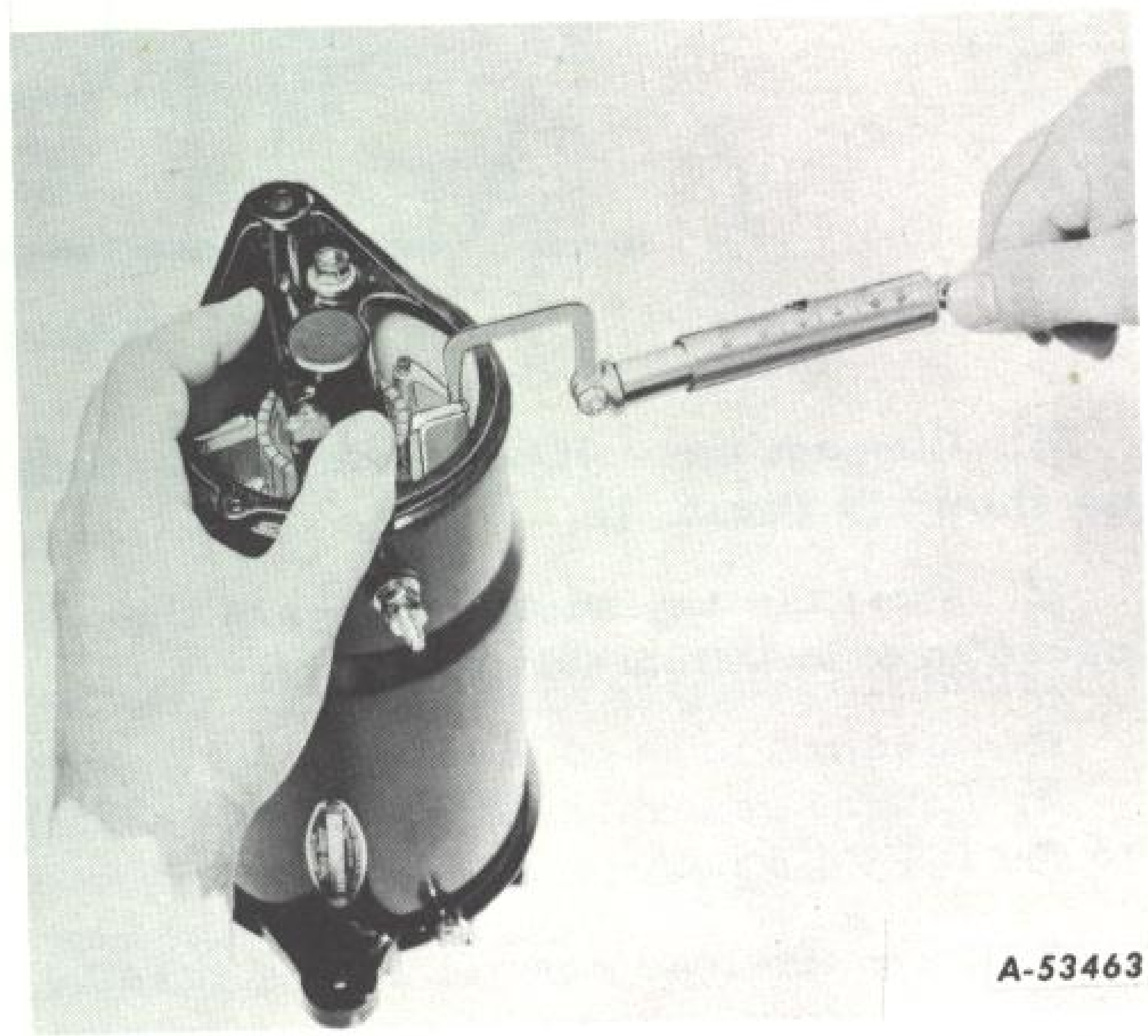
Brushes

Check to see if the brushes are stuck in their holders or if the spring tension is low. Illust. 19. Low spring tension prevents good contact between the brushes and the commutator which will cause arcing and burning of the brushes and commutator.

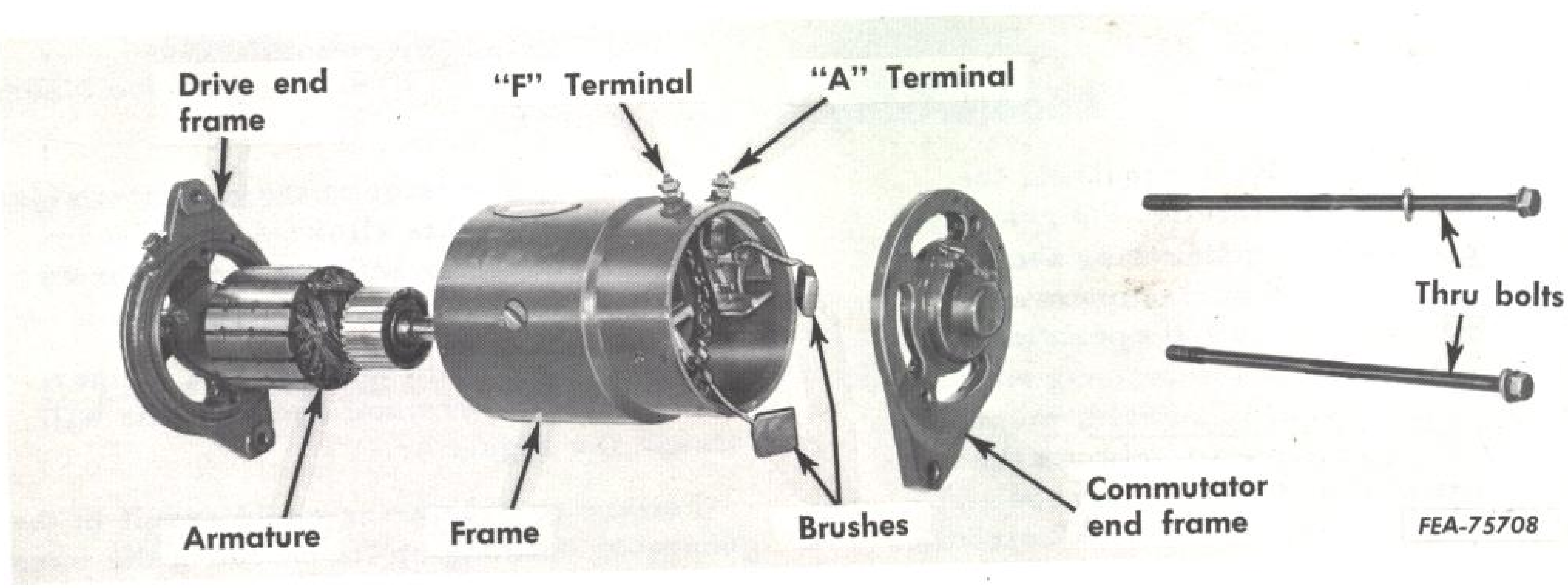
Brushes can be seated by use of a seating or bedding stone. This is soft abrasive material that, when held against a revolving commutator, gives off particles that are carried under the brushes and wear their



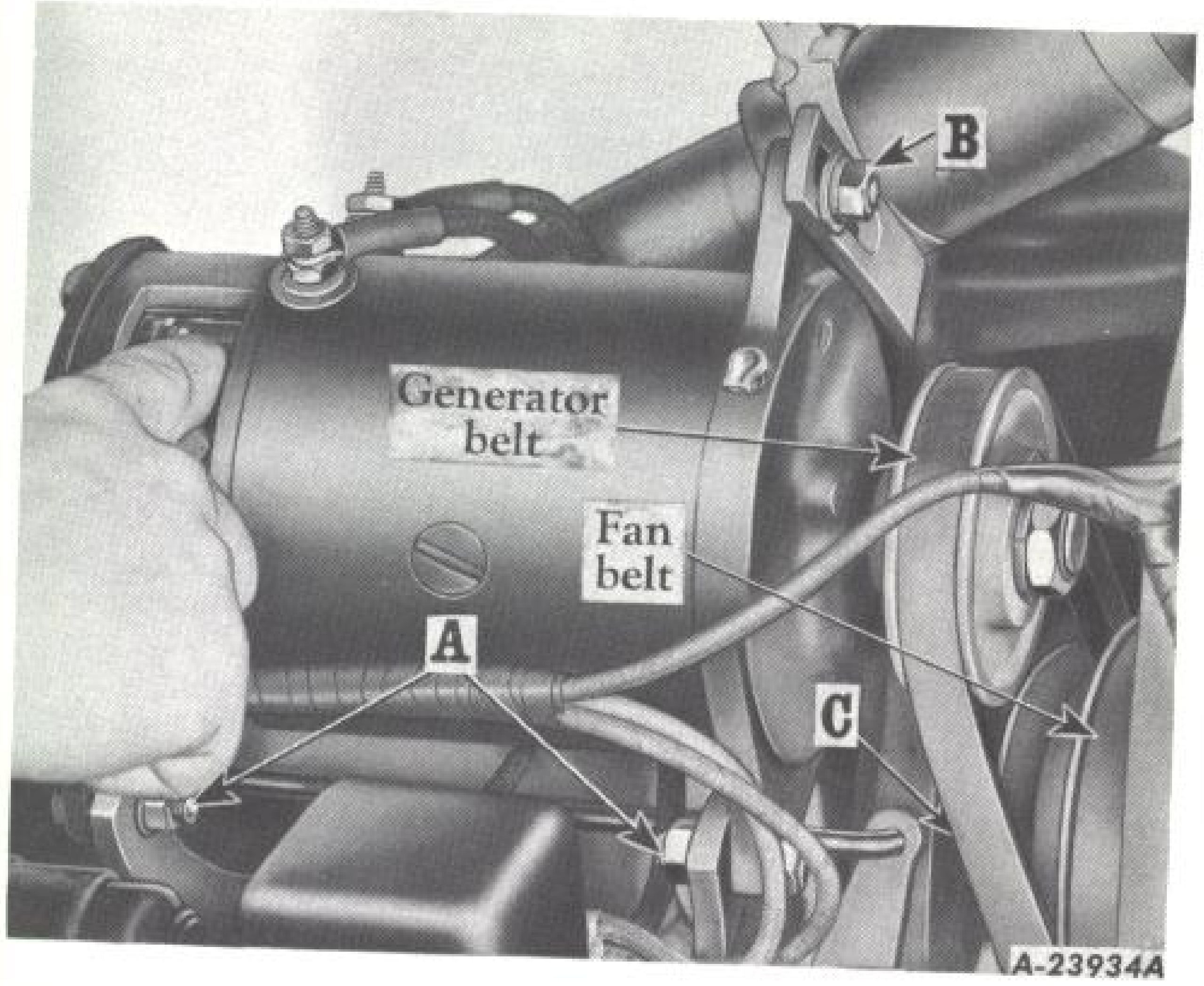
Illust. 17. Sectional view of generator.



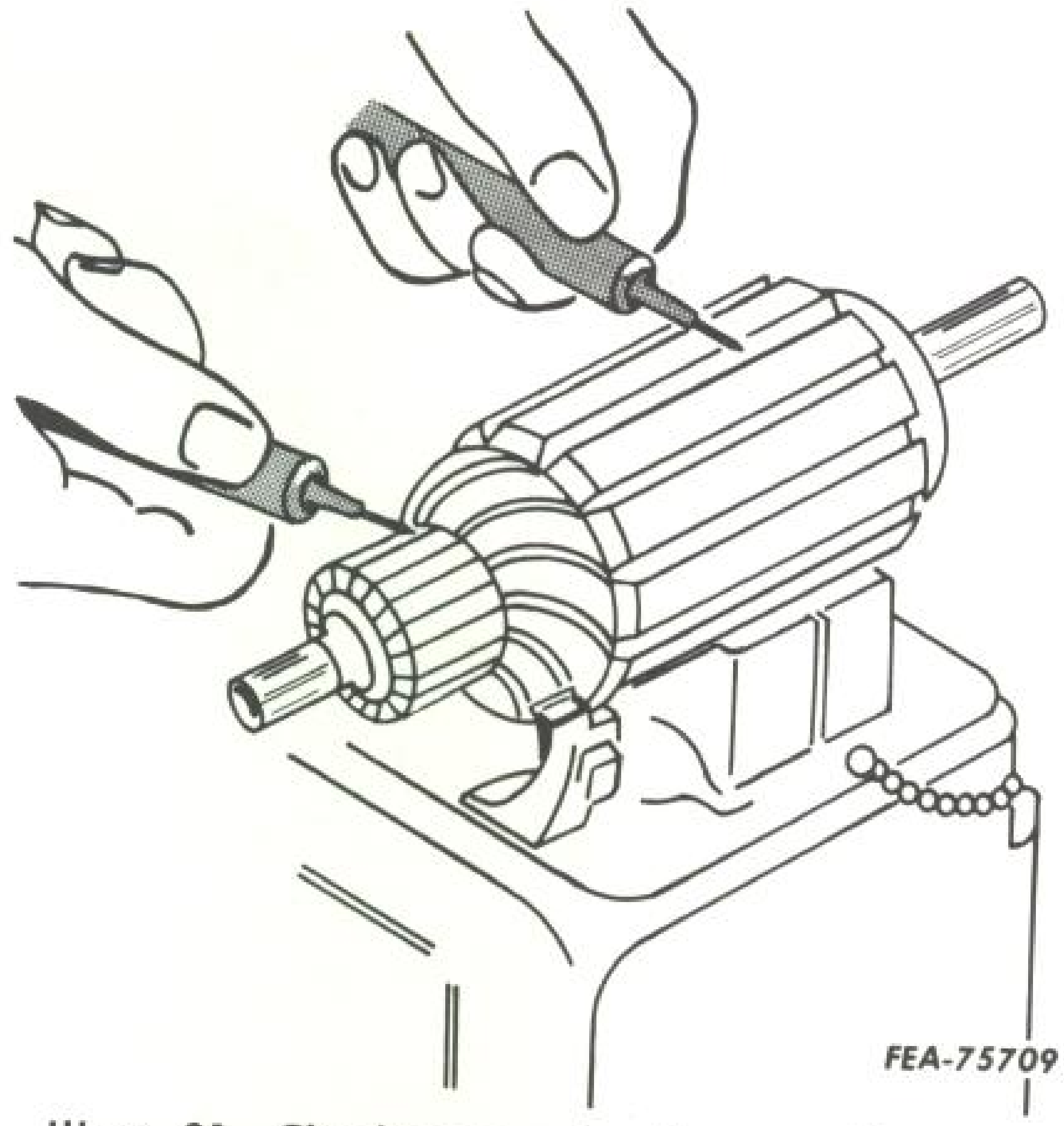
Illust. 19. Measuring brush spring tension (open-end generator shown).



Illust. 18. Exploded view of generator.



Illust. 20. Using brush seating stone to seat new brushes or to clean off commutator.



Illust. 21. Checking armature for open circuit.

contacting surface to the contour of the commutator in a few seconds. See Illust. 20.

The abrasive must be blown out of the unit after brush seating is completed. If a brush holder is bent, it may be impossible to eliminate brush noise by reseating. The damaged brush holders will require replacement.

If the brushes are satisfactorily seated and are making good contact with the commutator and the cause of trouble is not apparent, use the test light and series test point leads which are a part of the armature tester. External leads to generator terminals "A" and "F" must be disconnected, then proceed with the test as follows:

Raise the grounded brush from the commutator and slip a piece of cardboard between the commutator and the brush.

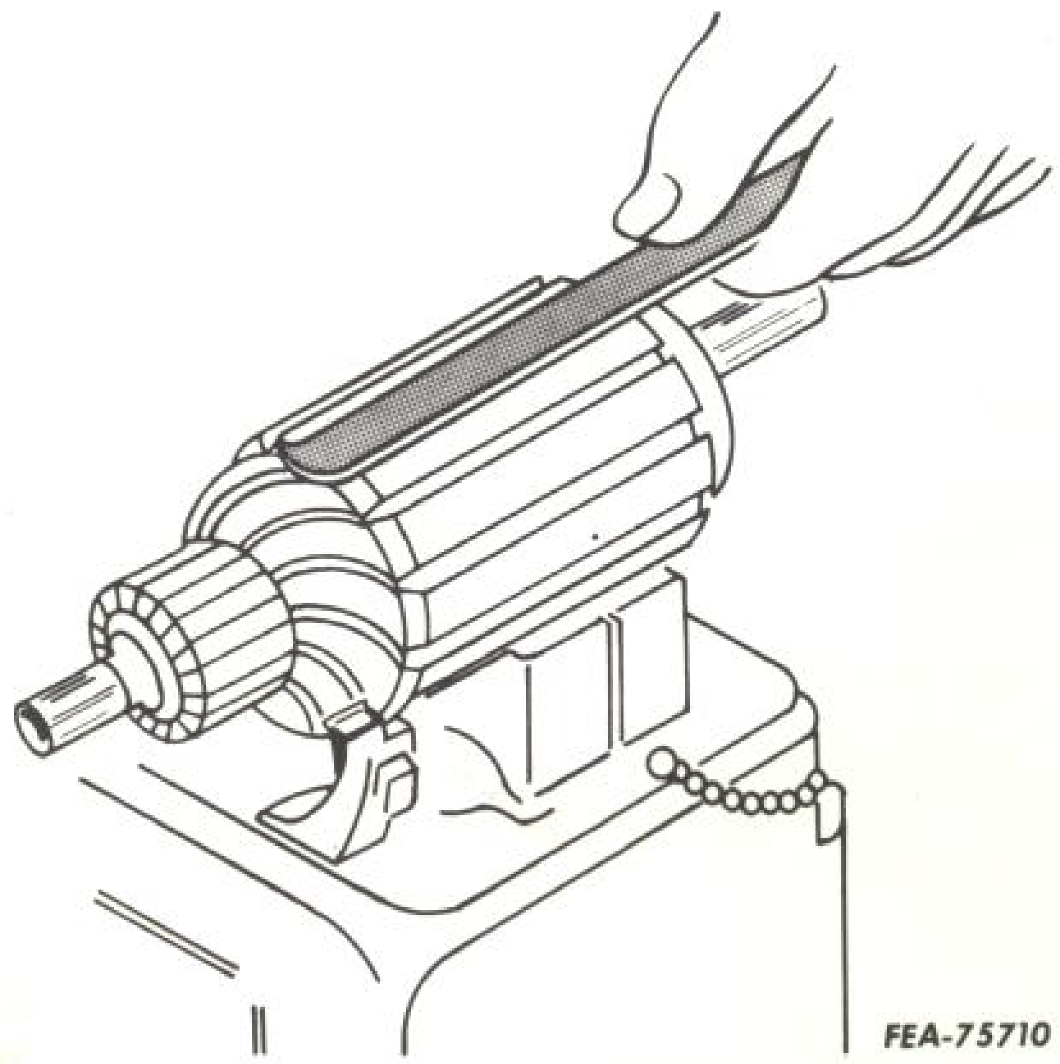
Check for grounds with test points from generator "A" terminal to generator frame.

If the test lamp lights, it indicates the generator is internally grounded. Location of ground can be found by raising and insulating all brushes from the commutator and checking the brush holding armature or commutator and field separately. Repair and replace as necessary.

Armature

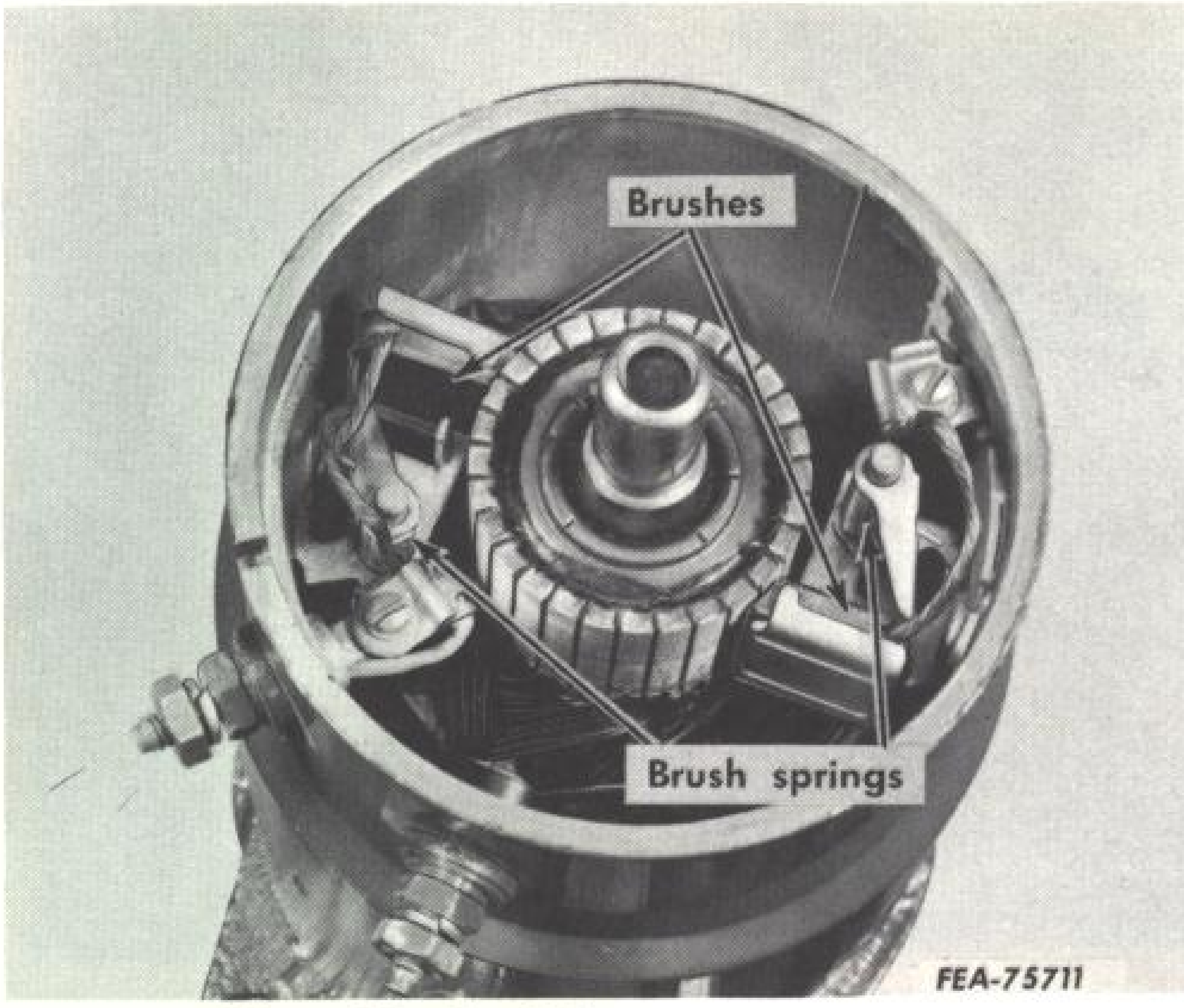
Check the armature for open circuit or short circuits. Open circuits in the armature are usually obvious because the open circuited commutator bars will arc each time they pass under the brushes so that they soon become burned. If the bars are not too badly burned and open circuit repaired, the armature may be reused. Use the test prods on the growler to check for openings. Illust. 21.

NOTE: Use only rosin flux when resoldering commutator riser bars.



FEA-75710

Illust. 22. Checking armature for short circuit.



FEA-75711

Illust. 23. Brush location in generator.

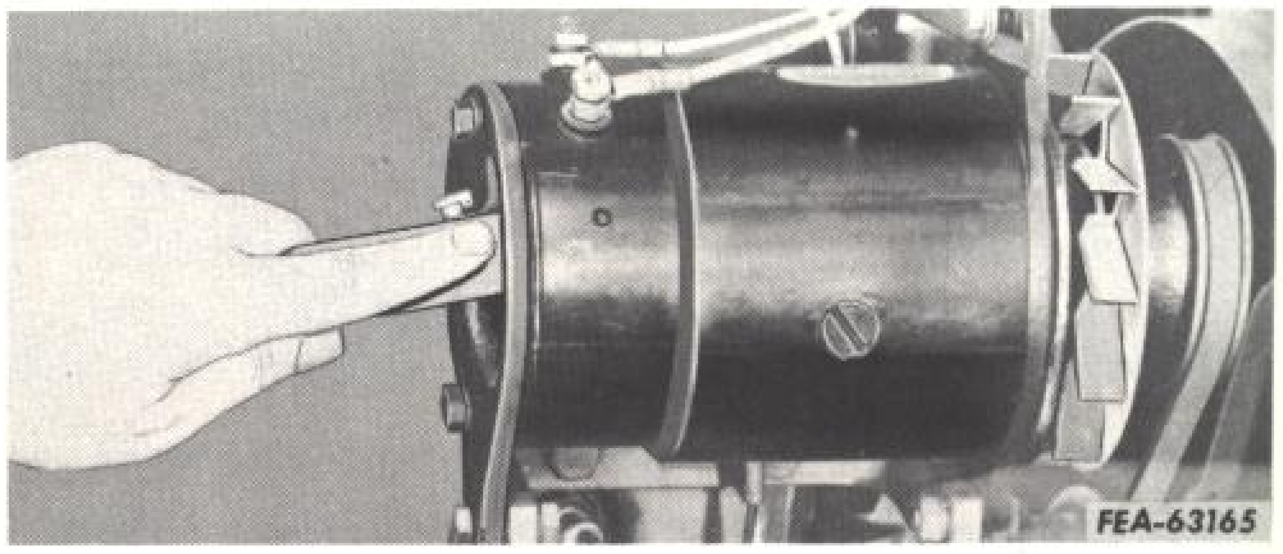
Short circuits in the armature are located with the armature tester (growler). The armature is placed in the Vee of the tester and slowly rotated. The thin strip of steel held above the armature will vibrate when the area of the armature core containing a short circuited coil is located. The armature may or may not be repaired depending on the location of defect. Illust. 22.

Thrown solder, spattered on the cover band or found in the frame adjacent to the commutator, indicates the generator has been overloaded or allowed to produce excessive output. The resulting overheating has melted solder at the connections of armature windings to commutator bars.

This loss of solder from the commutator bars, more often than not, results in an open circuit and burned commutator bars.

If the commutator is dirty, out of round, or has high mica, the correction is to turn the commutator down in a lathe and undercut the insulation 1/32 inch deep. New brushes should be installed and seated. Blow out abrasive dust after using seating stones. See Illusts. 20 and 23.

After periods of storage or prolonged low speed operation, the generator commutator tends to glaze over with an oxidized coating that prevents a good electrical contact with the generator brushes. This condition prevents the generator from operating in a normal manner.



FEA-63165

Illust. 24. Cleaning the generator commutator (open end generator shown).

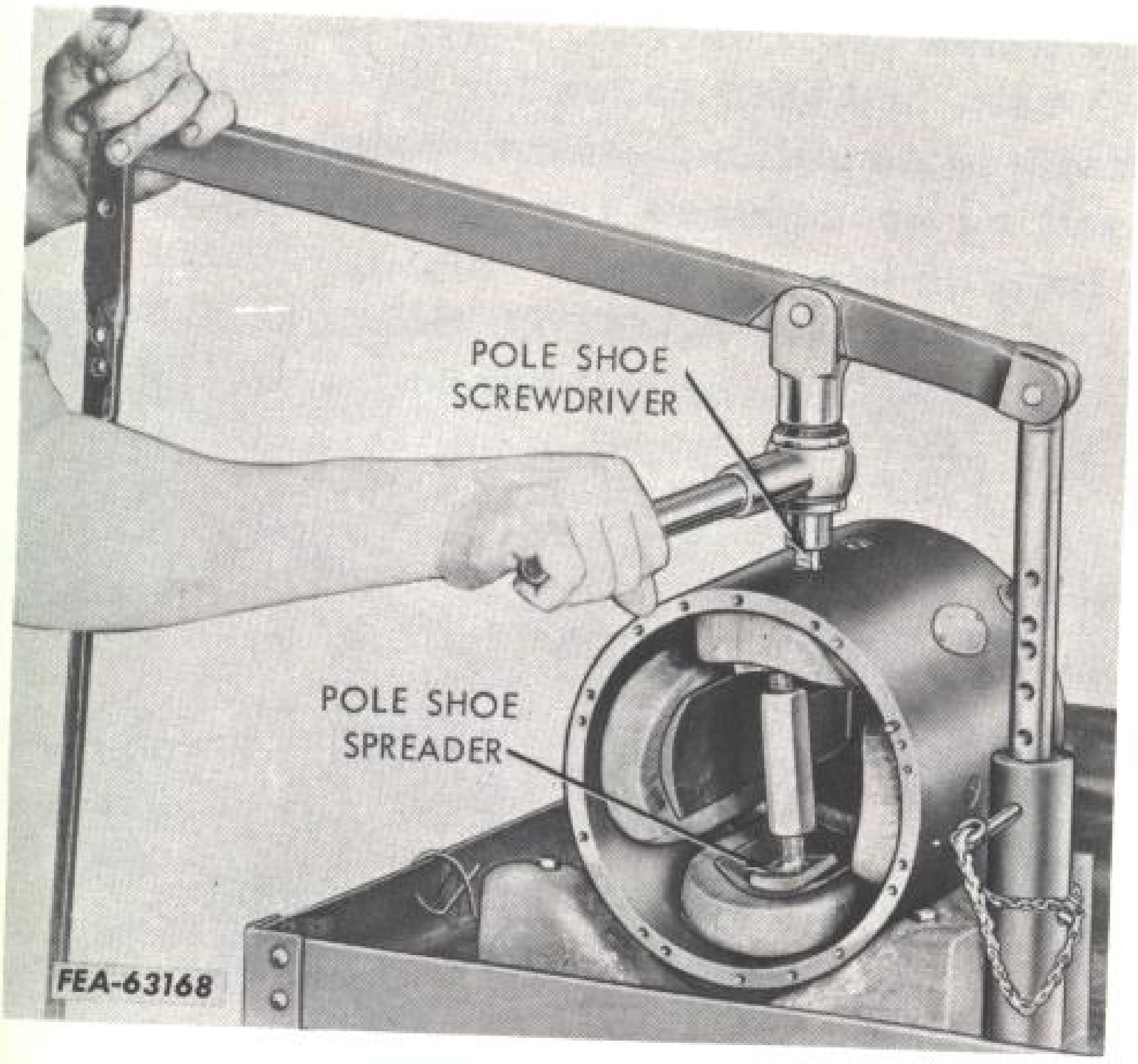
The correction is to polish the commutator by placing a piece of number "00" sandpaper in contact with the commutator while the armature is slowly revolving. See Illust. 24 for cleaning on engine.

CAUTION: Never use emery or carborundum cloth as these abrasives are conductors of electricity and would create short circuits between the bars of the commutator. After the polishing operation is completed, blow all dust from the commutator.

Fields

If the generator is not found to be grounded, check the field for an open circuit with the test lamp. The lamp should light when one test point is placed on the "F" terminal and the other point is placed on the brush holder to which the field is connected. If it does not light, the field circuit is open.

If the open circuit is due to a broken lead or poor connection, it may be repaired but if the open circuit is inside one of the field coils, the coil must be replaced.



Illust. 25. Removing the field pole shoe screws on generator or cranking motor.

If the field coil is not open, check for a short circuit in the field by connecting a battery of the specified voltage and an ammeter in series with the field circuit. Proceed with care because a shorted field may draw excessive current which might damage the ammeter. If the field draw is not within specifications, new field coils will be required. See Illust. 25.

NOTE: If a shorted field is found, check the regulator contact points because a shorted field may have caused excessive current that has damaged the points. Clean points or replace as necessary.

When the testing procedure indicates uncontrolled high output of the generator, even after the external lead of the generator "F" field terminal is disconnected, the generator field has become grounded. This internal ground may occur between the "F" terminal stud and generator frame, between the field coil leads and generator frame, or between field coils and pole shoes. Re-insulation at point of failure will correct the problem.

Bearings

Dirty bearings may be cleaned, but if they are worn, replacement is recommended. When the bushings in the commutator end frame are worn, it is recommended that a new commutator end frame complete with bushing be installed. In this manner the new bushing will be properly installed in relation to the oil well and wick, and already reamed to size, concentric with the end frame.

The ball bearing on the drive end may be cleaned, but if it is rough or shows sign of wear, it should be replaced.

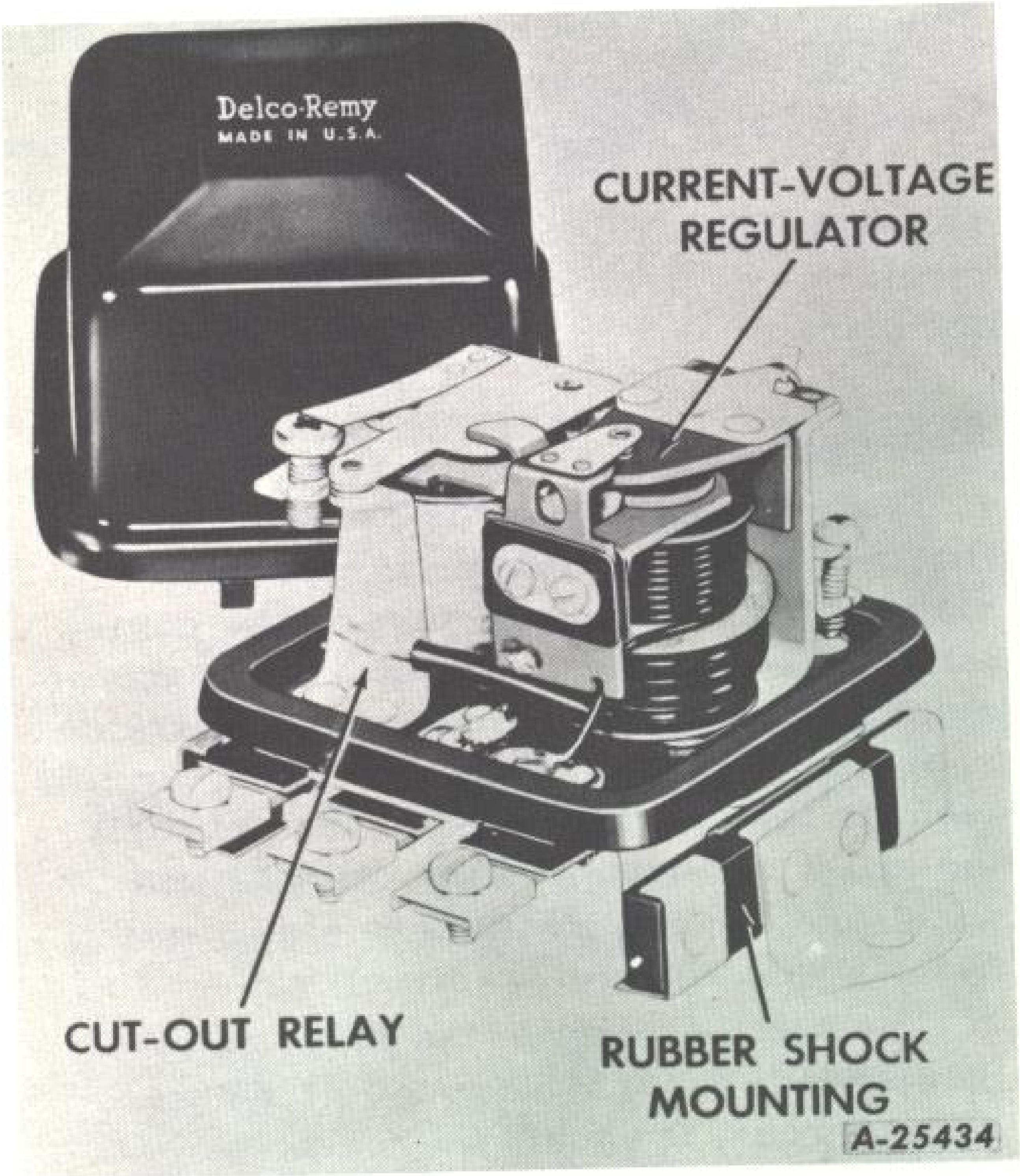
Repolarizing the Generator

After any electrical tests or replacement of components that require the opening of various circuits, the generator should be repolarized following the removal of meters and replacement of all wires and cables in their normal operating positions.

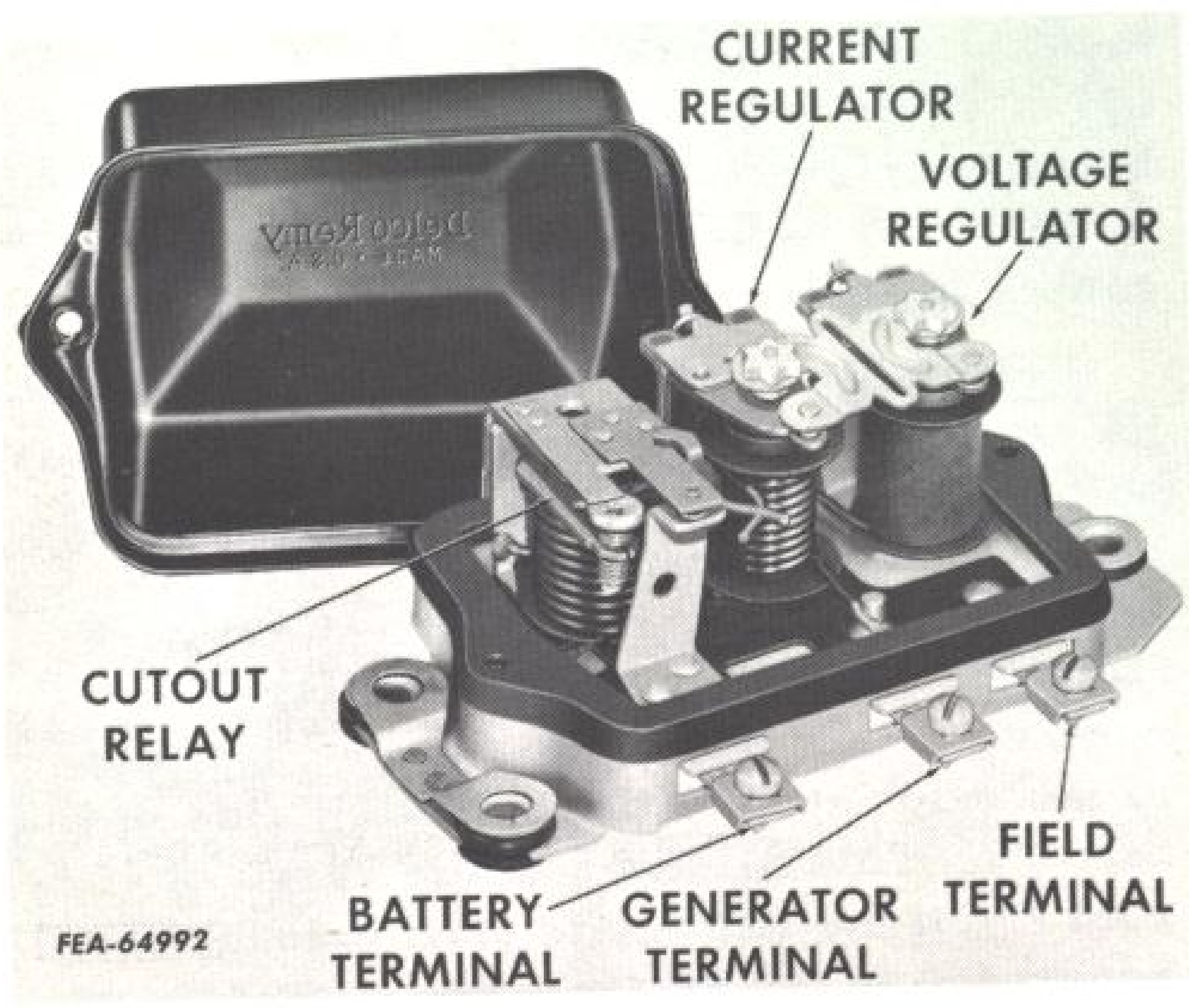
Before the engine is started, momentarily connect a jumper lead between the "Bat" (battery) terminal and "Gen" (generator) terminal of the regulator for "A" circuits. On Lucas generators, remove the field wire from the generator and momentarily connect a jumper lead from the "F" terminal of the generator to the insulated side of the battery. This allows a short surge of current from the battery to flow through the generator to correctly polarize it.

CAUTION: Avoid touching the jumper lead to the "F" terminal of the regulator because that will cause damage to the regulator unit.

Failure to repolarize could result in the generator building up its output in the wrong direction causing damage to the cut-out relay and no charging current reaching the battery.



Illust. 26. Voltage regulator (2-unit).

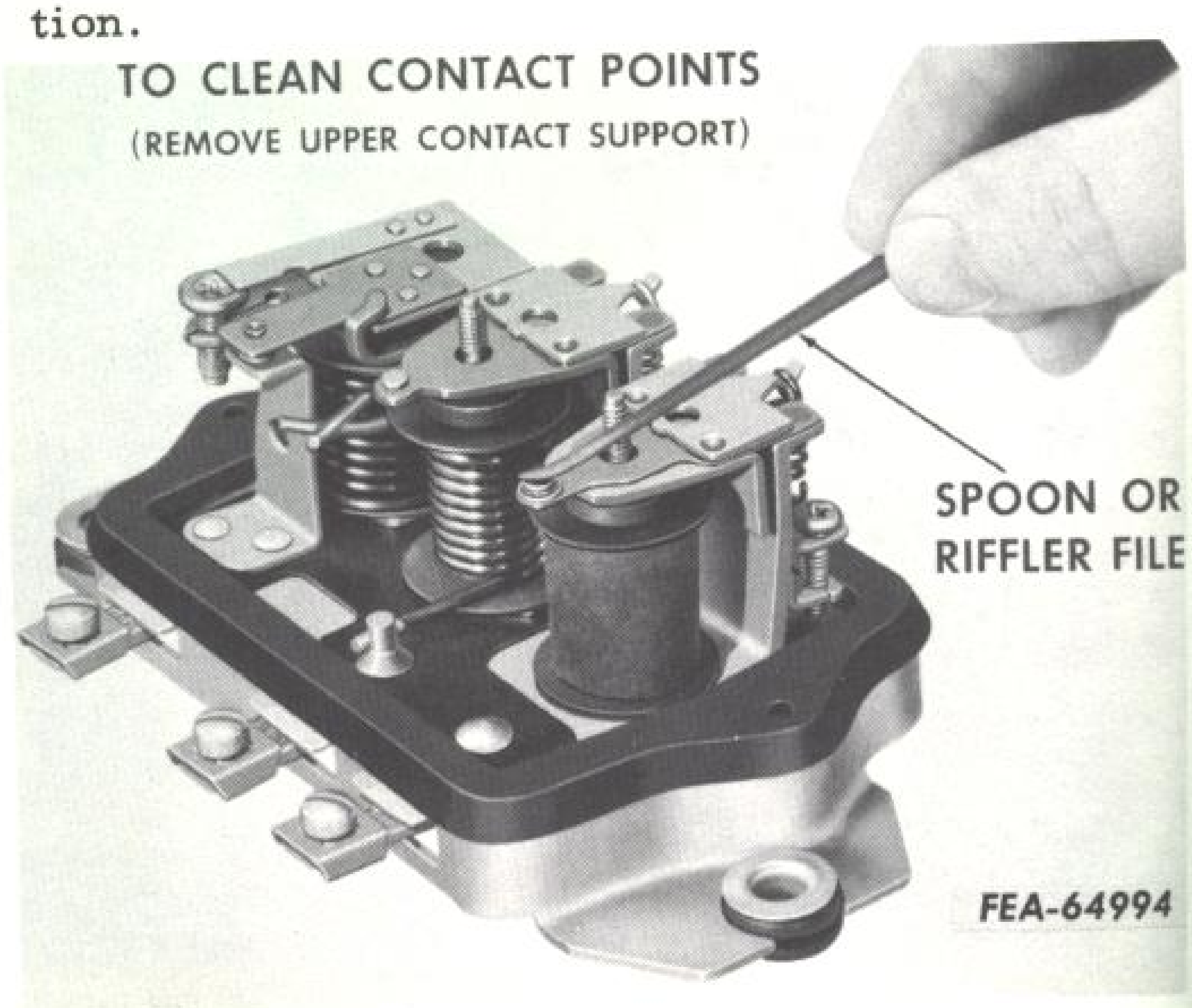


Illust. 27. Voltage regulator (3-unit).

Both two-unit and three-unit regulators are used. Illusts. 26 and 27.

It is important to remember that the voltage setting for one type of operating condition may not be satisfactory for a different type of operating condition. Vehicle underhood temperatures, operating speeds, and nighttime service all are factors which help determine the proper voltage setting. The proper setting is attained when the battery remains fully charged with a minimum use of water.

If no circuit defects are found, yet the battery remains undercharged, raise the setting by .3 volt, and then check for an improved battery condition over a service period of reasonable length. If the battery remains overcharged, lower the setting by .3 volt, and then check for an improved battery condition. Recommended voltage setting procedures are covered in this section.



Illust. 28. Riffler file used to clean flat contact points in regulator (3-unit regulator shown).

Contact Points

The contact points of a regulator will not operate indefinitely without some attention. A great majority of regulator troubles can be eliminated by a simple cleaning of the contact points and slight adjustments. See Illust. 28.

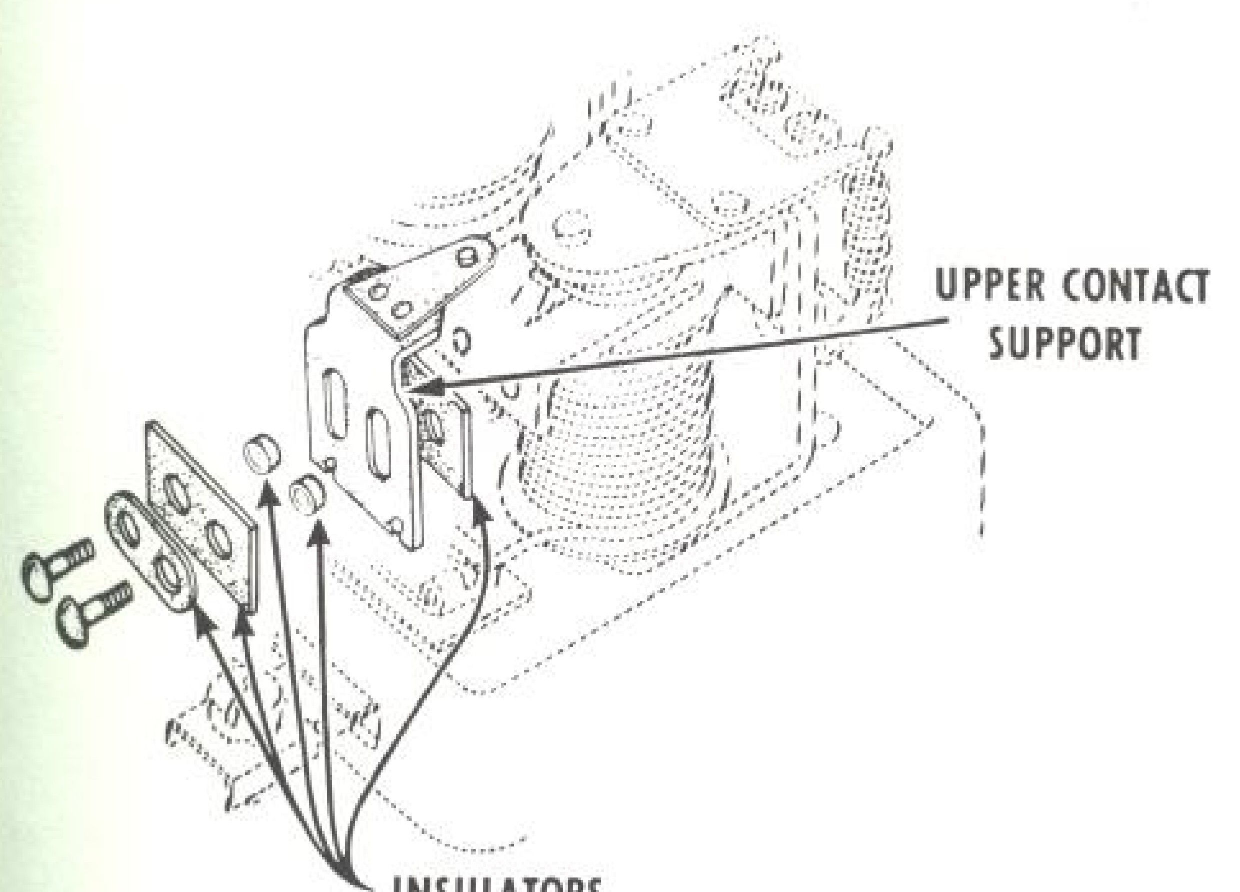
The flat point always develops a slight cavity and is the point that requires the most attention. It is not necessary to have a perfectly flat surface on this point, but cleaning the surface down to pure metal with a fine-cut riffler file will insure long periods of service without difficulty.

The file should not be allowed to become greasy and should not be used to file other metals. After filing, wipe points with lintless cloth saturated in carbon tetrachloride to insure clean surfaces.

If a new machine is left in inventory for several weeks, there is a possibility that the voltage regulator and relay points may have oxidized to the extent that initial operation will be affected.

New machines removed from storage will not have sufficient running time to result in the regulator and relay points being pitted or damaged to the extent that would require filing and readjustment. Simple cleaning by drawing a clean paper, saturated in carbon tetrachloride, between the points will remove the oxide film and restore good electrical contact surfaces.

CAUTION: Avoid excessive removal of contact point metal. Never use sandpaper or emery cloth to clean points.



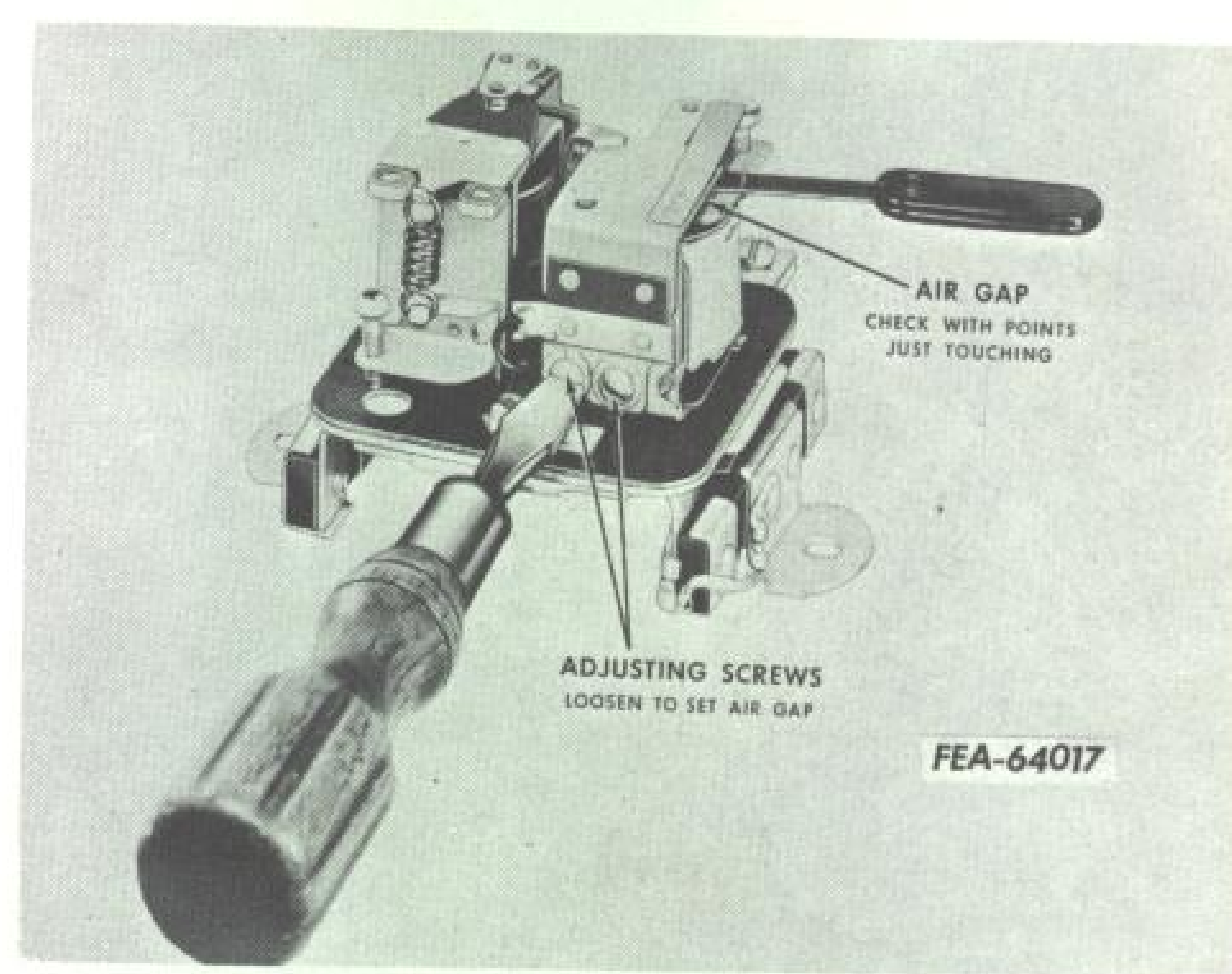
Illust. 29. Disassembly of upper contact support for cleaning. Use new insulator bushings upon reassembly.

On (+) positive grounded system regulators the flat point is in the upper contact bracket and will require removal for cleaning. See Illust. 29. On (-) negative grounded system regulators the flat point is in the armature. Clean them by loosening the upper contact support and moving it to one side.

NOTE: Regulators are designed for use with a system having a given battery ground polarity. Using the wrong polarity regulator on an installation will shorten the life of the regulator contact points. Be careful to avoid interchanging the two types of regulators in service. Check the parts catalog for the machine model involved and the specified regulator part number when a replacement is necessary.

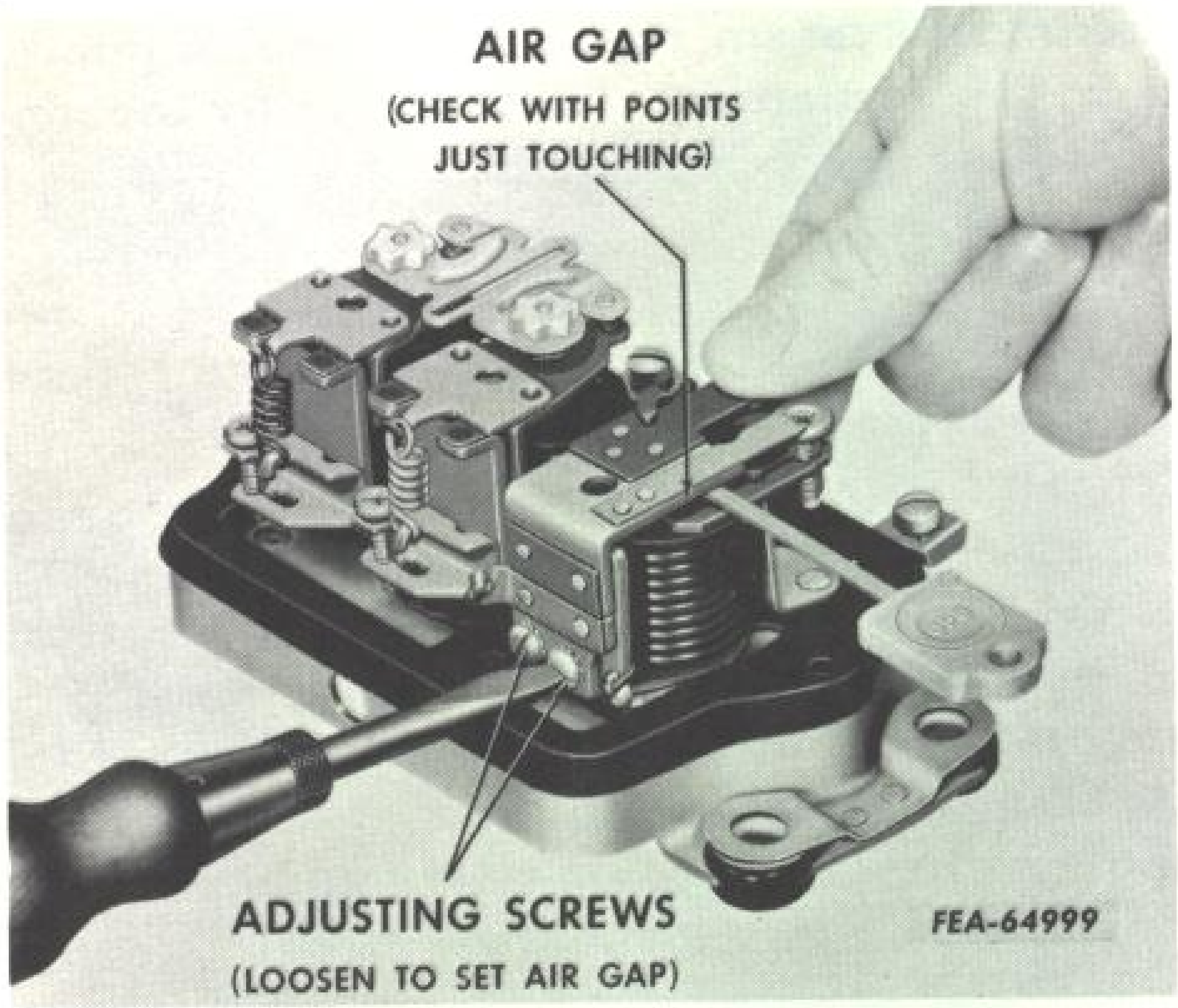
Cut-Out Relay Adjustments

There are three adjustments of the cut-out relay: Armature to core air gap, contact point opening, and voltage required to close points. The air gap and point opening adjustments must be made with the battery disconnected.

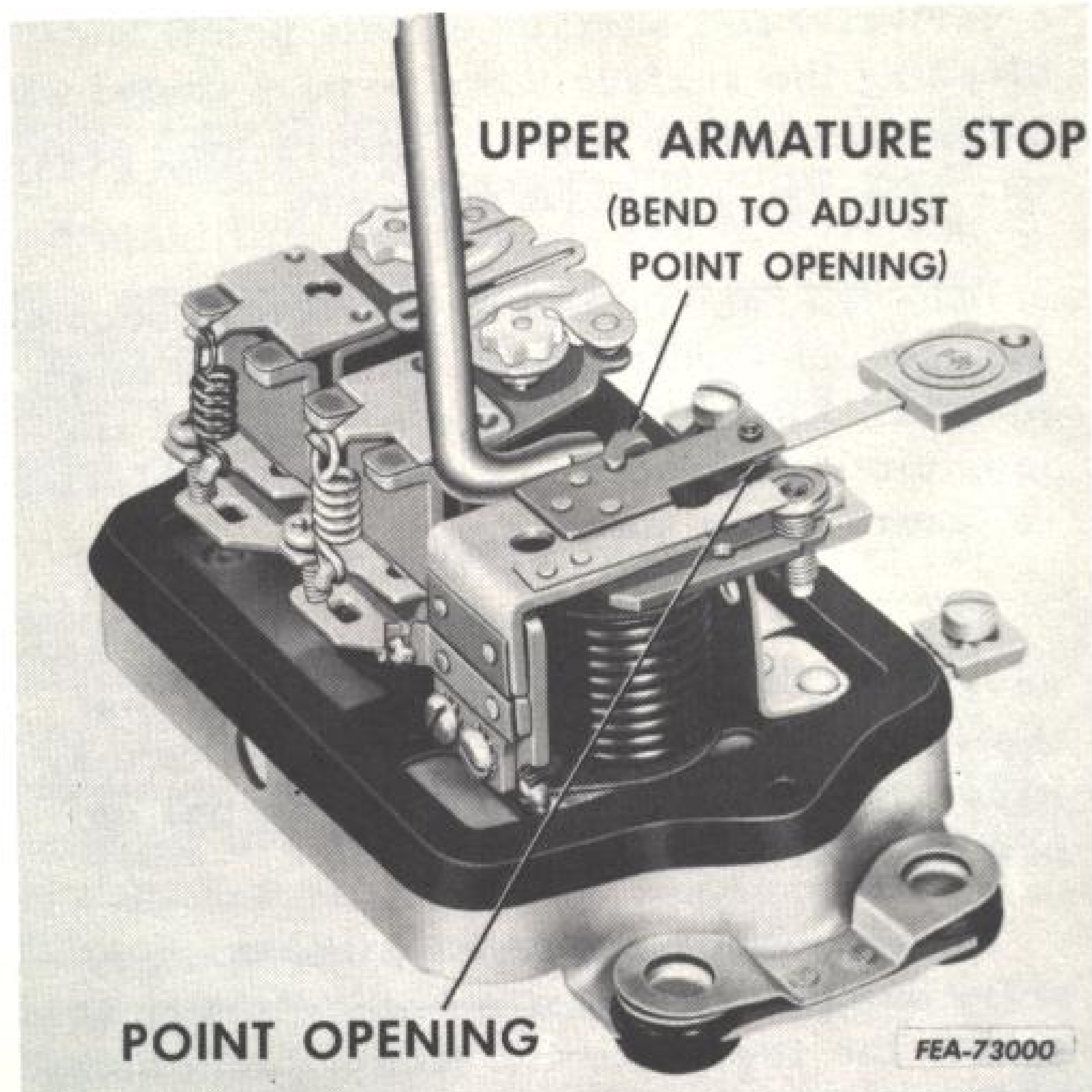


Illust. 30. Cut-out relay air gap check and adjustment (2-unit regulator).

1. Air gap. Place your fingers on the armature directly above the core and press the armature down until the points just close. Then measure the air gap between the armature and the center of the core. See Illusts. 30 and 31. Adjust by raising or lowering the armature at its hinge mounting. Retighten screws after adjustment.

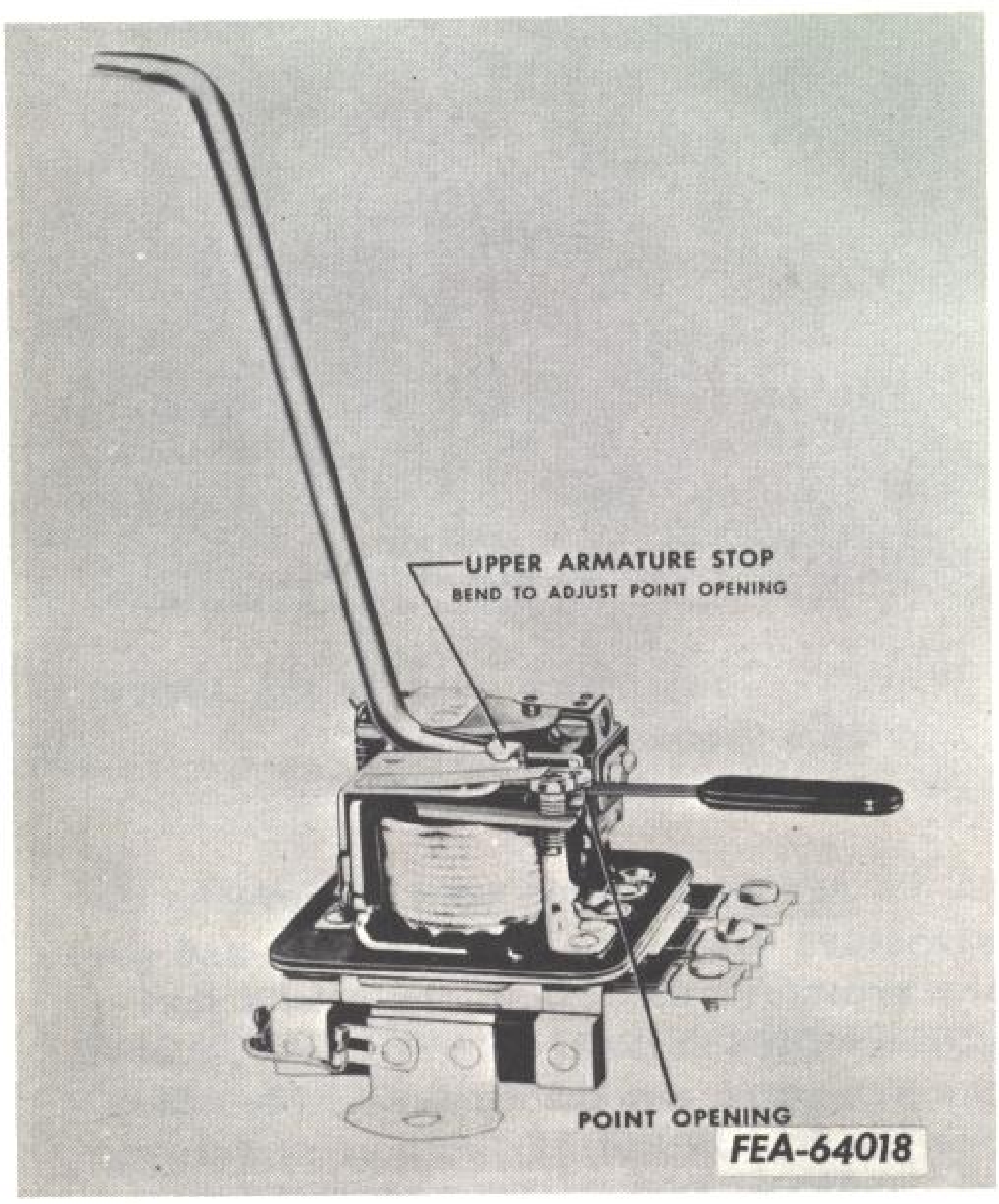


Illust. 31. Cut-out relay air gap check and adjustment (3-unit regulator) battery must be disconnected when this check is made.

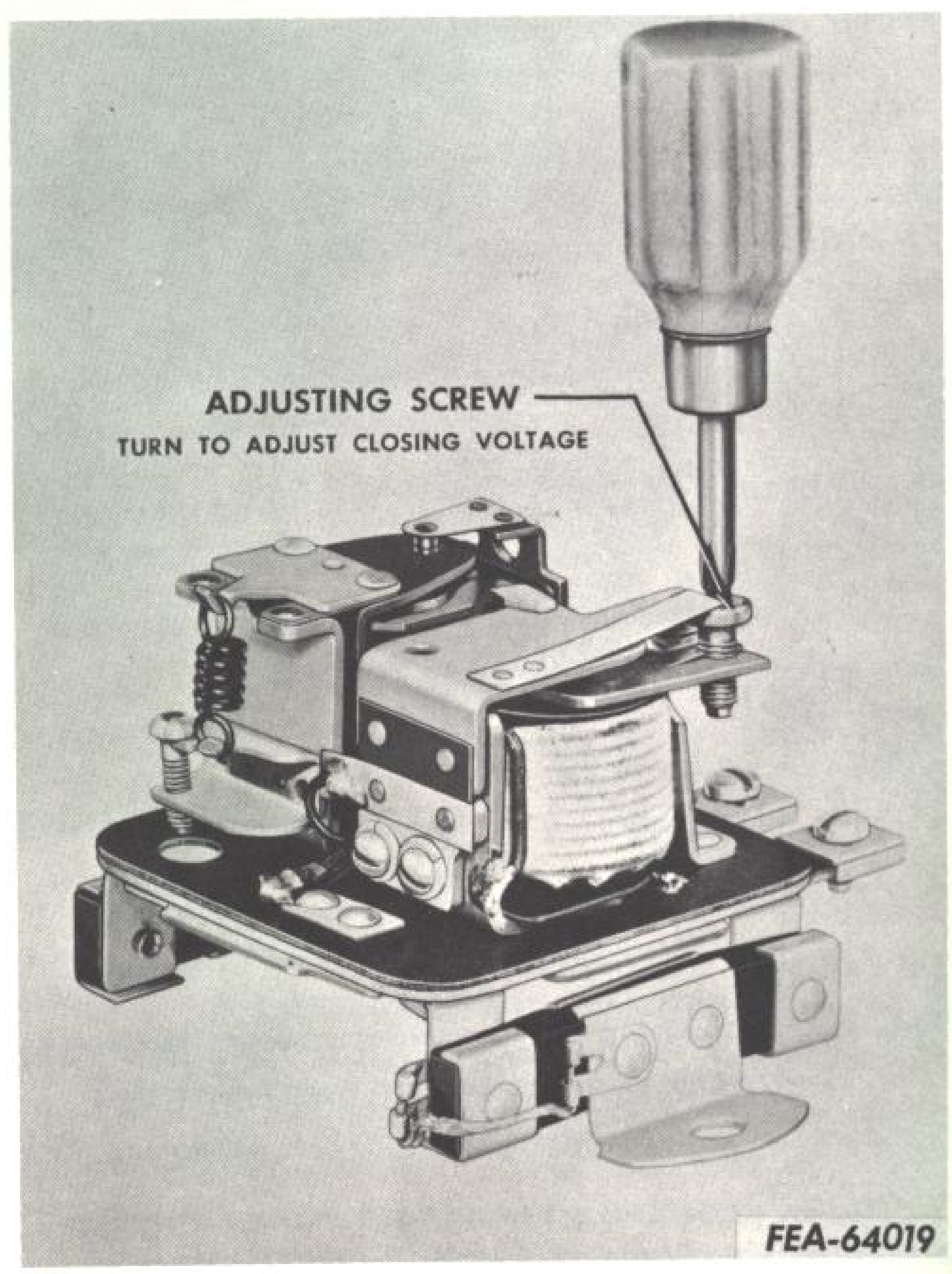


Illust. 33. Cut-out relay point opening check and adjustment (3-unit regulator).

2. Point opening. Adjust the point opening by bending the armature stop as shown in Illusts. 32 and 33.

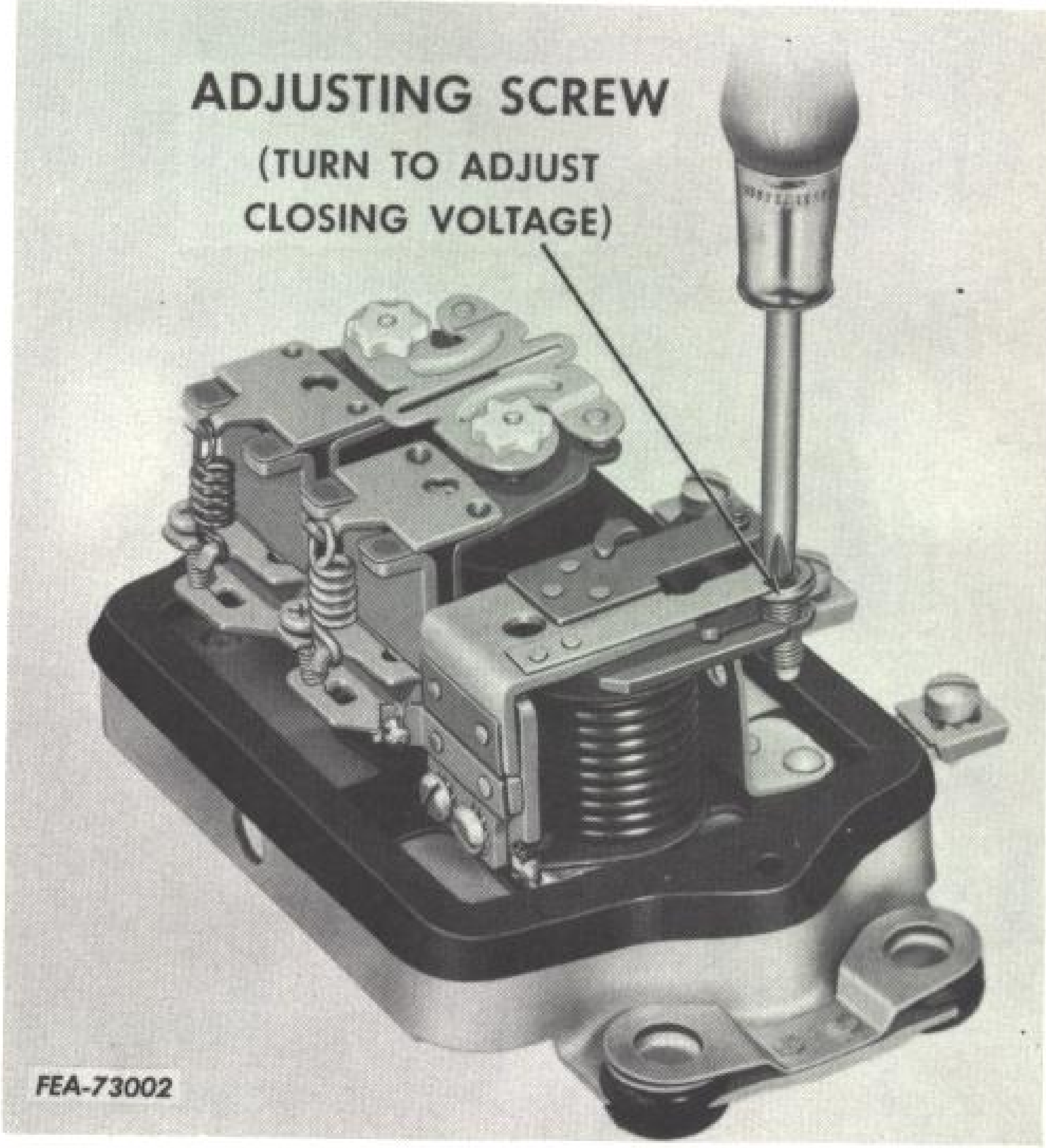


Illust. 32. Cut-out relay point opening check and adjustment (2-unit regulator).



Illust. 34. Adjustment of cut-out relay closing voltage (2-unit regulator).

3. Closing voltage. Check the closing voltage as already described under Cutout Relay tests. Adjust the closing voltage by turning the screw clockwise to increase spring tension and voltage, counterclockwise to decrease spring tension and closing voltage. Be sure that closing voltage adjustment is at least 0.5 volt less than the voltage regulator unit setting. See Illusts. 34 and 35.



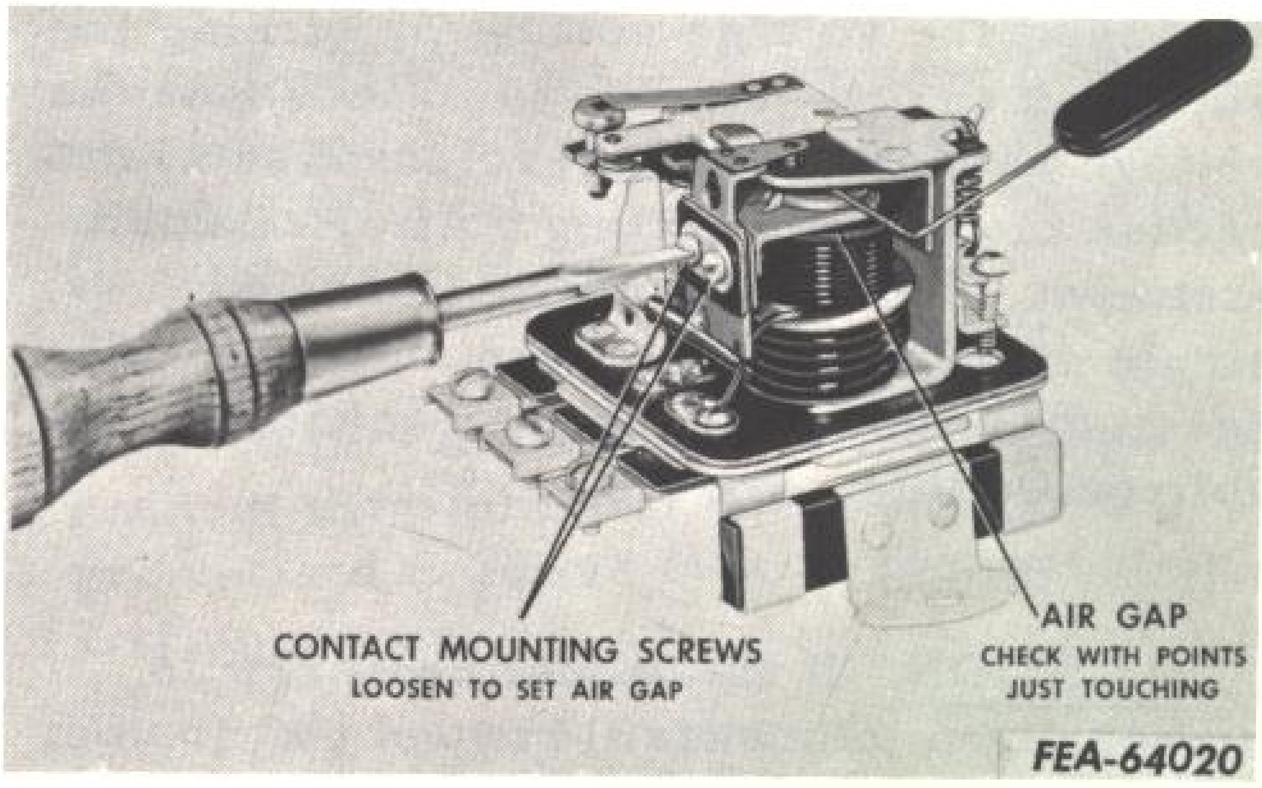
Illust. 35. Adjustment of cut-out relay closing voltage (3-unit regulator).

Voltage Regulator Adjustments

(2 unit regulator)

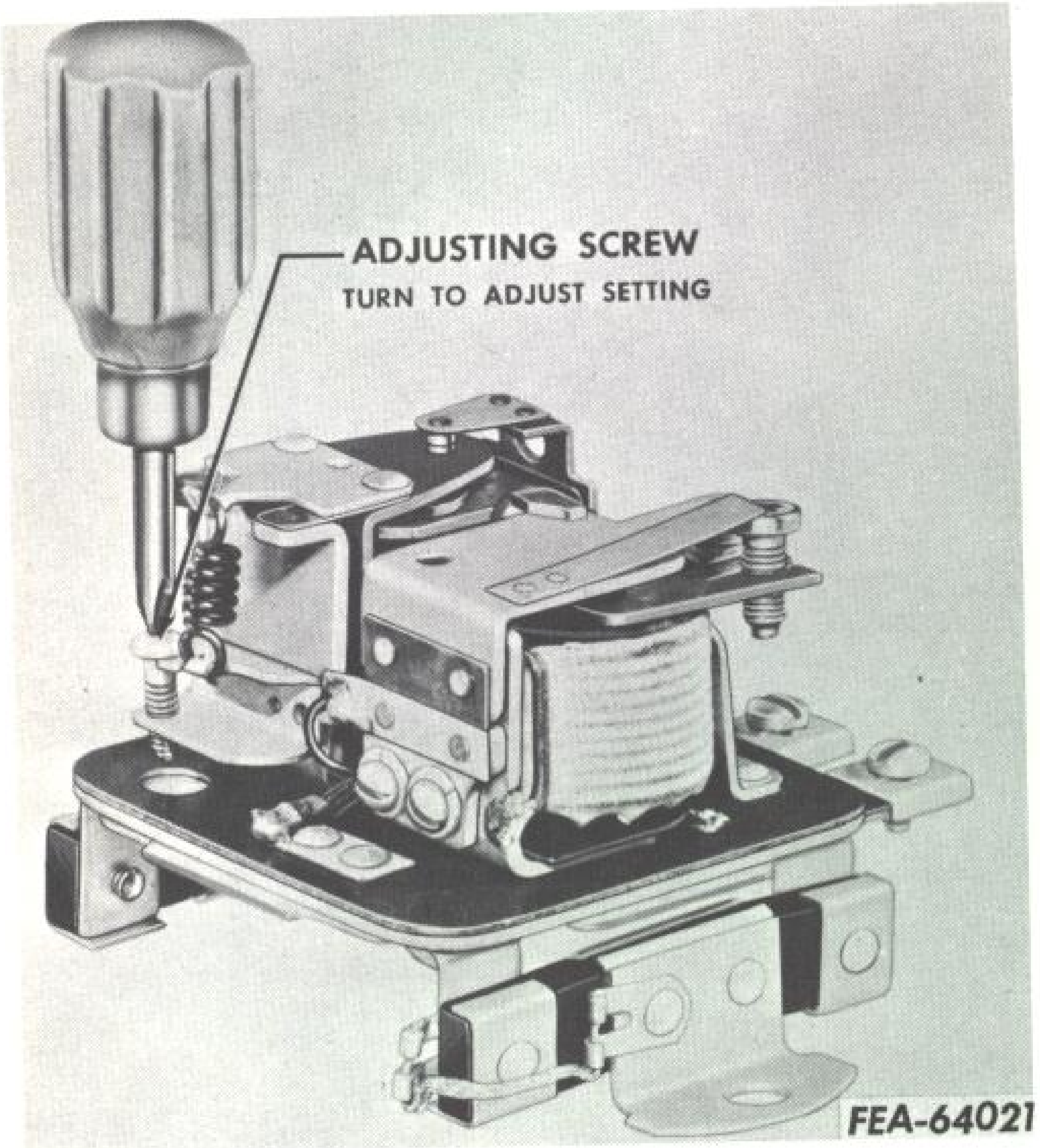
The current-voltage regulator unit requires two inspections and adjustments: the armature air gap, and the voltage setting.

1. Regulator air gap. To check the air gap, push the armature down until the contact points are still just touching; then measure the air gap. Adjust by loosening contact mounting screws and raising or lowering the contact bracket as required. Be sure the points are lined up and screws are retightened after adjustment and before retesting the voltage setting. See Illust. 36.



Illust. 36. Current-voltage regulator air gap check and adjustment (2-unit regulator).

2. Voltage setting. Test the regulator voltage setting as already described under the heading, Testing the Current-Voltage Regulator.



Illust. 37. Adjusting voltage setting, current-voltage regulator unit (2-unit regulator).

Adjust the voltage setting by turning the adjusting screw—clockwise to increase the setting and counterclockwise to decrease the voltage setting. After each adjustment, replace the cover and allow ample running time to again stabilize voltage and temperature before rechecking the voltage setting. See Illust. 37.

CAUTION: If the adjusting screw is turned down (clockwise) beyond the normal range required for adjustment, the spring support may fail to return when the pressure is relieved. If this happens, turn the screw counterclockwise until enough clearance develops between the screw head and the spring support. Then bend the spring support upward carefully with small pliers until contact is made with the screw head.

The final setting should always be approached by increasing the spring tension. In other words, if the setting is too high, the unit should be adjusted below the required value and then raised to the exact setting by increasing the spring tension. Be sure the screw is exerting force on the hanger.

Voltage Regulator Adjustments

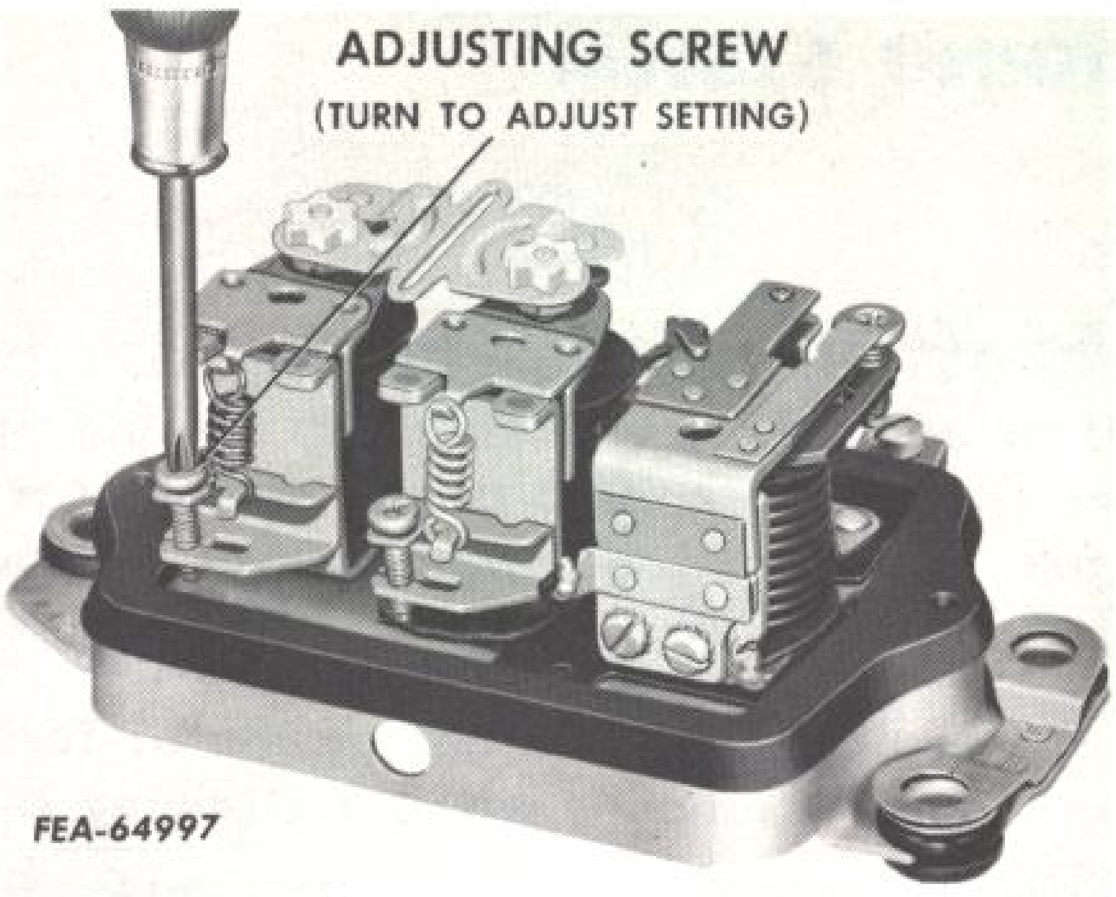
(3 unit regulator)

Two checks and adjustments are required on the voltage regulator; air gap and voltage setting.

Illust. 38. Voltage regulator air gap check and adjustment (3-unit regulator).

1. Air gap. Push down on the armature until the contact points are just touching. Measure the air gap between armature and winding core. Illust. 38.

2. Voltage setting. Test the regulator voltage setting as already described under Testing the DC Voltage Regulator.



Illust. 39. Adjusting voltage regulator setting (3-unit regulator).

Adjust the voltage setting by turning the adjusting screw, turn clockwise to increase the setting and counterclockwise to decrease the setting. Illust. 39. See CAUTION on page 30.

Current Regulator Adjustment

Two checks and adjustments are required on the current regulator: air gap and current setting.

1. Air gap. Check and adjust in exactly the same manner as for the voltage regulator above. See Illust. 38.

2. Current setting. Test the current regulator setting as already covered under DC voltage regulator testing.

To adjust the current setting, turn the adjusting screw clockwise to increase the setting and counterclockwise to decrease the setting. See Illust. 39. See preceding CAUTION.

Lucas DC Voltage Regulator (British)

The Lucas Voltage Regulator may be adjusted without removing the cover by removing the rubber plugs from the two access holes in the side of the regulator cover. With the base down, the left hole is the regulator adjusting screw and the right hole is the cutout adjusting screw.

Cut-Out Relay Adjustment

1. With an insulated sleeve over a screwdriver, connect a voltmeter between the "D" terminal and ground. Turn on the lights to place a load on the system.

2. Start the engine and increase the speed until the contacts close.

3. Turn the screw in to increase the setting and out to decrease the setting.

Voltage Regulator Adjustment

1. Install an insulated sleeve over a screwdriver to prevent shorting to the cover and install it as a prod on the negative voltmeter lead.

2. With the battery cable disconnected, connect the voltmeter positive lead to ground and negative lead to the cutout adjusting screw.

3. Start the engine and set speed to obtain 3000 generator rpm.

4. Adjust the regulator screw to obtain the specified setting. Turn the screw in to increase and out to decrease the setting.

TESTING THE AC CHARGING SYSTEM

Battery

The battery should be checked for state of charge and condition before any checks are made. Place a load on the battery by cranking or turning on all the lights and check the voltage of each cell. The voltage should not drop below 1.5 volts per cell and not vary more than .2 volt between cells. See Illust. 2. Specific gravity should read at least 1.250 (corrected to 80°F) per cell.

CAUTION: On carbureted engines, it will be necessary to disconnect the primary wire from its terminal on the distributor to prevent ignition during cranking period.

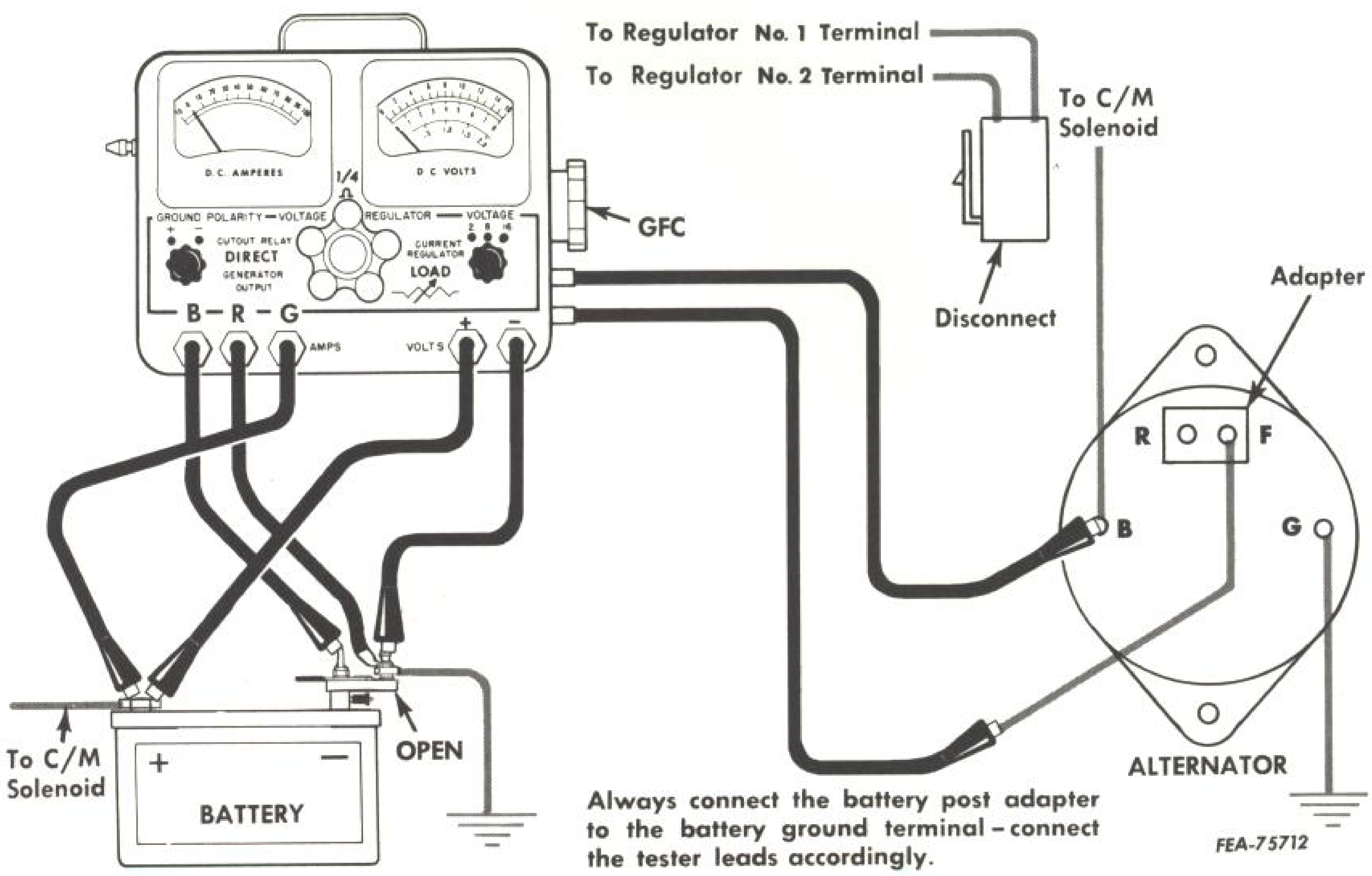
Never operate the cranking motor for more than 30 seconds without allowing it to cool.

Alternator

NOTE: The battery post adapter SE2057, Illust. 7 is installed on the battery ground terminal to prevent dangerous arcing during connection of leads. Due to this connection, the polarity of the tester must be reversed to obtain correct readings. The battery post adapter is used to ease tester connection to the circuit due to the inaccessibility of the regulator on some models. If the battery post adapter is not available, follow instructions furnished with the tester and connect the leads to the battery terminals.

Field Current Draw

1. To check field current draw of the alternator, connect the volt-ampere tester leads as shown in Illust. 40.



Illust. 40. Checking field current draw or alternator output.

2. Open the by-pass switch on the battery post adapter (BPA).

3. Turn the Generator Field Control (GFC) to the DIRECT position.

4. The ammeter should read the specified current draw as listed for the model alternator involved. If no reading is shown, the brushes are not contacting the slip rings or the field winding is open.

5. Return the GFC to the OPEN position.

Alternator Output

1. Close the by-pass switch on the battery post adapter (BPA) and start the engine.

2. Open the by-pass switch and adjust the engine speed to the specified idle rpm.

3. Observe the ammeter. It should indicate the current used by the machine at idle.

4. Set the generator field control (GFC) to the DIRECT position.

5. Observe the ammeter. It now indicates the output of the alternator at idle. For specified output add field current and current used by the machine to the ammeter reading. Refer to specifications.

6. Rotate the GFC to the OPEN position.

7. Adjust engine speed to obtain the specified alternator rpm for output as listed in specifications. (The photo-tach FES 61, may be used to read the alternator rpm.)

8. Adjust the load control knob to obtain approximately 8 volts.

9. Set the GFC to the DIRECT position.

10. Readjust the load control to obtain 14 volts.

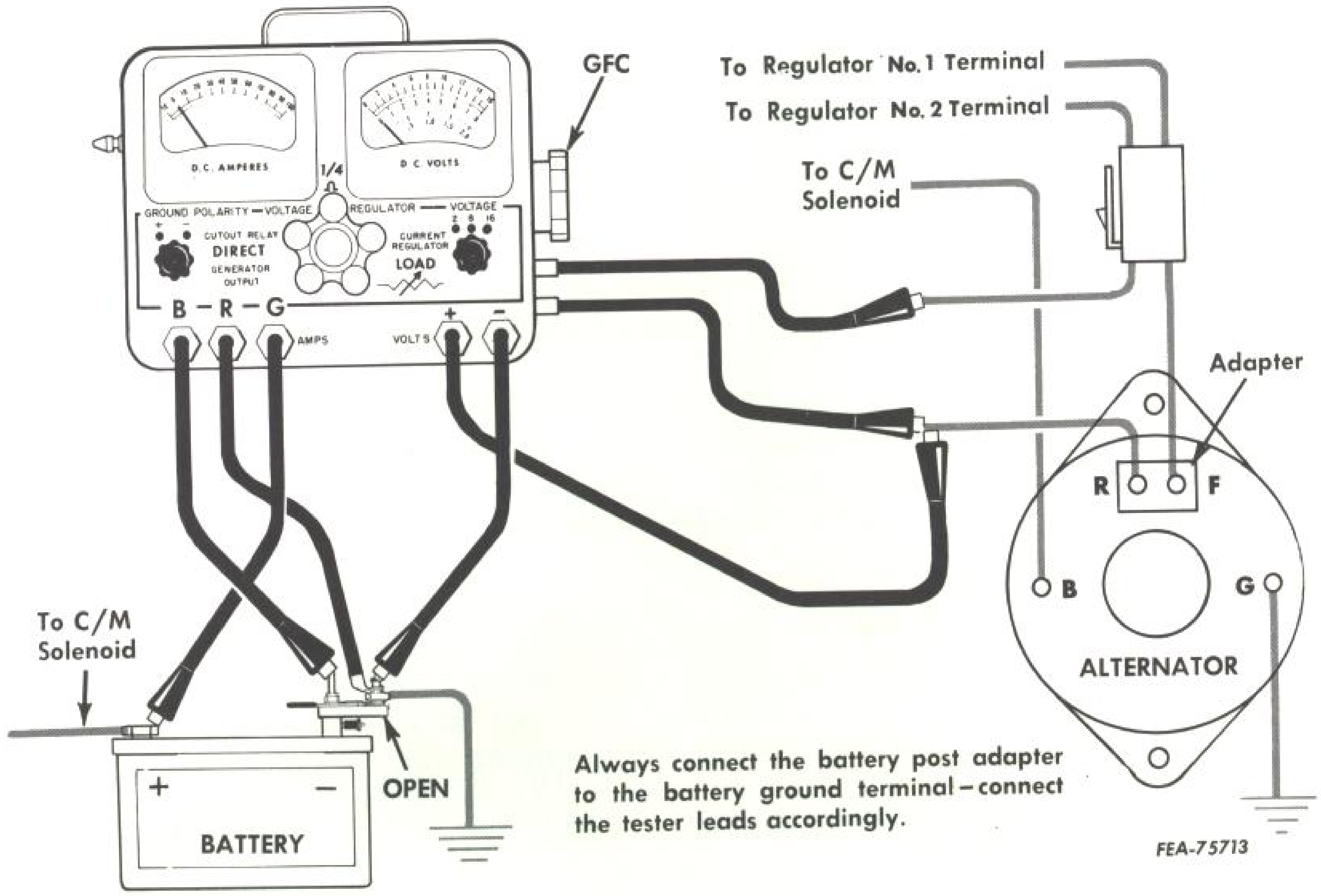
11. Observe the ammeter. It now indicates the output of the alternator. Refer to specifications or add the field current and current used by machine to the ammeter reading to obtain specified reading.

12. Rotate the GFC to the OPEN position.

13. Return the load control knob to the DIRECT position.

14. Stop the engine.

15. Remove the GFC leads and reconnect the field wire to the alternator.



Illust. 41. Checking field relay.

Field Relay

1. Disconnect the field and relay connector and install the test kit connector SE2060-5.

2. Connect the volt-ampere tester leads as shown in Illust. 41.

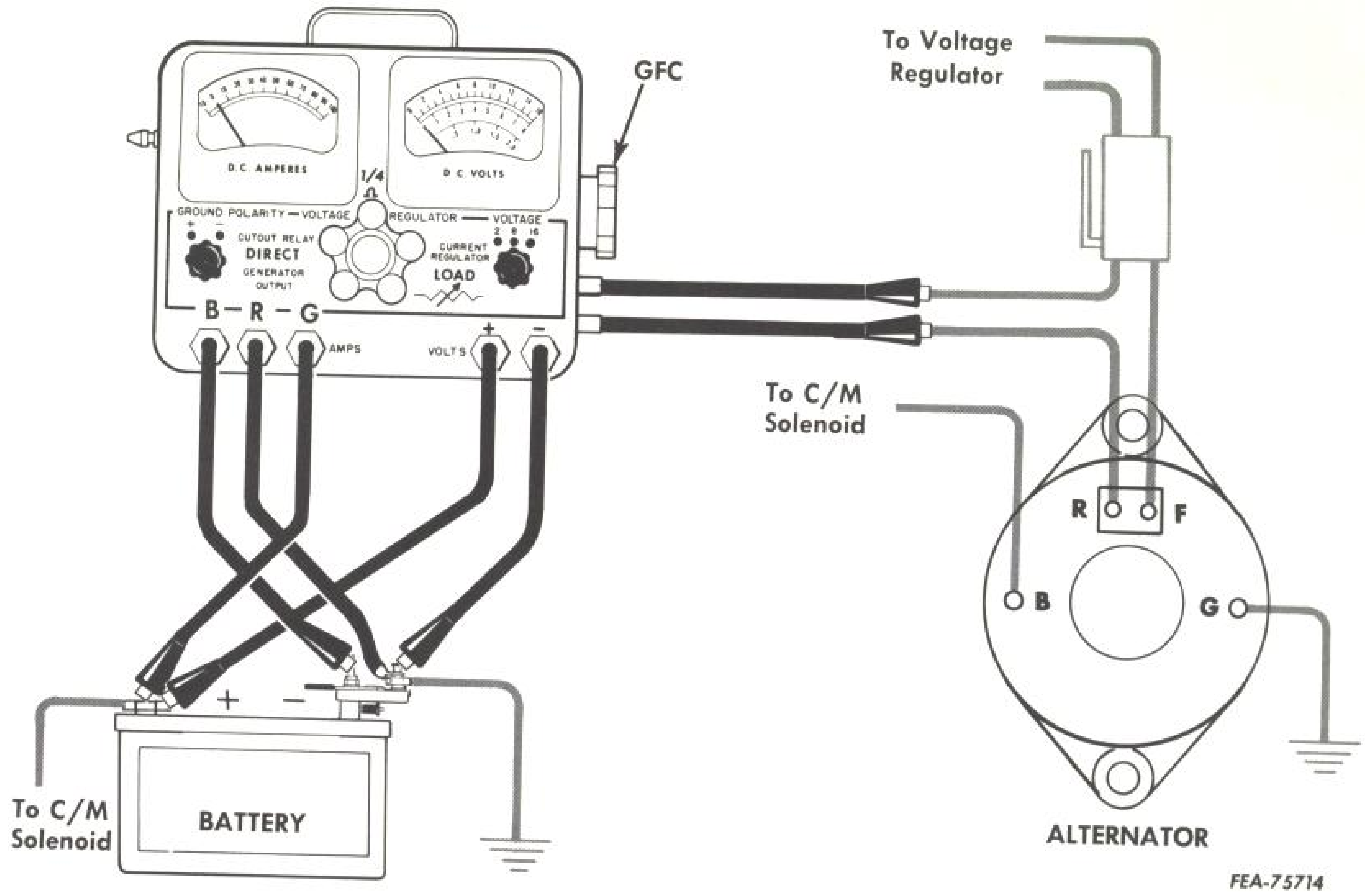
3. Close by-pass switch of the battery post adapter and start engine.

4. Open by-pass switch and operate engine at a moderate speed.

5. Set the generator field control (GFC) to the DIRECT position.

6. Observe the voltmeter. It indicates relay closing voltage.

7. Adjust by bending heel iron in the manner shown in Illust. 61.



Illust. 42. Checking the voltage regulator.

Voltage Regulator

1. Turn the generator field control (GFC) to OPEN. Close the battery post adapter (BPA) by-pass switch and start the engine. Illust. 42.

2. Turn the GFC slowly to DIRECT. Turn the load control to obtain a 20 ampere reading. Turn on the lights and increase speed to 1500 rpm for fifteen minutes to permit the system temperature to normalize.

3. Turn the load control to DIRECT and cycle the system by turning the GFC to OPEN and then back to DIRECT.

4. Adjust the engine speed to the specified alternator test rpm.

5. Rotate the load control knob to the LOAD position and adjust until the ammeter indicates approximately 12 to 15 amps.

6. Observe the voltmeter. It now indicates the series or lower contact voltage setting.

7. Always cycle the alternator as covered in "Step 3" before reading the final voltage setting on the voltmeter.

8. Rotate the load control knob to the 1/4 OHM position.

9. Observe the voltmeter. It now indicates the shorting or upper contact voltage setting. This should be .7 volts more than step 6.

10. Rotate the load control to DIRECT position and rotate the GFC to OPEN.

11. Shut off the engine.

SERVICING THE AC CHARGING SYSTEM

Alternator

Maintenance

While the alternator is constructed to give long periods of service, a regular inspection procedure should be followed to obtain its maximum life. The frequency of inspection is determined largely by operating conditions. High speed operation, high temperatures, dust, and dirt all increase the wear on brushes, slip rings, and bearings.

At regular intervals inspect terminals for corrosion and loose connections and wiring for frayed or deteriorated insulation. Check mounting bolts for tightness and belt for proper alignment, tension, wear, or glazing from slipping and bottoming in the pulley.

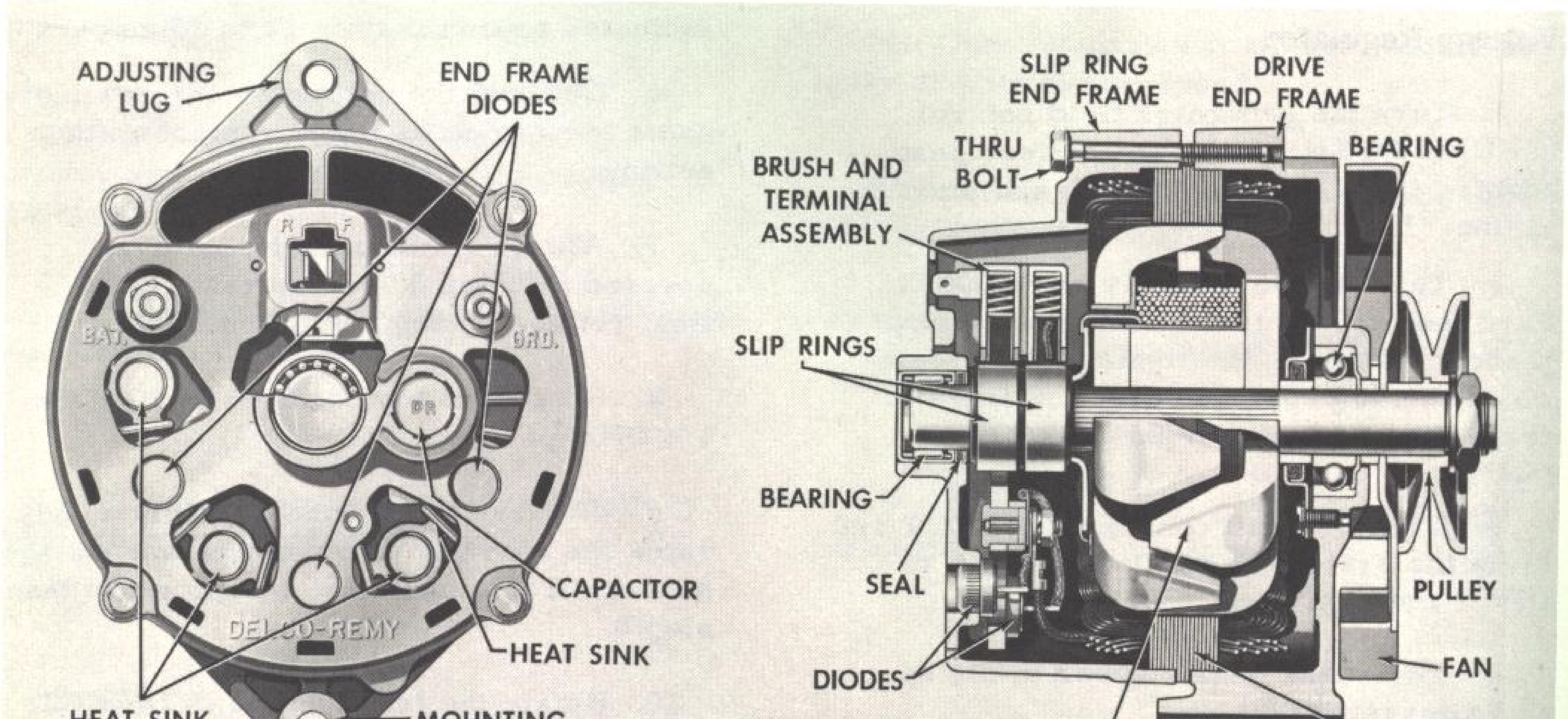
Replace belt if necessary. When tightening belt tension, apply pressure against the stator laminations between end frames and not against either end frame. Loose or slipping belts are quite often the cause of a "rundown" battery complaint.

Each bearing has a grease supply which eliminates the need for periodic lubrication. Illust. 43. However, after periods of extended operation or at engine overhaul time, the bearings should be checked to see that they are in satisfactory condition.

Hold the generator pulley with fingers and note the side play and freeness of rotation to determine the condition of the bearings. If the bearings are rough, worn, or have excessive side play, remove the alternator for servicing or replacement.

Noise from an alternator may be caused by worn or dirty bearings, loose mounting bolts, loose drive pulley, defective diode or defective stator.

The brushes used to carry current through the two slip rings to the field coil



Illust. 43. Sectional view of alternator.

on the rotor are extra long and under normal operating conditions will provide long periods of service. No periodic servicing, therefore, is required for the brushes. However, after periods of extended operation or at engine overhaul time, the brushes should be checked to assure that they are in satisfactory condition.

The diodes and stator need no periodic service but at time of overhaul or when output test shows faulty operation they should be checked as covered under the Disassembly section.

If the alternator is new but suspected of being faulty, an output test should be performed before removing the unit from engine. After extended periods of operation however, or at time of engine overhaul, the alternator should be removed for a thorough inspection and cleaning.

The alternator consists of four main components - the two end frames, the stator, and the rotor. To disassemble the unit, take out the four thru-bolts, and separate the drive end frame and rotor assembly from the stator assembly by prying apart with a screwdriver at the stator slot.

A scribe mark will help locate the parts in the same position during assembly. The fit between stator and frame is not tight, and the two can be separated easily. Note that the separation is to be made between the stator frame and drive end frame.

After disassembly, place a piece of tape over the slip ring end frame bearing to prevent entry of dirt and other foreign material, and also place a piece of tape over the shaft on the slip ring end.

To remove the drive end frame from the rotor, place the rotor in a vise and tighten only enough to permit removal of the shaft nut.

CAUTION: Avoid excessive tightening as this may cause distortion of the rotor. Remove the shaft nut, washer, pulley, fan and the collar, and then separate the drive end frame from the rotor shaft.

Additional disassembly procedures are covered in the following sections.

Diode Checks

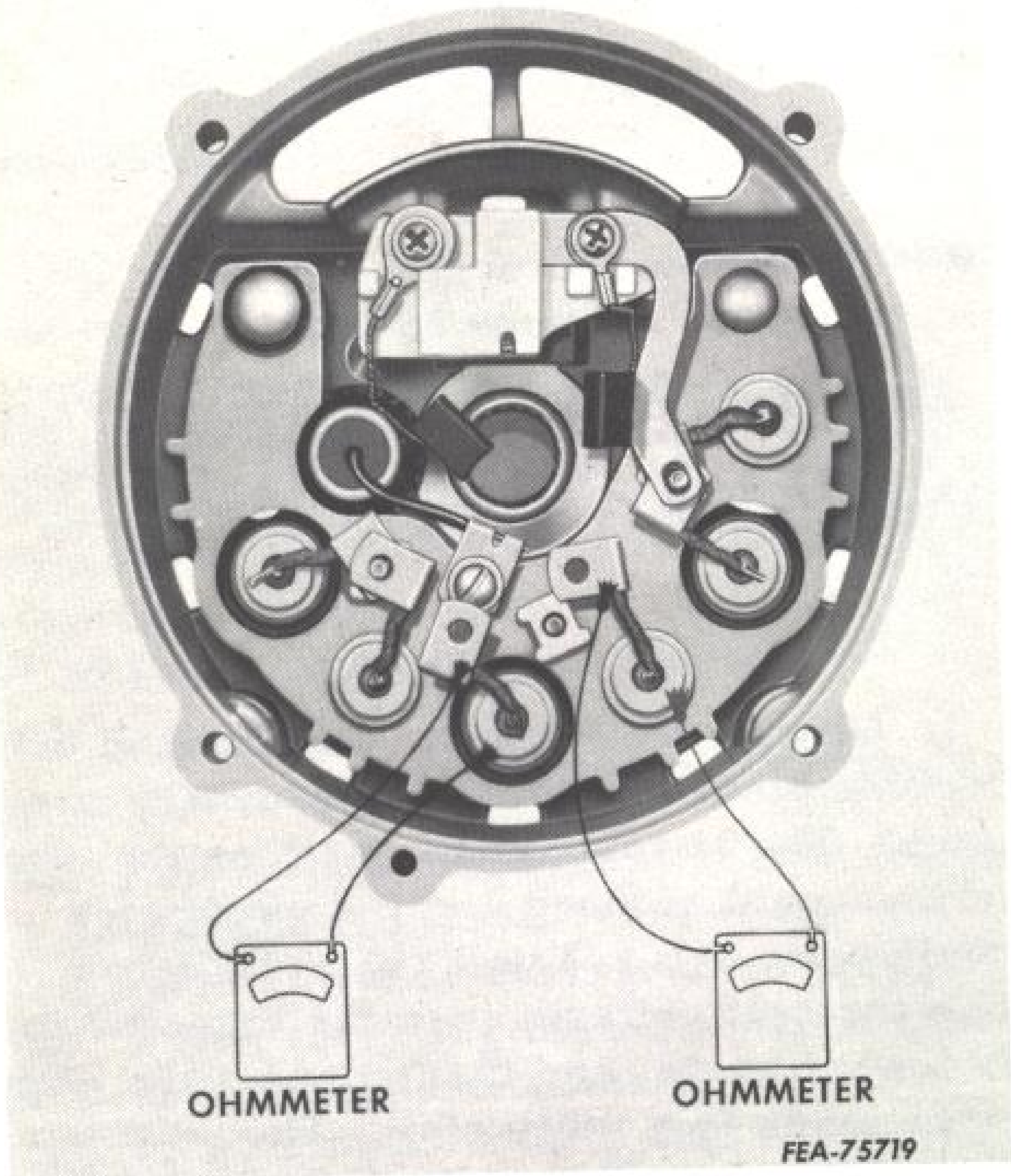
Each diode may be checked electrically for a shorted or open condition. Any one of the three methods outlined below may be used.

1. Ohmmeter Method: One method of checking diodes is to use an ordinary ohmmeter. The lowest range scale on the ohmmeter should be used and the ohmmeter should have a 1-1-2 volt cell. To determine the cell voltage, turn the selector to the lowest scale, and then connect the ohmmeter leads to a voltmeter. The voltmeter will indicate the cell voltage.

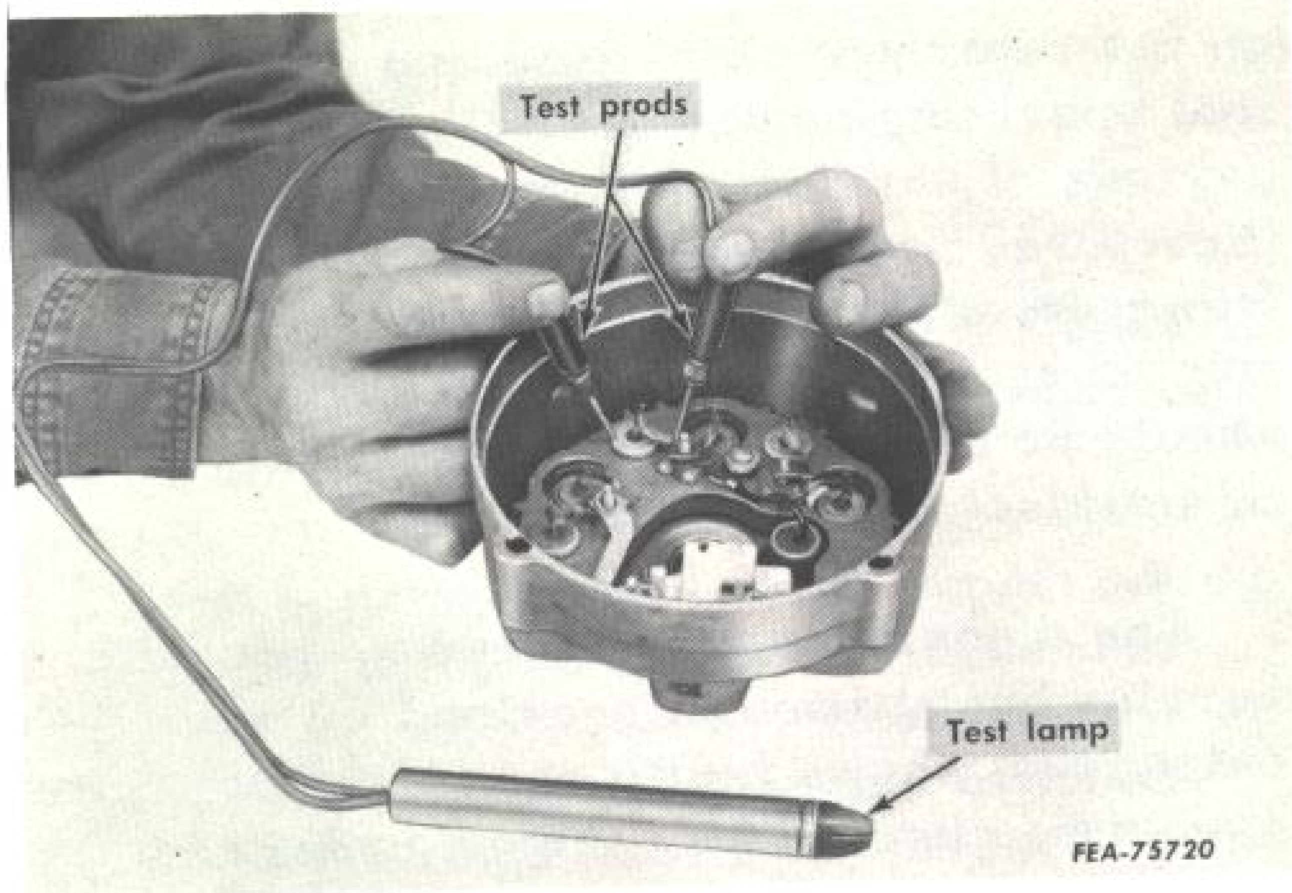
With the stator disconnected, check a diode in the heat sink by connecting one of the ohmmeter leads to the heat sink, and the other ohmmeter lead to the diode lead, and note the reading (Illust. 44). Then reverse the ohmmeter lead connections and note the reading. If both readings are very low, or if both readings are very high, the diode is defective. A good diode will give one low reading and one high reading. Check the other two diodes in the heat sink in the same manner.

To check a diode mounted in the end frame, connect one of the ohmmeter leads to the end frame, and the other ohmmeter lead to the diode lead (Illust. 44), and note the reading. Then reverse the ohmmeter lead connections, and note the reading. If both readings are very low, or if both readings are very high, the diode is defective.

A good diode will give one low reading and one high reading. Check the other two diodes in the end frame in the same manner.



Illust. 44. Checking diodes with Ohmmeter.



Illust. 45. Checking diodes with test lamp.

2. Test Lamp Method: An alternate method of checking the diodes is to use a test lamp (Illust. 45) of not more than 12 volts in place of the ohmmeter.

CAUTION: Do not use 110-volt test lamps to check diodes.

With the stator disconnected, connect the test lamp leads across each diode as previously described, first in one direction and then in the other. If the lamp lights in both checks, or fails to light in both checks, the diode is defective. When checking a good diode, the lamp will light in only one of the two checks.

3. Special Tester Method: Special testers are available which operate without disconnecting the stator. To use these testers, follow the tester manufacturer's recommendations.

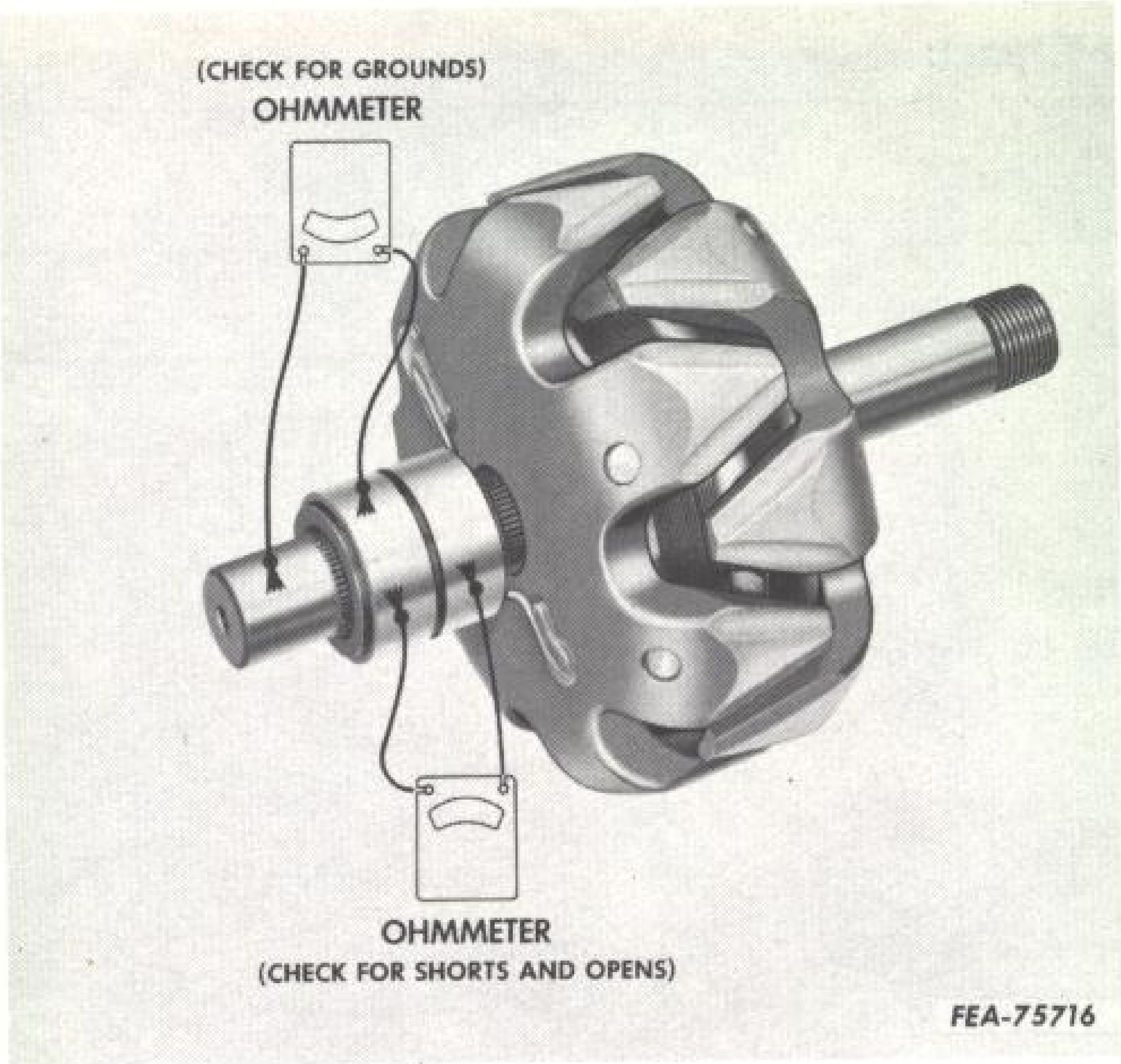
Rotor Checks

The rotor may be checked electrically for grounded, open, or short circuited field coils. To check for grounds, connect a 110 volt test lamp or an ohmmeter from either slip ring to the rotor shaft or to the rotor poles. If the lamp lights, or if the ohmmeter reading is low, the field winding is grounded (Illust. 46).

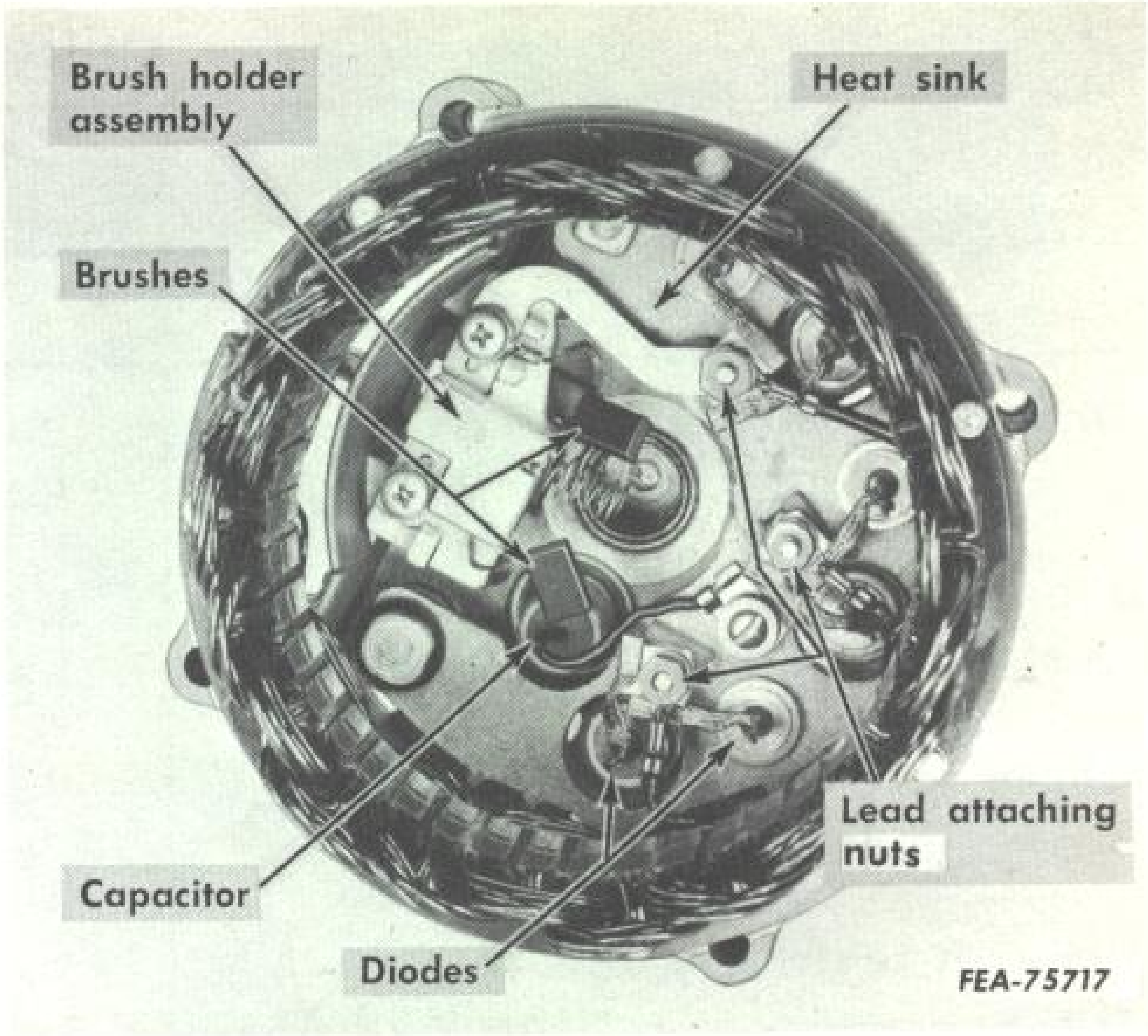
To check for opens, connect the test lamp or ohmmeter to each slip ring. If the lamp fails to light, or if the ohmmeter reading is high (infinite), the winding is open (Illust. 46).

The winding is checked for short circuits by connecting a battery and ammeter in series with the two slip rings. Note the ammeter reading and refer to Specifications.

An ammeter reading above the specified value indicates shorted windings. An alternate method is to check the resistance of the field by connecting an ohmmeter to the two slip rings (Illust. 46). If the resistance reading is below the specified value the winding is shorted. The specified resistance value can be determined by dividing the voltage by the current given in Specifications (GSS-1308-C).



Illust. 46. Checking rotor for grounds, shorts, and opens.



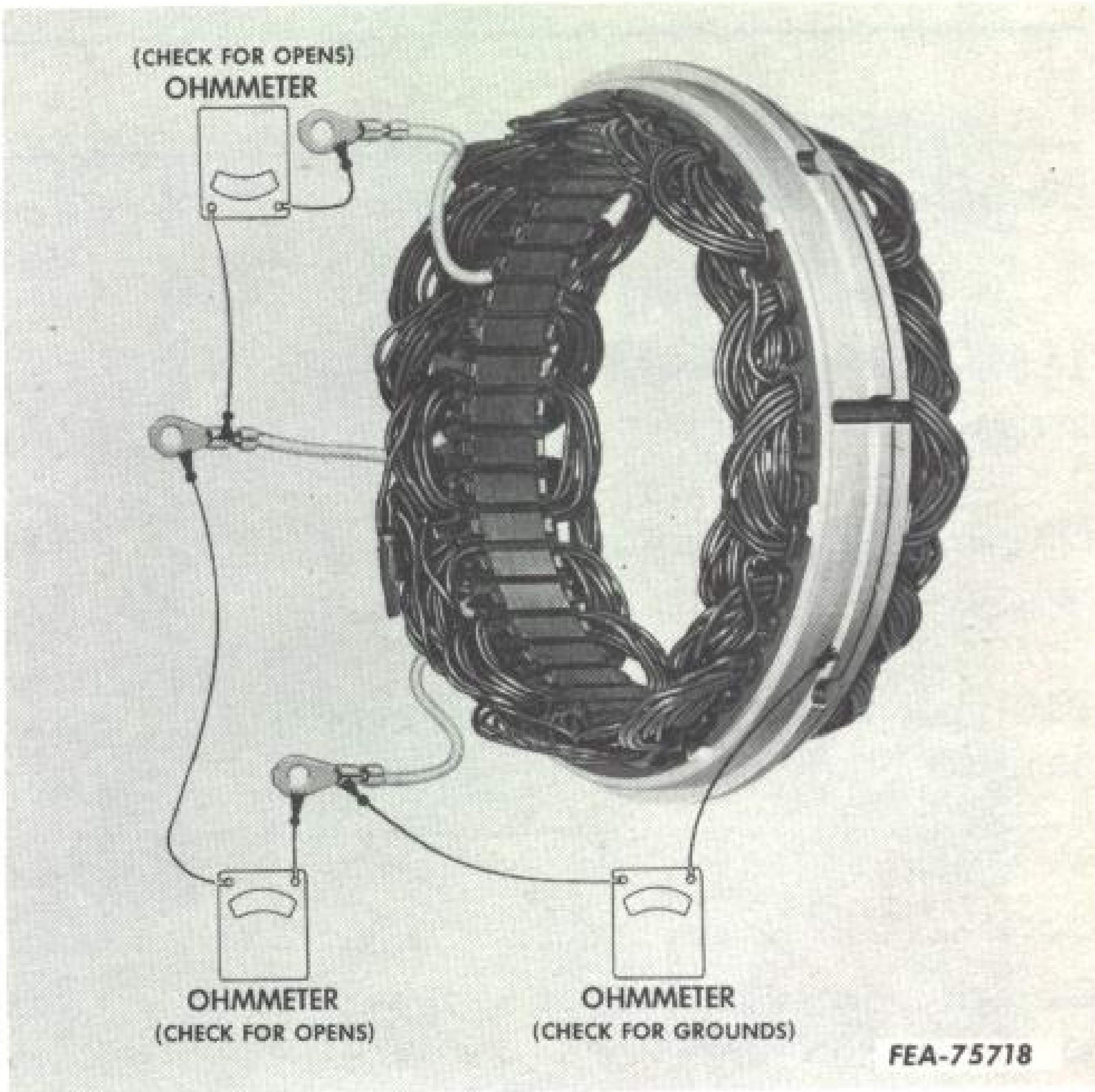
Illust. 47. View of slip ring end frame.

If the rotor is not defective, and the alternator fails to supply rated output when checked as covered in the paragraph entitled TEST BENCH CHECKS, the trouble is in the stator or rectifying diodes.

Stator Checks

To check the stator windings, remove all three stator lead attaching nuts (Illust. 47), and then separate the stator assembly from the end frame. The fit between stator frame and end frame is not tight, and the two can be separated easily.

The stator windings may be checked with a 110-volt test lamp or an ohmmeter. Connect the leads successively between each stator lead and the frame. If the lamp lights, or if the meter reading is low when connected from any stator lead to the frame, the windings are grounded. If the lamp fails to light, or if meter reading is high when successively connected between each pair of stator leads, the windings are open (Illust. 48).

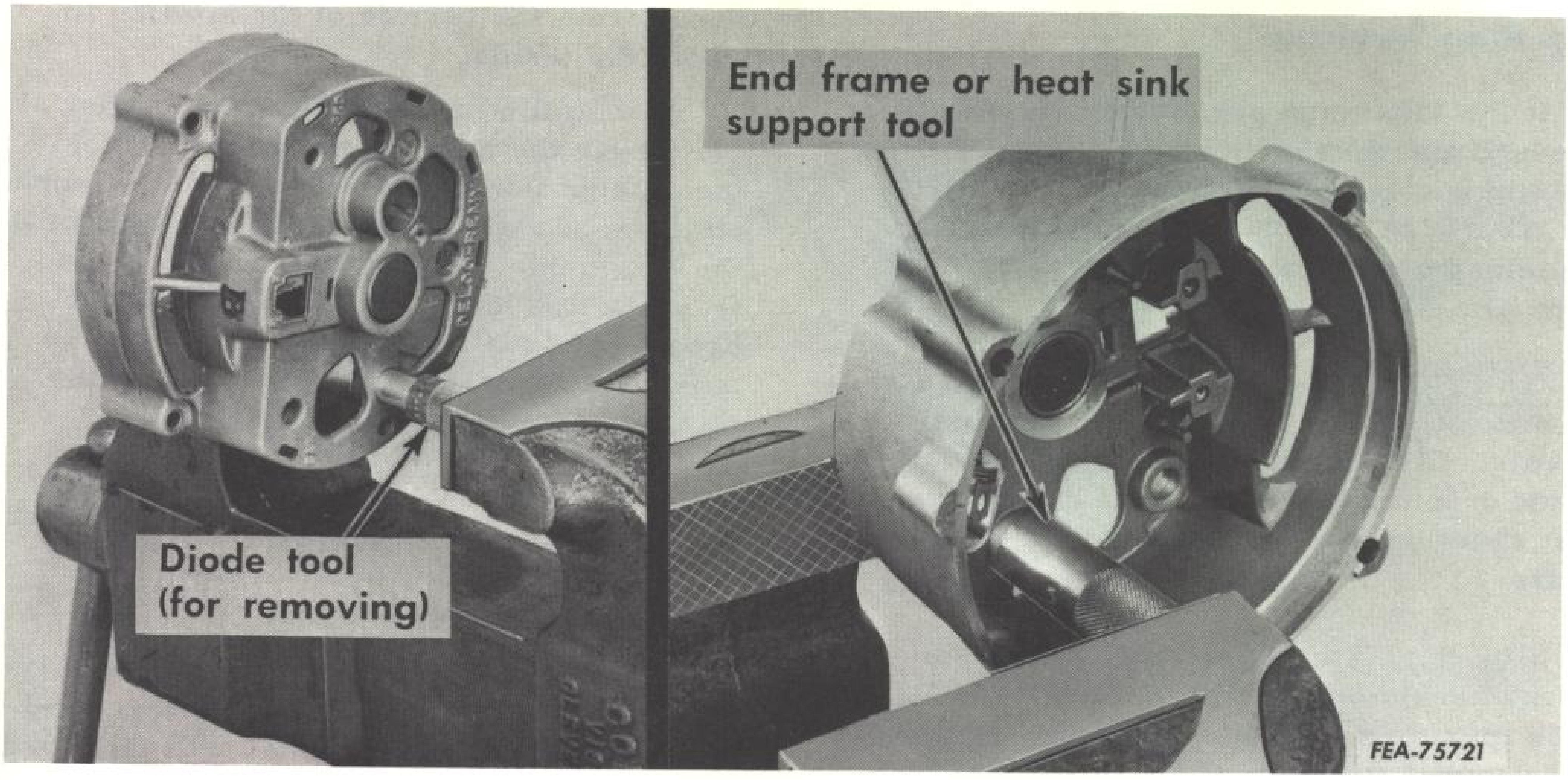


Illust. 48. Checking stator windings.

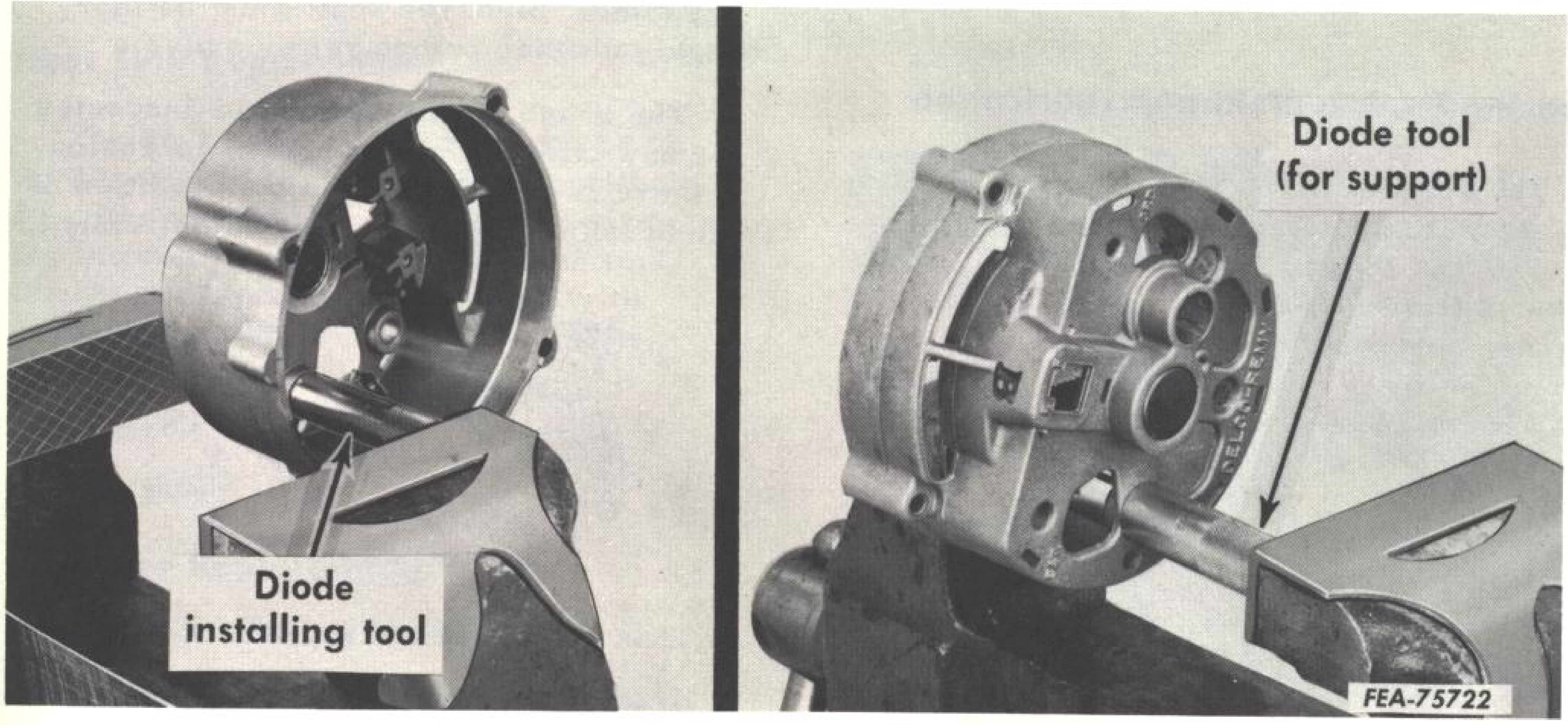
A short circuit in the stator windings is difficult to locate without laboratory test equipment due to the low resistance of the windings. However, if all other electrical checks are normal and the generator fails to supply rated output, shorted stator windings are indicated.

Quick Check Chart

Connection	Reading	Result
Rotor		
Ohmmeter from slip ring to shaft.	Very low. Very high.	Grounded OK
110 volt test lamp from slip ring to shaft.	Lamp lights. Lamp fails to light.	Grounded OK
Ohmmeter across slip rings.	Very high. Very low.	Open OK
110 volt test lamp across slip rings.	Lamp fails to light. Lamp lights.	Open OK
Battery and ammeter to slip rings, voltmeter across slip rings.	Observe voltmeter and ammeter readings.	Compare with figures in specifications for shorts (GSS-1308-C).
Stator		
Ohmmeter from lead to frame.	Very low. Very high.	Grounded OK
110 volt test lamp from lead to frame.	Lamp lights. Lamp fails to light.	Grounded OK
Ohmmeter across each pair of leads.	Any reading very high. All readings low.	Open OK
110 volt test light across each pair of leads.	Lamp fails to light. Lamp lights.	Open OK
Diode		
Ohmmeter across diode, then reverse connections.	Both readings very high.	Open
	Both readings very low.	Shorted
	One reading very high and one very low.	OK
12 volt or less test lamp across diode, then reverse connections.	Lamp fails to light in both checks.	Open
	Lamp lights in both checks.	Shorted
	Lamp lights in one check only.	OK



Illust. 49. Removing diodes with SE2060-2 and SE2060-3 diode tools.



Illust. 50. Installing diodes with SE2060-1 and SE2060-3 diode tools.

Diode Replacement

To replace a diode use SE2060-3 tool to support end frame or heat sink and use a press or vise with SE2060-2 tool to remove diode (Illust. 49). Use SE2060-1 installer tool which will fit over diode outer edge to push the diode in. Support heat sink and end frame with SE2060-3 tool while installing (Illust. 50). Positive diodes are marked with red printing, negative diodes with black. If all diodes are replaced, be sure that positive diodes are installed in heat sink and negative diodes installed in end frame.

CAUTION: Do not strike any of the diodes while removing. Shock may cause damage to the other good diodes.

Slip Ring Servicing

If the slip rings are dirty, they may be cleaned and finished with 400 grain or finer polishing cloth. Spin the rotor in a lathe, or otherwise spin the rotor, and hold the polishing cloth against the slip rings until they are clean.

CAUTION: The rotor must be rotated in order that slip rings will be cleaned evenly. Cleaning the slip rings by hand without spinning the rotor may result in flat spots on the slip rings, causing brush noise.

Slip rings which are rough or out of round should be trued in a lathe to .002 inch maximum indicator reading. Remove only enough material to make the rings smooth and round. Finish with 400 grain or finer polishing cloth and blow away all dust.

Bearing Replacement and Lubrication

The bearing in the drive end frame can be removed by detaching the retainer plate screws and then pressing the bearing from the end frame. If the bearing is in satisfactory condition, it may be re-used, and it should be filled one-quarter full with special grade ball bearing lubricant before reassembly.

CAUTION: Do not overfill, as this may cause the bearing to overheat.

To install a new bearing, press in with a tube or collar that just fits over the outer race. It is recommended that a new retainer plate be installed if the felt seal in the retainer plate is hardened or excessively worn.

The bearing in the slip ring end frame should be replaced if its grease supply is exhausted. No attempt should be made to relubricate and re-use the bearing. To remove the bearing from the slip ring end frame, press out with a tube or collar that just fits inside the end frame housing. Press from the outside of the housing towards the inside.

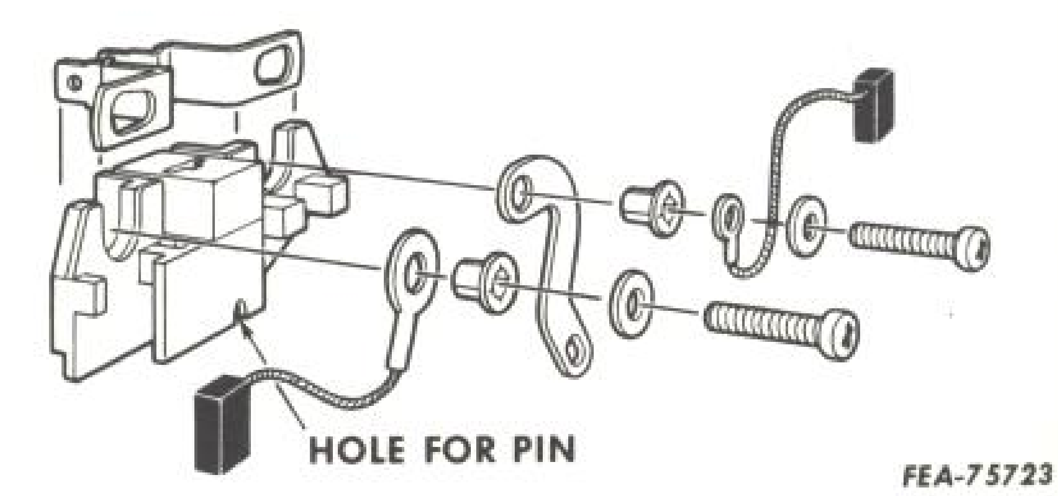
To install a new bearing, place a flat plate over the bearing and press in from the outside towards the inside of the frame until the bearing is flush with the outside of the end frame. Support the inside of the frame with a hollow cylinder to prevent breakage of the end frame. Use extreme care to avoid misalignment or otherwise placing undue stress on the bearing.

Saturate the felt seal with SAE-20 oil, and then reassemble the felt seal and steel retainer.

Brush Replacement

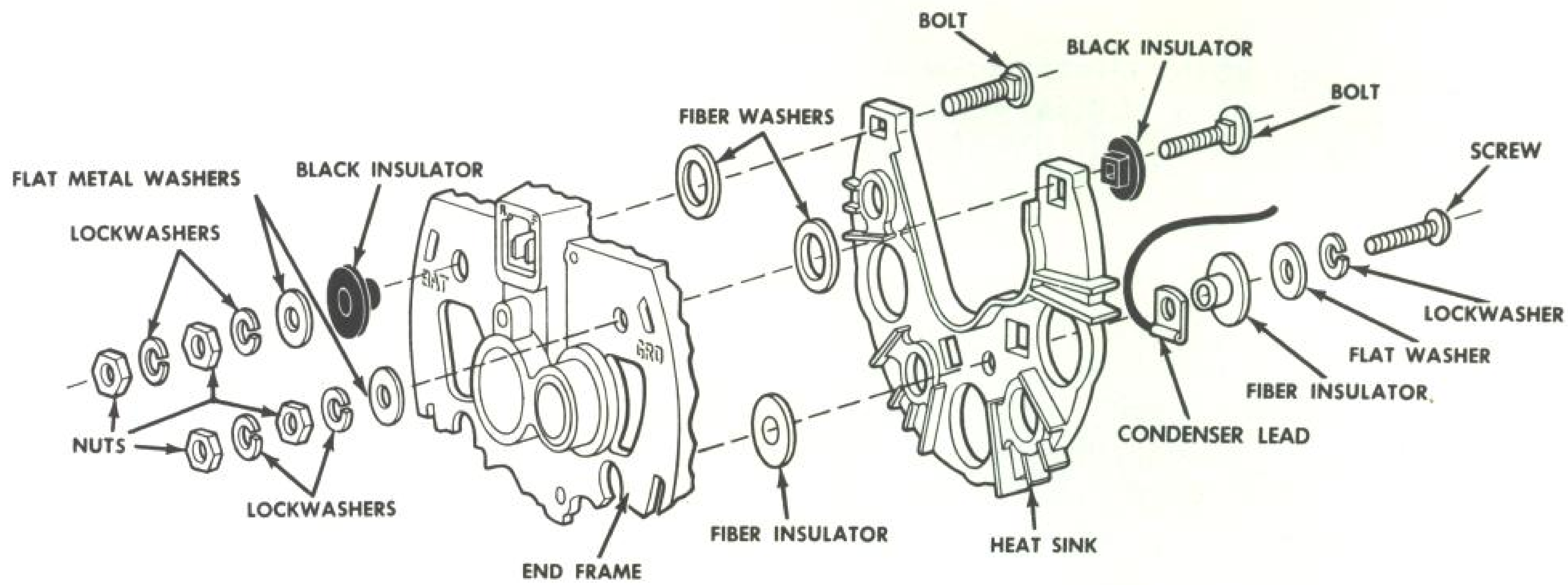
When the slip ring end frame assembly is separated from the rotor and drive end frame assembly, the brushes will fall down onto the shaft and come in contact with the lubricant. If the brushes are to be re-used, they must be thoroughly cleaned with a soft dry cloth. Also, the shaft must be thoroughly cleaned before reassembly.

The brush springs should be inspected for any evidence of damage or corrosion. If there is any doubt as to the condition of the brush springs, they should be replaced.



Illust. 51. Exploded view of brush holder assembly.

If inspection warrants replacement of the brushes, remove the brush holder assembly from the end frame by detaching the two brush holder assembly screws. Install the springs and brushes into the brush holder, and insert a straight wire or pin into the holes at the bottom of the holder to retain the brushes. Then attach the brush holder assembly onto the end frame, noting carefully the proper stack-up of parts as shown in Illust. 51. Allow the straight wire to protrude through the hole in the end frame.



Illust. 52. Exploded view of heat sink.

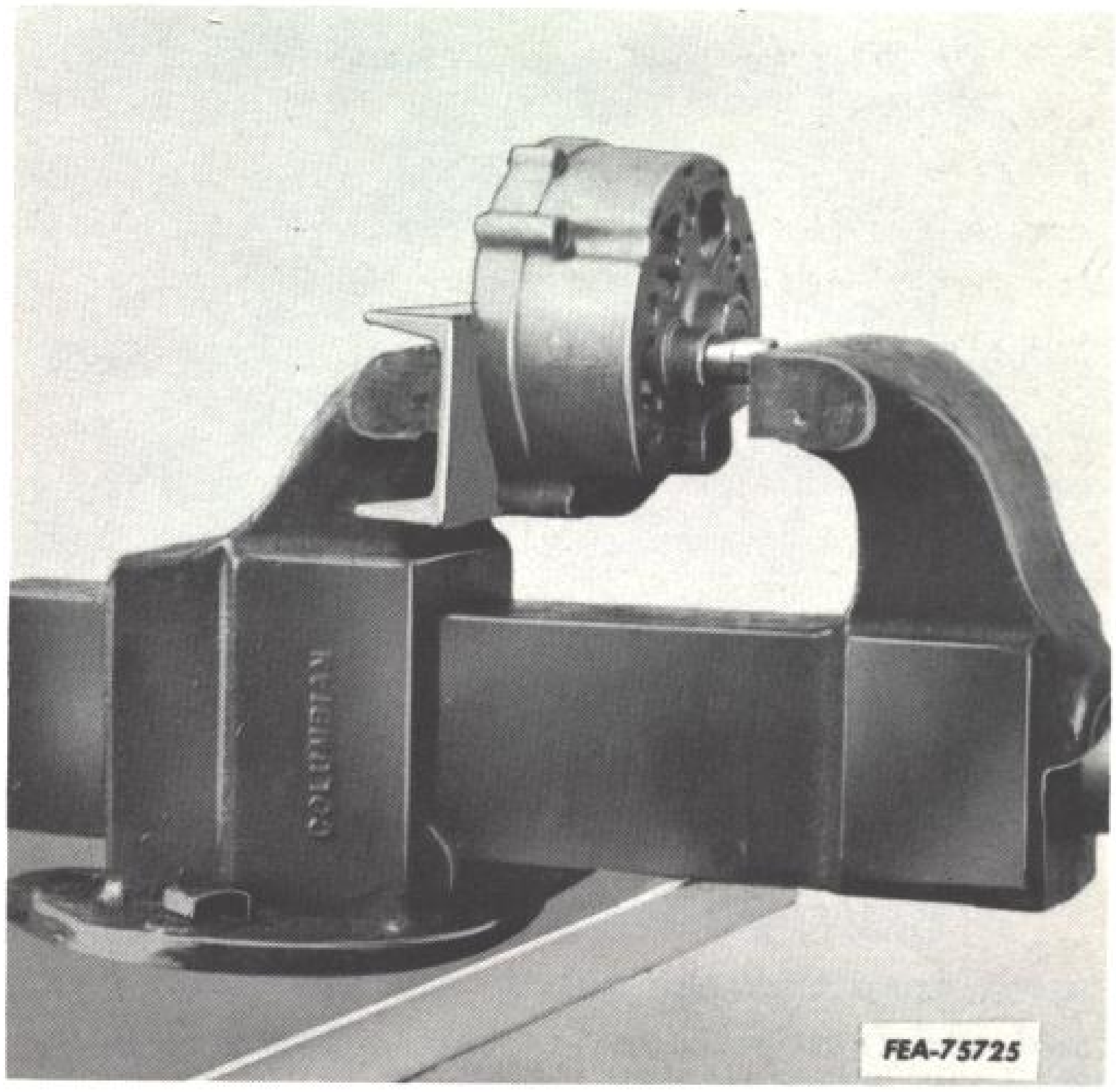
Heat Sink Replacement

The heat sink may be replaced by removing the "BAT" and "GRD" terminals from the end frame, and the screw attaching the condenser lead to the heat sink. During reassembly, note carefully the proper stack-up of parts as shown in Illust. 52.

Capacitor Replacement

(Models 1100630 and 1100687 only)

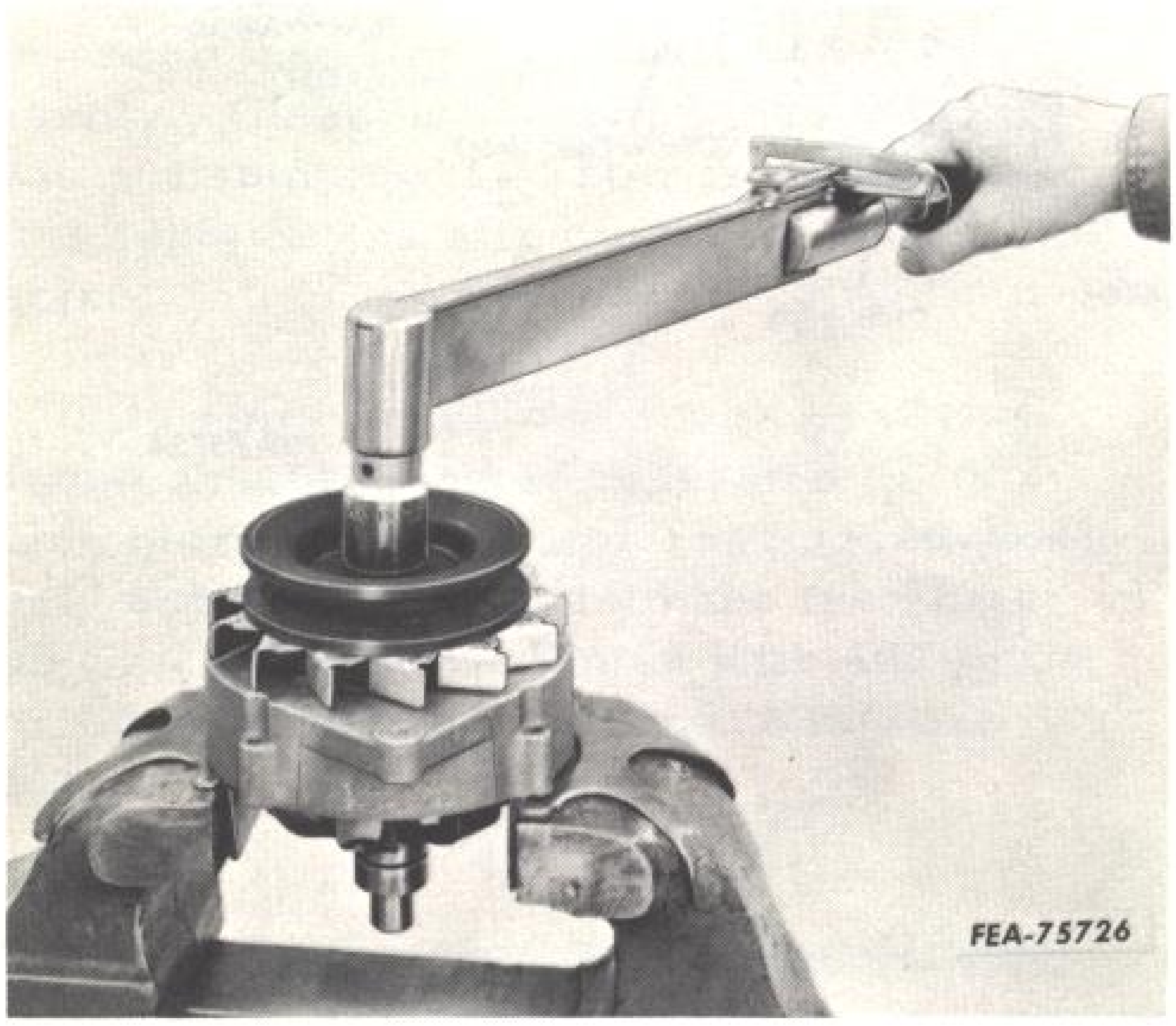
To remove a defective capacitor, place the end frame in a vise (after removing heat sink), supporting the end frame with a deep socket. Use a socket or tube of correct size to press the capacitor out. Press the capacitor out from the outside to the inside. Illust. 53.



Illust. 53. Removing Capacitor.

Assembly

The reassembly of the alternator will follow the reverse order of disassembly. There are a few points to note however and these are:



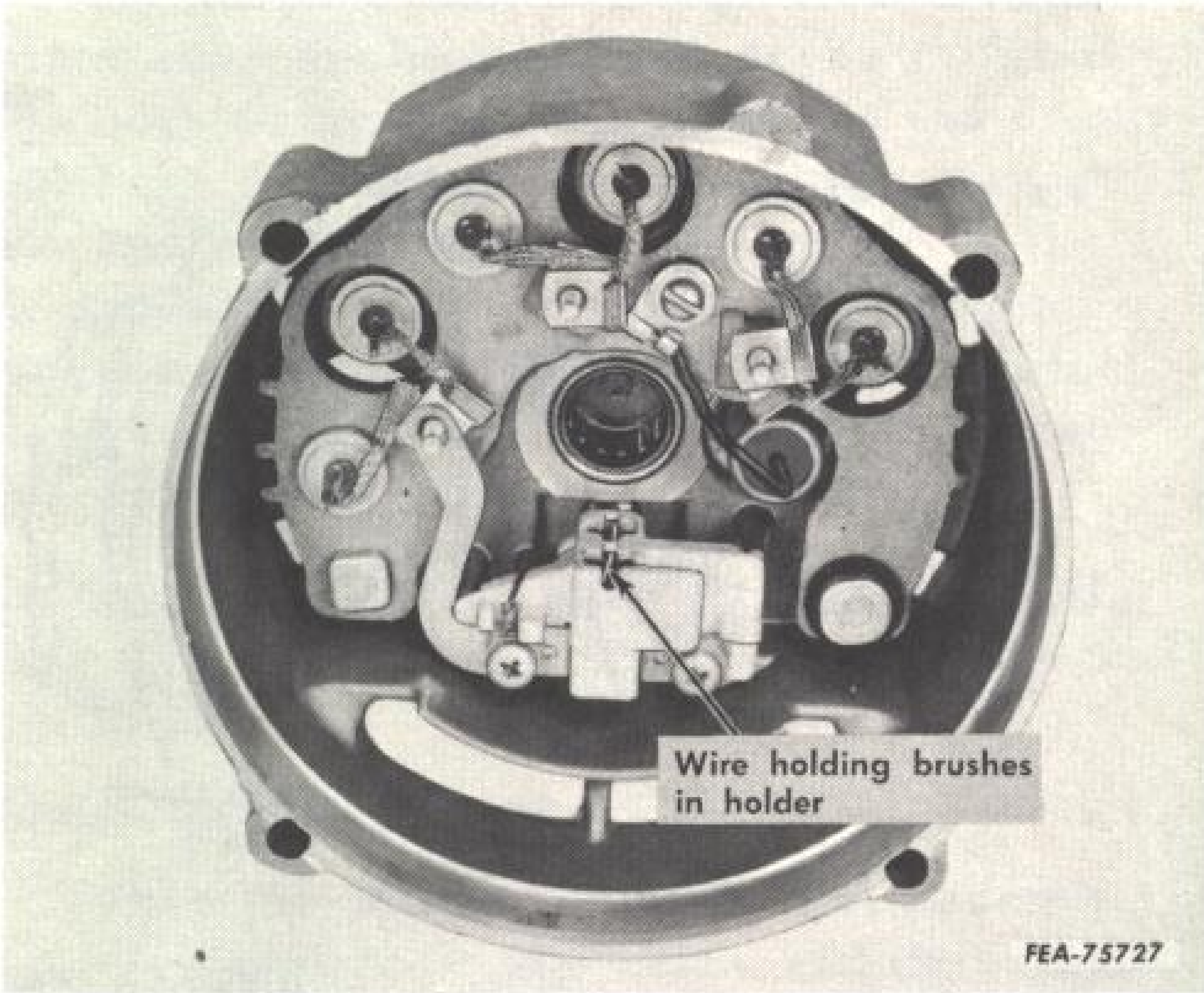
Illust. 54. Torquing shaft nut 45 ft. lbs.

1. Remember when assembling pulley to shaft to secure rotor in a vise only tight enough to tighten shaft nut to 45 lbs. If excessive pressure is applied against rotor, the assembly may become distorted (Illust. 54).

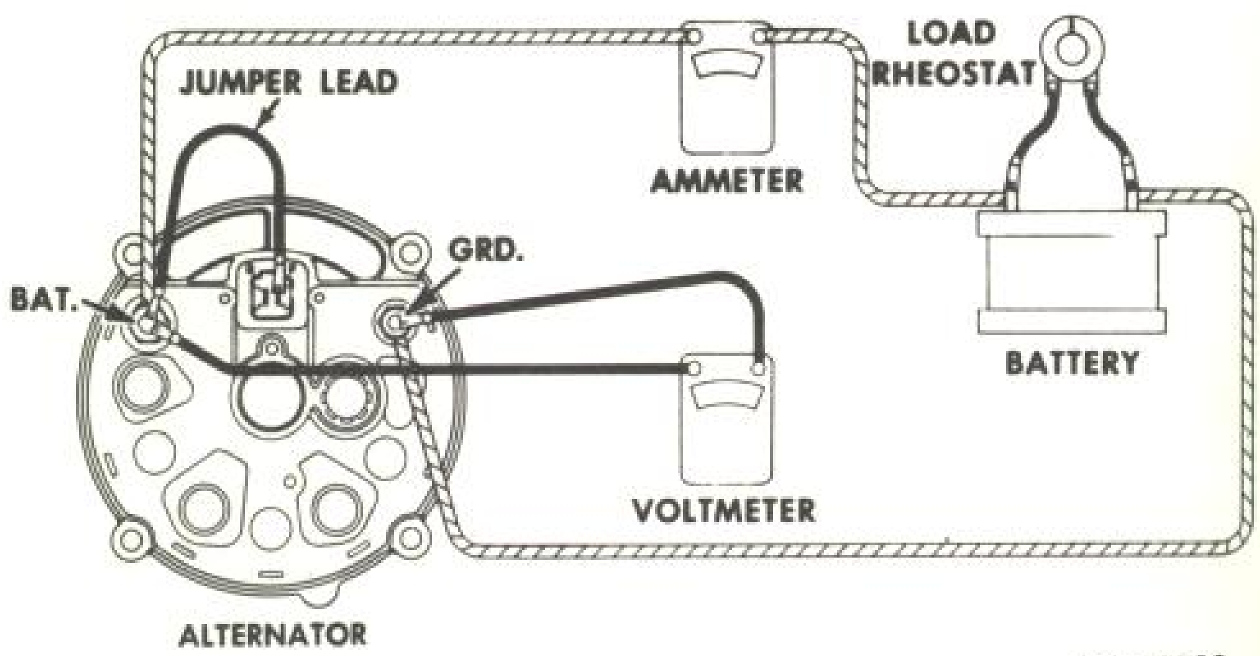
2. When installing slip ring end frame assembly to rotor and drive end frame assembly, remove tape over the bearing and shaft. Make sure shaft is perfectly clean.

3. Insert a straight wire as previously mentioned through holes in brush holder and end frame to retain the brushes (Illust. 55.) Remove the wire after the alternator has been completely assembled. The brushes will then drop into place on slip rings.

Test Bench Checks



Illust. 55. Wire holding brushes in brush holder.



Illust. 56. Checking alternator output on test bench.

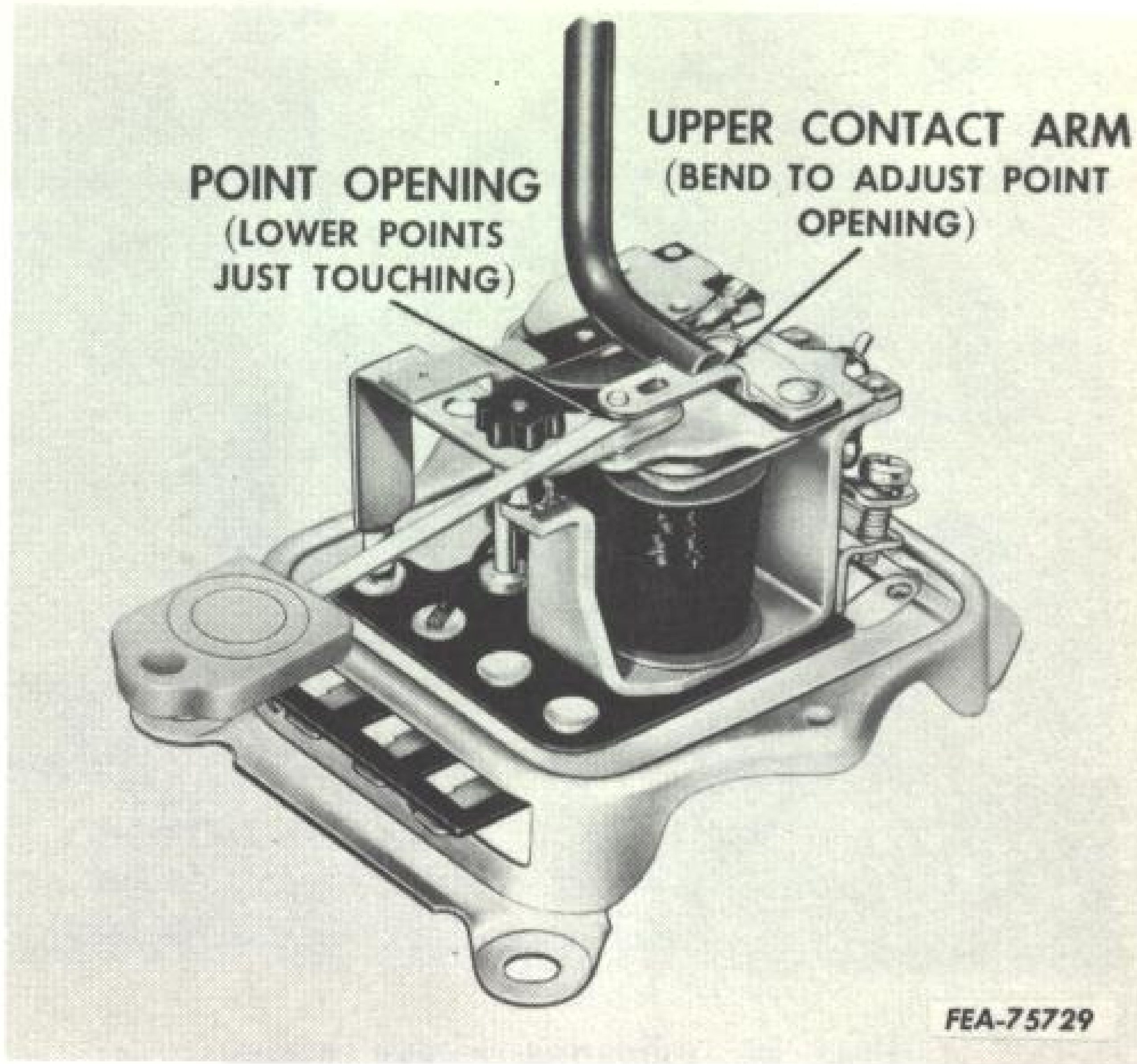
To check the alternator on a test bench make electrical hookup as shown in Illust. 56. Refer to Specifications. Operate at specified speed and check for rated output. Adjust load rheostat if necessary to obtain desired output. A special adapter which can be used for making connections to the alternator is available.

CAUTION: Since the alternator covered in this section is negative ground, connect negative battery post to ground terminal on alternator frame.

AC Voltage Regulator

It is important to remember that the voltage setting for one type of operating condition may not be satisfactory for a different type of operating condition. Vehicle underhood temperatures, operating speeds, and nighttime service all are factors which help determine the proper voltage setting. The proper setting is attained when the battery remains fully charged with a minimum use of water.

If no circuit defects are found, yet the battery remains undercharged, raise the setting by .3 volt, and then check for an improved battery condition over a service period of reasonable length. If the battery remains overcharged, lower the setting by .3 volt, and then check for an improved battery condition. Recommended voltage setting procedures are covered in this section.



Illust. 57. Checking voltage regulator point opening.

Voltage Regulator

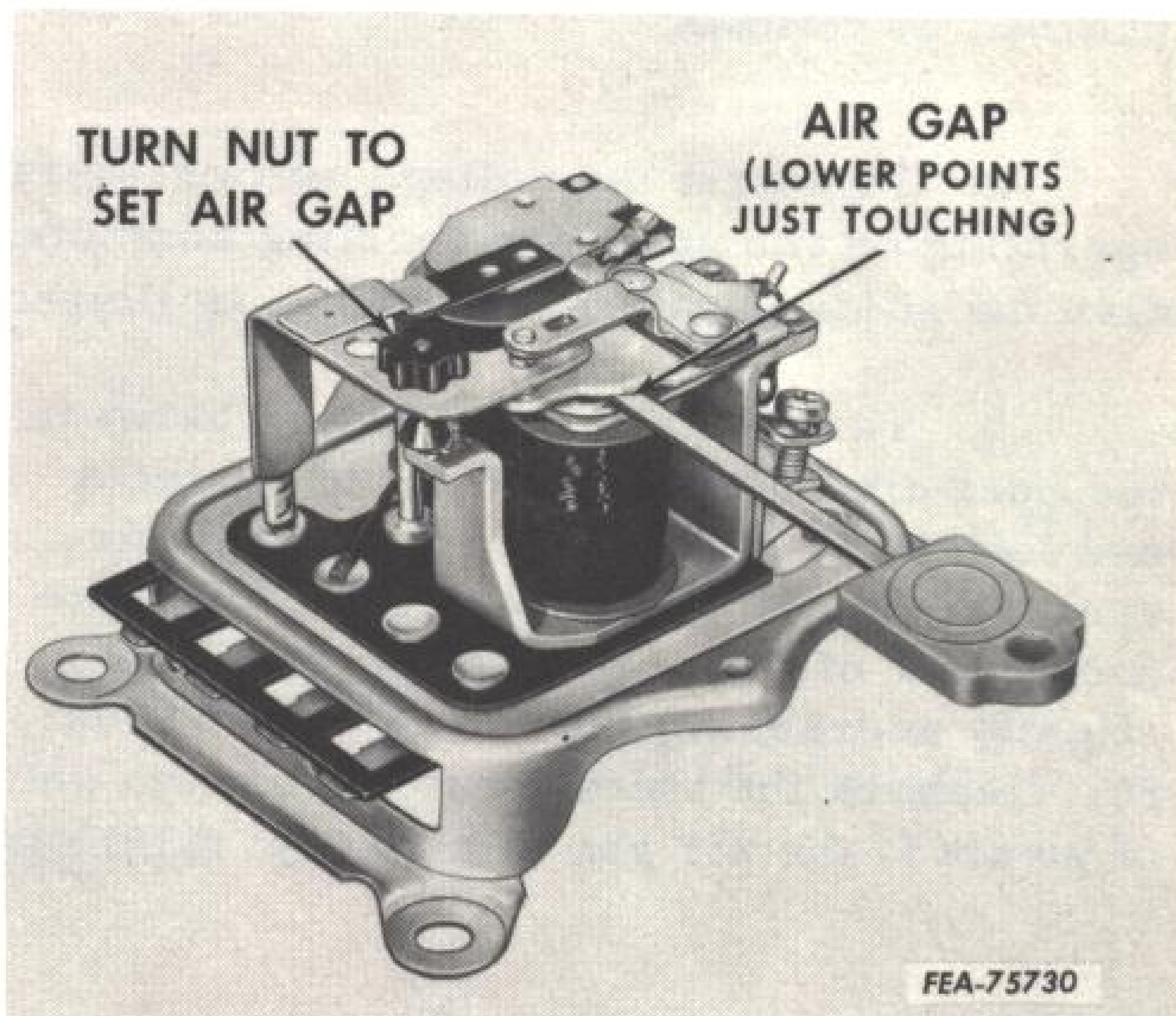
Regulator checks and adjustments are made as follows:

Three checks and adjustments are required on the double contact voltage regulator unit: (1) point opening, (2) air gap, and (3) voltage setting.

1. Point Opening: With the lower contacts touching, measure the point opening between the upper contacts as shown in Illust. 57. Adjust by bending the upper contact arm being careful not to bend the hinge.

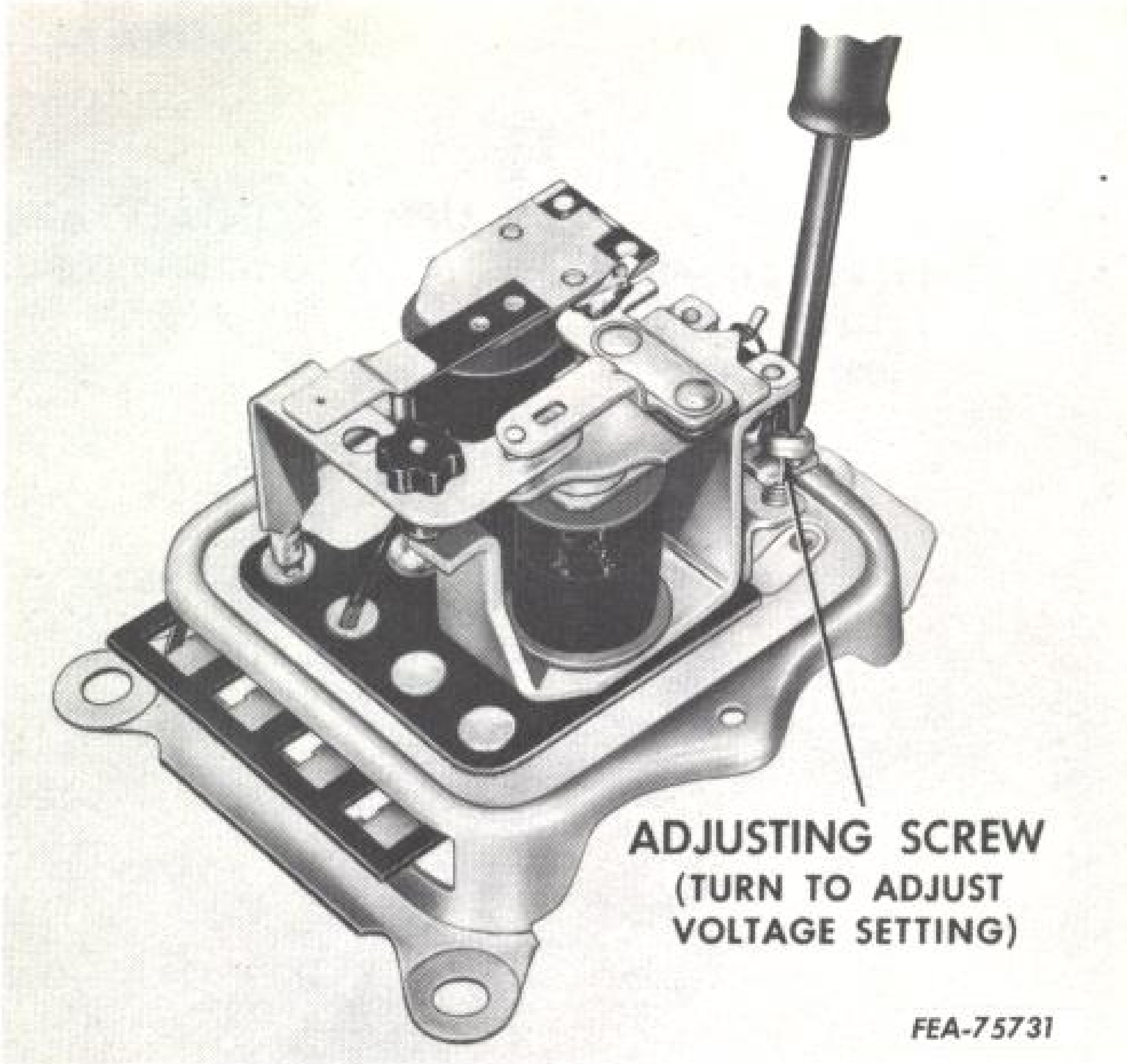
2. Air Gap: Measure the air gap with a feeler gauge placed between the armature and core when the lower contacts are touching as shown in Illust. 58. To adjust the air gap, turn the nylon nut located on the contact support.

NOTE: Only an approximate voltage regulator air gap setting should be made by the "feeler gauge" method. The final air gap setting must be whatever is required to obtain the specified difference in voltage between the upper and lower sets of contacts. This is covered in the next section.

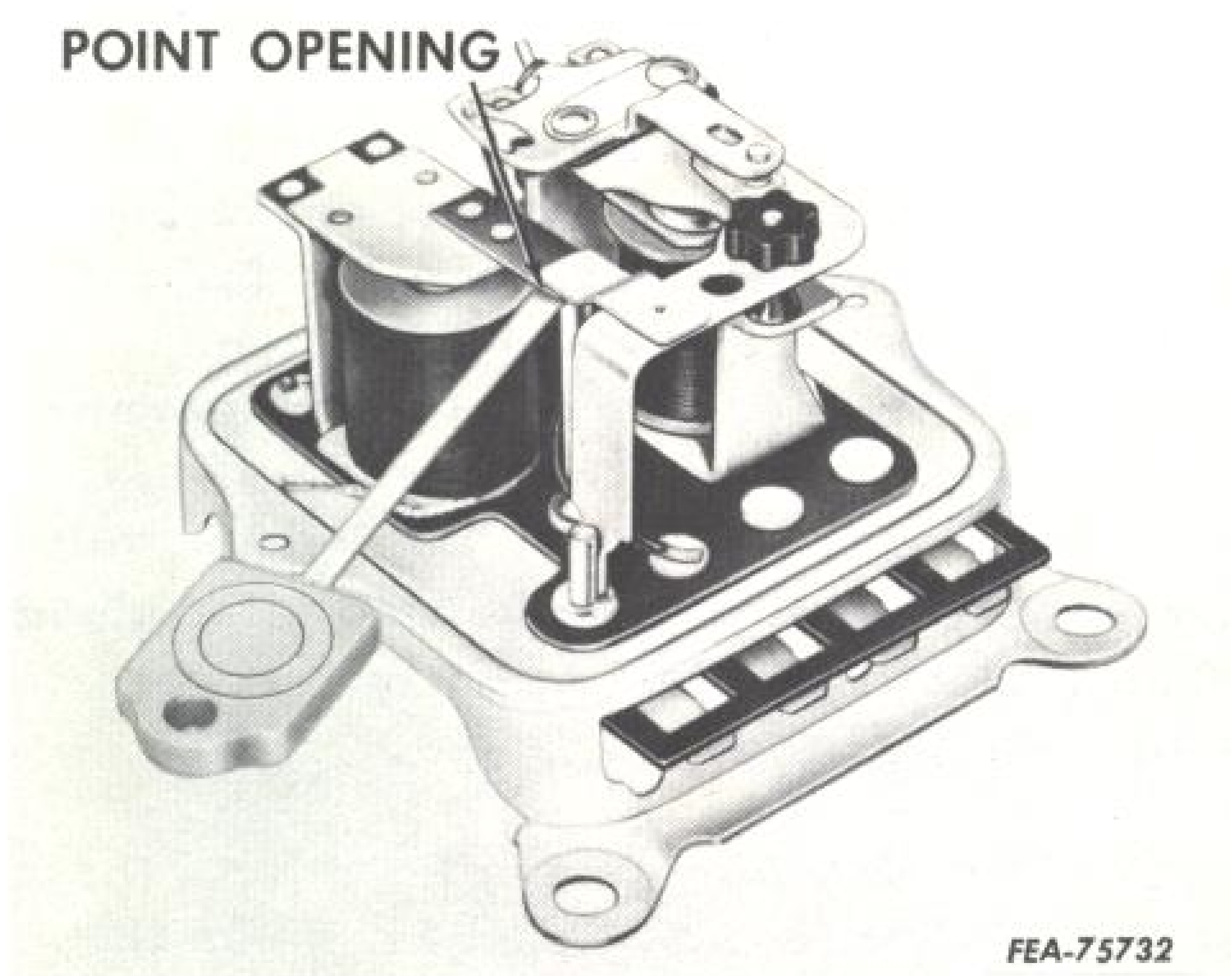


Illust. 58. Checking voltage regulator air gap.

3. Voltage Setting: The voltage at which the regulator operates varies with changes in regulator ambient temperatures. The ambient temperature is the temperature of the air measured 1/4 of an inch from the regulator cover. When checking and adjusting the voltage setting, always refer to specifications.



Illust. 59. Adjusting voltage setting.



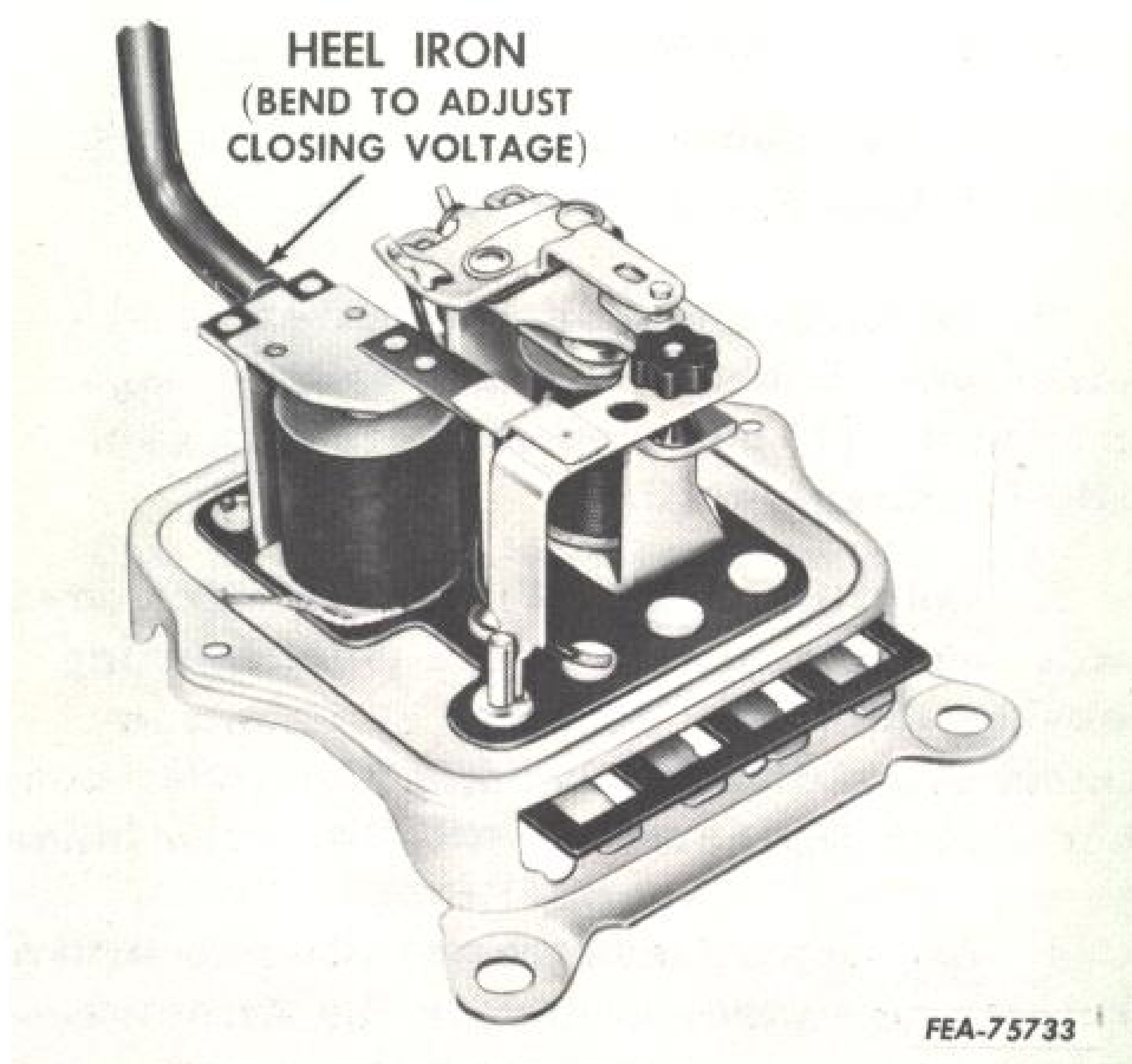
Illust. 60. Checking field relay point opening.

2. Point Opening: Measure the opening between the points, and adjust by bending the armature stop (Illust. 60).

To check and adjust the voltage setting, proceed as follows:

a. To adjust the voltage setting while operating on the upper or shorting contacts, turn the adjusting screw as shown in Illust. 59.

b. The difference in voltage between the operation of the upper set of contacts and lower set is increased by slightly increasing the air gap between the armature and center of the core and decreased by slightly decreasing the air gap. See Illust. 58. Recheck the voltage setting of both sets of points if the air gap is changed.



Illust. 61. Adjusting field relay closing voltage.

Field Relay

Three checks are required on the field relay: (1) air gap, (2) point opening, (3) and closing voltage.

1. Air Gap: With the regulator removed from the vehicle, check the air gap with the points just touching. If adjustment is necessary, carefully bend the flat contact support spring.

3. Adjust the closing voltage by bending with a heel iron as shown in Illust. 61.

Maintenance

The voltage regulator contacts should not be cleaned unless the electrical performance indicates it is necessary. A sooty or discolored condition of the contacts is normal after a relatively short period of operation and is not an indication that cleaning is necessary. However, if the voltage fluctuates as evidenced by an unsteady voltmeter reading when checking the voltage setting, the contacts may have excessive resistance or be sticking and they, therefore, should be cleaned.

CAUTION: Before cleaning contacts, make sure the unsteady voltage is not being caused by loose connections or high resistance elsewhere in the system.

The contacts on the voltage regulator unit are of a soft material and must not be cleaned with a file. A strip of No. 400 silicon carbide paper or equivalent folded over and then pulled back and forth between the contacts is recommended as a satisfactory method of cleaning. After cleaning, the contacts should be washed with trichloroethylene or alcohol to remove any residue. If the voltage control has not improved, repeat the cleaning and washing process.

To clean the field relay contacts, use a thin, fine-cut, flat file. Remove only enough material to clean the points.

Never use emery cloth or sandpaper to clean contact points.

CRANKING SYSTEM

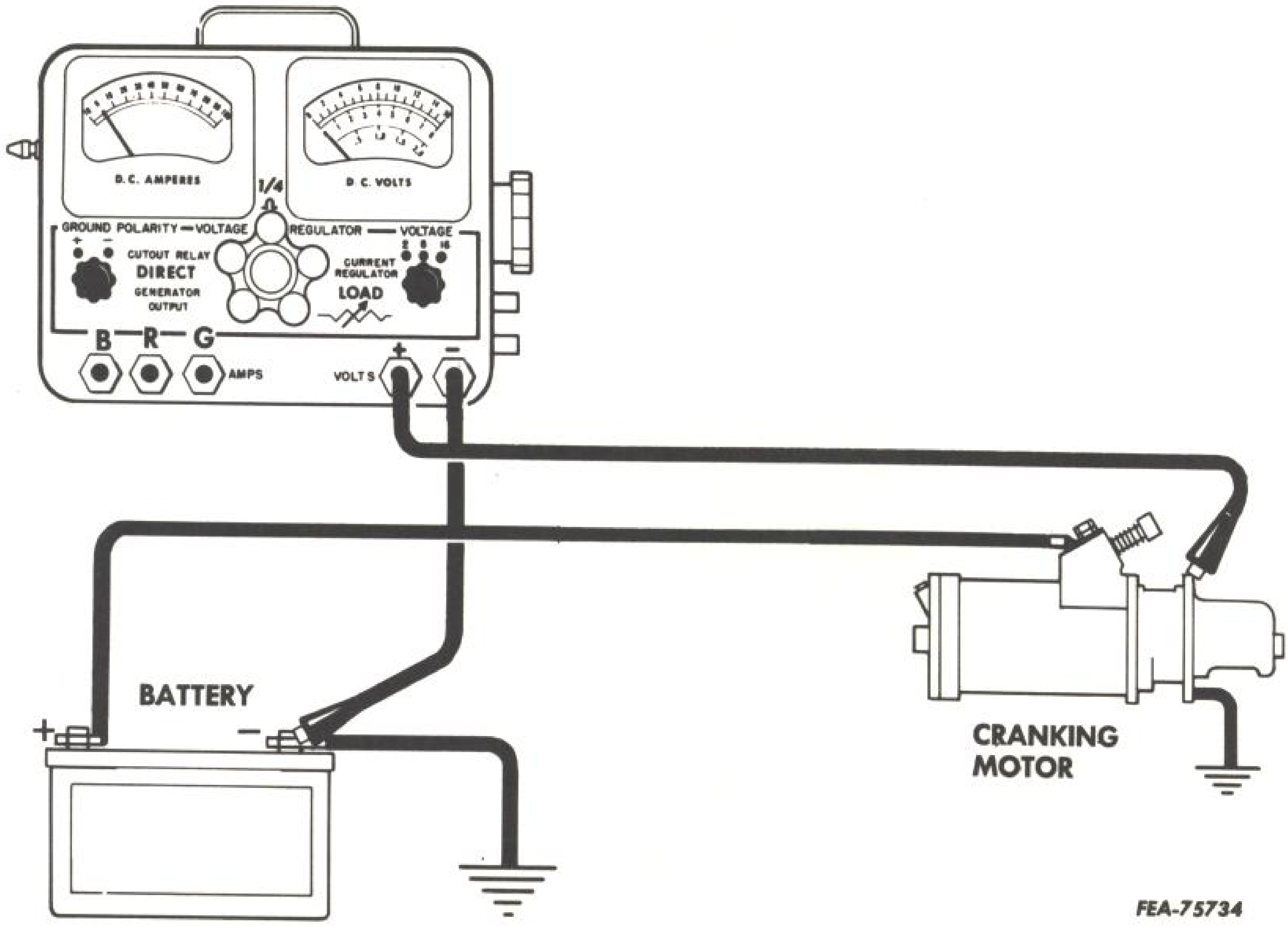
TESTING THE CRANKING SYSTEM

Battery

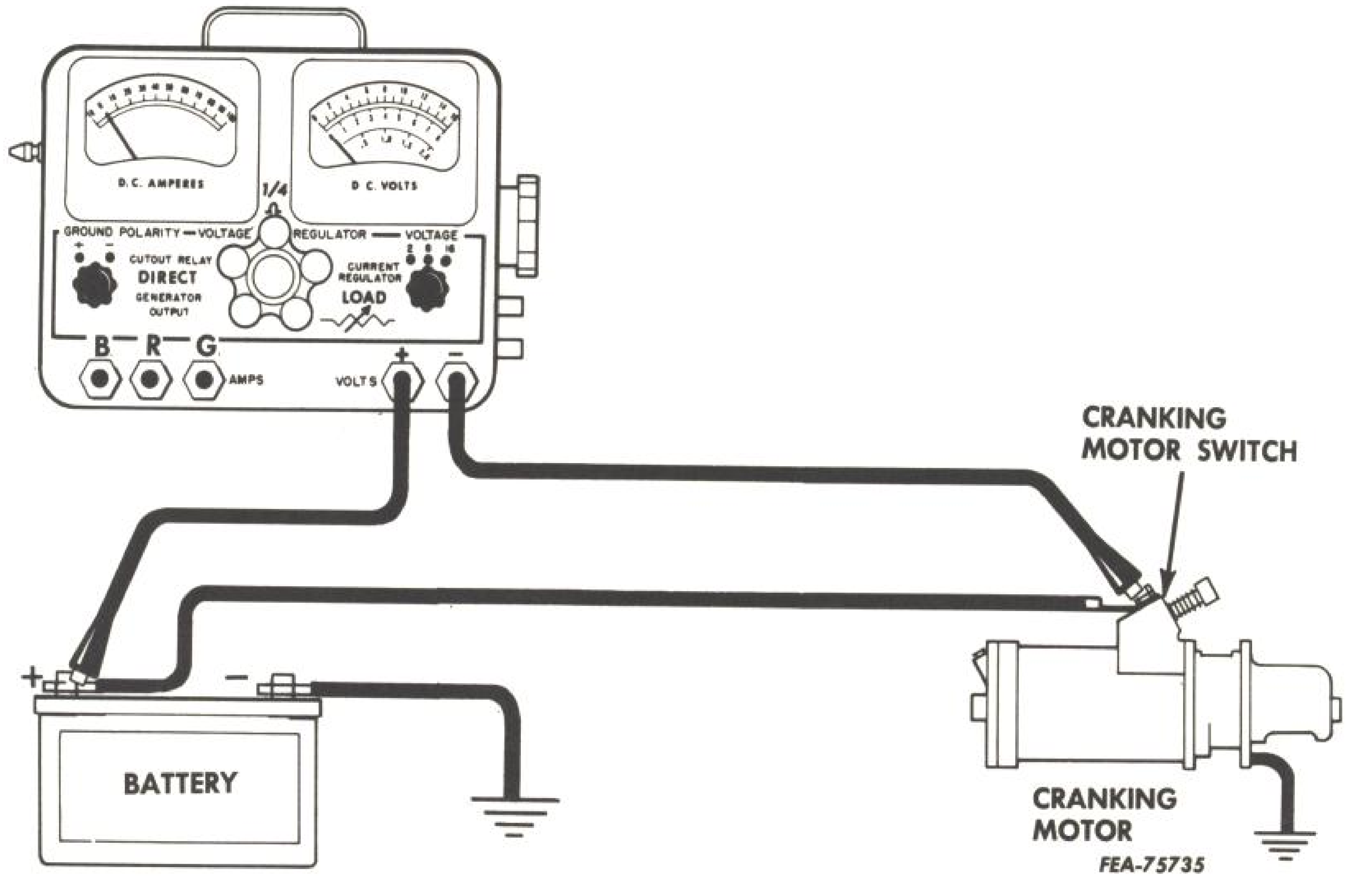
The battery should be checked for state of charge and condition before any checks are made. Place a load on the battery by cranking or turning on all the lights and check the voltage of each cell. The voltage should not drop below 1.5 volts per cell and not vary more than .2 volt between cells. See Illust. 2. Specific gravity should read at least 1.250 (corrected to 80°F) per cell.

CAUTION: On carbureted engines, it will be necessary to disconnect the primary wire from its terminal on the distributor to prevent ignition during cranking period.

Never operate the cranking motor for more than 30 seconds without allowing it to cool.



Illust. 62. Checking battery ground cable resistance.



Illust. 63. Checking battery cable resistance.

Battery Ground Cable

Battery Ground Cable and Connections. With the cranking motor turning the engine and the ignition wire disconnected, check the voltage drop from the battery post to a clean ground on the cranking motor. See Illust. 62. Connect the voltmeter as shown. See caution note under Battery. Voltage should not exceed .2 volt. A higher reading indicates high resistance due to poor electrical connections or broken strands in the ground cable.

Battery Cable

Battery Cable and Connections. With the cranking motor in operation, ignition wire disconnected, check the voltage drop from the battery post to the cranking motor switch. See caution note under Battery. See Illust. 63. Voltage should not exceed .1 volt. A higher reading indicates high resistance because of poor electrical contacts at connections or broken strands in the cable.

Cranking Motor

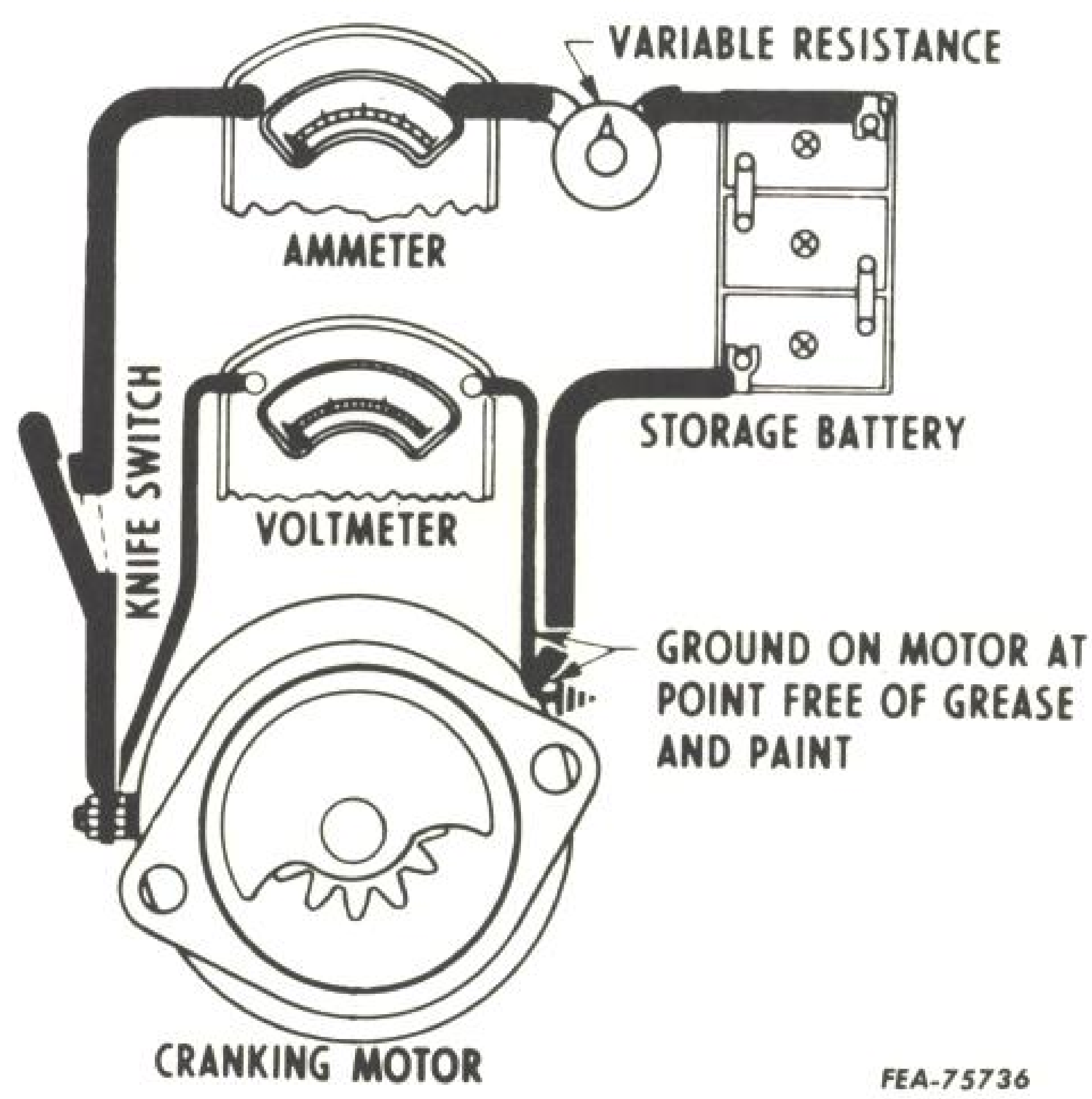
To locate the cause of abnormal operation, the cranking motor should be given a no-load test. This test is made with the cranking motor removed from the engine.

The no-load test requires some special equipment. Connect a three hundred amp ammeter in series with a switch, high-current carrying variable resistance and battery from the insulated terminal to a good ground on the motor. Connect a voltmeter from the insulated terminal to a good ground on the motor. A tachometer is used to check the motor rpm.

The circuit is closed and the variable resistance is adjusted until the specified voltage is obtained at the cranking motor. The current draw and the motor rpm is then noted. See Illust. 64.

IMPORTANT: The above test should be completed as rapidly as possible to avoid overheating the motor. The motor should be held in a fixture or vise during this test.

The specifications are given for low voltages in the no-load test so that the ammeter reading will be within the range of available test equipment. The effectiveness of the test depends on the accuracy of the test equipment and accurate adjustment of test voltages.



Illust. 64. Connections for no-load test of cranking motors.

The way you analyze the results of the no-load test is also important. Use the following checklist as your guide.

1. If test indicates current draw, and no-load speed, the cranking motor is in normal condition.

2. A low, no-load speed and high current draw may result from:

a. Excessive friction from tight bearings or from dragging of the armature against field poles due to worn bearings, bent armature shaft, or loose field pole screws.

NOTE: Motor armature may turn freely by hand but will drag badly when starting switch is closed due to normal magnetic pull of motor fields.

b. Shorted armature windings. Remove armature and test on growler.

c. Grounded armature or field winding. Check by raising the grounded brushes and insulating them from the commutator with cardboard, and then checking with a test lamp between the insulated terminal and the frame. If the test lamp lights, raise the other brushes and insulate them from the commutator to check fields and commutator separately to determine whether the field or armature is grounded.

3. Failure to operate, combined with high current draw:

a. A direct ground in the switch, insulated terminal or fields.

b. Frozen shaft bearings that prevent rotation.

c. Armature windings thrown from core slots, due to over-speeding when overrunning clutch freezes. Caused by operator error in holding starting switch too long after engine has started.

4. Failure to operate, combined with no current draw:

a. Open field circuit. Inspect internal connections and trace circuit with test lamp.

b. Open armature coils. Inspect commutator for badly burned bars. Running at no-load an open armature winding will show excessive arcing at the commutator bar where open circuit has occurred.

c. Broken or weakened brush springs, worn brushes, high mica on the commutator, or other causes, preventing good electrical contact between brushes and commutator. Any of these conditions will cause arcing and burned commutator bars.

5. Low no-load speed with low current draw indicates:

a. High internal resistance due to poor connections, defective leads, dirty commutator, and causes listed under condition number 4-c, above.

6. High no-load speed combined with high current draw would indicate:

a. Shorted fields. There is no easy way to detect shorted cranking motor fields because the field resistance is normally low due to the size of wire and number of turns used. If shorted fields are suspected, replace the fields using new field coil insulating strips.

Cranking Motor Switches

To determine whether or not the switch contacts are in poor enough condition to cause high resistance in the cranking motor circuit, proceed as follows:

1. Connect low reading voltmeter leads to battery cable and motor terminals of the switch.

2. Close the starting switch. Voltage drop should not exceed 0.1 volt with the motor cranking the engine,

NOTE: A voltage reading across the switch in excess of 0.1 volt will require replacement of switch.

To determine the condition of the electromagnet winding of magnetic switch, follow these steps:

1. Remove both battery and motor leads from the main switch terminals; connect a

battery, variable resistance, and ammeter in series, to the switch control terminal and to the switch case.

2. Connect a voltmeter to the switch control terminal and to the switch case.

3. Increase the voltage on the switch with the variable resistance. Closing of the switch contacts is indicated by a click that normally can be heard.

4. Continue to increase the voltage to that shown in specifications. Then read the ammeter.

If the current draw is within the range given in the specifications at the specified voltage, the switch winding is satisfactory. The switch closing also can be checked by connecting test lamp points between battery and motor terminals. The lamp will light the instant the switch closes.

To determine whether the switch contacts are in poor enough condition to cause high resistance in the cranking motor circuit, proceed as follows:

1. Connect low reading voltmeter leads to battery terminal and motor terminal of the switch.

2. Close the starting switch. Voltage drop should not exceed 0.1 volt with the motor cranking the engine.

A voltage reading across the switch in excess of 0.1 volt indicates burned or pitted switch contacts that need cleaning or parts replacement. Inspect for a damaged cover or gasket that may have allowed the entry of dirt or moisture, causing arcing at contacts.

Motor-Generator

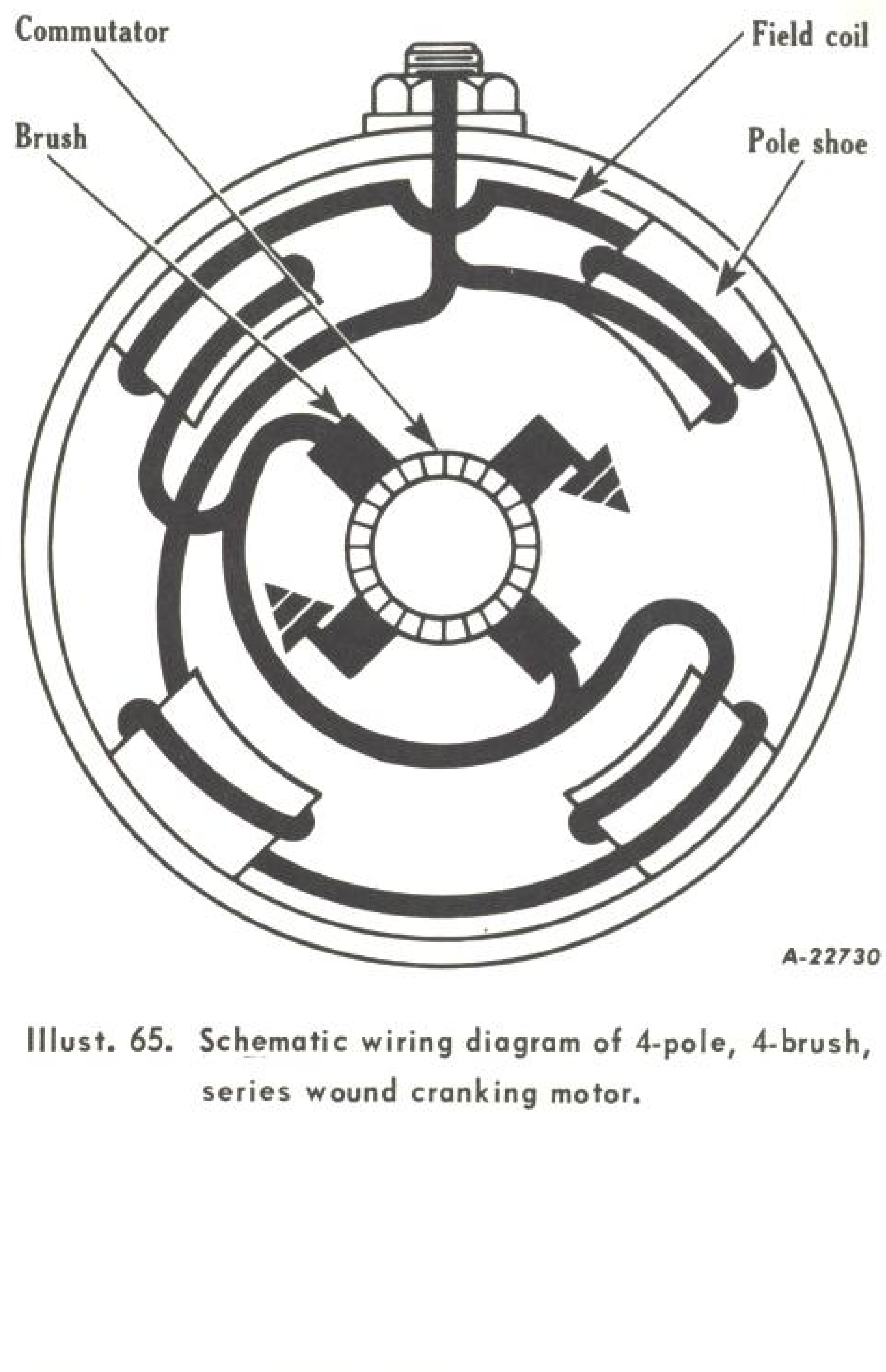
For testing of the motor-generator, refer to testing the motor-generator under DC charging system.

SERVICING THE CRANKING SYSTEM

Cranking Motor

In the earlier portions of this manual section, under Testing the Cranking System, external and circuit defects, if any, in the cranking system and engine have been located and corrected. Cranking motors found to be questionable in the preceding tests may be checked further to determine the location and cause of trouble.

The disassembly of the cranking motor should proceed only far enough to repair or replace the defective parts. For example, the pole shoes need not be removed unless it becomes necessary to renew or re-insulate the field coils. See Illust. 65.



Illust. 65. Schematic wiring diagram of 4-pole, 4-brush, series wound cranking motor.

The armature and field coils should not be dipped or soaked in strong degreasing compounds because this may damage insulation to the extent that a short circuit or ground would develop. Neutral petroleum base solvents are satisfactory for brush cleaning of these and other parts of the cranking motor. Use compressed air after cleaning to remove excess solvent. Then closely inspect all parts for wear or other damage.

Open circuited armatures are readily identified by burned commutator bars caused by arcing at the brushes as the open portion of the commutator passes each brush. The most likely place for an open circuit to occur is at the commutator riser bars where solder has been thrown out due to overheating. This is caused by the operator's error in excessively long cranking periods.

If the bars are not too badly burned, repair can often be made by resoldering the leads in the riser bars (use only rosin flux) and turning down the commutator in a lathe to remove the burned material. The mica should then be undercut 1/32 inch wide and 1/32 inch deep, and the slots should be cleaned out to remove any trace of dirt or copper dust. Then sand lightly with 00 sandpaper to remove burrs left from the undercutting procedure.

Short circuits in the armature are located with the armature tester or (growler). When the armature is revolved in the Vee of the tester, the test blade will vibrate above the area of the armature core in which the short circuit is located. Copper or brush dust in the commutator slots sometimes produces shorts between bars. These can be corrected by cleaning out the slots.

Grounds in the armature can be detected by use of the test light and its series test point leads, which are furnished as part of armature tester. If the lamp lights when one test point is placed on the commutator with the other point on the core or shaft, the armature is grounded.

Grounds occur as a result of insulation failure which usually is caused by overheating of the motor. This again is an operator's error - excessively long cranking periods. An accumulation of brush dust between commutator bars and the steel retainer ring will also result in grounded armature windings.

Field coil removal requires the use of a pole shoe screwdriver, such as shown in Illust. 25. A pole shoe spreader should also be used to prevent distortion of the field frame because of the pressure placed on the screwdriver. Careful installation of field coils is necessary to prevent cutting through insulation and thus shorting or grounding of the coils as the pole shoes are tightened into place.

Long triangular insulating strips are used in some motors to protect the field leads from grounding to the frame. They must be renewed upon reassembly.

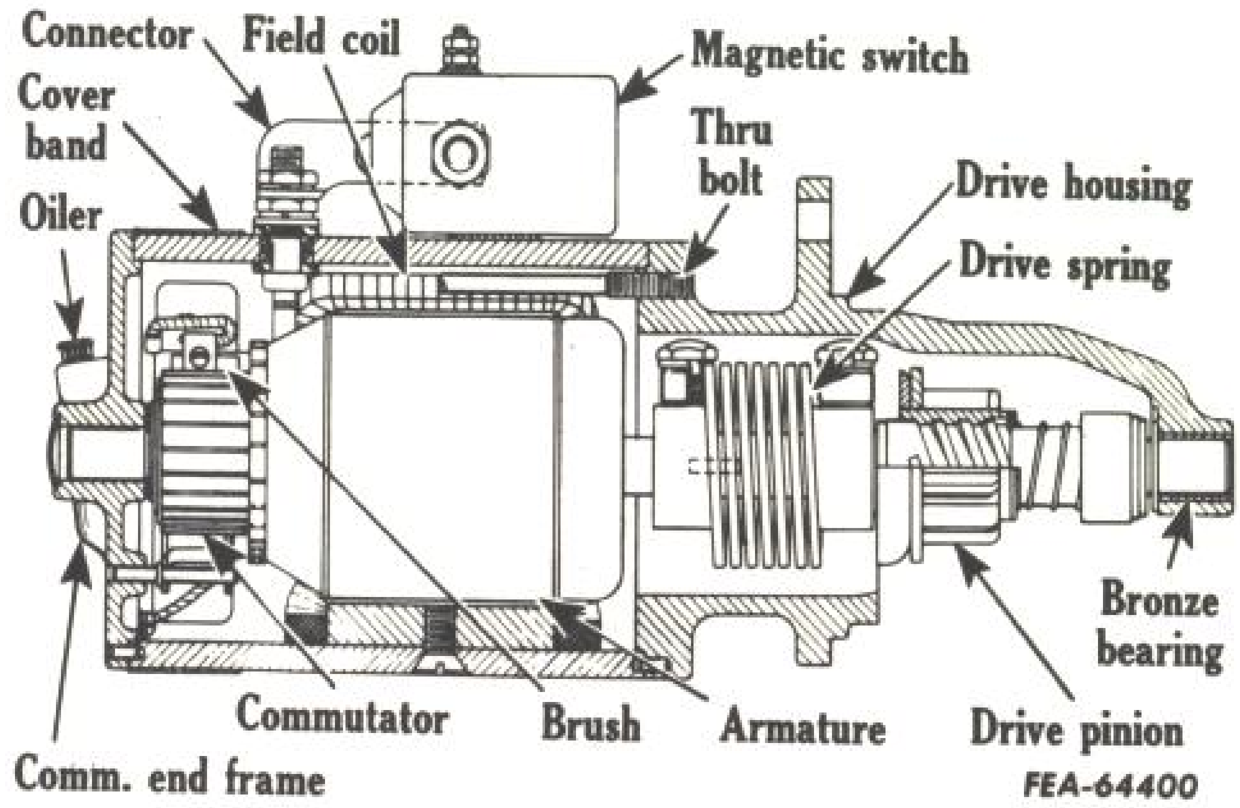
Brushes should be replaced when worn down to one-half of their original length. Make sure brush movement is free from binding and that the brushes are resting on the commutator with specified tension for good electrical contact. Brush leads must be positioned to prevent shorts or grounds, and their screws must be securely tightened. Use a seating stone or 00 sandpaper to seat new brushes to the commutator for full current carrying contact.

Cranking motor end plates, center bearing plates, and drive housings are available complete with bearings already reamed to size. Where oil wicks are used, these are also correctly placed in the assemblies. The use of these assemblies eliminates the need for line reaming and fitting of bushings to insure centering the armature in the frame.

Cranking Motor Switches

Three general types of cranking motor switches are used:

1. The manual switch, mounted on the cranking motor frame and actuated by the operator by a pull rod. This switch is spring loaded to hold it open. When closed, electrical contact is made directly between the cranking motor terminal stud and the battery terminal stud of the switch.



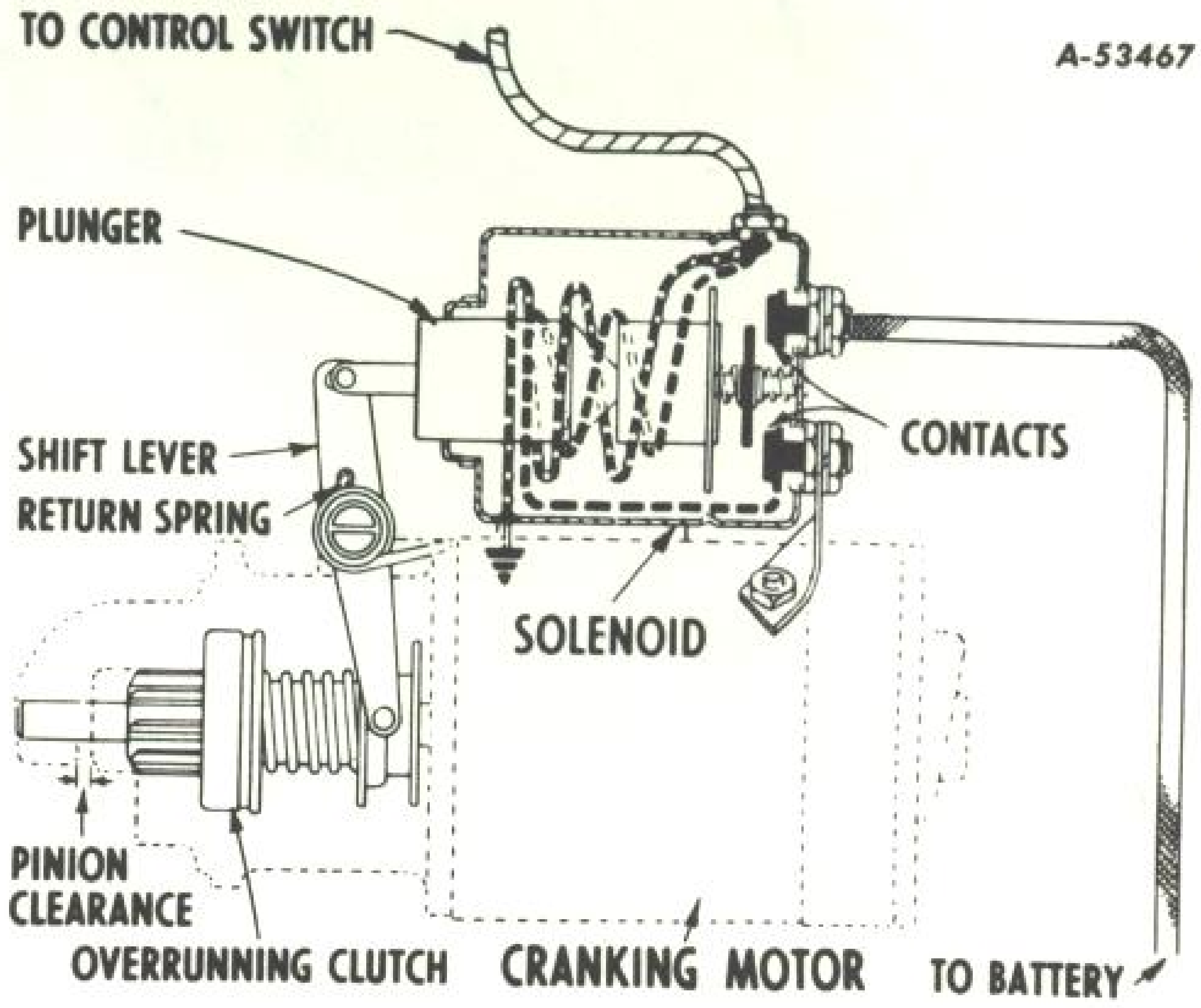
Illust. 66. Cross-section of cranking motor having magnetic switch and Bendix drive.

2. The magnetic switch also is mounted on the cranking motor frame, but it is actuated by battery current from a push button on the instrument panel. See Illust. 66.

This switch is spring loaded to hold it open, and it is closed against this spring tension by the pull of its electromagnet on the switch plunger. The switch is sealed in an enclosure having three terminals: one for exterior connection to the cranking motor terminal stud, one for connection to the battery cable, and the smallest terminal for connection to the operator's push button.

3. The solenoid switch is also actuated by battery current from the operator's push button on the instrument panel, similar to the magnetic switch. See Illust. 67. But it has an added function: the pull of the electromagnet is also used to shift the cranking motor drive pinion into mesh with the engine flywheel ring gear just before closing the motor circuit.

The solenoid plunger and drive shifting mechanism is spring loaded to open the



Illust. 67. Diagram of wiring circuit in typical solenoid switch.

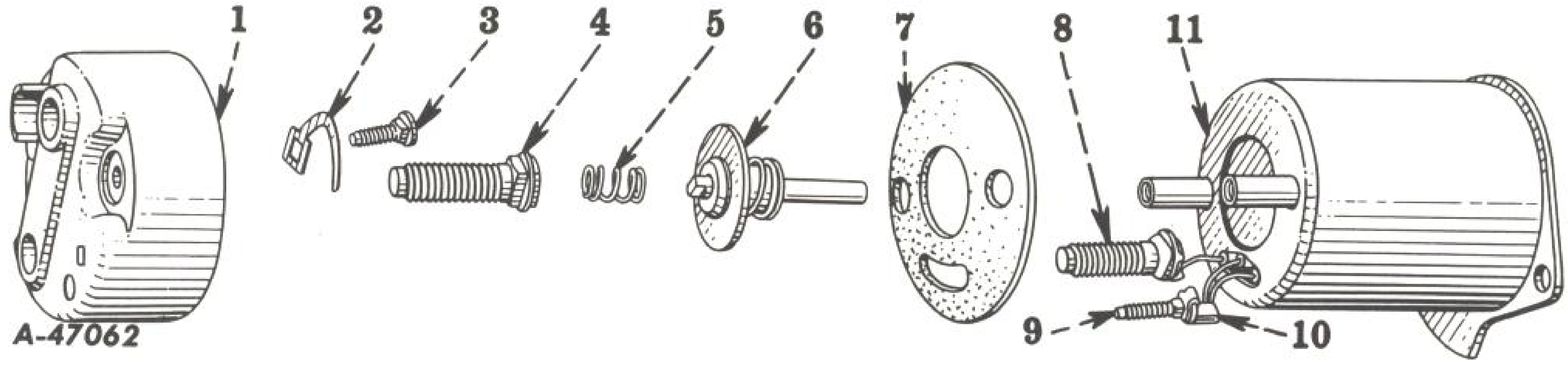
switch and demesh the drive gear when the operator releases the starting push button.

A third function is to by-pass the ignition coil resistor to provide full voltage for ignition during the cranking period. The fourth terminal (R) on this switch is the contact finger for ignition resistor by-pass.

The manual switch is enclosed in a die cast housing and sealed against entry of dirt or moisture by a gasket between its housing and the cranking motor frame. Failure of this gasket or damage to the housing that would allow entry of dirt or moisture will cause arcing at the switch contacts and erratic switch action. When this occurs, the replacement of the switch assembly with the gasket is necessary.

The motor terminal stud which forms one of the switch contacts may be filed down to solid metal if not burned too deeply. Otherwise it also must be replaced.

The magnetic switch assembly is sealed against entry of moisture and dirt and is not designed for disassembly. When found defective, the complete assembly must be replaced. The electromagnet in this switch consists of a single winding. One end of it is grounded to the case; the other end is



Illust. 68. Exploded view of solenoid switch assembly.

1. Switch cover
2. Contact finger
3. (R) terminal
4. Battery terminal
5. Contact disc return spring
6. Contact disc
7. Cover gasket
8. Motor terminal
9. Starting switch terminal
10. Terminal clip
11. Solenoid

brought out through the smallest of the three insulated terminals to the switch control.

The solenoid switch, as shown in Illust. 67, has two windings in the electromagnet solenoid: a "pull-in" winding shown by a dashed line and a "hold-in" winding shown by a dotted line. Also see Illust. 68.

Both windings are energized when the operator closes the starting push button. They produce a strong magnetic field that pulls the plunger in so that the drive pinion is shifted into mesh. After that, the last bit of plunger travel closes the main contacts, connecting the battery directly with the cranking motor.

The closing of the main switch contacts by-passes the "pull-in" winding (dashed line) because this winding is connected by the push button across the main contacts. The "hold-in" winding alone has enough magnetism to hold the plunger in cranking position. The elimination of the powerful "pull-in" winding has reduced the drain on the battery.

When the operator releases the push button, the "hold-in" winding is no longer energized; the pull of the return spring opens the main contacts and withdraws the drive pinion from mesh.

The third function of this switch - that of by-passing the ignition coil resistor - is accomplished through the small (R) terminal and contact finger. When the solenoid is in cranking position, the contact finger touches the contact disc and provides a direct circuit between the battery and the ignition coil. This circuit is opened when the main contacts open at end of the cranking period.

The solenoid windings can best be tested with the solenoid off of the cranking motor. This is necessary because both the motor lead and battery lead must be removed from the main switch terminals to prevent interference. The main switch terminal, which is normally connected to the cranking motor, must be grounded to the solenoid base by a jumper wire.

1. For the first test of both windings, connect a battery, variable resistance, and ammeter in series, to the (S) starting switch terminal and to a good ground on the solenoid base. Connect a voltmeter between the same two points. Slowly increase the voltage to that called for in the specifications, and note the current draw on ammeter. Compare it with the specification range for "all windings."

2. For the test of "hold-in" winding only, disconnect the jumper lead grounding

the main switch terminal. Readjust the variable resistance to the specified voltage and note the current draw on the ammeter. Compare it with the specification range for "hold-in" winding.

If either test indicates a current draw outside the specified range, the solenoid assembly should be replaced. Proper operation of the switch depends on this definite balance between the two windings. An open circuit in the "hold-in" winding will cause the switch to chatter and arc at the main contacts. An attempt to crank with a discharged battery will also cause the switch to chatter because the amperage necessary for holding is not available.

When reassembling the switch, the contact finger from terminal (R) must be adjusted to touch the contact disc before the disc makes contact with the main switch terminals. There should be 1/16 to 3/32 inch clearance between the contact disc and the main terminals when the finger touches. Use a new cover gasket upon reassembly, and be sure the cover is in good condition and properly installed for a dirt and water-tight seal of the switch.

Cranking Motor Drives

Two general types of cranking motor drives are used:

1. The standard Bendix type drive shown in Illust. 66, is used in cranking motors that are controlled by a manual or a magnetic switch. This type of drive is complete in itself; it requires no external means of meshing and demeshing the drive pinion.

2. The over-running clutch type of drive as shown in Illusts. 67 and 70 is used in cranking motors that are controlled by a solenoid switch. This drive (also called a positive engagement type) depends on the action of the switch solenoid for meshing and demeshing the drive pinion.

Engine flywheel ring gears used in common with all types of drives will show normal use by slight wear on leading edges of a few teeth at points of engine compression - two locations 180 degrees apart on 4-cylinder engines, three locations 120 degrees apart on 6-cylinder engines. In normal use, a single ring gear will give several thousand hours of satisfactory service.

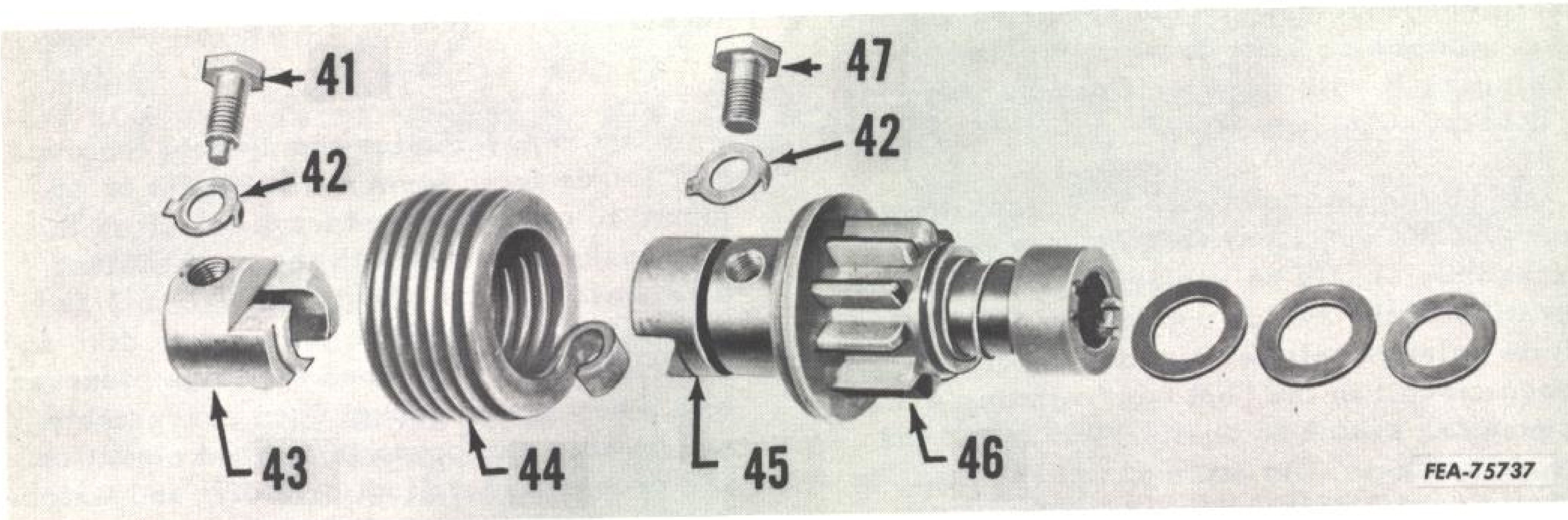
Where excessive dubbing of leading edges of ring gear teeth occur at points of engine compression, the cranking motor drive splines or threaded sleeve may be fouled with gummy deposits preventing smooth engagement. Erratic action of the starting switch because of burned or dirty contacts causes rough engagement. Damage to the drive - from operator error in engagement during engine rock-back - causes rough engagement. Loss of hardness of the teeth in the ring gear is caused by overheating the ring gear during installation.

If ring gear teeth are dubbed badly around the complete diameter of the gear, it is evident that attempts have been made to engage the drive while the engine was running. This may have been due to operator error in closing the starting switch or because of a defective switch.

When installing a new flywheel ring gear, be careful to avoid overheating the gear before shrinking it in place. To prevent destroying the hardness of the gear teeth, it is essential to heat the entire circumference of the gear uniformly. A household or similar type gas or electric oven with a temperature control is ideal. Spotty heating, such as may be expected through the use of a hand torch, should be avoided.

CAUTION: Avoid heating in excess of 400 degrees F.

If no accurate method of recording the heat is available, polish a section of the ring gear so that you can observe the drawing color when the proper temperature



Illust. 69. Exploded view of the Bendix type drive.

41. Drive head screw
42. Screw lock
43. Drive head
44. Drive spring
45. Sleeve
46. Shaft and pinion assembly
47. Driveshaft screw

is reached. DO NOT heat it beyond the first indication of color in the gear, which will range from a light yellow to straw color. The heating of the gear for shrinking on the flywheel also serves as a drawing operation; therefore, the ring gear should be allowed to cool in air after being positioned on the flywheel.

The Bendix type drive provides an automatic means of engaging the cranking motor drive pinion with the engine flywheel ring gear for cranking the engine and for disengaging the drive pinion from the flywheel ring gear after the engine starts. Illust. 69 shows the (44) drive spring and (43) drive head that is keyed and anchored to the cranking motor shaft with the (41) head screw and (42) lock. Power is transferred through the drive spring to the (46) driveshaft and pinion assembly by the (47) shaft screw and (42) lock.

The (46) drive shaft and pinion assembly is a loose fit on the cranking motor shaft, free to rotate against the torsion of the (44) drive spring and also free to move endways against the compression of the drive spring. The (45) sleeve is attached to, and is free to turn on the shaft and pinion assembly. This sleeve forms a core for the drive spring, preventing collapse of the spring when under torsional shock load.

The drive pinion is mounted loosely on its hollow shaft on spiral threads. A small anti-drift spring, between the pinion and the pinion stop, prevents the pinion from drifting into the flywheel gear while the engine is running.

When the cranking motor is not operating, the pinion is in position shown in Illust. 66. When the cranking motor switch is closed, the motor begins to rotate, picking up speed rapidly. However, the drive pinion, being a loose fit on the shaft assembly, does not pick up speed instantly. The result is that the shaft assembly turns within the pinion, forcing the pinion endwise along the shaft and into mesh with the flywheel ring gear.

As the pinion reaches its stop on the end of the shaft assembly, it can move out no further and it must then rotate with the shaft assembly so that the engine flywheel is turned and the engine is cranked. The drive spring is wound up slightly by the torque of the motor and the shock of engagement.

The teeth of the Bendix pinion are chamfered on one side and specially rounded and polished to make the automatic meshing with the flywheel gear teeth natural and easy. However, if the ends of the pinion teeth meet end to end with the flywheel teeth, the driveshaft and pinion assembly, being freely mounted on the motor shaft, is pushed backwards against the compression of the driving spring; the endwise movement of the pinion shaft permits the pinion to turn slightly further and enter the flywheel gear.

Because it is natural that the teeth may often meet end to end in this manner, it is of utmost importance that the drive is free to compress in this way and that it is free to return to its original position easily. Any restriction of this longitudinal freedom will prevent the pinion teeth from releasing from the ends of the flywheel teeth and ultimately bring about the destruction of the flywheel gear, plus many other starting troubles caused by this failure to mesh easily and naturally.

After the engine has started, the flywheel spins the drive pinion more rapidly than the cranking motor is turning. As a result, the pinion is screwed back out of mesh with the flywheel ring gear.

Broken cranking motor drive housings or wrapped-up or broken Bendix drive springs can be caused by engine backfire during cranking. Or the same failure, plus flywheel gear tooth damage, can result from operator error - - - from attempting to restart during engine rock-back following a false start of the engine.

Engine backfire during cranking may be caused by ignition timing being too far advanced or from surface ignition due to hot spots in the combustion chambers. To correct operator error, he should be instructed to pause a few seconds after a false start to make sure the engine has come completely to rest before another start is attempted.

Restriction of free movement of the drive gear and shaft assembly on the cranking motor shaft may be caused by the following conditions:

1. Drive rusted to motor shaft.

2. Rough or burred motor shaft under driveshaft assembly.

3. Bent motor shaft.

4. Use of too long a shaft spring screw, causing it to protrude through the driveshaft and bind on the motor shaft.

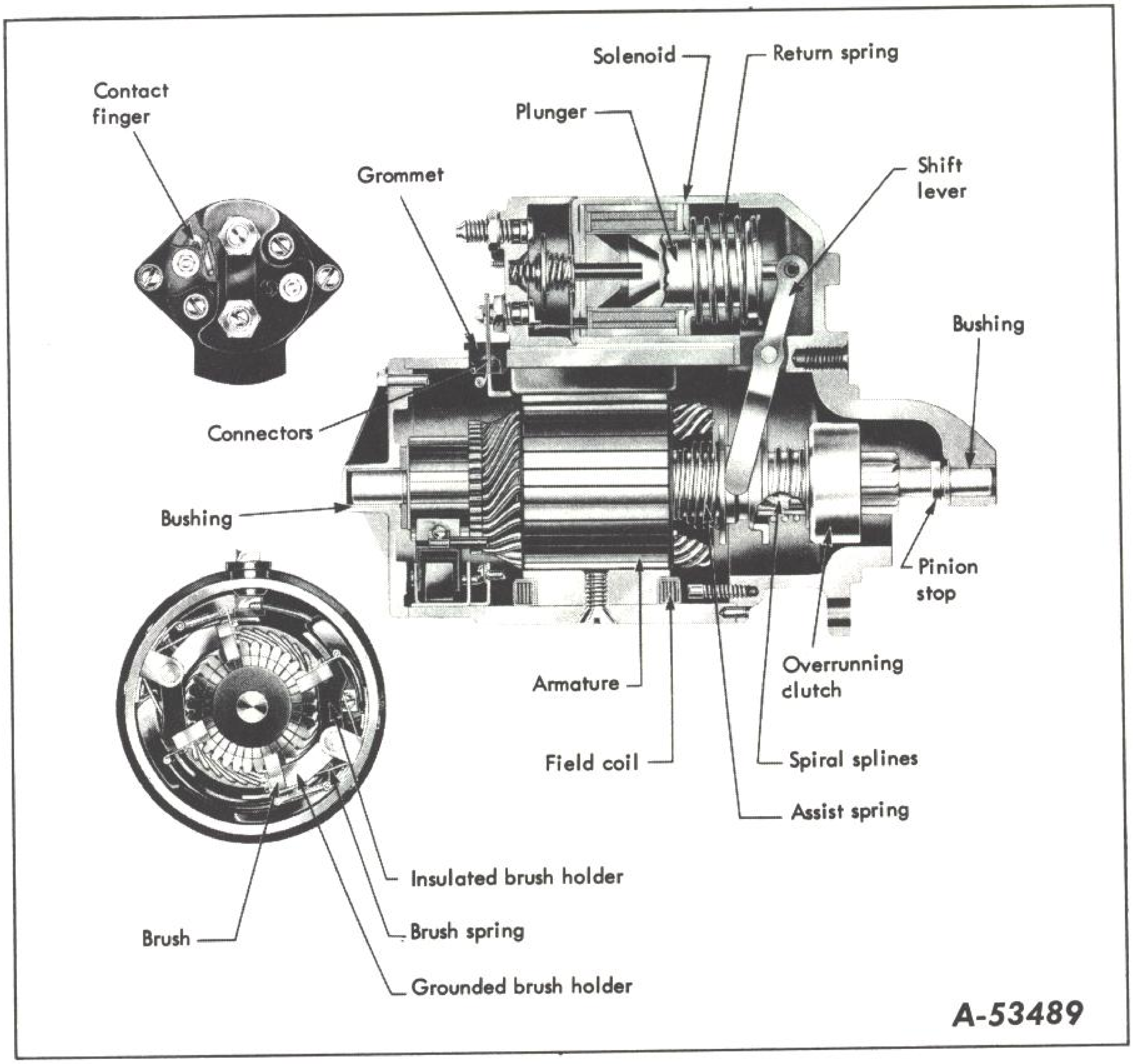
5. Distorted condition of drive spring coils causing drag between drive assembly and motor shaft.

6. Distorted sleeve which would prevent compression of drive spring.

7. Unhooked or improper assembly of the tongue and groove portions of the drive head and sleeve, preventing free movement.

Normal endwise motion of the drive pinion and shaft assembly from an at-rest position to a coil-to-coil compression of the drive spring will be approximately 5/16 inch. End clearance between the drive assembly (at rest) and the end of the drive frame may be from .020 to .0625 inch. Add washers to the motor shaft to secure proper end clearance.

Demeshed or home position of the pinion on its threaded shaft will allow approximately 3/16 inch clearance between the pinion and flywheel gear. When fully engaged, the pinion will enter the flywheel 17/32 inch.



Illust. 70. Sectional view of overrunning clutch drive, solenoid operated cranking motor.

The overrunning clutch type drives, used in some series of tractors, are shifted into cranking position by the action of the starting solenoid. See Illust. 70. When the operator pushes the starting button, the solenoid shift lever moves the clutch drive assembly endwise along the spiral splines of the armature shaft. Because the armature is at rest, this pinion movement along the spiral splines tends to rotate the pinion a small amount, aiding in a natural and easy meshing of the pinion with the flywheel ring gear.

When the pinion and flywheel teeth butt together instead of meshing, the pinion becomes spring loaded as the shift lever movement continues and compresses the clutch collar spring. Completion of the solenoid movement closes the cranking motor switch and the armature begins to turn, the pinion rotates only the width of one-half a tooth before alignment occurs and the pinion drops into mesh.

The overrunning clutch transmits cranking torque from the cranking motor shaft to the engine flywheel, but permits the drive pinion to overrun, or run faster than the armature after the engine is started. This protects the armature from excessive speed during the interval that the operator allows the drive pinion to remain in mesh after the engine starts. When the operator releases the starting button, the solenoid is de-energized, the cranking motor switch opens, and the return spring shifts the drive assembly home, out of mesh with the flywheel.

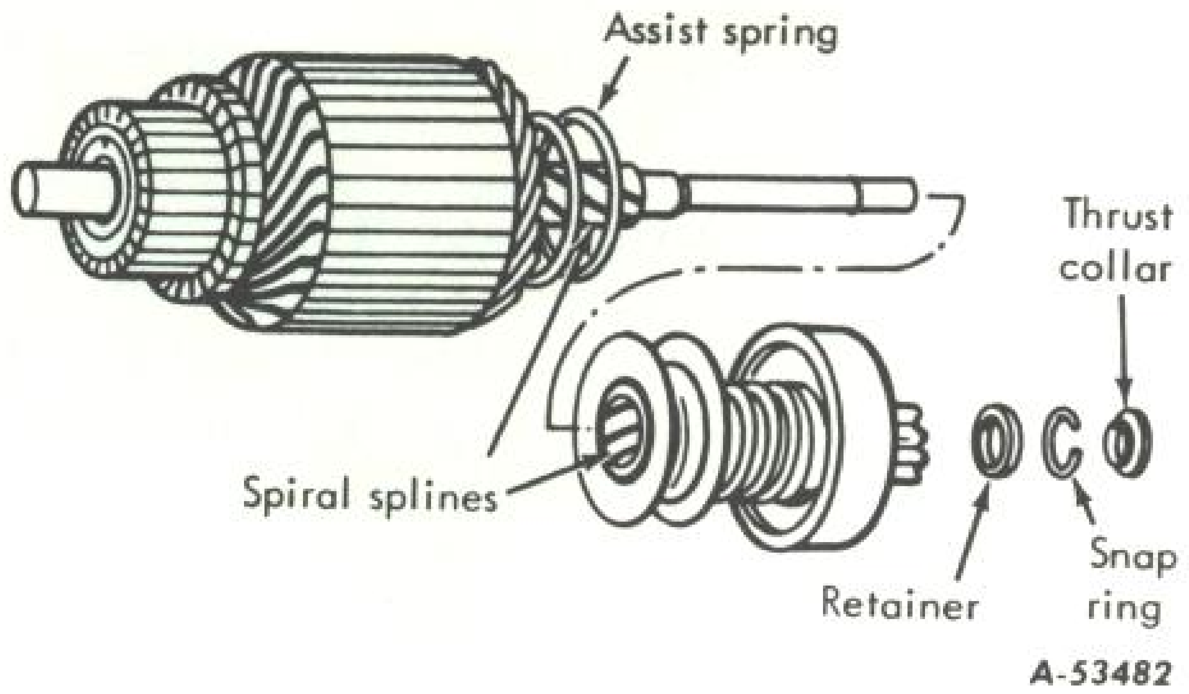
As soon as the engine begins to operate, the operator should release the starting button. Otherwise the drive pinion remains in mesh and continues to overrun the armature. The overrunning clutch can withstand this condition for brief periods. However, if the overrunning effect is continued too long, overheating occurs, causing loss of lubricant from the sealed clutch assembly. Ultimately the clutch will seize and spin the armature at excessive speed to destruction. A similar effect will result if the operator opens the throttle too wide during initial starting.

Evidences of such abuse are galling of the clutch bearings under the drive pinion and bluing or deposit of bearing material on the motor shaft from the heat developed. The overrunning clutch in the drive assembly is a conventional ramp and roller type, using four spring loaded rollers. Components of this sealed unit are not serviced individually. When damage or excessive wear is found, the complete assembly must be replaced. See Illusts. 71 and 72.

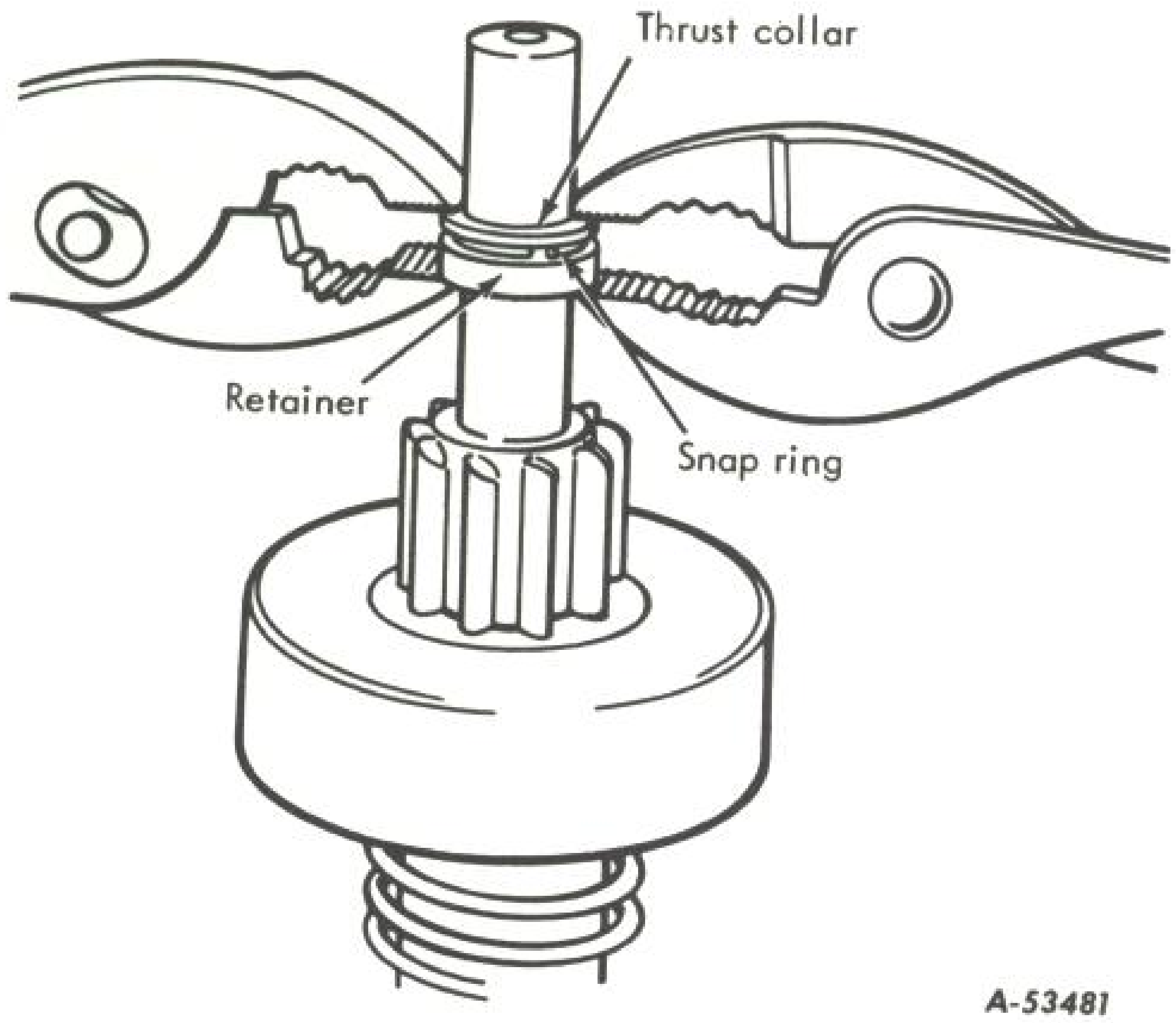
The overrunning clutch assembly must not be cleaned by high temperature degreasing methods because that would remove the lubricant originally packed in the clutch and cause rapid clutch failure. Do not immerse the clutch assembly in solvent; clean only with a brush dipped in petroleum base solvent or other neutral spirits.

Whenever the overrunning clutch drive type cranking motor has been disassembled or the solenoid has been replaced, be sure to check and correct the pinion clearance. After the cranking motor is re-assembled, the pinion clearance must be adjusted to insure full pinion engagement and to give enough clearance between the end of the pinion and the pinion stop collar on the armature shaft.

Clamp the cranking motor in a vise and disconnect the lead from the cranking motor



Illust. 71. Armature and overrunning clutch assembly.



Illust. 72. Assembly pinion stop on armature shaft.

to the solenoid so that the motor will not operate. Connect a battery of the proper voltage between the (S) switch terminal of the solenoid and the motor frame (ground) and assist the engaging movement of the pinion by hand. Normal lateral movement of the pinion is 3/4 inch for the full stroke of the solenoid plunger.

The battery current will hold the plunger in this bottomed position while the pinion clearance is checked. It should measure .010 to .140 inch (3/32) between the pinion and its stop, with lost motion in linkage held lightly toward disengaged position. Do not compress the clutch spring. On those motors where the solenoid linkage is exposed, adjust by changing the length of the serrated link. On the enclosed linkage types, pinion clearance is preset by design of components; clearance will increase with wear of parts.

Always check alignment of the linkage between the pinion and the solenoid to insure free movement. The moving parts of this linkage and the drive splines may be lubricated with a small amount of light engine oil. Heavy oil or grease must not be used because this may retard or prevent normal action of the drive mechanism. The overrunning clutch is packed with lubricant during original assembly and requires no additional lubrication.

IGNITION SYSTEM

TESTING THE IGNITION SYSTEM

Battery

The battery should be checked for state of charge and condition before any checks are made. Place a load on the battery by cranking or turning on all the lights and check the voltage of each cell. The voltage should not drop below 1.5 volts per cell and not vary more than .2 volt between cells. See Illust. 2. Specific gravity should read at least 1.250 (corrected to 80°F) per cell.

CAUTION: On carbureted engines, it will be necessary to disconnect the primary wire from its terminal on the distributor to prevent ignition during cranking period.

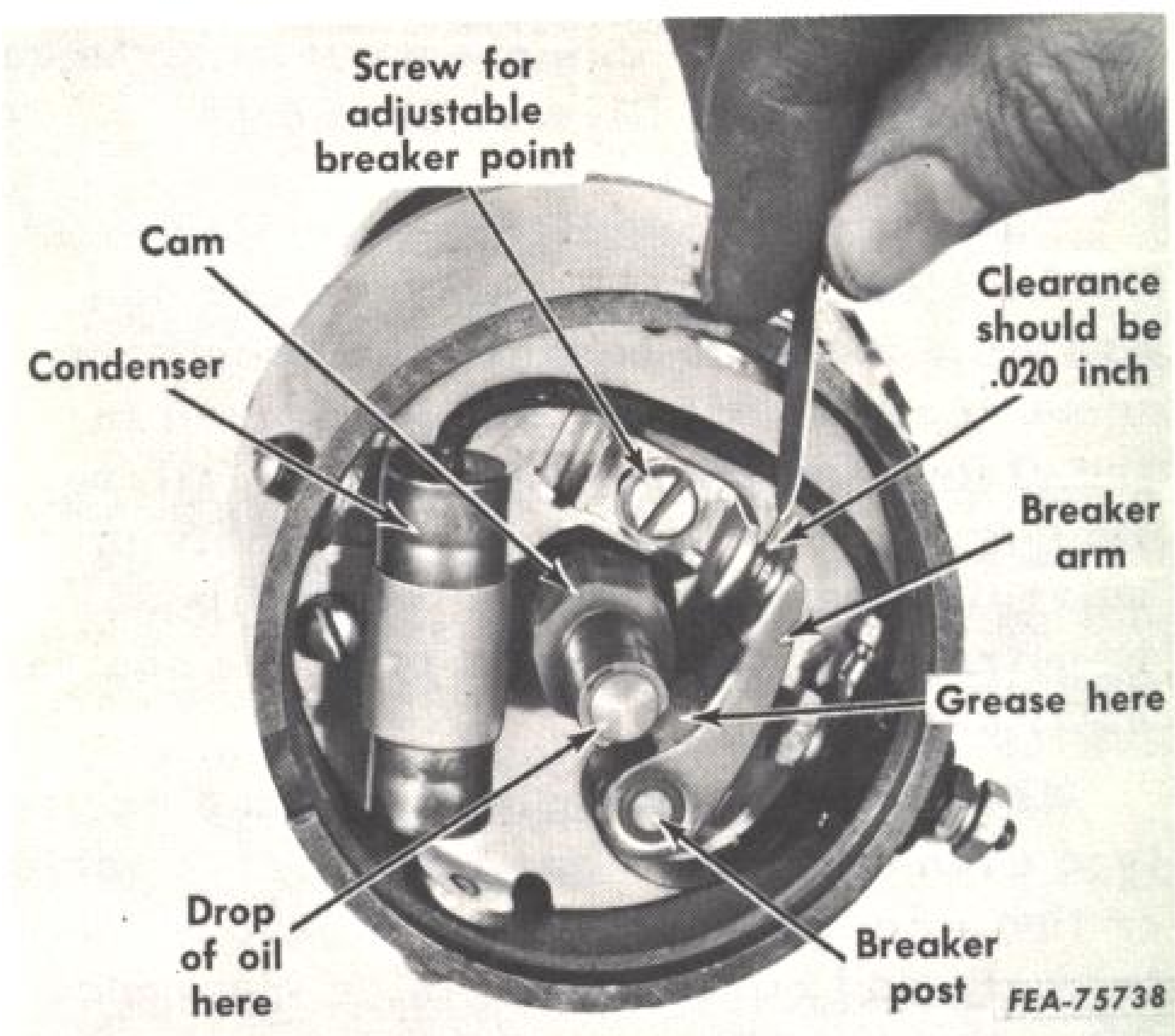
Never operate the cranking motor for more than 30 seconds without allowing it to cool.

Distributor

A check of distributor breaker point gap setting and the timing of the ignition system is considered a good predelivery procedure because satisfactory engine performance is so dependent upon these two adjustments.

Remove the distributor cap, rotor, and breaker cover. Crank the engine slowly by hand until the highest point of the cam is in line with the breaker arm rubbing block. In this condition the breaker point gap should be .020 inch on all gasoline engines. To adjust, loosen the screw in stationary point, using a screwdriver blade between the screw head and the point bracket to shift the bracket toward or away from the breaker arm until the correct clearance is obtained. Retighten the stationary point screw and recheck the breaker point clearance. The .020 inch feeler gage should slip snugly into the opening, as shown in Illust. 73.

An accurate .020 inch setting of the breaker point gap accomplishes two important jobs. It provides sufficient point opening to make frequent readjustment unnecessary to compensate for normal wear, and it provides sufficient cam dwell angle to insure full magnetic saturation of coil at



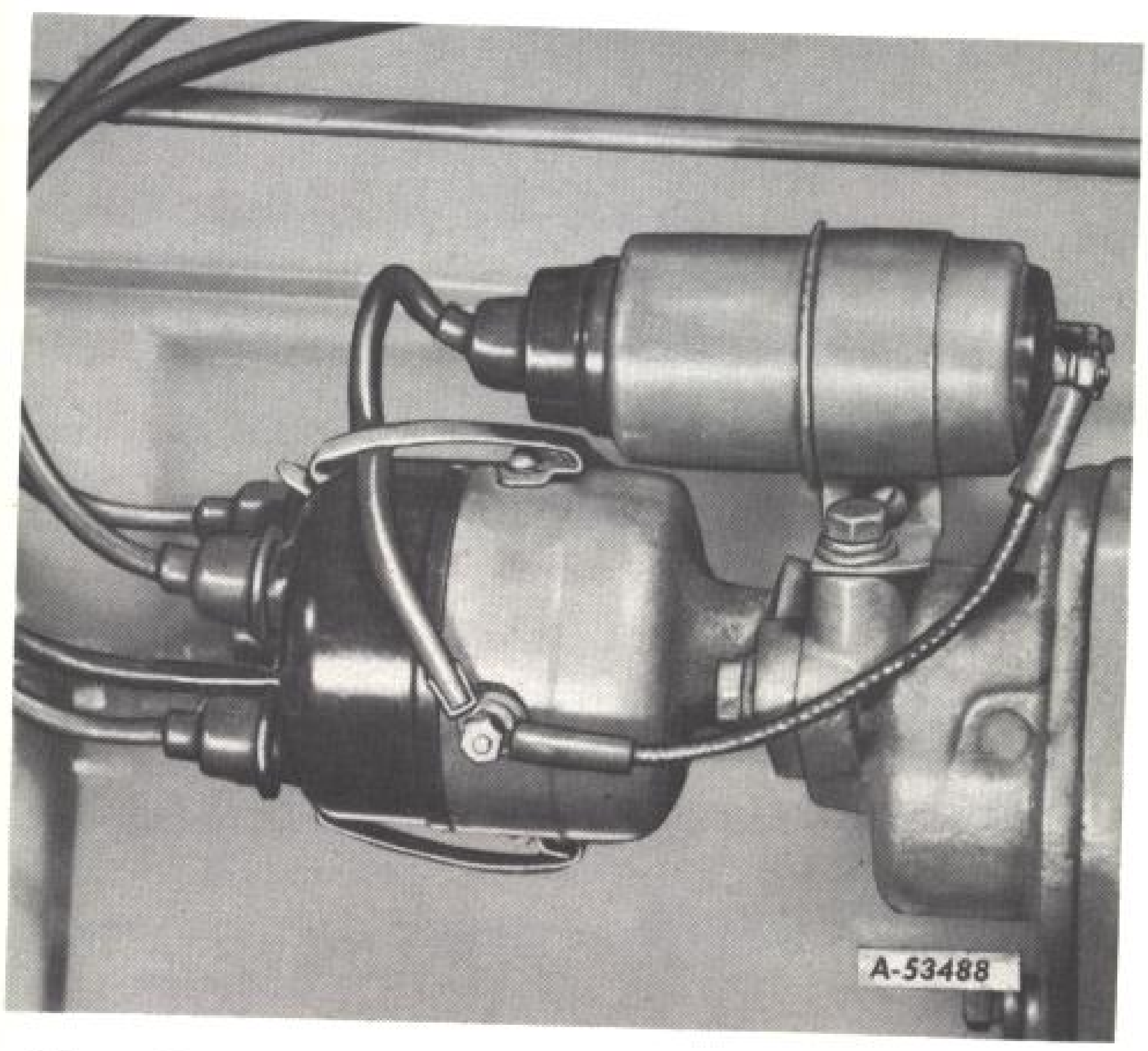
Illust. 73. Checking adjustment of the distributor breaker points.

maximum engine speeds. No other cam dwell test or adjustment is necessary.

NOTE: It is important that the breaker point gap is adjusted before the timing is reset because a change in gap setting after the timing operation would also change the timing.

After the breaker point adjustment is completed, replace the breaker cover, rotor, and distributor cap and check the timing of the distributor with the engine as follows:

1. Pull secondary cable out of the center socket on the distributor cap and remove its rubber nipple.



Illust. 74. Secondary cable held under the distributor cap spring for check of spark timing.

2. Place the secondary cable under the distributor cap spring and position the cable terminal within 1/16 inch to 1/8 inch of the distributor primary terminal as shown in Illust. 74.

3. Turn on the ignition switch and crank the engine slowly by hand. The spark should occur at the specified time as listed in GSS-1356.

NOTE: If the spark does not occur at the correct time, loosen the distributor mounting clamp bolts and advance or retard the distributor body so that a final cranking check results in the spark occurring correctly.

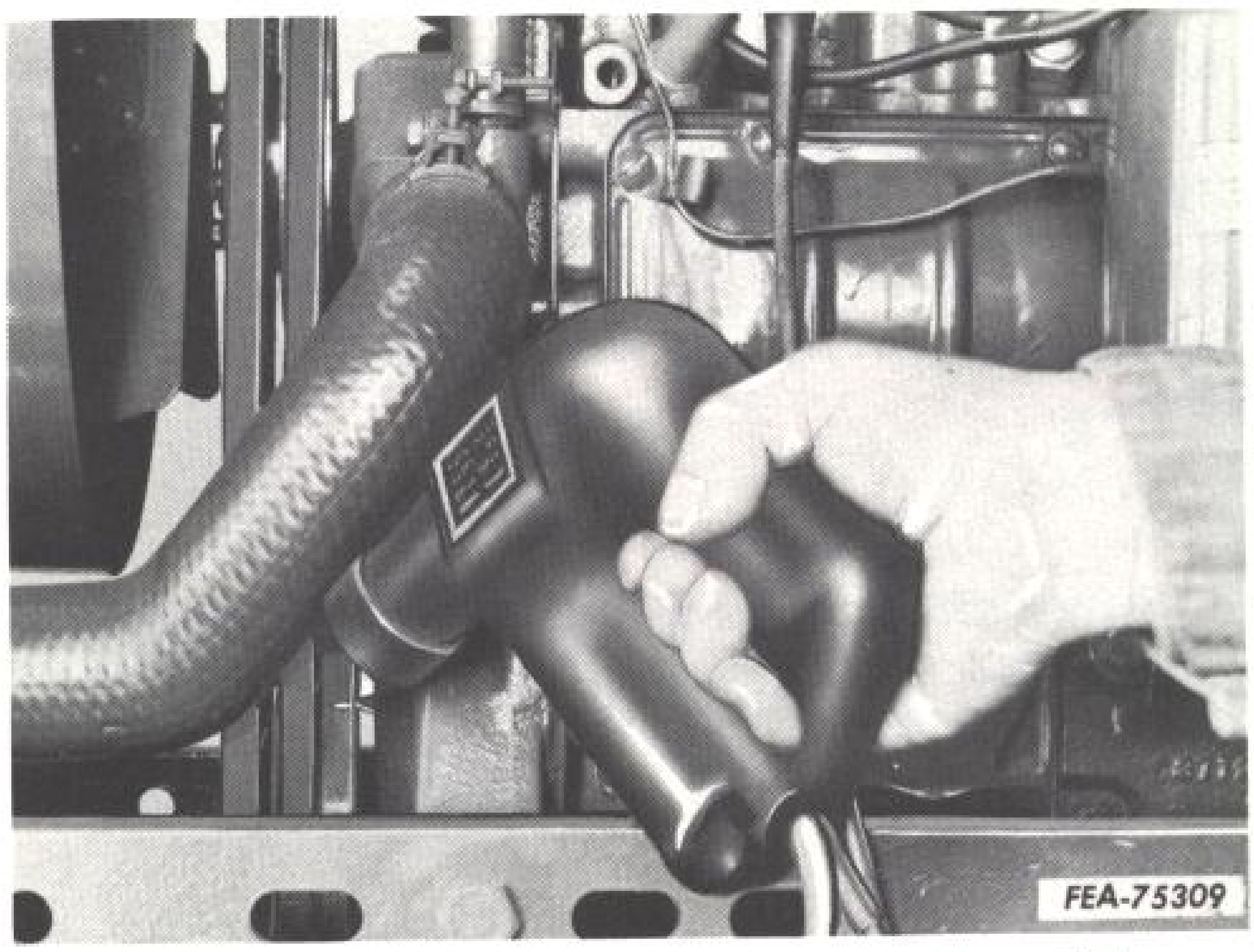
IMPORTANT: Be sure the distributor mounting clamp bolts are retightened before the final check is made.

Top dead center position for number one cylinder is stamped DC on the graduated flange of the fan drive pulley, or on the flywheel along with degree marks. The specified mark should align with the pointer when the spark occurs.

Replace the secondary cable nipple and replace the cable in its socket in the distributor cap. See also that all spark plug cables are firmly seated in their cap sockets and that their nipples are in place to seal out moisture.

Using the Power Timing Light

An accurate and fast check of ignition timing is possible on all models with a neon-type timing light, using timing marks and while operating the engine at low idle speed. See Illust. 75. The timing marks on the fan drive pulley or flywheel must be whitened with white lead or chalk to make them more visible. The low idle speed of the engine must be adjusted to 25-50 rpm below low idle. A higher engine speed will cause the automatic spark advance to function, thus introducing an error into the timing adjustment.



Illust. 75. Final check of timing, using timing light.

While operating the engine at this speed, direct the timing light on the pointer and fan drive pulley or flywheel, depending on the model; then observe the mark that aligns with the pointer. This mark should agree with the specifications. Correct the timing if necessary as outlined under the previous steps.

After adjustment of timing of the distributor to the engine, as outlined above, the action of the automatic spark advance may also be observed by use of the power timing light. Operate the engine at maximum speed and direct the timing light on the pointer and fan drive pulley or flywheel; then observe the mark that aligns with the pointer. Refer to specifications for the correct mark, indicating the degree of maximum advance and the distributor symbol for the various engines in this series of tractors.

A slight readjustment of timing may be made to align the correct mark with the pointer at maximum engine speed, but in no case should readjustment result in the spark occurring before the recommended setting when the engine speed is again reduced to 25-50 rpm below idle. After the above checks or adjustments have been made, readjust the engine low idle rpm by turning in the carburetor throttle stop screw.

SERVICING THE IGNITION SYSTEM

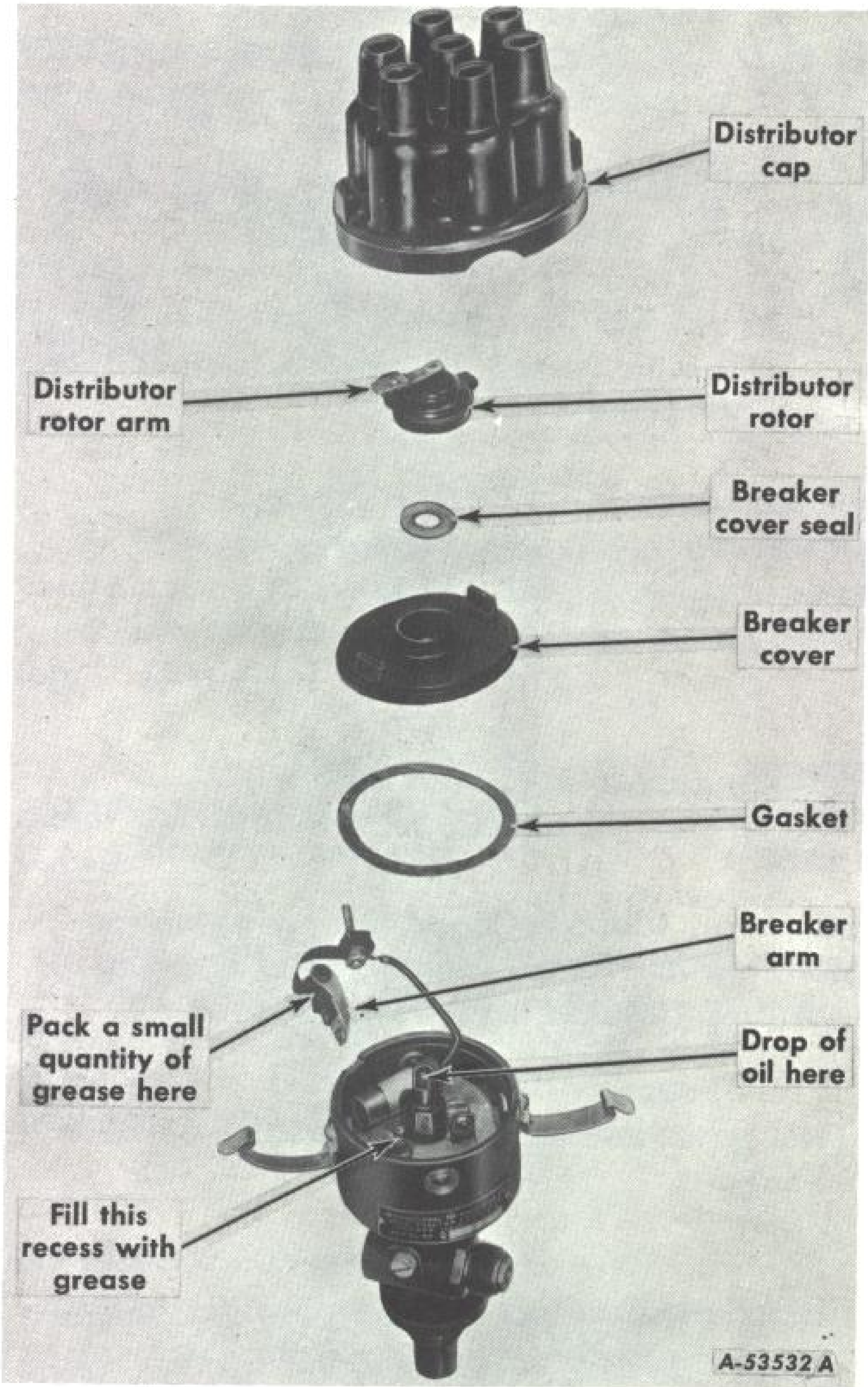
Distributor

Under Ignition System Testing, the location and correction of external and circuit defects in the ignition system and engine were discussed. Distributors found to be questionable during tests may be disassembled and inspected further to determine the location and cause of trouble. See Illust. 76. Use the following as a guide:

1. Where rapid burning of breaker points has occurred, look for the following conditions:

a. Excessive lubrication through operator error, wherein grease or oil reaches the breaker contact surfaces.

Failure of the distributor shaft seal allows crankcase vapors of moisture and



Illust. 76. Distributor partly disassembled for servicing.

oil to enter the breaker compartment, fouling the breaker contact surfaces. A plugged engine crankcase breather will cause a buildup of pressure in the crankcase, forcing vapor past the seal into the distributor.

Failure of the distributor shaft seal in distributors Y, AA, and AC from grease gun pressure may be due to a plugged grease by-pass groove in the outer diameter of the lower bushing in the distributor housing.

Either excessive lubrication or entrance of crankcase vapor will be evident by a dark smudgy spatter line under the breaker points.

b. Breaker point gap opening too small, resulting in high average current flow and arcing, causing short point life.

c. High series resistance in condenser circuit, preventing normal condenser action, causing rapid burning of points. High resistance may be caused by a defective condenser or poor electrical connections at the condenser lead wire or mounting clamp.

d. Use of condenser other than that specified for the system. Use only the part listed in the catalog for the machine model involved.

e. Use of ignition coil other than that specified for the system. Refer to parts catalog covering machine model involved for correct coil part number.

2. Erratic breaker point opening. After adjustment, the breaker point gap should be within the range of .019 to .023 inch as checked at each cam lobe. Failure to secure gap within this range may be caused by:

a. Sprung or bent distributor shaft.

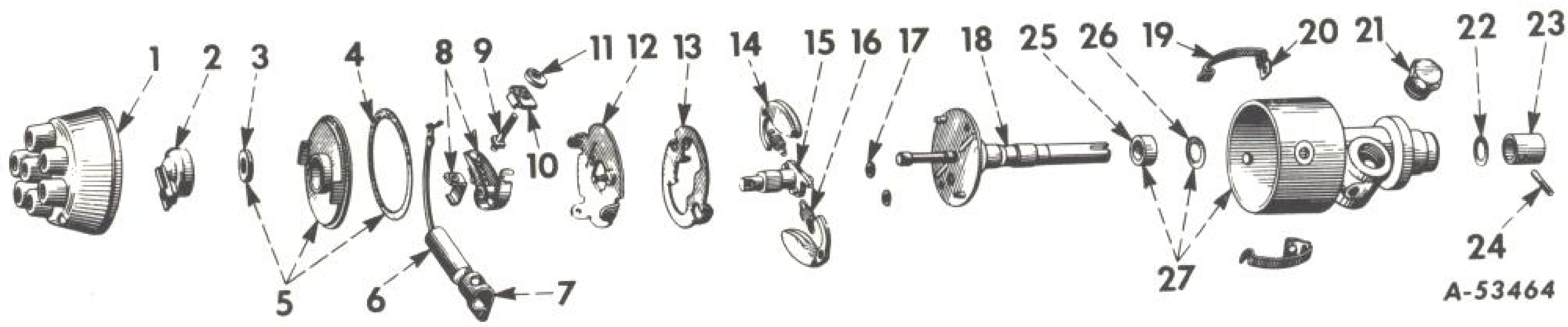
b. Worn cam, distributor shaft, and/or distributor bushing.

3. Failure of breaker points to close between each cam lobe at all engine speeds.

a. Lack of specified breaker spring tension. Attach hook of scale at center line of arm contact point and pull at right angle to arm. Read the scale when the points just begin to open.

b. Stiff action of breaker arm, due to lack of lubrication at breaker armpost or due to entry of dirt, past gasket and seals, that absorbs lubrication at the breaker arm post.

c. Loss of all breaker arm spring tension because of an accidental connection between the distributor primary terminal and a battery lead wire. The resulting short circuit will anneal the spring.



Illust. 77. Exploded view of ignition distributor.*

1. Cap
2. Rotor
3. Felt seal
4. Cover gasket
5. Cover
6. Condenser
7. Clamp
8. Point set
9. Primary terminal
10. Spring anchor insulator
11. Terminal insulator
12. Breaker plate
13. Weight guard
14. Weight arm
15. Cam
16. Governor springs
17. Weight arm spacers
18. Distributor shaft
19. Cap spring
20. Support
21. Plug
22. Lower thrust washer
23. Collar (or gear)
24. Pin
25. Oil seal
26. Upper thrust washer
27. Housing assembly

* The designs of these parts vary with distributors, who are identified by symbols, because of difference in direction of rotation, number of cylinders, total amount of automatic advance, the rate of advance, and/or breaker arm spring tension.

4. If the automatic spark advance is erratic and the rotor fails to return to its original position when tested by hand, look for the following conditions in the governor:

a. Broken governor springs.

b. Stiff action of cam and governor parts because of the entrance of dirt and gumlike condition of the lubricant.

c. Interference between governor weight arms and weight guard because of a damaged weight guard.

d. Interference between cams and weight guard due to damaged weight guard.

5. If the amount of advance is too great or too little, look for the following:

a. Interference with governor movement due to damaged weight guard or foreign material in governor compartment. The lug on the bottom of the cam should move from side to side of the limit slot in the governor base plate for full advance range.

b. Use of distributor shaft other than that specified for this symbol distributor. The slot in the governor base plate controls the amount of advance. The plate is stamped to identify the amount of advance and the direction of rotation. Thus, "30R" would indicate total of 30 degrees advance and (right hand) clockwise rotation, etc. Use only the part number listed in the parts catalog for the symbol of the distributor involved.

6. If the rate of advance does not correspond to the specified engine speed, look for:

a. Stiff action of governor parts due to heavy lubrication.

b. Distorted governor springs or use of springs other than those specified. Use both springs from the package listed in the parts catalog for the symbol of the distributor involved.

c. Use of weight arms other than those specified. Check parts list for correct part for symbol of distributor involved.

d. Lost motion due to wear in distributor drive parts. Lost motion in engine timing gear train allows lead and lag of spark timing at varying engine speed.

7. If both the rate and amount of advance does not correspond to that specified for the engine involved, look for the following:

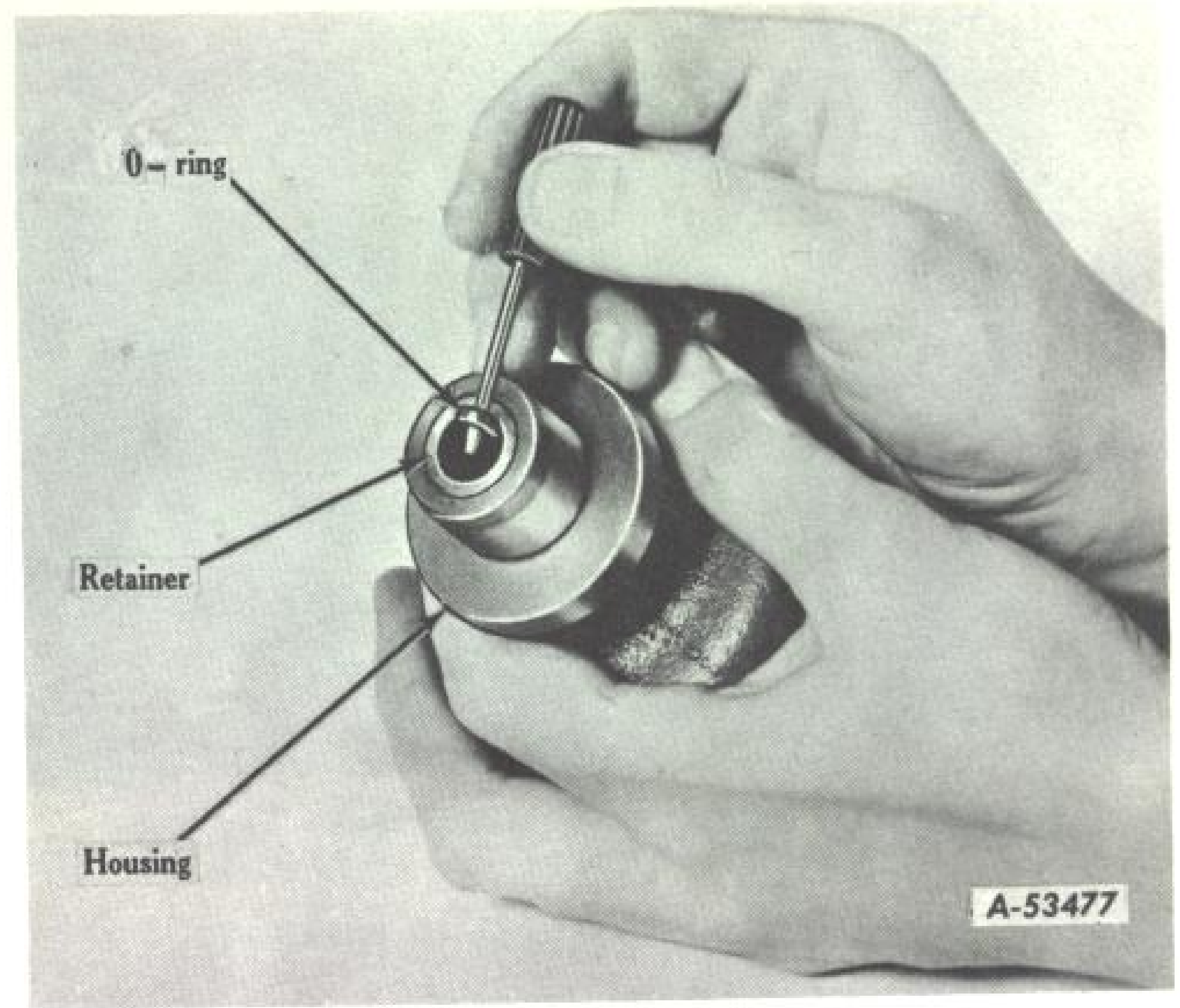
a. The cause may be combination of those listed under conditions (5) and (6) above.

b. Use of distributor assembly other than that specified for the engine involved. Distributor symbol identification is first letter or two letters of code stamped on mounting flange of distributor housing.

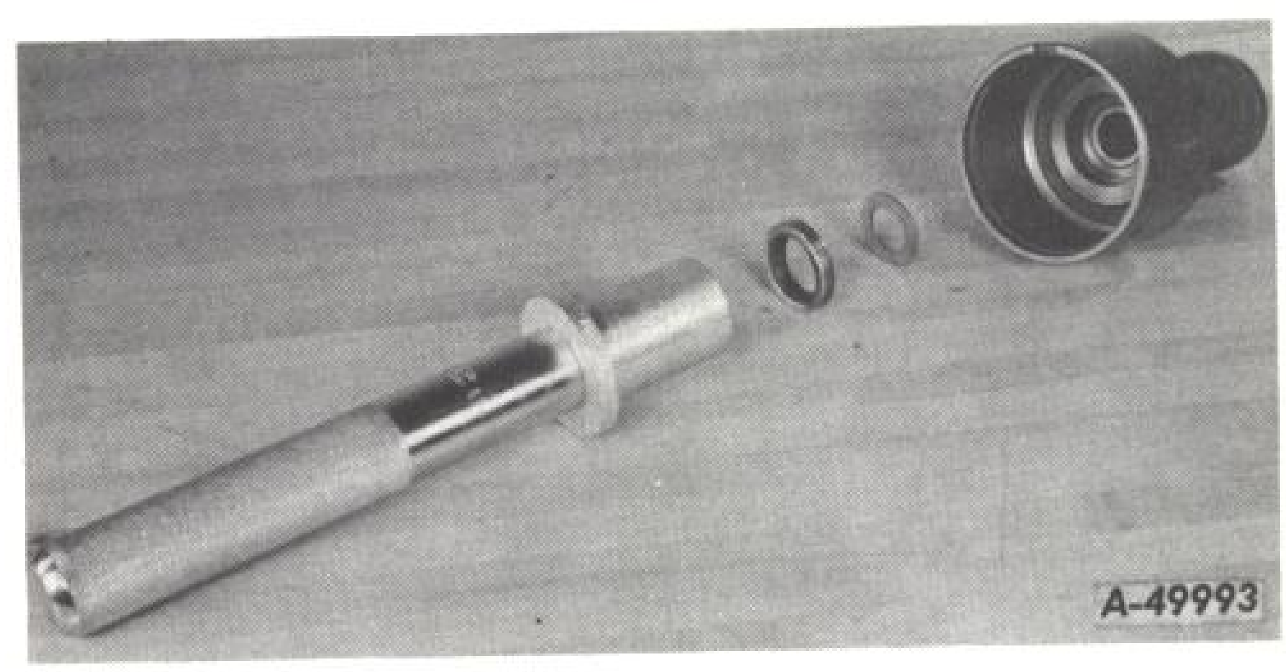
Clean and examine all parts of the distributor after disassembly. Use only clean petroleum base type solvent for cleaning. Strong degreasing compounds will cause surface damage to cap, rotor, condenser insulation, and similar plastic parts, reducing the effective insulation.

If both the distributor shaft and bushings show excessive wear, use a new shaft and housing assembly. This will insure perfectly aligned and fitted parts.

The distributor shaft seal in some symbol distributors, such as AB, X, and S, is an O-ring, as shown in Illust. 78. The retainer is pressed into the bottom of the housing bore; it need not be removed to replace O-ring. Replace the retainer only if damaged. Use a small amount of sealer on the outside diameter and press in flush with the end of the housing.

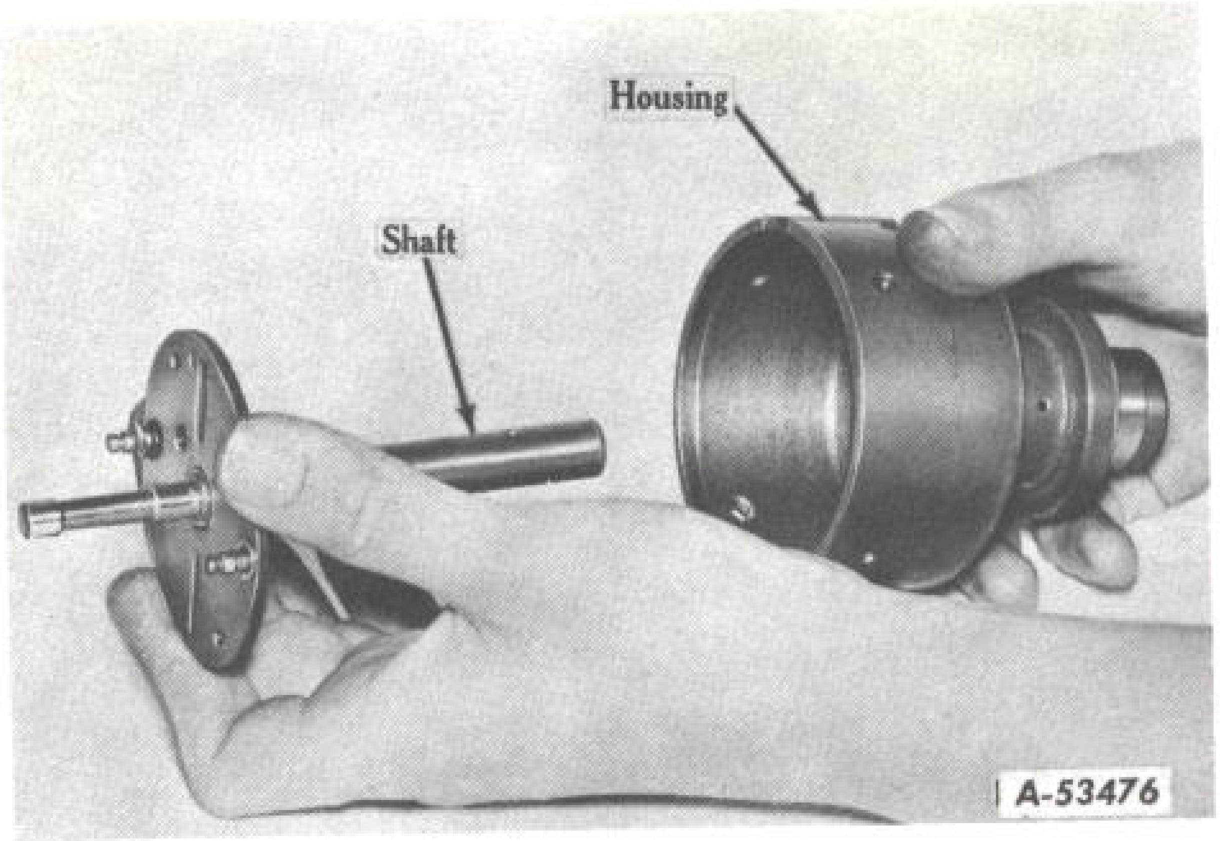


Illust. 78. Distributor shaft O-ring seal.



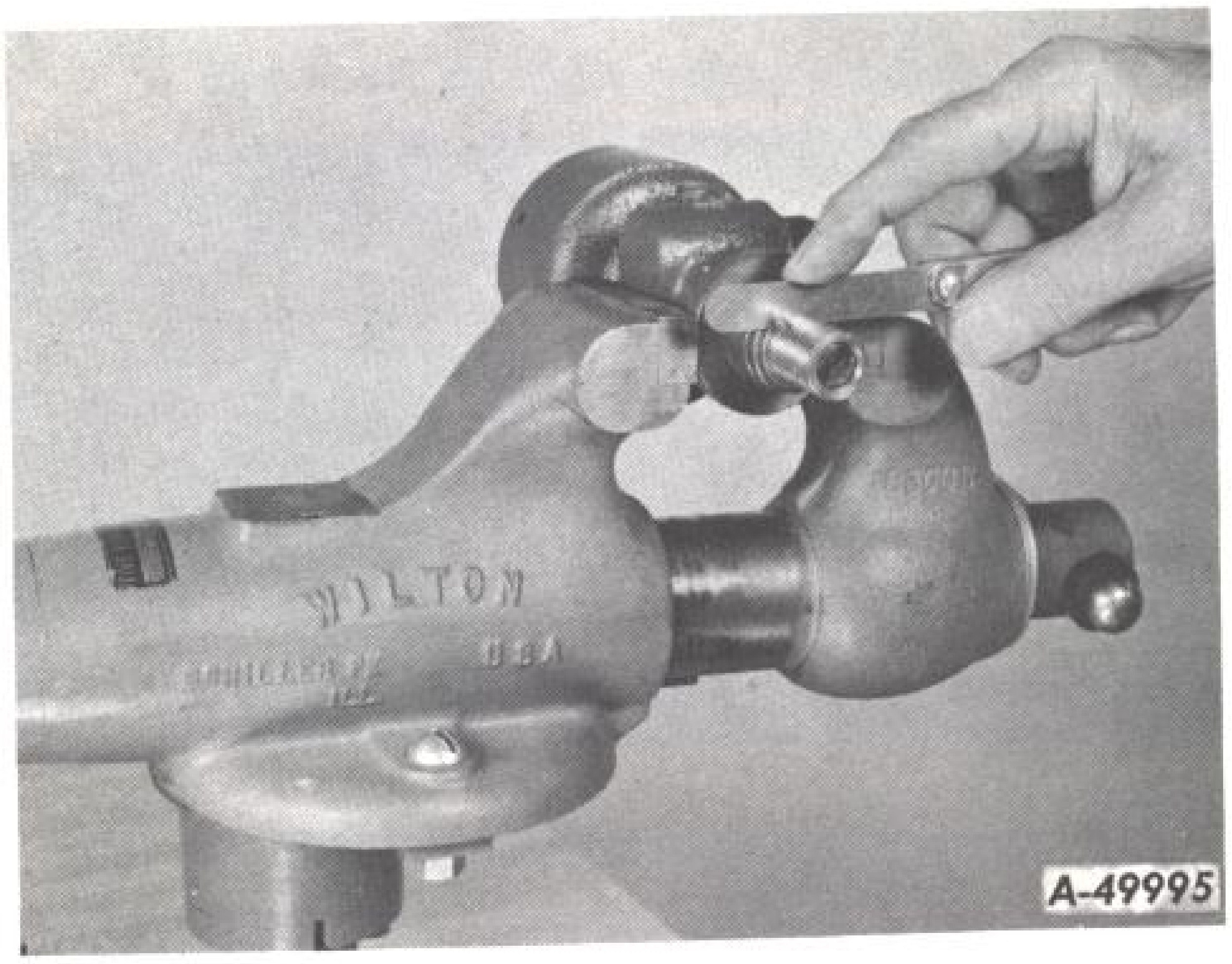
Illust. 79. Installing distributor shaft seal assembly.

The distributor shaft seal in some symbol distributors such as Y, AA, and AC, is a lip-type seal assembly pressed into the top of the housing bore. When installing a new seal, be sure the upper thrust washer (26), Illust. 77, is first placed in the housing. Use a small amount of sealer on the outside diameter of the new seal assembly. Press into place with the lip of seal toward the thrust washer, using FES 10-27 driver and FES 10-23 mandrel from the FES 10 torque amplifier tool set, as shown in Illust. 79. Lubricate the seal with pressure gun grease before installing shaft.



Illust. 80. Installing shaft in distributor housing.

Install distributor shaft in housing, being sure both upper and lower thrust washers are in place. See Illust. 80. Install drive gear or collar and pin, but do not rivet pin.

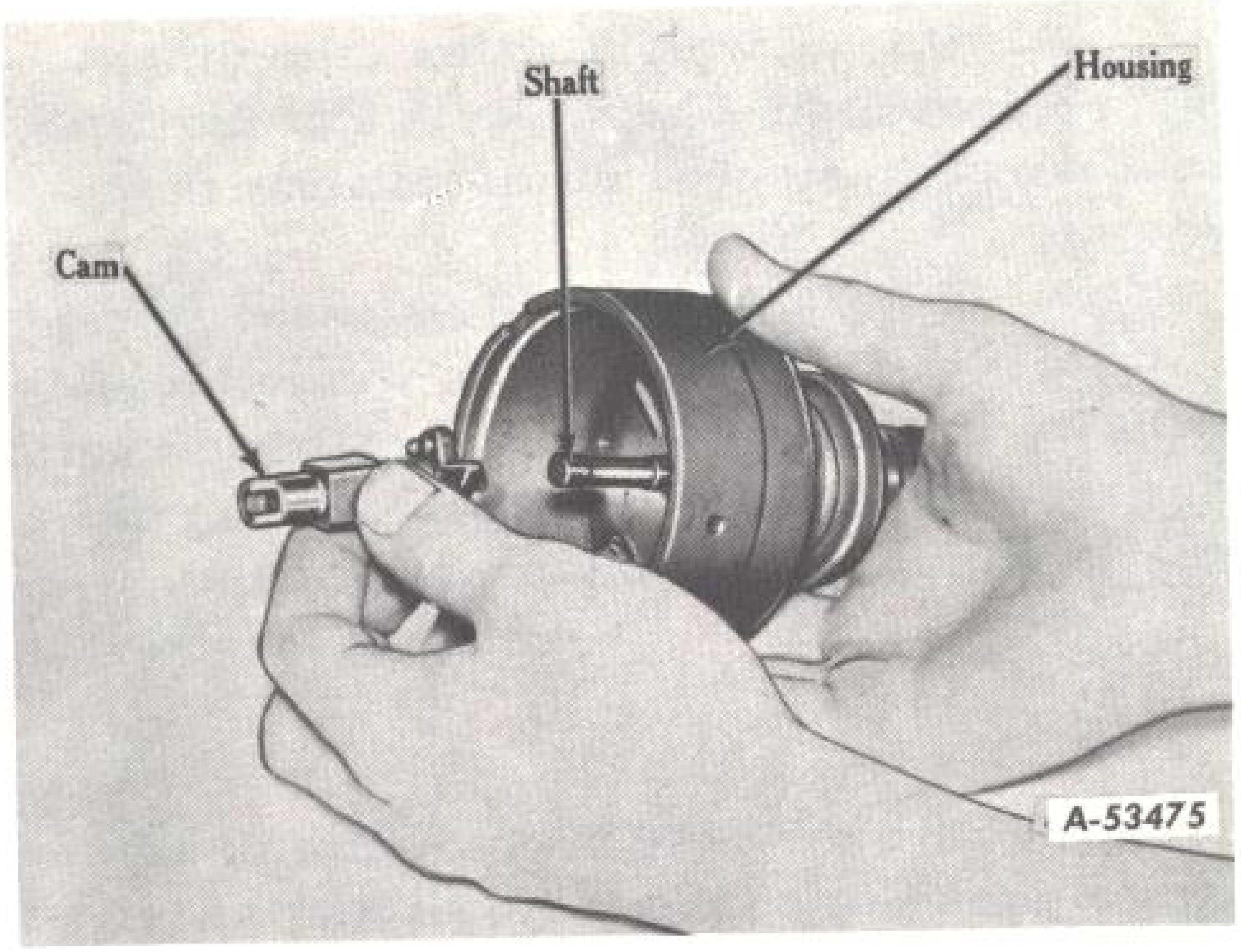


Illust. 81. Use feeler gauge to check end play of shaft.

Where a new shaft or a new drive gear or collar is being installed, the new parts must be drilled for the pin after assembly. Use a No. 30 (.1285) drill through collar (or gear) and shaft with parts assembled to result in .003 to .009 inch end play of shaft in housing. See Illust. 81.

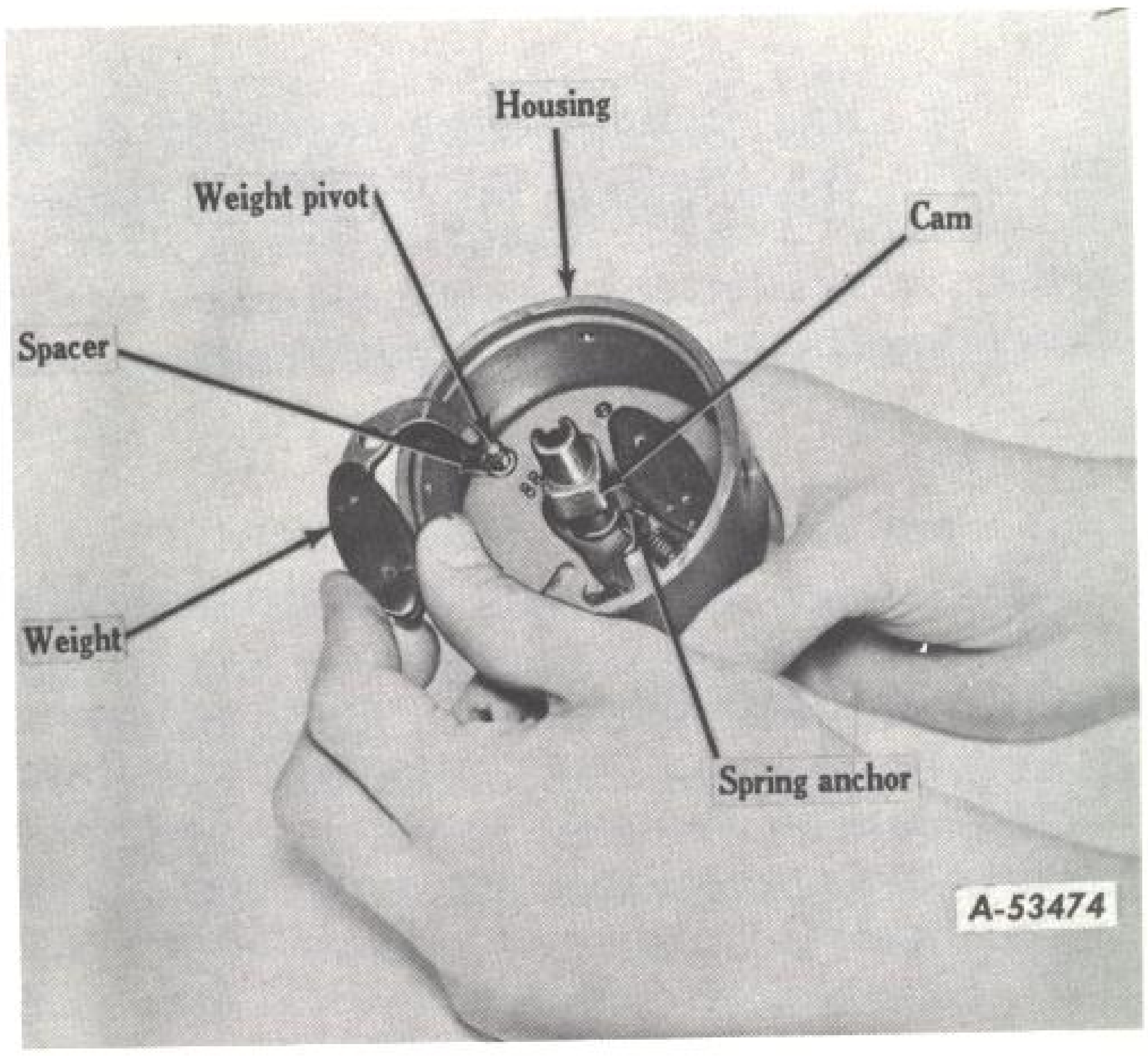
After determining that end play of shaft will be within the range of .003 to .009 inch rivet the ends of the pin to fill the hole.

Lubricate lightly and place the cam on the shaft, being sure the lug on the bottom



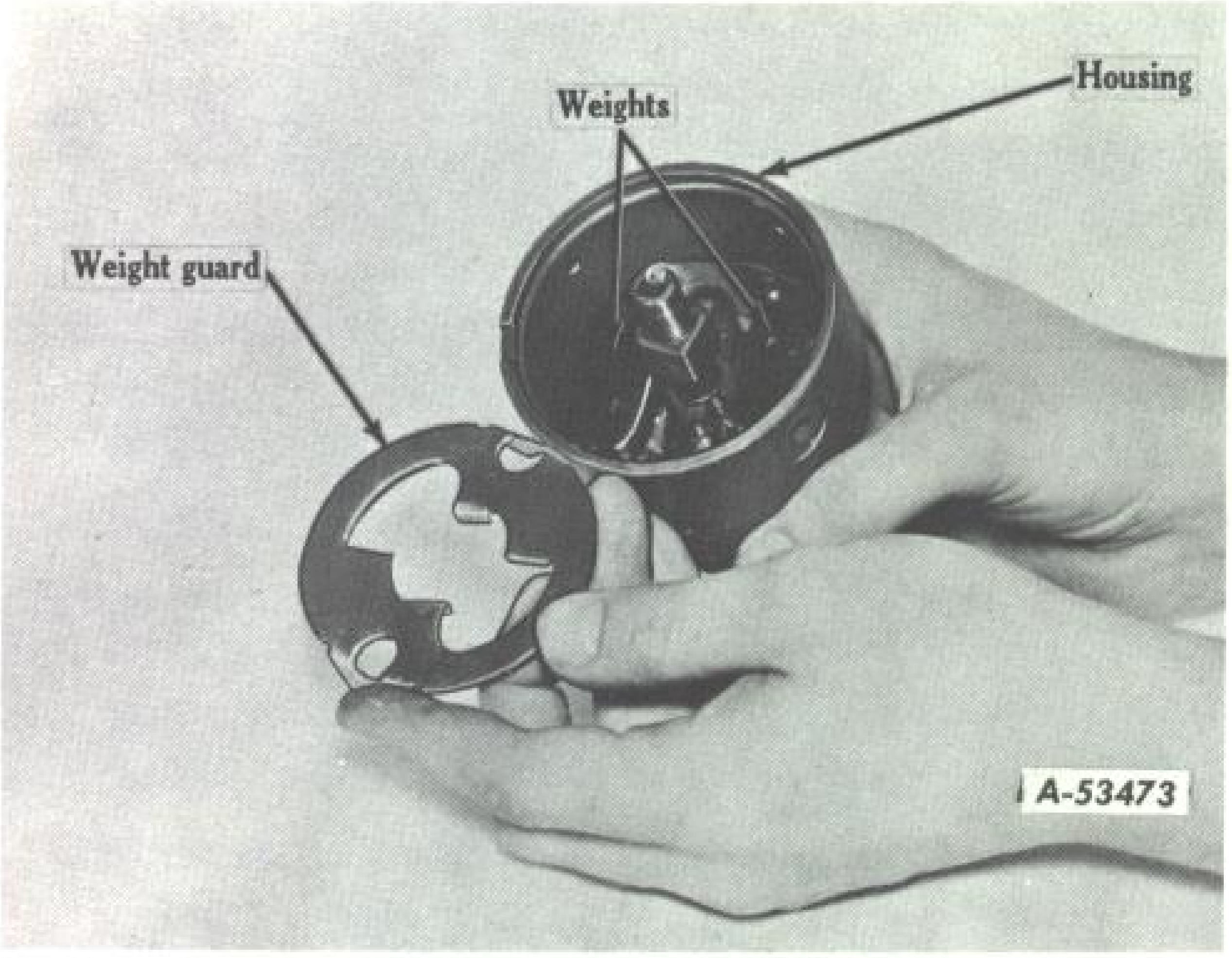
Illust. 82. Install cam on distributor shaft.

of the cam enters the slot in the governor base plate. See Illust. 82. Place felt oiler pad in the end of the cam.

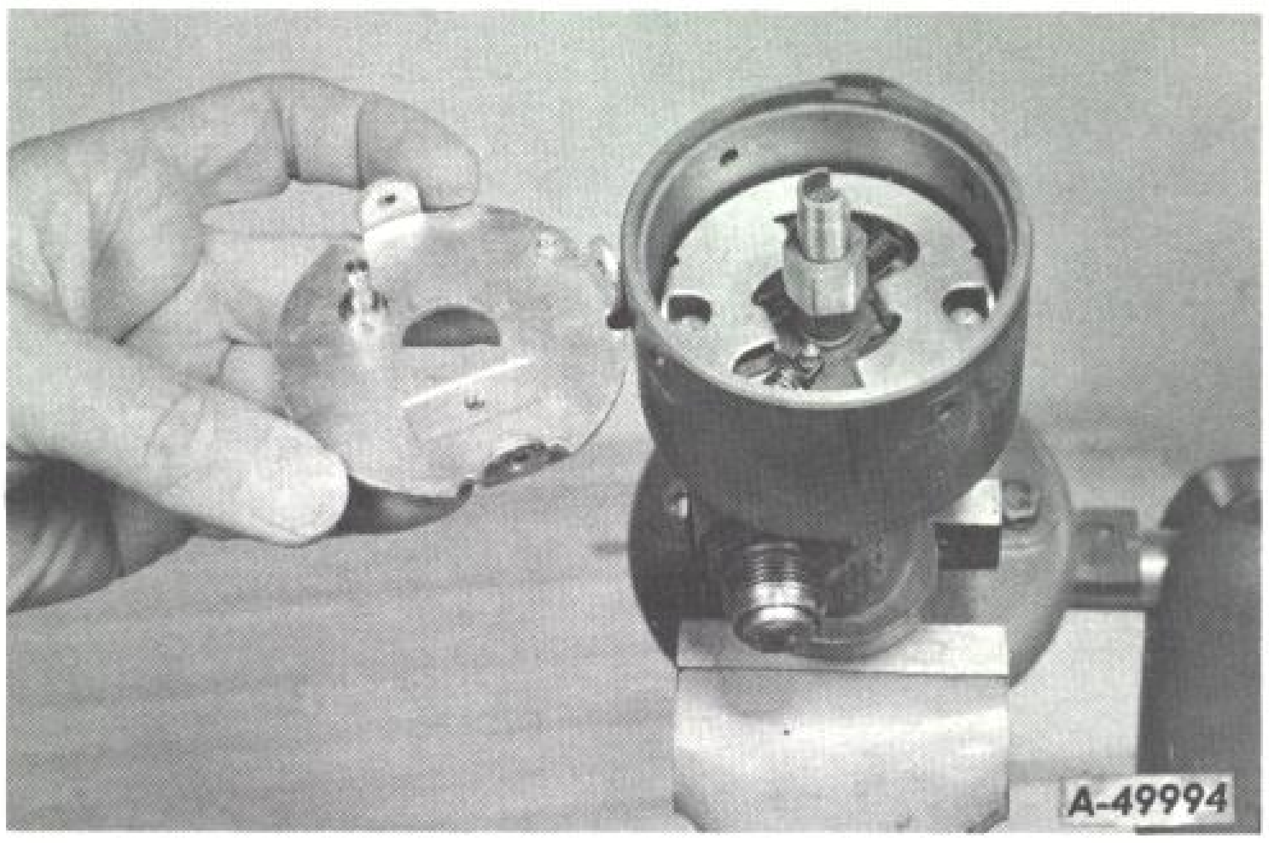


Illust. 83. Installing spacers, weights, and springs.

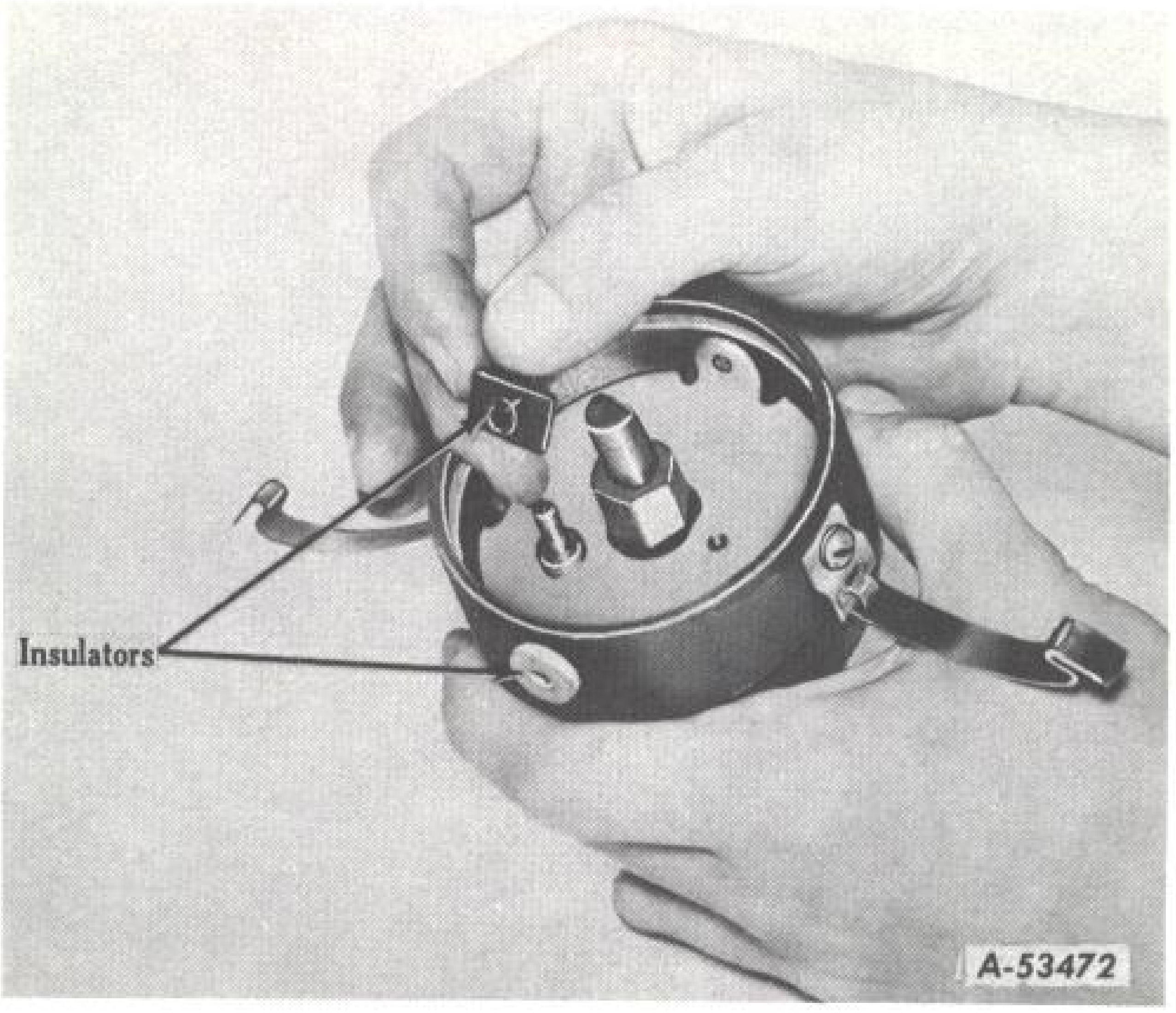
Place a governor weight spacer over each of the pivots. Install the weight arms on the pivots so that the body of the weight is nearest to the cam spring anchor. See Illust. 83. Lubricate lightly. Place a second spacer on each of the pivots and install the governor springs. In governor spring packages for many types of distributors, it will be noticed that dissimilar springs make up the set. These may be installed in the same manner as similar pairs, without regard to position in the assembly.



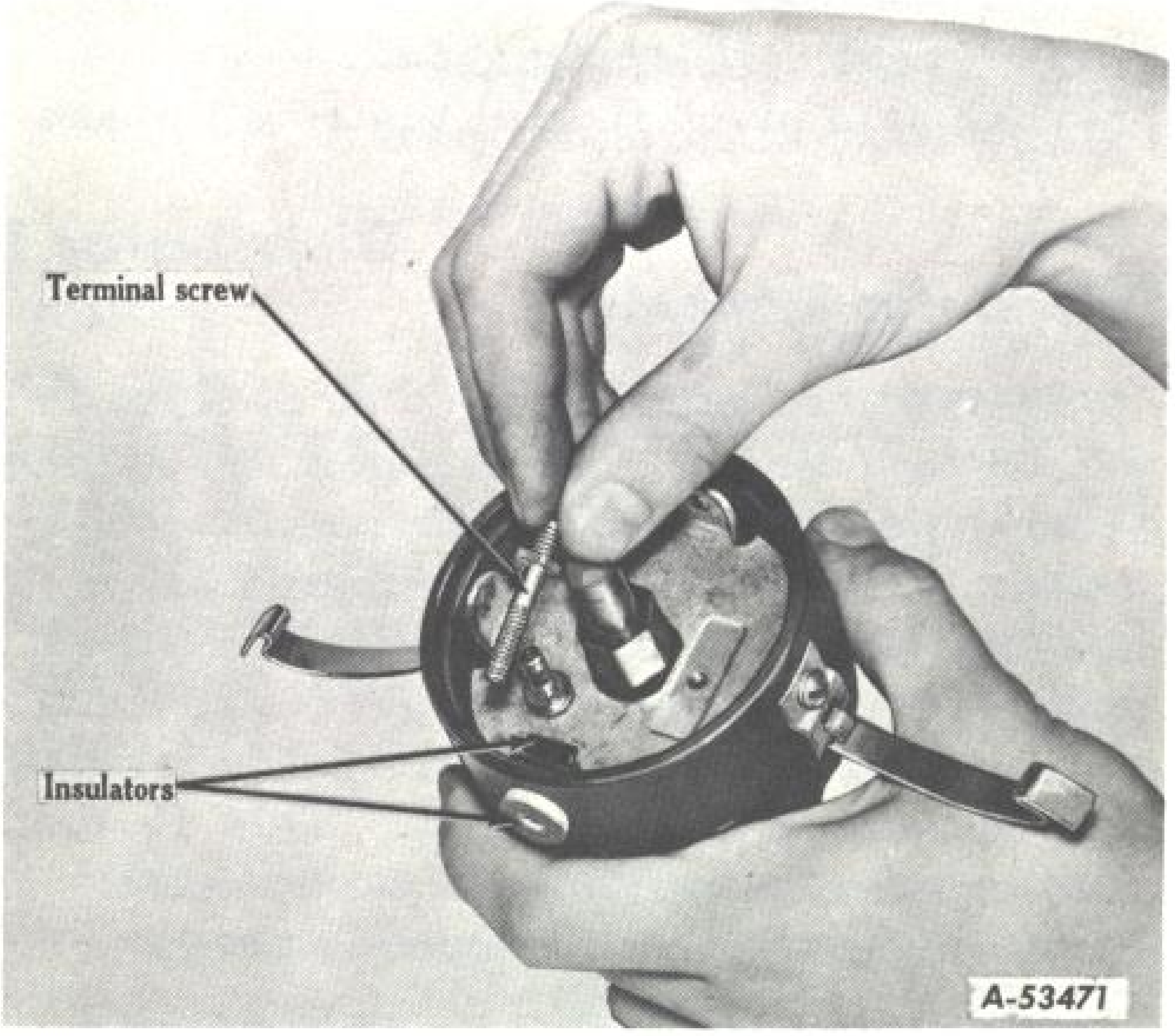
Illust. 84. Weight guard installation.



Illust. 85. Installation of breaker plate.



Illust. 86. Spring anchor and primary terminal insulators.

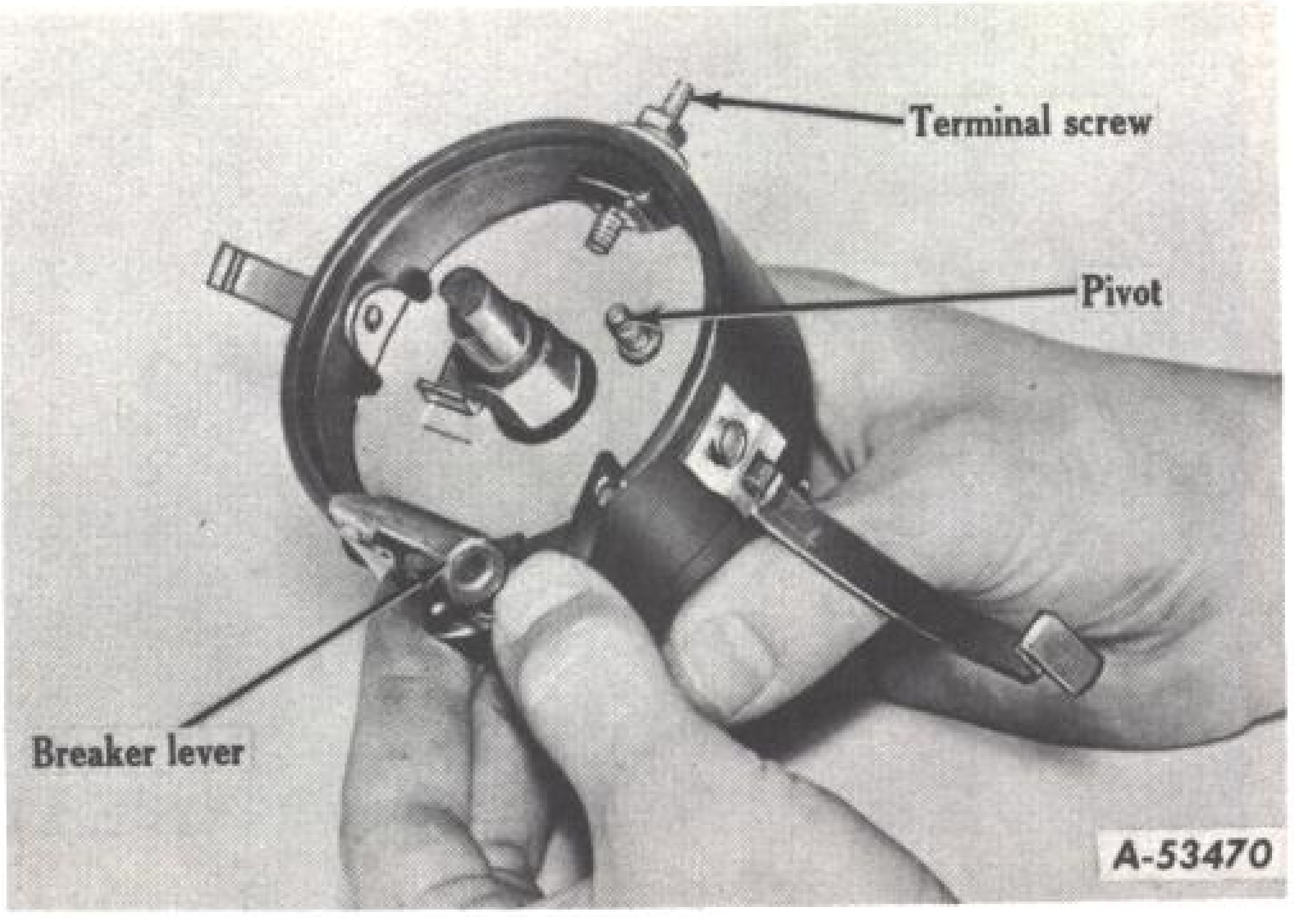


Illust. 87. Primary terminal screw inserted in insulators.

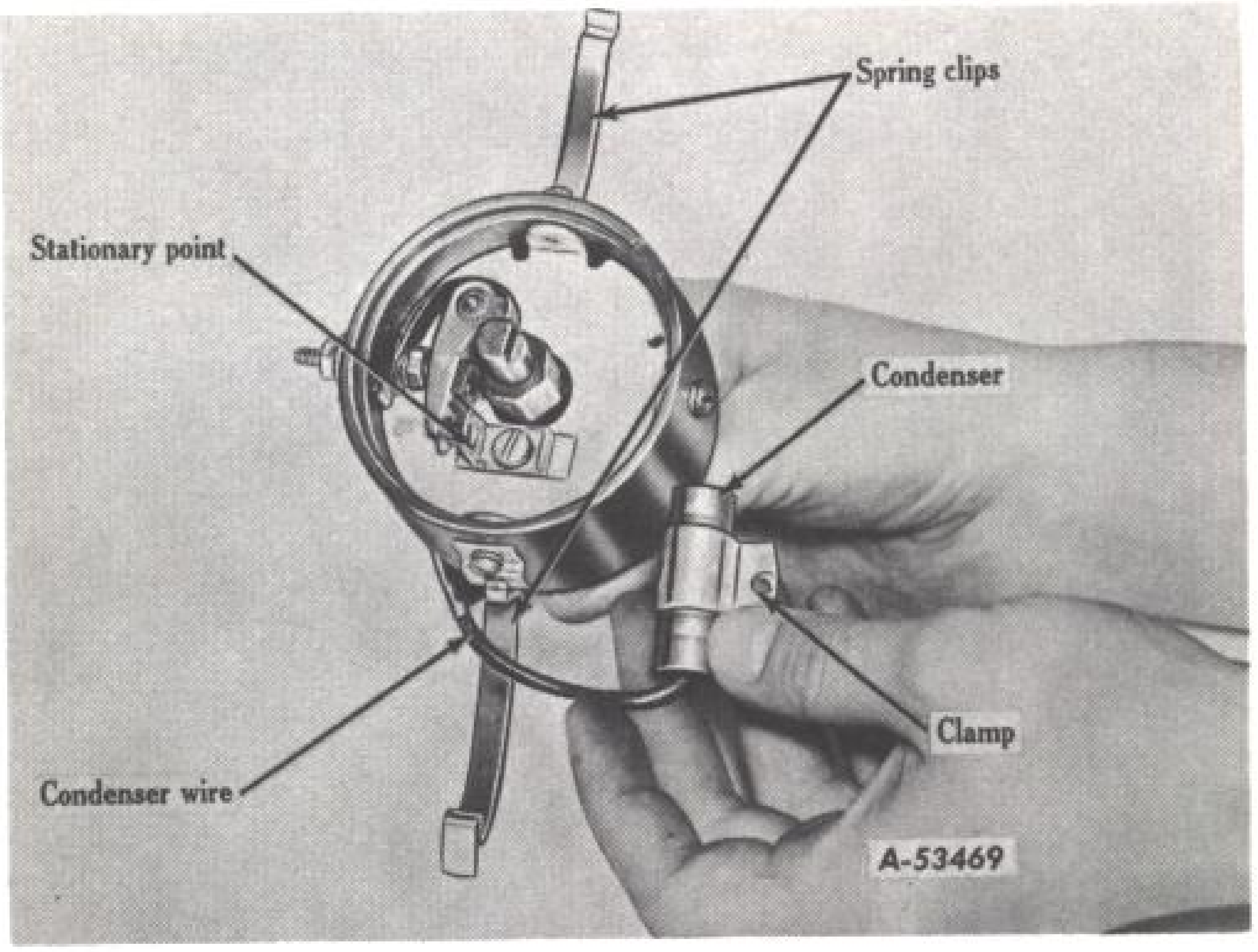
The weight guard is now installed with two slotted screws and lock washers. See Illust. 84. At this point in the assembly, test the advance mechanism for freeness of operation. Hold the shaft, and advance the cam fully. Upon release of the cam, the assembly should return to its stop by the pull of the governor springs. Make sure that the weight guard is not bent or damaged so that it will interfere with the free movement of parts.

The breaker plate is installed next. Slotted screws and lock washers retain the plate; two of them also retain the cap spring supports. See Illust. 85. Enter all three loosely to align the plate; then tighten evenly.

The spring anchor insulator is placed in the housing with the inner ledge up. The terminal and its insulator are next. Note that the square shoulder on the terminal screw fits into the square socket of the spring anchor. Fasten the terminal screw with plain washer, lock washer, and hex nut. See Illusts. 86 and 87.



Illust. 88. Install breaker point set.



Illust. 89. Install condenser.

Apply a small amount of IH magneto grease, part number 21 372-D, to the breaker arm pivot and fill the small space between the breaker arm rubbing block and spring with this grease. The IH magneto grease will withstand high temperature without melting and spreading to foul points.

Install stationary point and breaker arm. Adjust the breaker point gap to specified .020 inch. Check the gap with each cam lobe in turn to be sure the opening is uniform within range of .019 to .023 inch. See Illust. 88. Install condenser and tighten nut on primary screw retaining breaker spring and condenser lead terminal. See Illust. 89.

Then the breaker arm spring tension can be checked. Attach the hook of a spring scale to the breaker arm at the center line of the contact point. Read the ounces of pull required when the points just open. See Specifications.

The housing cover and its gasket and felt seal are next in assembly, followed by the rotor and cap. These parts should be examined for breakage or carbonized leakage paths between terminals or between ground and terminals. Also see that the cable sockets in the cap are free from corrosion that could be caused from arc when cables are not fully seated in their sockets.

When assembling spark plug and coil cables, use new cable nipples to insure operation in damp weather. Cables must be fully seated in their sockets to prevent corrosion.

Distributor Drives and Timing

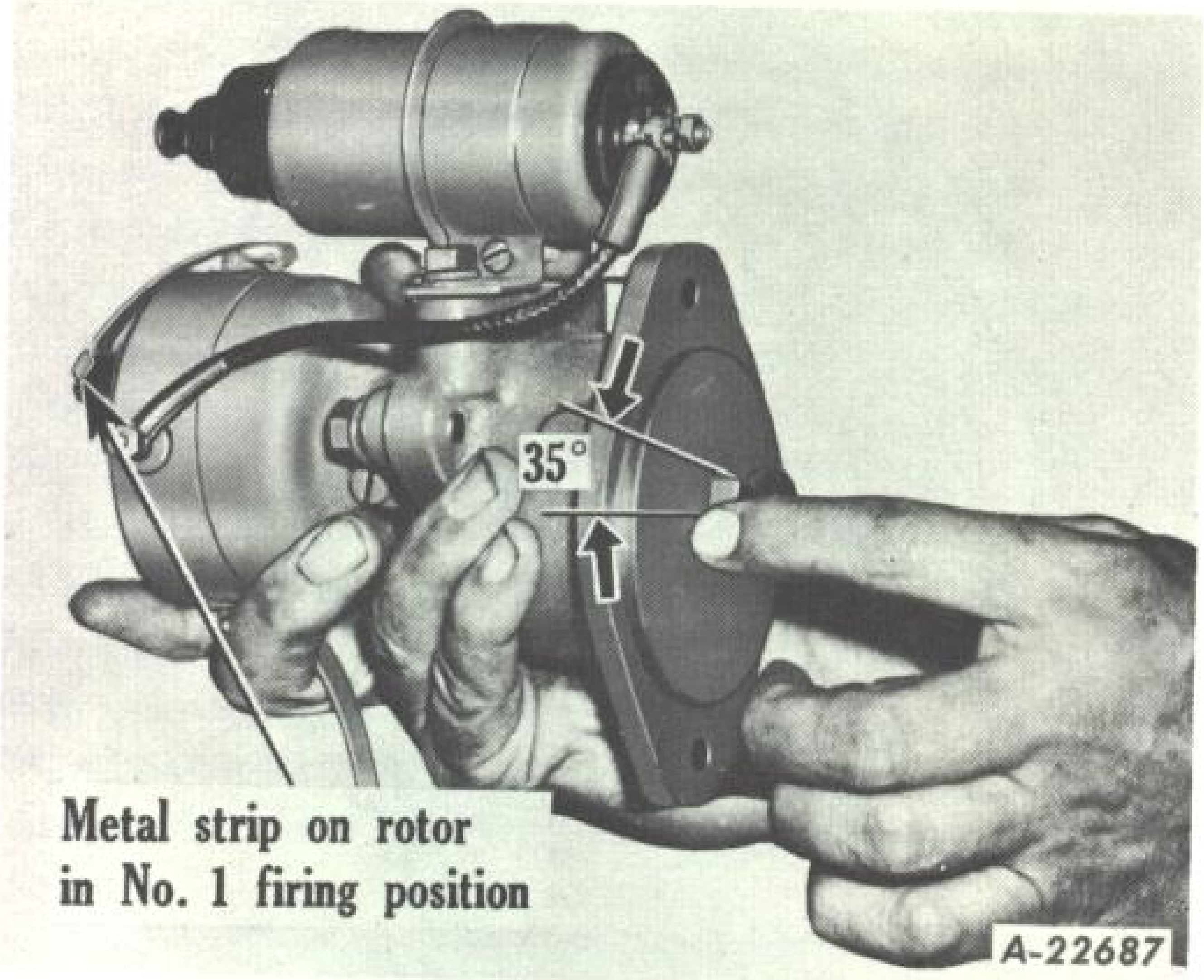
Distributor Symbols

Distributor symbols such as S, X, and AB, on the four cylinder engines, are driven from the engine timing gear train through a gear reduction in the distributor drive housing. The 16-tooth drive gear meshes with a 32-tooth distributor gear, resulting in the necessary distributor rpm being half that of the engine crankshaft. This 16-tooth drive gear also meshes the tachometer drive, where this attachment is used.

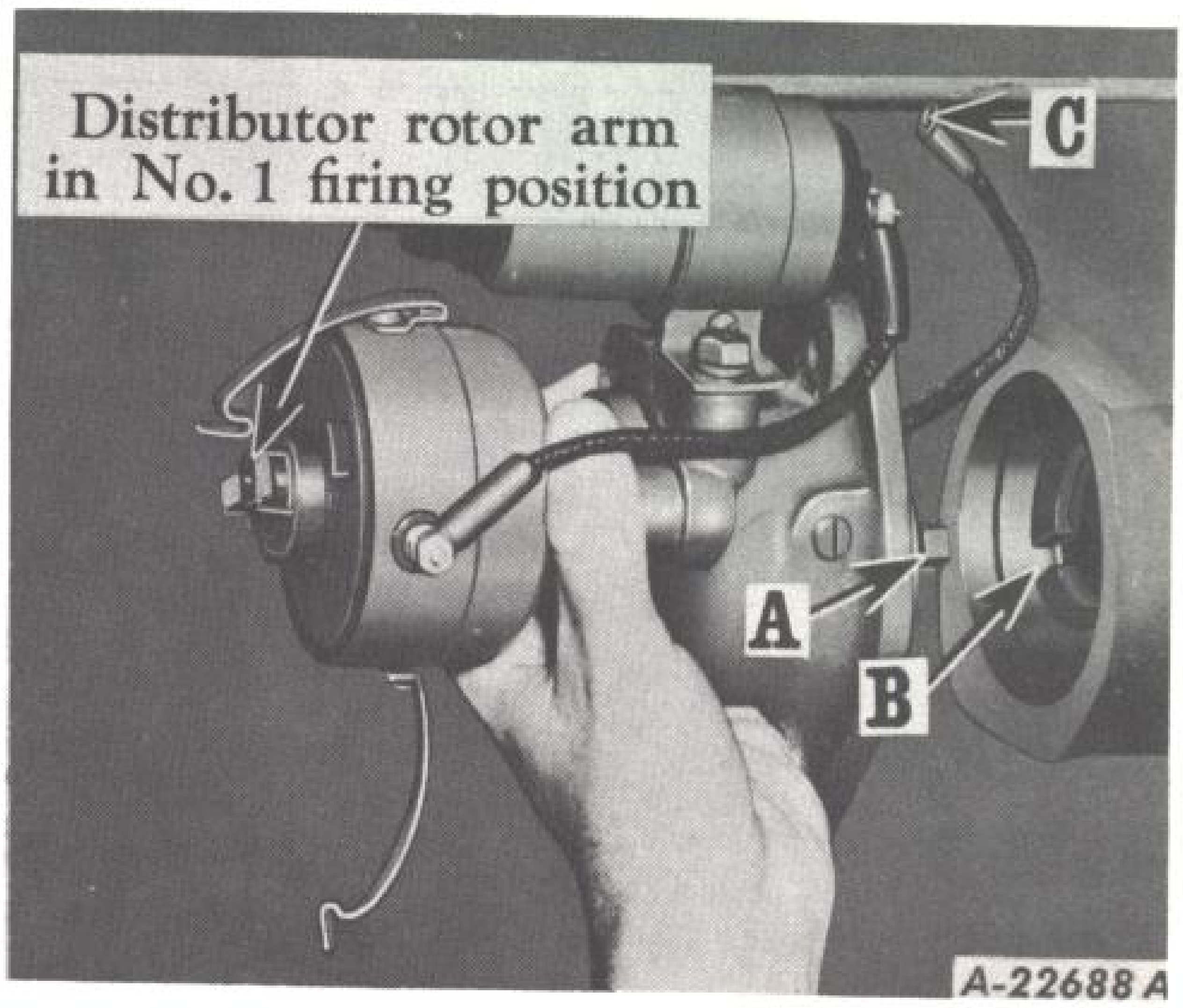
The distributor drive housing is lubricated with chassis lubricant (pressure gun grease). Failure of the operator to lubricate properly may result in excessive wear of the drive and components. If the bushing and driveshaft are badly worn, the driveshaft and housing (complete with bushing) must be replaced to maintain proper alignment and bearing area.

Horizontally Mounted Distributors

To reassemble the distributor and its drive housing, mount the distributor with its primary terminal in about the position shown in Illust. 90. Use a new gasket be-



Illust. 90. Positioning distributor rotor and driveshaft lugs for mounting unit to engine (horizontally mounted).



Illust. 91. Assembling ignition unit to engine.

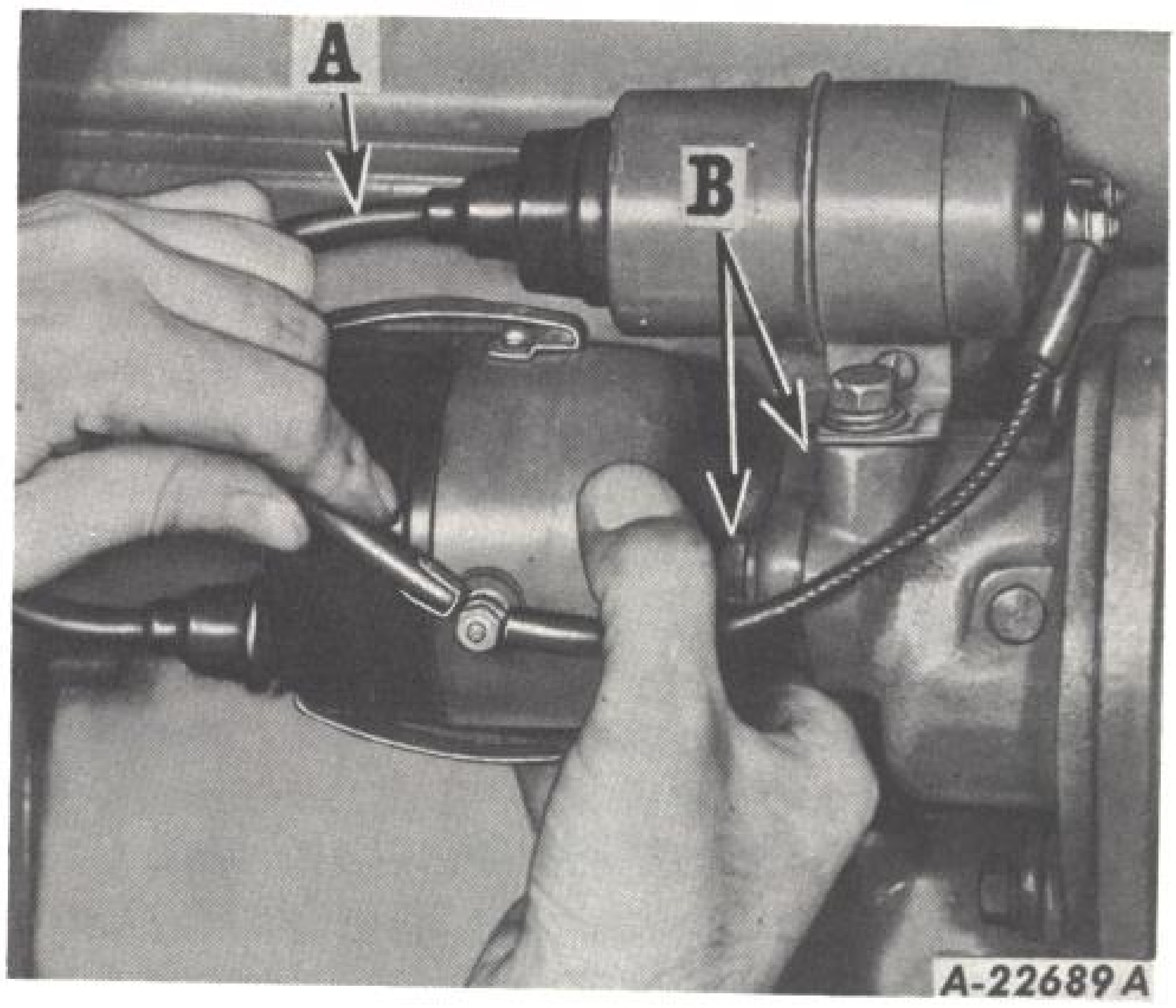
tween the housing and the distributor, and assemble the two clamps, capscrews, and lock washers that retain the distributor.

Turn the driveshaft clockwise until the rotor arm is approximately in No. 1 firing position (number one plug socket in cap). Continue to turn slowly and lightly until a slight resistance is felt as the cam contacts the breaker arm. With the distributor in this position, pull out the driveshaft and replace it so that its lugs are approximately 35 degrees past horizontal as shown in Illust. 90.

With the ignition unit in the position just described in the engine positioned at top dead center with number one piston up to fire, the driveshaft lugs "A" should enter the drive slots "B", requiring only slight movement for alignment as shown in Illust. 91. Use a new gasket between the housing and the engine. Assemble clamp, capscrews, and lock washers. Tighten evenly to secure unit to engine.

Connect cable "C" from ignition switch to negative (-) terminal of ignition coil. Primary wire from distributor is connected to positive (+) terminal of ignition coil.

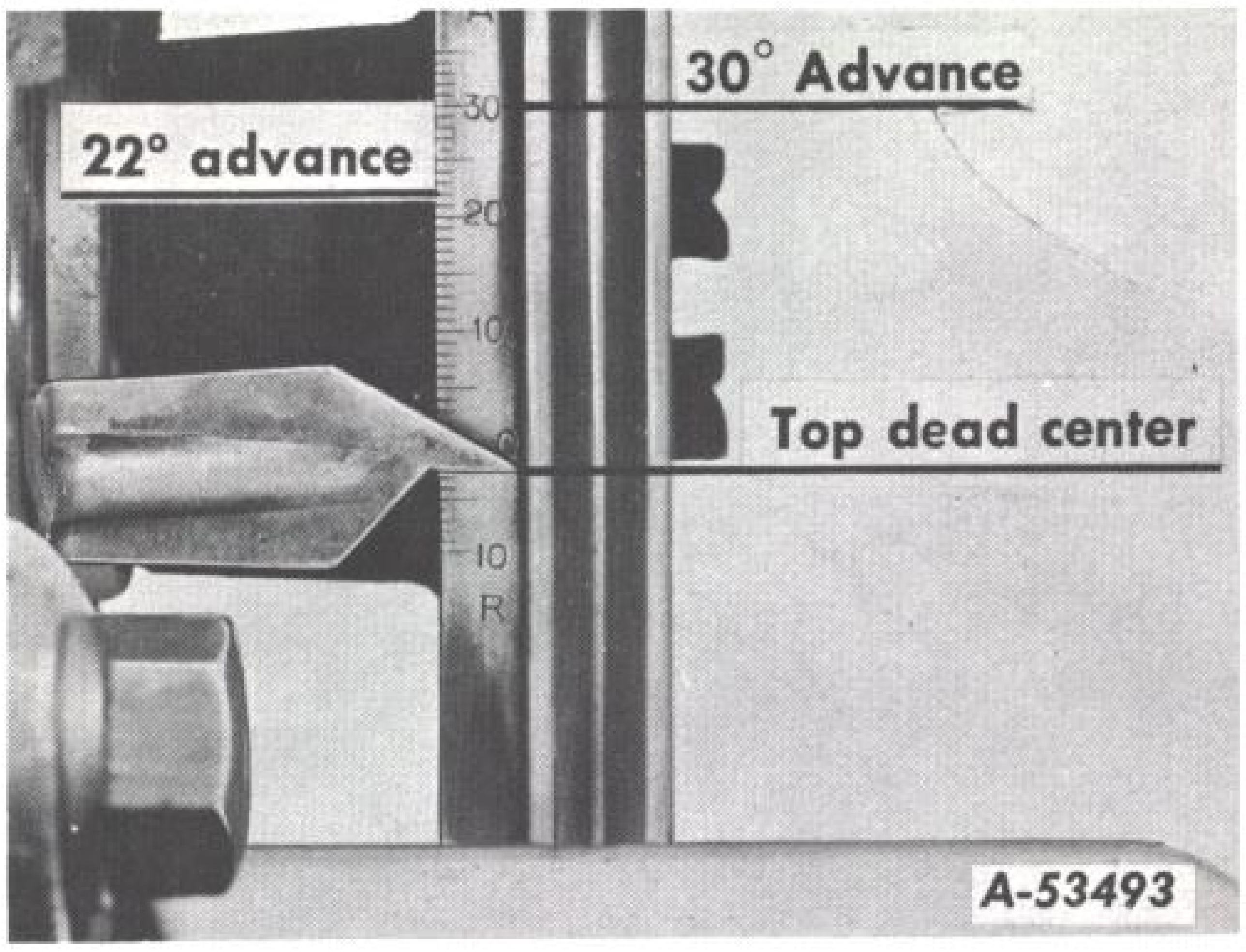
With the engine and distributor positioned as outlined above, initial timing may be set as follows: Loosen distributor clamp bolts "B", Illust. 92, so that the distributor may be advanced or retarded as required.



Illust. 92. Advancing the distributor while holding the secondary cable from coil 1/16 to 1/8 inch from the primary terminal.

Turn the ignition switch key clockwise (to the right) and note whether the charge indicator shows discharge. If it does, the points are closed, and retarding the distributor is not necessary. If the charge indicator does not show discharge, retard the distributor by turning the body about 30 degrees. (Turn top away from engine.)

Hold the free end of the secondary cable "A" within 1/16 to 1/8 inch from the distributor primary terminal, Illust. 92. Advance the distributor by turning the body slowly toward the engine until a spark occurs.



Illust. 93. Timing pointer and timing marks on the fan drive pulley, pointer in line with the O or DC mark.

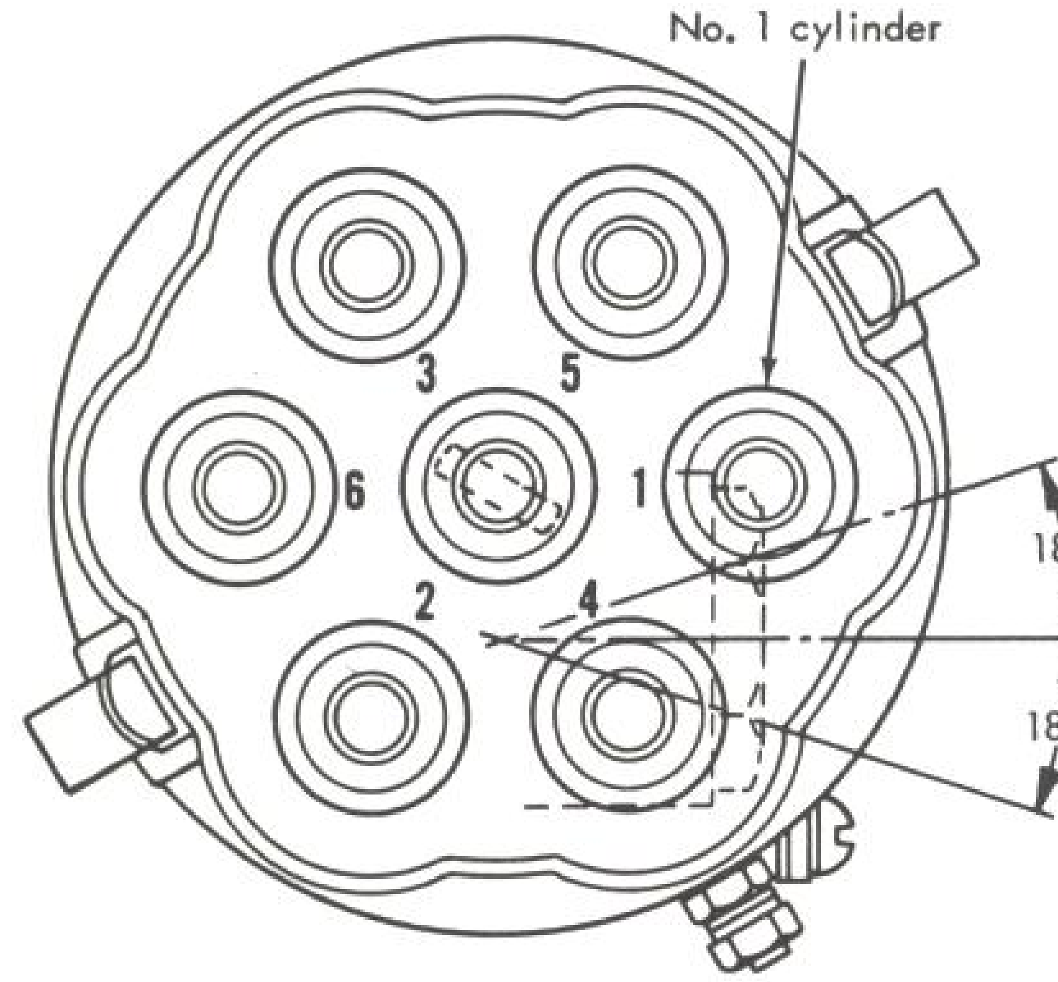
Make a final check by taping the secondary cable "A" to retain the 1/16 to 1/8 inch gap at the primary terminal. Crank the engine slowly by hand until the DC mark on the fan drive pulley is in line with the pointer (Illusts. 93 and 96) and continuing until the spark just occurs at the gap between the secondary cable and the primary terminal. The DC mark should be in line or slighly past the pointer at the instant the spark occurs. If necessary, make the required adjustment to have spark occur as specified. Retighten distributor clamp bolts. See "B", Illust. 92.

The power timing light, as explained earlier, may be used as an accurate and fast check of ignition timing. It also will check the rate of automatic spark advance when used with an accurate tachometer for comparing the actual advance at the given engine rpm as shown in the specification chart.

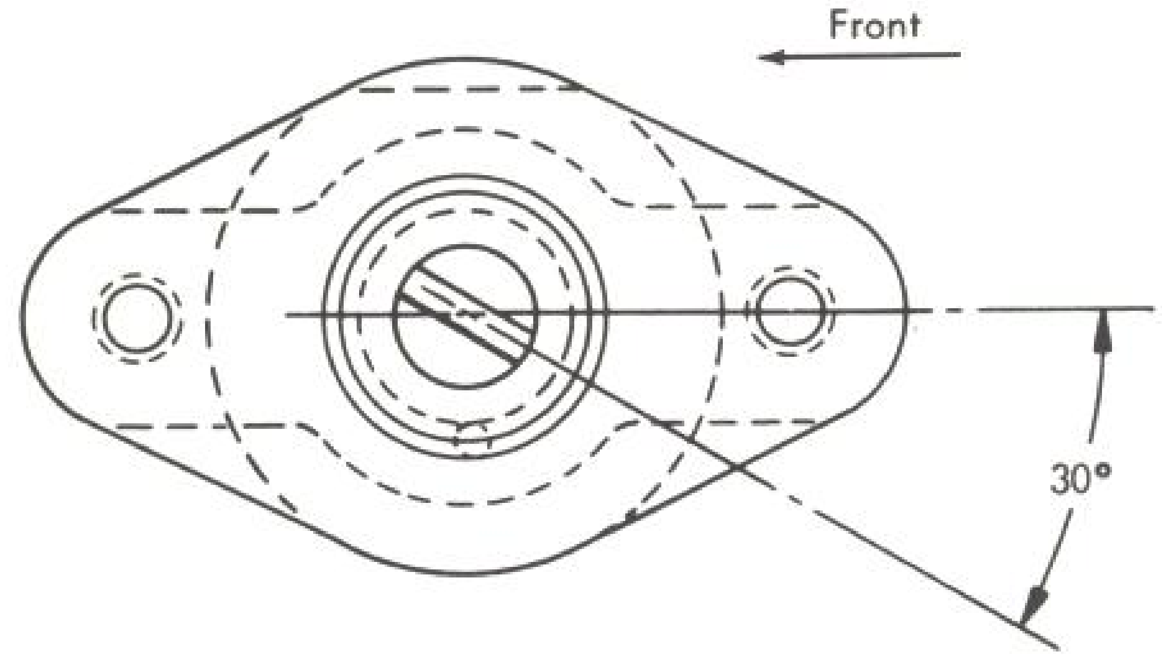
Vertically Mounted Distributors

Distributors on six-cylinder engines, are driven directly from the engine oil pump shaft, resulting in the necessary distributor rpm of half that of the engine crankshaft speed.

When it becomes necessary to replace the distributor mounting adapter, the old adapter may be driven out of the crankcase



With oil pump and distributor timed to the engine, the tachometer drive must be aligned as shown.



Set engine on firing position of No. 1 cylinder, mesh oil pump gear so that tang of pump shaft is as shown.

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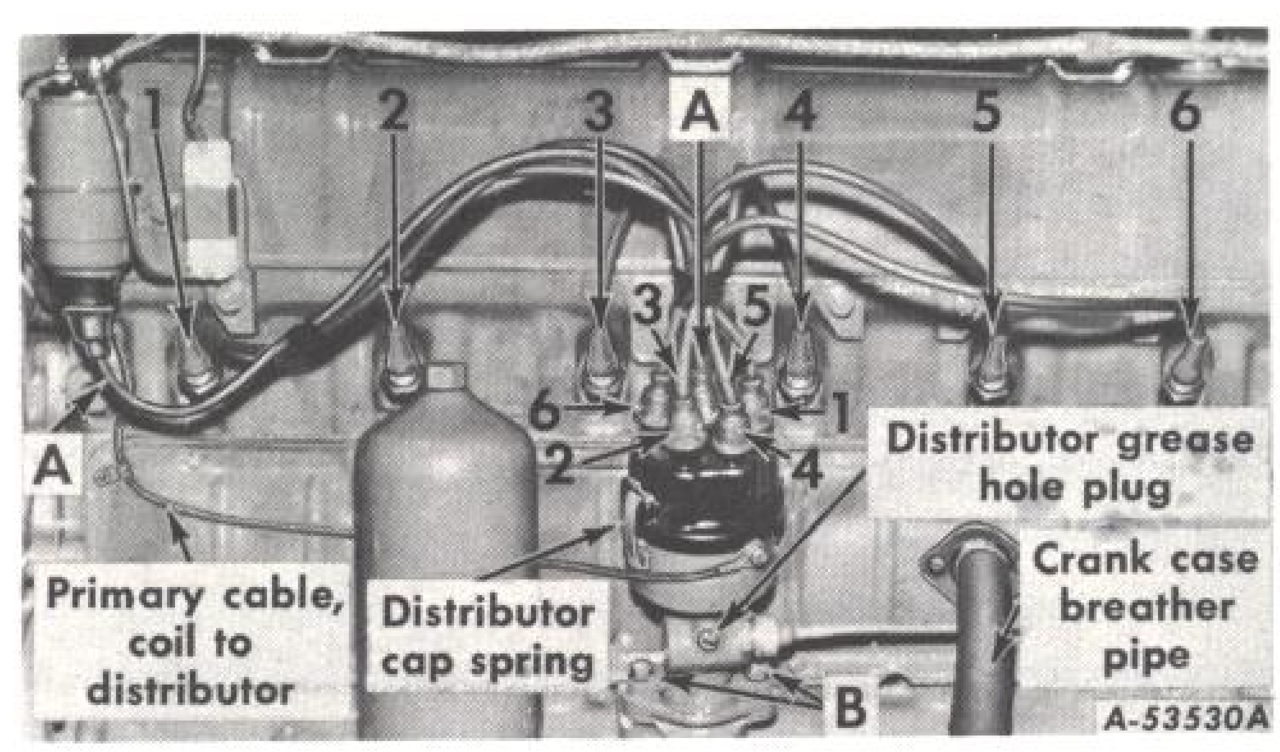
Illust. 94. Positioning of oil pump shaft, the distributor, and its mounting adapter, for installing distributor on the engine (vertically mounted).



Illust. 95. Spark plug wiring; firing order 1,5,3,6,2,4.

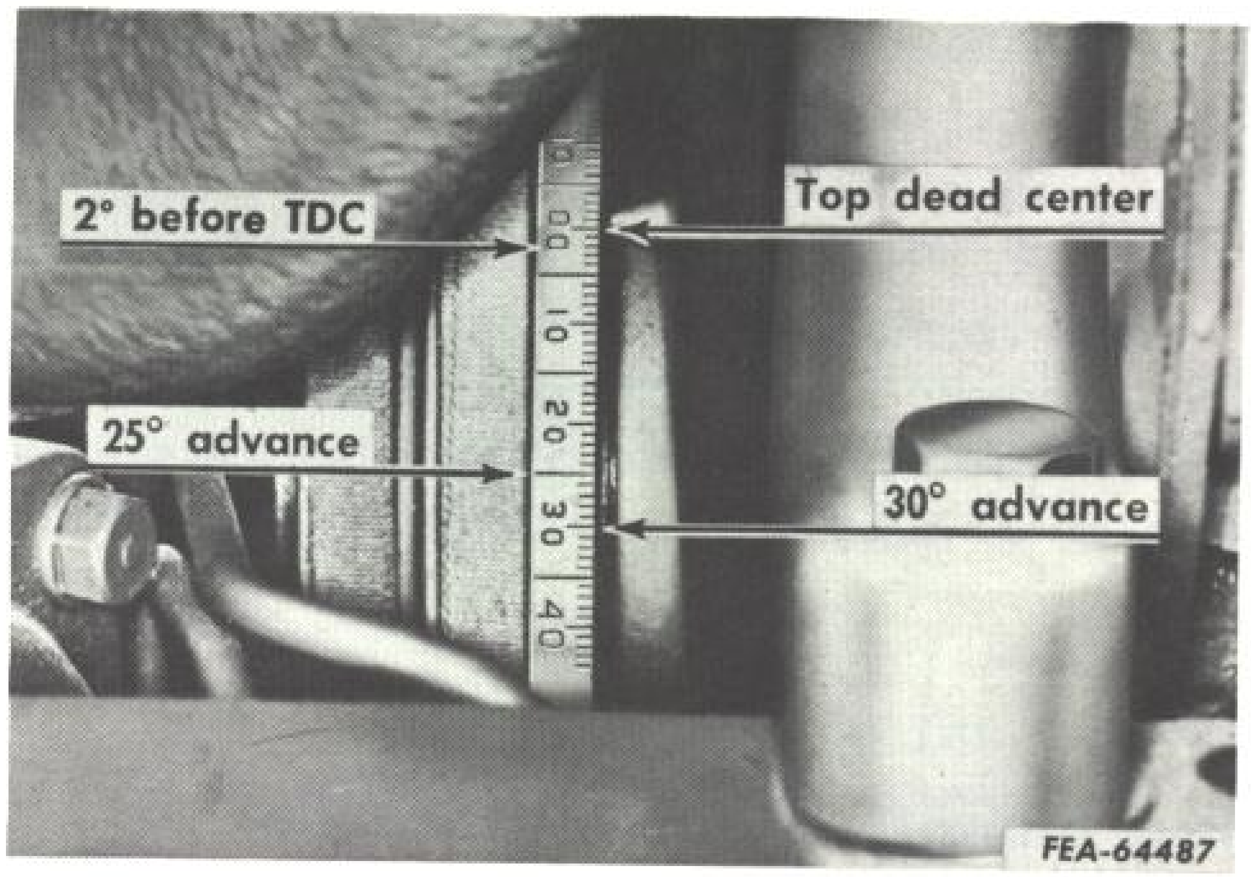
and a new adapter pressed in its place. Align the new adapter so that the center line of the bore and the two bolt holes is parallel to the side of the crankcase. See Illust. 94.

To install the distributor on the engine, first, place the engine on firing position of No. 1 cylinder. If necessary remesh engine oil pump gear with camshaft so that the tang of the pumpshaft is as shown in Illust. 94. Turn the distributor shaft collar clockwise (to the right) until the rotor arm approaches No. 1 spark plug socket in cap. Continue to turn slowly and lightly until a slight resistance is felt as the cam contacts the breaker arm. With the distributor in this position, install the distributor (with new mounting gasket) in the engine so that the center line of Nos. 1 and 6 sockets in cap is parallel to the side of the crankcase.

The tang of the oil pump shaft should enter the slot in the distributor shaft, requiring only a slight movement of the distributor for alignment.

Assemble distributor retainer clamps, bolts, and locks "B" (see Illust. 95), but do not tighten until the final timing adjustment is completed. Assemble spark plug cables with new nipples as shown in Illust. 95. Be sure cables are fully seated in their sockets to prevent arcing and corrosion. The primary wire from the negative (-) terminal of the ignition coil is connected to distributor primary screw. The positive (+) coil terminal is connected to coil resistor and to lead from "R" terminal of cranking motor solenoid. With the engine and distributor positioned as outlined above, initial timing may be set as follows:

Turn the ignition switch key clockwise (to the right) and note whether the charge indicator shows discharge. If it does, the points are closed, and retarding the distributor is not necessary. If the charge indicator does not show discharge, retard the distributor by turning the body about 30 degrees counterclockwise.



Illust. 96. Timing marks on fan drive pulley with 1 degree retard mark in line with pointer.

Hold the plug end of the No. 1 spark plug cable within 1/16 inch to 1/8 inch from the crankcase, and advance the distributor by turning the body slowly clockwise until a spark occurs.

Make a final check by cranking the engine until No. 1 piston is again coming up on compression stroke. Hold this plug end of No. 1 spark plug cable within 1/16 to 1/8 inch from the crankcase, and continue cranking very slowly until a spark occurs. At this moment the pointer should be opposite the 1 degree retard mark on the fan drive pulley. See Illust. 96. If necessary, make the required adjustment to have the spark occur as specified. Tighten the distributor mounting bolts evenly.

The power timing light may be used as an accurate and fast check of ignition timing. It also will check the rate of automatic spark advance when used with an accurate tachometer for comparing the actual advance at the given engine rpm as shown in the specification chart.

LIGHTING AND ACCESSORY SYSTEM

Lights

A systematic check of the lighting system will reveal any problems. Check for a blown fuse, burned out filaments, broken or frayed wires or damaged switch.

Fuel Shutoff Solenoid (Gasoline)

When the shutoff solenoid is suspected, listen for the operation click. If no click, check for an open circuit or faulty solenoid.

Cigarette Lighter

When the cigarette lighter fails to operate, check for an open circuit or burned out element.

Fuel Gauge

If the fuel gauge reads empty at all times, check for an open circuit, defective sending or receiving unit or mechanical failure of the float linkage.

If the fuel gauge reads full at all times, check for an open or grounded circuit, defective units or mechanical failure of the float linkage.

Electric Fuel Pump

When the operation of the electric fuel pump is questioned, connect a voltmeter from the pump electrical terminal to ground. With the switch on, you should note a voltage reading. If no reading is noted, check for an open circuit up to the pump. If a reading is noted and the pump doesn't operate, check for electrical or mechanical failure inside the pump.

Glow Plugs

Parallel Wired Glow Plugs

If a parallel wired glow plug is suspected, check the glow plugs by removing all the spade connections at the glow plugs. Do not allow the cables to be grounded on the tractor. Illust. 97.

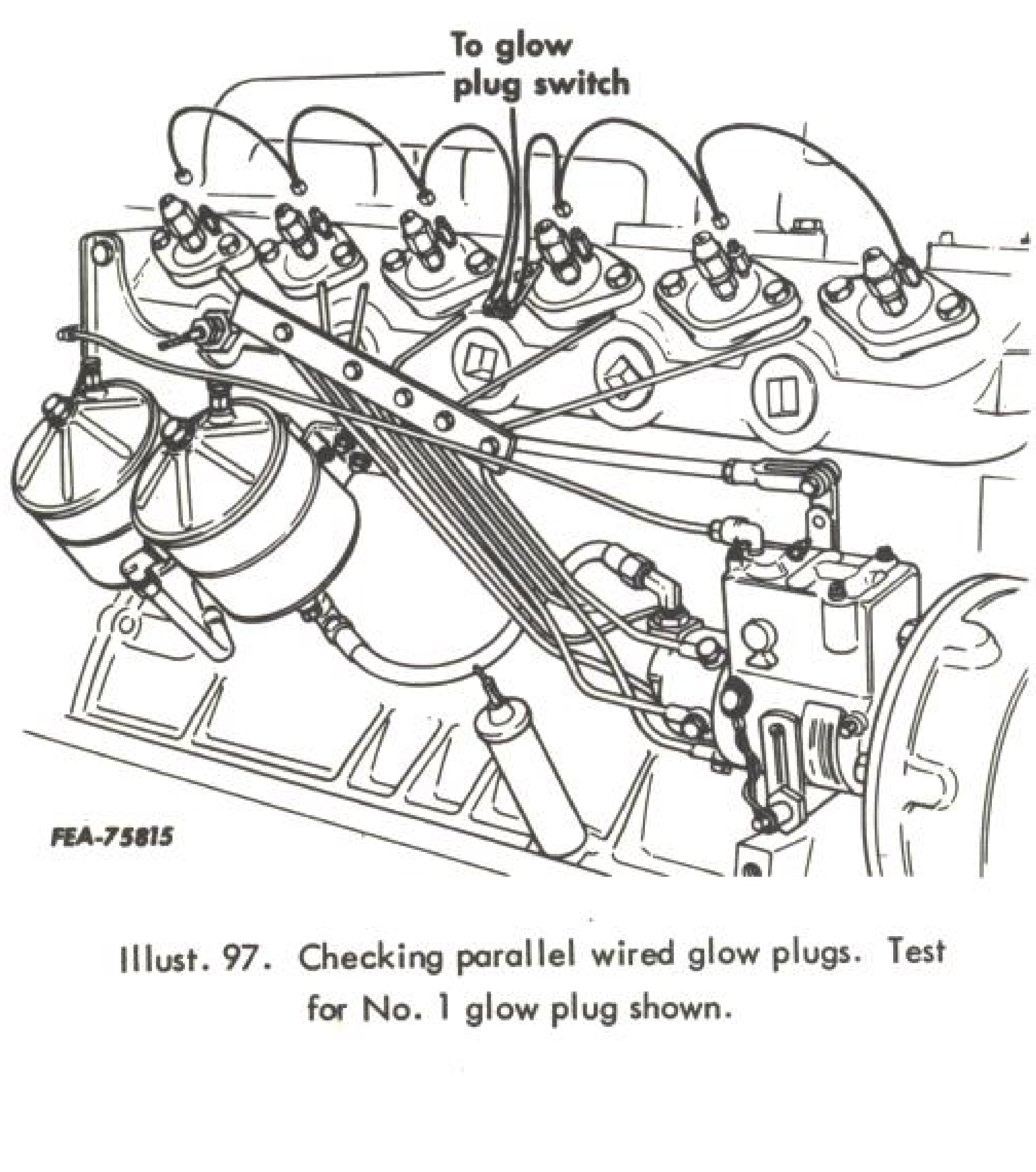
Connect one glow plug at a time and push the glow plug switch button.

Disconnect the spade lug connection and repeat this procedure for all the glow plugs, one at a time.

NOTE: With a comparative reading between all the glow plugs, an extremely low or extremely high deflection denotes a faulty glow plug.

If no meter deflection is observed on a plug, that plug is faulty and should be replaced.

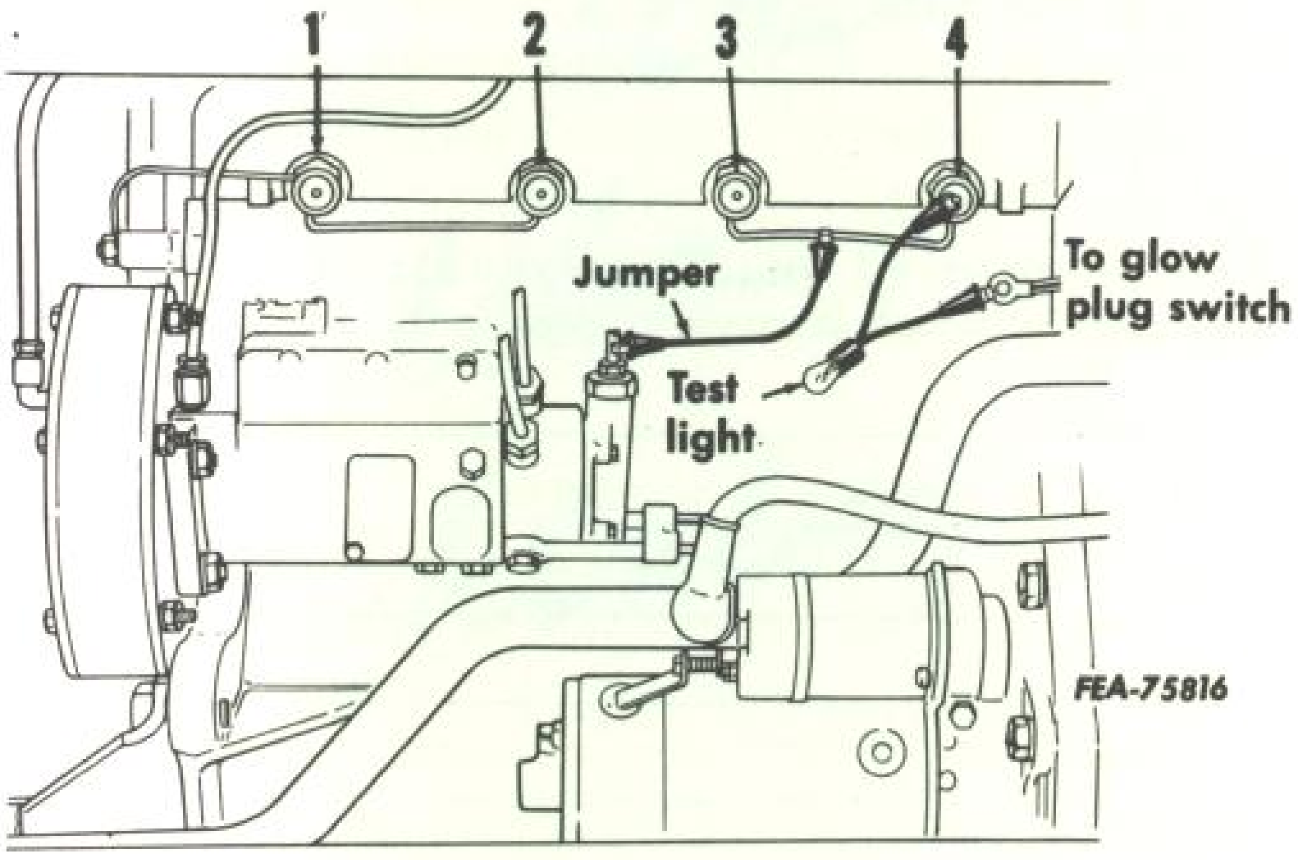
If no meter deflection is observed on all plugs, check for an open circuit due to faulty wiring, gauge or switch or all plugs open circuited due to excessive voltage impressed on the circuit.



Illust. 97. Checking parallel wired glow plugs. Test for No. 1 glow plug shown.

Series Wired Glow Plugs

Glow plugs wired in series will not function if a single glow plug, the indicator resistor, the switch or a wire is open circuited. Failure of the indicator to glow indicates a failure in one or more of the units.



Illust. 98. Checking series wired glow plugs. Test for No. 4 glow plug shown.

Check the glow plugs and indicator as follows: (Refer to Illust. 98.)

Remove the center copper bar connecting glow plugs No. 2 and 3. Remove the wire from the glow plug switch to glow plug No. 4 at the glow plug. Replace and tighten the nuts.

Connect a test light (made up of a 12-volt bulb, socket and two leads) from the wire disconnected from No. 4 glow plug to a good ground.

NOTE: Be sure when making contacts that the copper bars and surfaces used as grounds are scraped clean.

Turn on the ignition switch and depress the glow plug switch. If the test light bulb glows, the wires, switch and indicator are satisfactory. If the light does not glow, there is an open circuit due to a broken wire or a defective switch or indicator. Replace any faulty units before checking the glow plugs further.

Connect a jumper wire from the copper bar between No. 3 and 4 glow plugs to ground.

Connect the test light between the wire disconnected from No. 4 glow plug and No. 4 glow plug. Depress the glow plug switch. If the test bulb glows, this glow plug is functioning. If the bulb does not glow, the plug is faulty.

Move the test light cable from No. 4 glow plug to No. 3. Depress the glow plug switch again to test the glow plug.

Move the jumper wire from the copper bar between No. 3 and 4 glow plugs to the copper bar between No. 1 and 2 glow plugs.

Move the test light lead from No. 3 to No. 2 glow plug and depress the glow plug switch to test the glow plug.

Move the test light lead to the copper bar between No. 1 and 2 glow plugs and remove the jumper wire to ground. Depress the glow plug switch to test No. 1 glow plug.

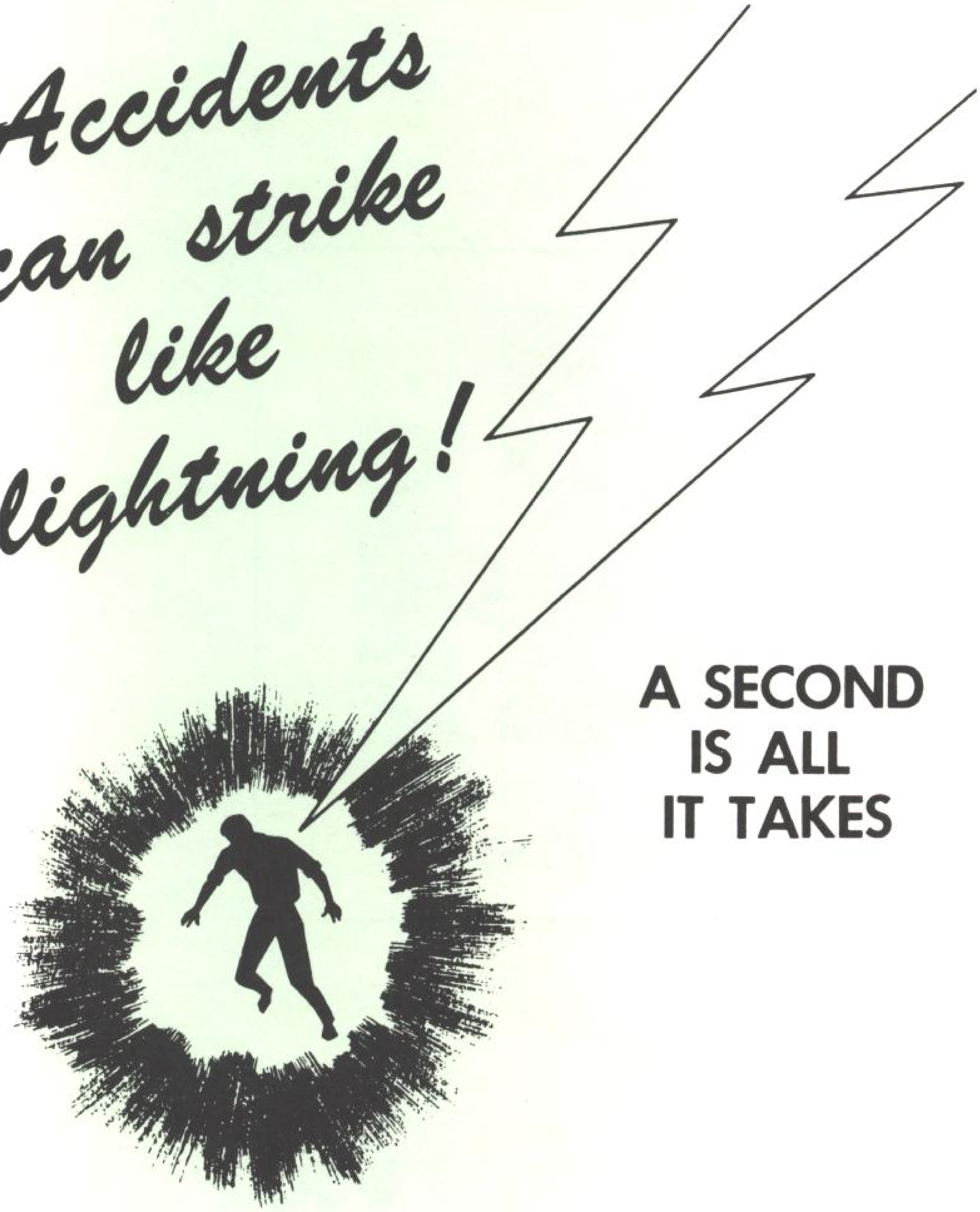
If the test light bulb fails to glow during any of these tests, that glow plug is open circuited and should be replaced.

SERVICE BULLETIN RECORD

Important: Information in this manual section is subject to change or supplementing from time to time as a result of field experience and engineering modifications. As Service Bulletins are received, record them on this page for handy reference whenever this manual is to be used.

Bulletin No.	Date Issued	Book No.	Topic or part of machine involved.

Accidents can strike like lightning!



A SECOND IS ALL IT TAKES

BE CAREFUL at all times, or YOU may be next!

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