Delco-Remy
ANDERSON, INDIANA, U.S.A.

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MOTOR-GENERATORS

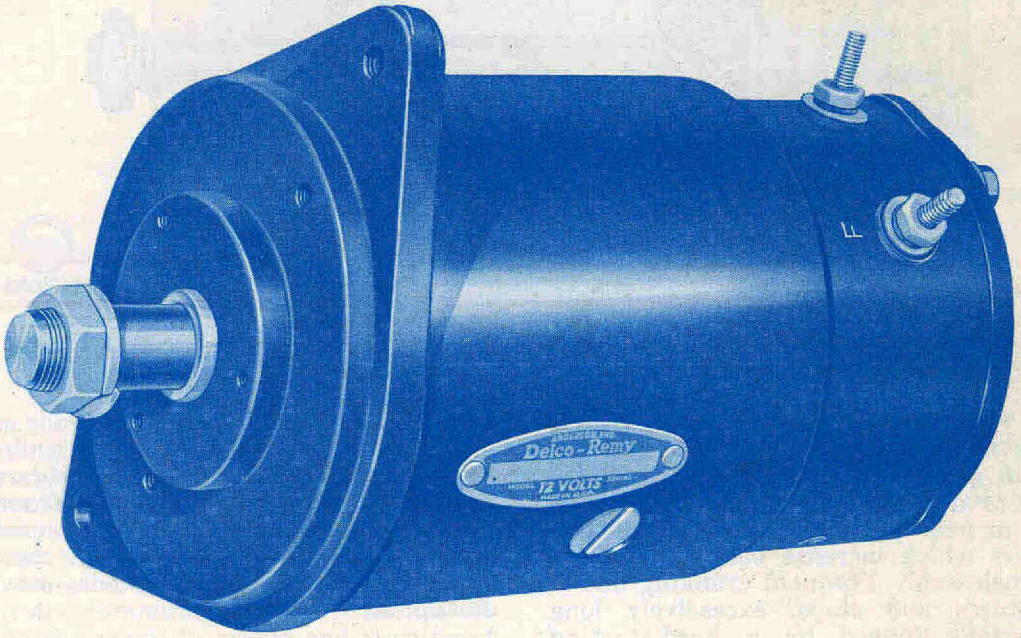

Figure 1—Typical motor-generator.

This bulletin provides a guide for the servicing and maintenance of motor-generator units as used on small gasoline engines. The motor-generator illustrated (Fig. 1 and 2) is a 4⅝" diameter extruded frame unit. The armature is supported on ball bearings at both the drive and commutator ends. A pulley-belt drive is usually used for both the motor and generator operation.

The motor-generator contains a series and a shunt field. Both fields are effective for developing torque when the unit performs as a cranking motor. Figure 3 illustrates the circuitry of a two terminal motor-generator with a 2 unit regulator. When this unit operates as a generator, the shunt field is the main field and the series field acts as a bucking field, which tends to limit generator output at high speed. Figure 4 illustrates the circuitry of a 3 terminal motor-generator with a 3 unit regulator. When this unit operates as a generator, the shunt field is the only field operating and the series field is by-passed. Greater output at low and high speed is achieved in this manner.

The motor-generator functions as a cranking motor when the motor switch is closed. After the engine is operating and the motor switch opens the circuit, the unit functions as a generator. In the two terminal motor-generator, control of the generator output and system voltage is achieved by using a current-voltage regulator. The operation of a 2 unit regulator is discussed in service bulletin 1R-111. The 3 terminal motor-generator is controlled by a 3 unit regulator as discussed in service bulletin 1R-118A.

INSPECTION

At periodic intervals, the unit should be inspected to determine its condition. The frequency with which this should be done will be determined by the type of service in which it is used. Operating

MOTOR-GENERATOR

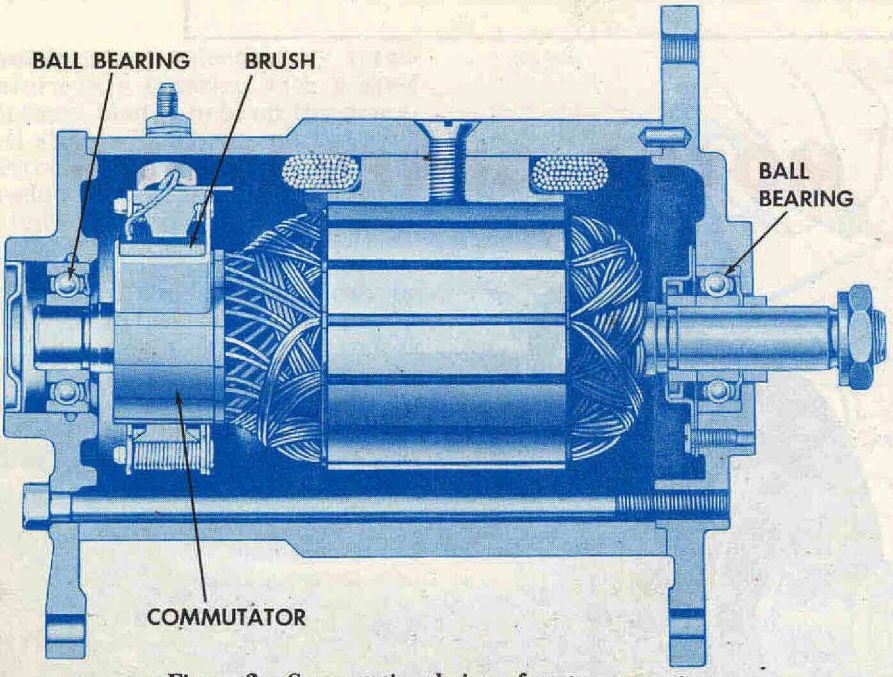

Figure 2—Cross sectional view of motor-generator.

the unit as a generator at high speeds, in excessive dust or dirt, at high temperatures, and operating at or near full output most of the time are all factors which increase bearing, commutator and brush wear. Frequent cranking due to numerous starts and stops, excessively long cranking periods caused by a hard-starting engine condition, excessively dirty or moist operating conditions or heavy vibration, make inspection checks of the motor-generator unit necessary at more frequent intervals than when operating in less severe conditions.

CAUTION: Never operate the motor-generator during cranking for more than 30 seconds at a time without pausing to allow it to cool off for at least two minutes. Overheating, caused by excessively long cranking periods, may seriously damage it.

The inspection procedure should include not only a check of the motor operation but should include also a check of the mounting, wiring and connections, all of which should be tight and in good condition. During inspection,

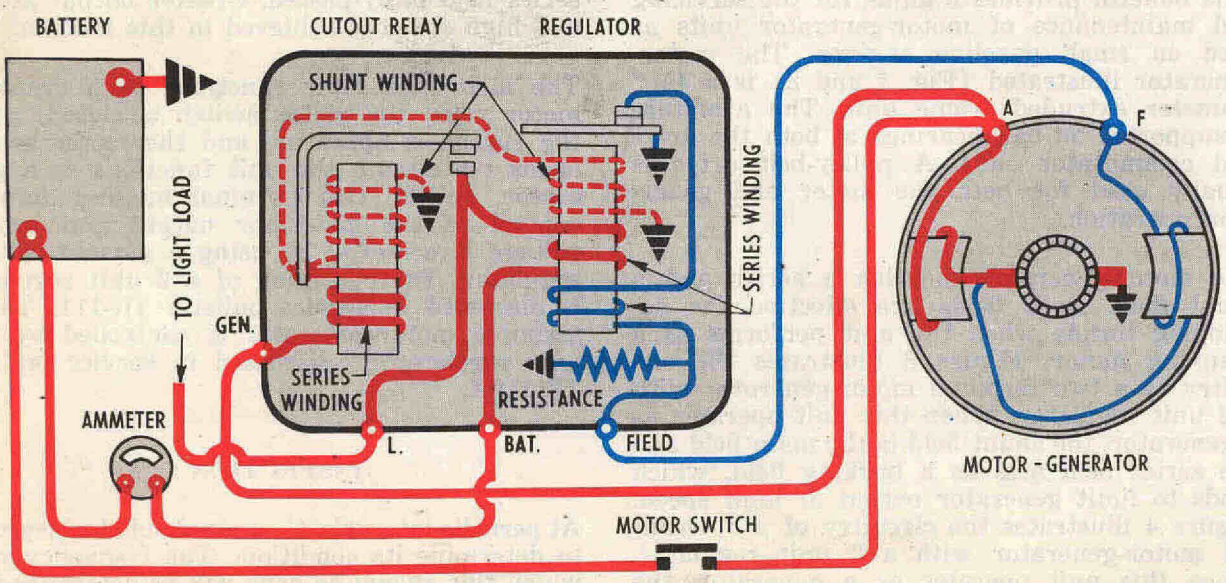

Figure 3—Wiring diagram showing motor-generator, regulator, battery, ammeter and switch.

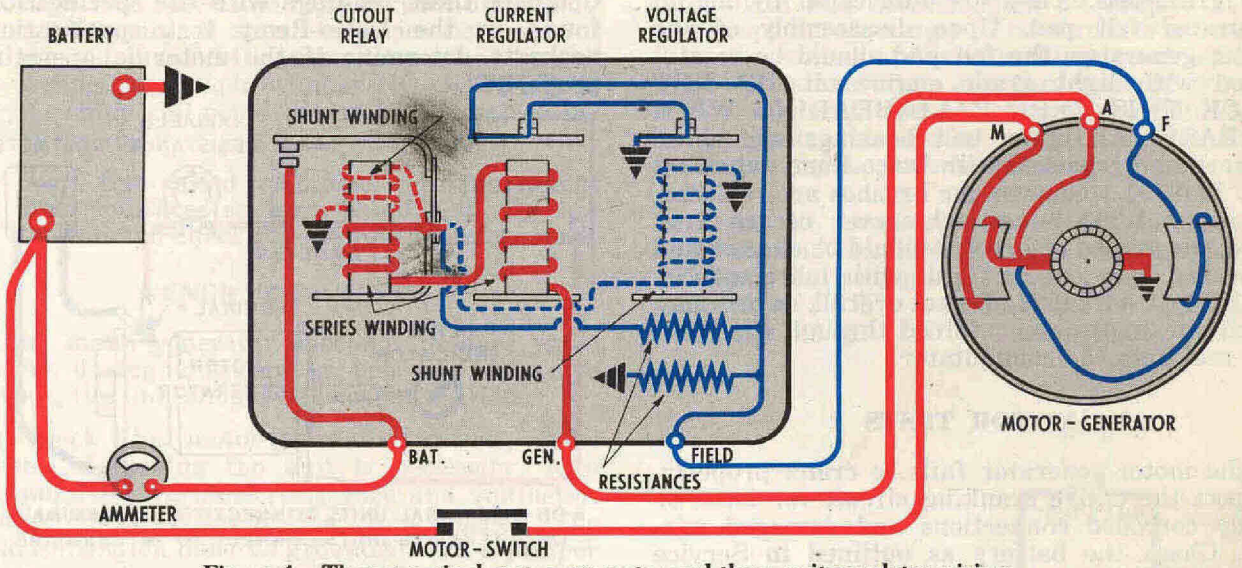

Figure 4—Three terminal motor-generator and three unit regulator wiring.

the brushes should be checked to make sure they are not binding in the brush holder and that they are resting at the proper angle and are making a good firm contact on the commutator. The brush spring tension must be as recommended by the manufacturer (Refer to Test Specification Booklets) since excessive tension will cause rapid brush and commutator wear, while insufficient tension will result in arcing and burning of the brushes and commutator. Brush spring tension can be checked with a spring gauge hooked on the brush arm. Correction in tension can be made by bending the brush spring as required. If the brush spring shows evidence of overheating by appearing blued or burned, a new spring should be installed. Overheating will cause a spring to lose its temper. If the brushes are worn down to one-half their original length, when compared with new brushes, they should be replaced.

When inspecting the motor-generator, also note the condition of the commutator. If the commutator is glazed or dirty, it can be cleaned by placing the armature in a lathe. While the armature is rotating, hold a strip of number 00 sandpaper lightly against the commutator, moving the sandpaper back and forth. (Fig. 5) Blow out all dust after sanding the commutator. If the commutator is rough, out of round, has high mica, or is extremely dirty, it will require "turning down" in a lathe and the mica undercut between the bars.

The drive belt should be checked to make sure it is in good condition and has the correct tension. Low belt tension will permit belt slippage and result in rapid belt wear and either low or erratic generator output. Excessive belt tension will also cause rapid belt and bearing wear. The belt tension should be adjusted in accordance with specifications of the engine or vehicle manufacturer.

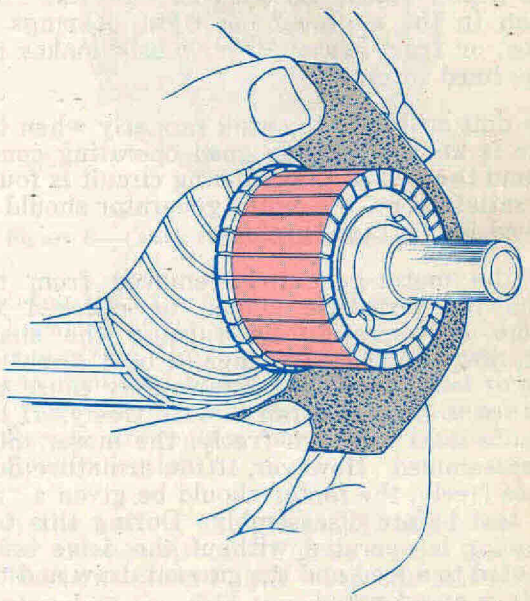

Figure 5—Sanding Commutator.

LUBRICATION

The hinge cap oilers should be filled with 8-10 drops of light engine oil every 100 hours of motor-generator operation. Some ball bearings

are greaseless. They are lubricated by an oil saturated felt pad. Upon disassembly of the motor-generator, the felt pad should be resaturated with light grade engine oil. DO NOT PACK THIS TYPE BALL BEARING WITH GREASE. All other ball bearings should be cleaned and repacked with Delco-Remy lubricant No. 1948791 whenever the brushes are replaced, or every 1,000 hours, whichever occurs first. Also, the grease reservoirs should be cleaned and repacked *only* one-half full with lubricant No. 1948791. CAUTION: Do not overfill, as this may result in grease being forced through the bearing seal onto the commutator.

MOTOR TESTS

If the motor-generator fails to crank properly, inspect the entire cranking circuit for loose or badly corroded connections and damaged wiring. Check the battery as outlined in Service Bulletin 7D-100 to determine its condition. When the battery is satisfactory and the wiring and connections are in good condition, close the motor switch. If the unit fails to crank, wire around the motor switch with a heavy jumper lead. If the motor-generator operates, the motor switch is defective and should be replaced. If the unit fails to operate, trouble can be attributed to the engine or the motor-generator. Excessive friction in the engine from tight bearings or pistons, or from heavy oil obviously makes the engine hard to crank.

If the unit still fails to crank properly when the engine is known to be in good operating condition, and the rest of the cranking circuit is found to be 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.

To perform the "no-load" test, connect the motor in series with a battery of proper voltage and an ammeter capable of reading several hundred amperes. A tachometer or r.p.m. indicator may be used to measure armature revolutions per minute or free speed. (Fig. 6) With the motor operating and the field grounded, measure the current draw and note the armature speed. Compare these readings with the specifications found in the Delco-Remy test specifications books to determine if the motor is operating properly.

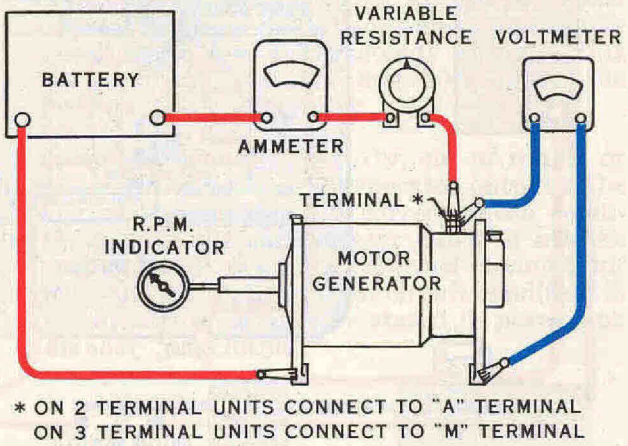

Figure 6—Checking motor-generator free speed.

Interpreting Results of Tests

1. Rated current draw at rated speed, as found in specifications, indicates normal condition of the motor-generator.
2. 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.
3. Failure to operate with high current draw indicates:
   (a) A direct ground in the terminal or fields.
4. 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.
5. Low no-load speed and low current draw indicates:
   (a) High internal resistance due to poor connections, defective leads, dirty commutator and causes listed under No. 4.

6. High free speed and high current draw indicates a shorted shunt or series field coil. A shorted shunt coil can be determined by following paragraph 3 under NO OUTPUT. If the shunt coil performs properly, replace the series coil.
7. High free speed and near normal current draw indicates an open shunt coil. Replace the coil and check for improved performance.

GENERATOR TESTS

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

To check the motor-generator output, some means of driving the unit is necessary. Also an ammeter, variable resistance and voltmeter, connected as shown in Fig. 7, is needed. The field connection must be grounded with a jumper lead.

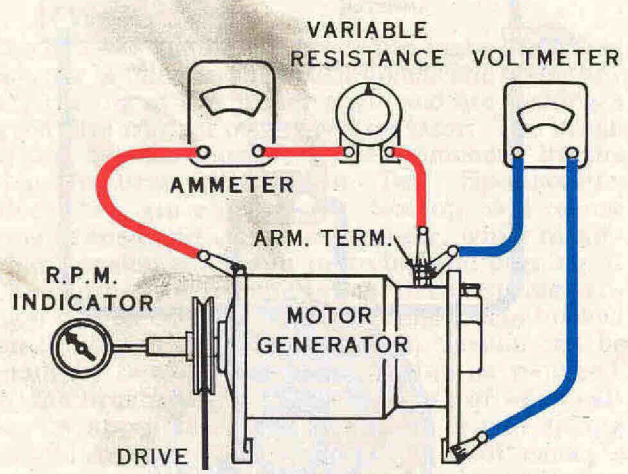

Figure 7—Checking motor-generator output.

Drive the unit at specified RPM as indicated in test specification booklets, adjust the voltage by varying the resistance and read the ammeter. The unit should function according to test specifications. If not, use the following section as a guide and repair or replace parts as necessary.

No Output

If the generator will not produce any output, check the commutator, brushes and internal connections. Sticking brushes, a dirty or gummy commutator (see Armature Service), or poor connections may prevent the generator from producing any output. Solder thrown from the commutator riser bars indicates that the generator has been overheated from excessive output. Often this leads to an open circuit and burned commutator bars and consequently no output. (See paragraph 4, following.) If the brushes are satisfactorily seated and are making good contact with the commutator, and the cause of trouble is not apparent, use a test lamp as follows to locate the trouble (leads must be disconnected from motor-generator terminals).

1. 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. (Fig. 8) If the lamp lights, it indicates that the unit is internally grounded. Location of the ground can be found by disconnecting the field and brush leads from the insulated brush holder and checking the brush holders, armature and field separately. Repair or replace parts as required. (See Repair Section.)

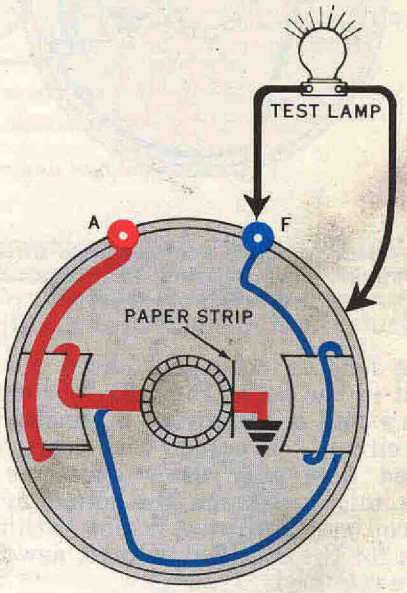

Figure 8—Check for grounded motor-generator.

2. If the unit is not grounded, check the field for an open circuit (Fig. 9) with a test lamp. The lamp should light when one test point is placed on the field terminal and the other is placed on the armature terminal. On three terminal motor-generators connect test lamp from the field terminal to the motor terminal. (Paper strip between insulated brush and commutator.) 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 one of the field coils, the coil must be replaced.

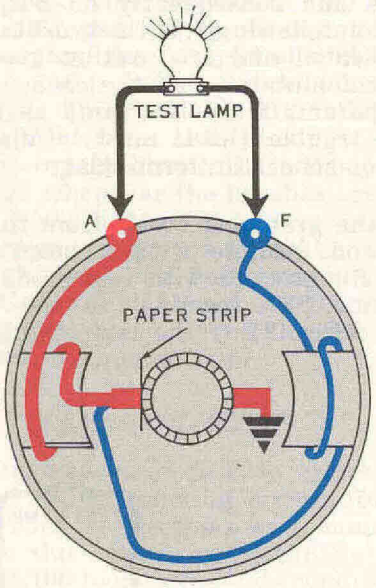

Figure 9—Check for open field coils. On three terminal motor-generators, connect from "F" terminal to "M" terminal with test lamp prods.

3. If the field is not open, check for a short circuit in the field (Fig. 10) by connecting a battery and an ammeter in series with the field circuit. Proceed with care, since a shorted field may draw excessive current which might damage the ammeter. If the field coil current draw is not within specification for the specified voltage, new field coils will be required.

   NOTE: If a shorted shunt field 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 or replace points as required.

4. If the trouble has not yet been located, check the armature 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 every time they pass under the generator brushes and consequently become burned. If the bars are not too 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 so the setting is within specifications.

Unsteady or Low Output

If the generator produces a low or unsteady output, the following factors should be considered:

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

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

3. A commutator that is dirty, out of round, or has high mica causing generator output to be low and 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 paragraph 4 under "No Output."

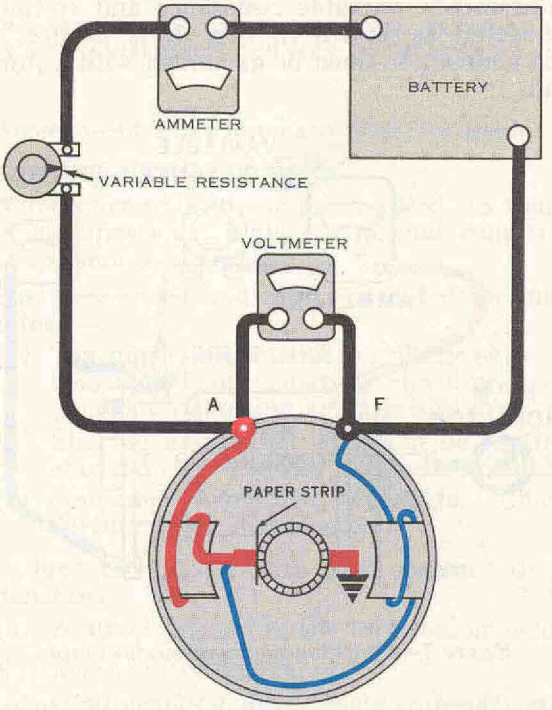

Figure 10—Check for shorted field coils. On three terminal motor-generators, connect from "F" to "M" terminal.

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.

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 brush to which the field lead is connected inside the generator should be raised off the commutator before this test is made. 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 where a ground has occurred at the 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.

Excessive Noise

Noise emanating 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 relubrication, 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 must be replaced.

DISASSEMBLY

Design features greatly simplify disassembly of this unit. The end frames, bearings, and armature can be removed or replaced without disturbing any electrical connections. The brush holder assemblies are mounted individually on the walls of the field frame.

To disassemble this type motor-generator:

1. Unscrew the thru bolts and remove the commutator end frame from the field frame.
2. Place the armature in a vise with soft jaws and remove the shaft nut, the pulley and the drive end frame.
3. Remove the brush holders if new ones are to be installed, by drilling out the rivets holding them to the field frame. Install the new holders, securing them to the frame with the screws, nuts and washers provided in the replacement package.
4. Field coils can be removed from the field frame most easily by the use of a pole shoe screwdriver. This tool permits easy loosening and removal of the pole shoe screws so that the pole shoes and field coils can be taken out of the field frame. When loosening the pole shoe screws, it is also advisable to use a pole shoe spreader, since this prevents distortion of the field frame. The pole shoe screwdriver and spreader should also be used when reassembling the field coils and pole shoes into the field frame. Careful assembly is necessary to prevent shorting or grounding of the field coils when the pole shoes are tightened into place.

CLEANING PARTS

The armature or field coils should not be cleaned in any degreasing tank or by use of degreasing compounds since this might damage insulation so that a short or ground would subsequently develop. Ball bearings should be serviced as covered in the LUBRICATION section. Other parts should be cleaned and carefully inspected for wear and other damage. Any defective parts should be repaired or replaced. On reassembly all soldered electrical connections should be made with rosin flux. Acid flux must never be used on electrical connections.

FIELD COIL SERVICE

The field coils should be checked for grounds, opens or shorts as previously explained. Grounded field coils may sometimes be repaired by removing them so they can be reinsulated. Care must be used to avoid excessive bulkiness when applying new insulation since this might cause the pole shoe to cut through and cause another ground when the coils are reinstalled.

Usually, if a field coil is open or shorted internally, it must be replaced since it is difficult to repair such a defect.

ARMATURE SERVICE

The armature should be checked for opens, shorts and grounds. (Fig. 11 and 12)

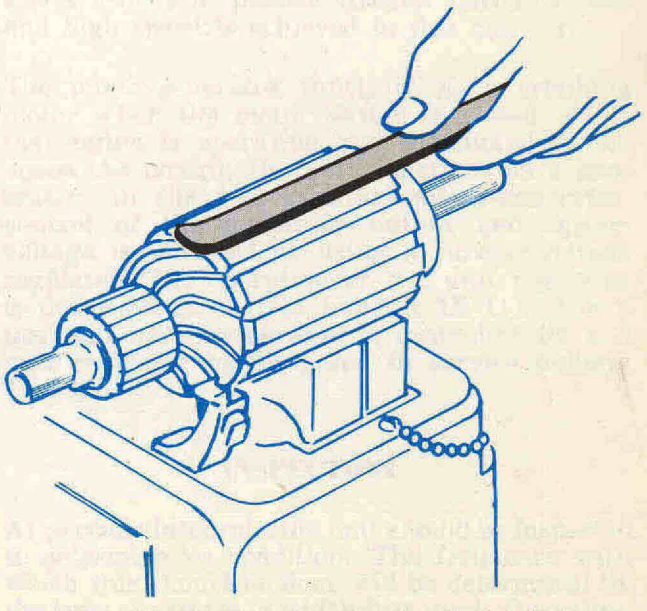

Figure 11—Checking armature for short circuits.

1. **Shorts**—Short circuits are located by rotating the armature in a growler with a steel strip (i.e., hacksaw blade) held on the armature. The steel strip will vibrate on the area of the short circuit. Shorts between bars are sometimes produced by brush dust or copper between the bars. Undercutting the insulation will eliminate these shorts.
2. **Grounds**—Grounds in the armature can be detected by use of a test lamp and prods. If the lamp lights when one test prod is placed on the commutator and the other test prod on the armature core or shaft, the armature is grounded.
3. **Opens**—Inspect the points where the conductors are joined to the commutator for loose connections. Poor connections cause arcing and burning of the commutator. If the bars are not badly burned, resolder the leads in the riser bars. Turn the commutator down in a lathe. Undercut the insulation between the commutator bars 1/32″.

If the commutator is worn, dirty, out of round, or has high insulation, the commutator should be turned down and undercut as previously described.

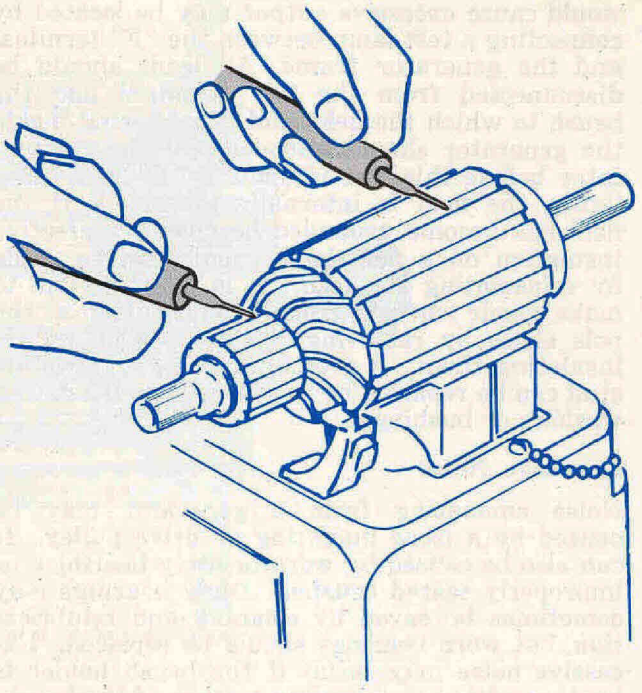

Figure 12—Checking armature for grounds.