Service Bulletin 1M-156

Pages: 8 *Dated 11-1-80*

Reference: 1B-115, 1B-116
1M-188, 1S-188

Delco Remy

CRANKING MOTORS

40-MT/400 and 40-MT/450
50-MT/400

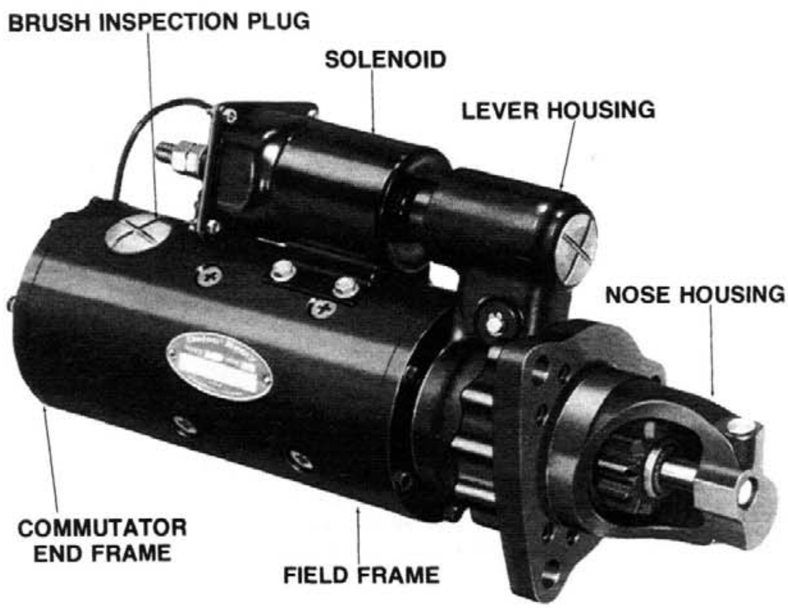

Figure 1—Typical 40-MT/400 motor

Heavy duty cranking motors have a shift lever and solenoid plunger that are totally enclosed to protect them from exposure to dirt, icing conditions and splash. The nose housing can be rotated to obtain a number of different solenoid positions with respect to the mounting flange.

Lubrication is provided to the sintered bronze bushings by an oil saturated wick. Oil can be added to each wick by removing an oil reservoir cup which is accessible on the outside of the motor. Additional information on lubrication is provided on page 7.

The pinion is moved into mesh with the ring gear by the action of the solenoid. The pinion remains engaged until the solenoid circuit is interrupted. In case of a butt engagement the motor will not be energized to prevent damage to the pinion and gear teeth.

MAINTENANCE

Under normal operating conditions, no maintenance will be required between engine overhaul periods. At time of engine overhaul, motors should be disassembled, inspected, cleaned, and tested as described in succeeding paragraphs.

ADJUSTABLE NOSE HOUSING

As shown in the cross-sectional view of Figure 2, the nose housing is attached to the lever housing by means of bolts located around the outside of the housing. To relocate the housing, it is only necessary to remove the bolts, rotate the housing to the desired position, and reinstall the bolts. The bolts should be torqued to 13-17 lb. ft. during reassembly. In this type of assembly, the lever housing and the commutator end frame are attached to the field frame independently by bolts entering threaded holes in the field frame.

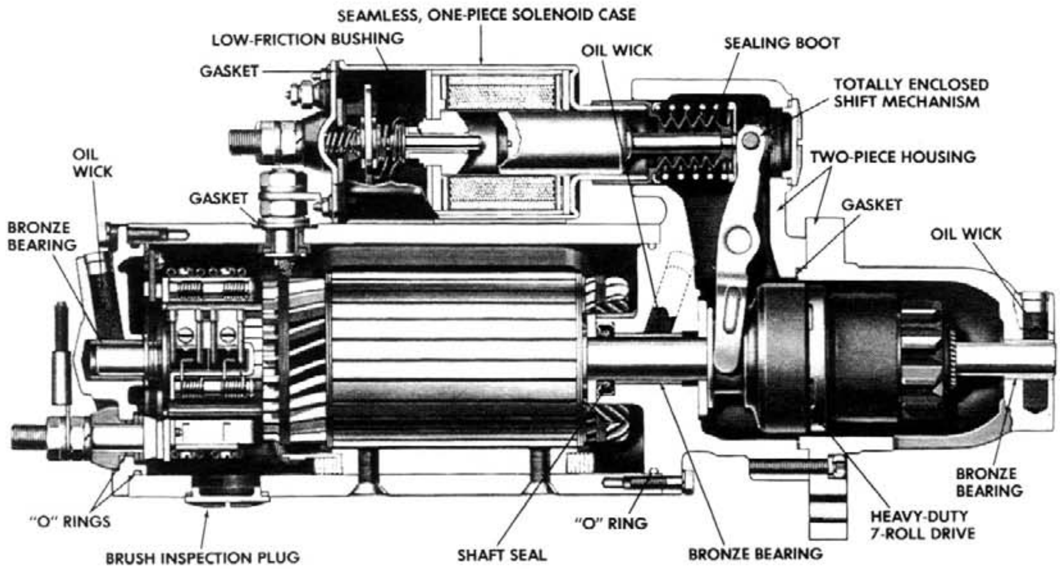

Figure 2—Cross-sectional view

OPERATION

There are many different cranking motor circuits used on various applications. The cranking circuit may contain a key start switch or push switch, or both, a relay, magnetic switches, solenoids, oil pressure switch, fuel pressure switch and other protective devices, such as an "ADLO" relay.

Reference should be made to the vehicle manufacturer's wiring diagram for the complete cranking circuit.

A typical circuit is shown in Figure 3. The motor shown has a built-in thermostat to protect against damage due to over-cranking for excessively long periods of time. Thermostat components separated from the field coils and motor frame are shown in Figure 4. Also a motor with harness disconnected from the thermostat is shown in Figure 5.

When the start switch is closed, battery current flows through the magnetic switch winding and the thermostat to ground, as shown in Figure 3. The magnetic switch closes, connecting the motor solenoid "S" terminal to the battery.

The solenoid windings are energized and the resulting plunger and shift lever movement causes the pinion to engage the engine flywheel ring gear and the solenoid main contacts to close, and cranking takes place. When the engine starts, pinion overrun protects the armature from excessive

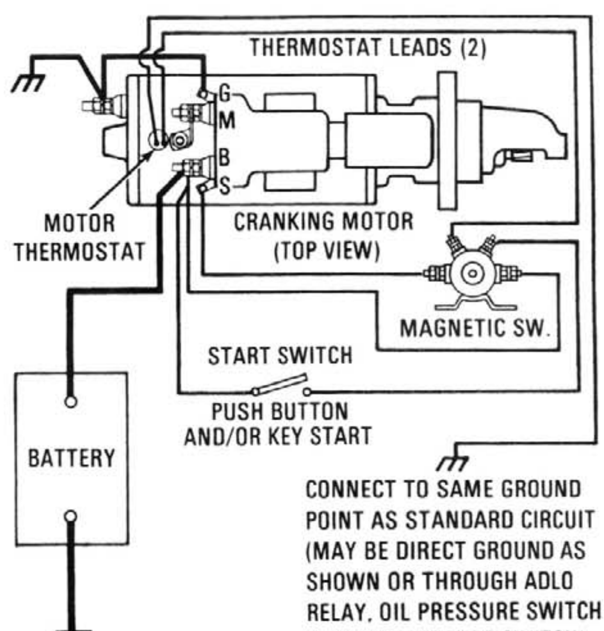

Figure 3—Typical wiring circuit

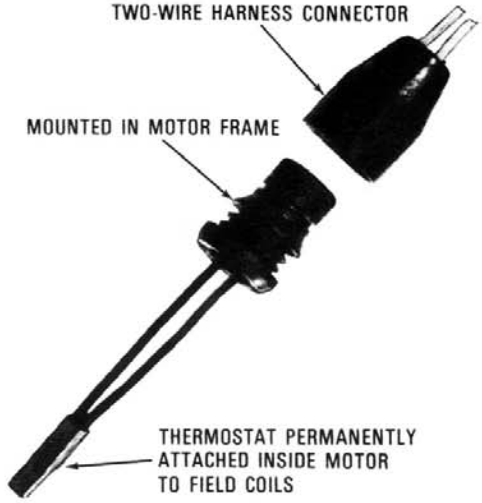

Figure 4—Typical thermostat

speed until the switch is opened, at which time the return spring causes the pinion to disengage. To prevent excessive overrun and damage to the drive and armature windings, the switch must be opened immediately when the engine starts.

A cranking period for all types of motors should never exceed 30 seconds without stopping to allow the motor to cool. If over-cranking should occur, the thermostat will open and the cranking cycle will stop to protect the motor. After the cranking motor cools, usually 1-6 minutes, the thermostat will close and then a new starting attempt can be made.

A circuit without the motor thermostat would be the same as Figure 3, except the magnetic switch winding terminal would be grounded directly to the point noted in Figure 3, without passing through a thermostat.

TROUBLESHOOTING THE CRANKING CIRCUIT

If the cranking system is not performing properly, make the following checks to help determine which part of the circuit is at fault.

Battery: To determine the condition of the battery, follow the testing procedure outlined in Service Bulletin 1B-115 or 1B-116. Insure that the battery is fully charged. **The wiring, switches, and cranking motor cannot be checked if the battery is defective or discharged.**

Wiring: Inspect the wiring for damage. Inspect all connections to the cranking motor, solenoid, magnetic switch, ignition switch or any other control switch, and battery, including all ground connections. Clean and tighten all connections as required. **The cranking system cannot operate properly with excessive resistance in the circuit.**

Magnetic Switch, Solenoid and Control Switches: Inspect all switches to determine their condition. From the vehicle wiring diagram, determine which circuits should be energized with the starting switches closed. Use a voltmeter to detect any open circuits.

Thermostat, or Overcrank Protection:

To check the thermostat for continuity, detach wiring harness connector and connect an **ohmmeter** to the two thermostat terminals on the motor (Fig. 5). The ohmmeter should read zero. If not, thermostat is open circuit. DO NOT check thermostat when hot, since it is supposed to be open-circuit above certain temperatures.

Motor: If the battery, wiring and switches are in satisfactory condition, and the engine is known to be functioning properly, remove the motor and follow the test procedures outlined below.

A cranking motor is designed for intermittent duty only, and should never be operated for more than 30 seconds at a time. After 30 seconds, the cranking must be stopped for at least two minutes to allow the motor to cool. The same rule applies to a motor with a thermostat. The thermostat is an added protection against damage from overcranking.

With the cranking motor removed from the engine, the armature should

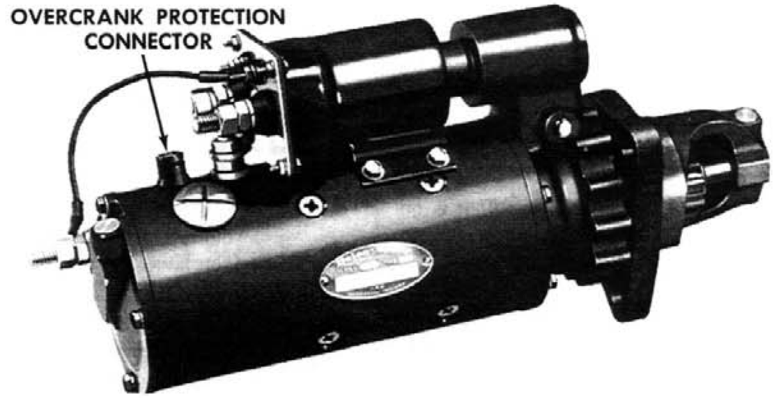

Figure 5—Typical motor showing thermostat connector (Overcrank Protection Connector)

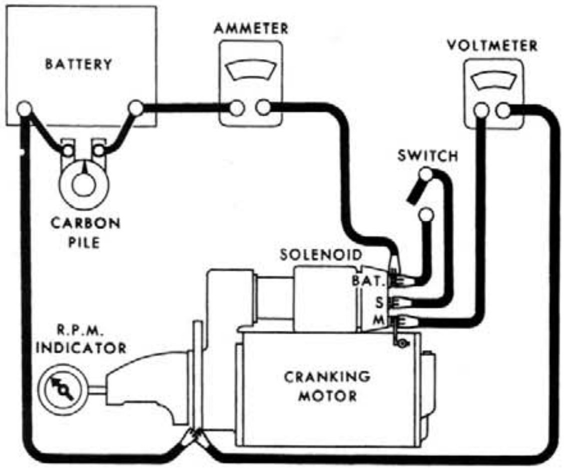

Figure 6—No-load test circuit

be checked for freedom of rotation by prying the pinion with a screwdriver. Tight bearings, a bent armature shaft, or a loose pole shoe screw will cause the armature to not turn freely. If the armature does not turn freely the motor should be disassembled immediately. However, if the armature does rotate freely, the motor should be given a no-load test before disassembly.

No-Load Test (Fig. 6)

Connect a voltmeter from the motor terminal to the motor frame, and use an r.p.m. indicator to measure armature speed. Connect the motor and an ammeter in series with a fully charged battery of the specified voltage, and a switch in the open position from the solenoid battery terminal to the solenoid switch terminal. Close the switch and compare the r.p.m., current, and voltage reading with the specifications in Service Bulletins 1M-188. It is not necessary to obtain the exact voltage specified in these bulletins, as an accurate interpretation can be made by recognizing that if the voltage is slightly higher the r.p.m. will be proportionately higher, with the current remaining essentially unchanged. However, if the exact voltage is desired, a carbon pile connected across the battery can be used to reduce the voltage to the specified value. If more than one 12-volt battery is used, connect the carbon pile to only one of the 12-volt batteries. If the specified current draw does not include the solenoid, deduct from the ammeter reading the specified current draw of the solenoid hold-in winding. Make disconnections only with the switch open. Interpret the test results as follows:

Interpreting Results of Tests

1. **Rated current draw and no-load speed indicates normal condition of the cranking motor.**
2. **Low free speed and high current draw indicate:**
   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.
   b. "Frozen" bearings (this should have been determined by turning the armature by hand).
4. **Failure to operate with 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 indicate:**
   a. High internal resistance due to poor connections, defective leads, dirty commutator and causes listed under Number 4.
6. **High free speed and high current draw indicate shorted fields.** If shorted fields are suspected, replace the field coil assembly and check for improved performance.

DISASSEMBLY

Normally the cranking motor should be disassembled only so far as is necessary to make repair or replacement of the defective parts. As a precaution, it is suggested that safety glasses be worn when disassembling or assembling the cranking motor.

1. Note the relative position of the solenoid, lever housing, and nose housing so the motor can be reassembled in the same manner.
2. Disconnect field coil connector from solenoid motor terminal, and lead from solenoid ground terminal.
3. On motors which have brush inspection plates, remove the plates

and then remove the brush lead screws. This will disconnect the field leads from the brush holders.

4. Remove the attaching bolts and separate the commutator end frame from the field frame.
5. Separate the nose housing and field frame from lever housing by removing attaching bolts.
6. Remove armature and clutch assembly from lever housing.
7. Separate solenoid from lever housing by pulling apart.

CLEANING

The drive, armature and fields should not be cleaned in any degreasing tank, or with grease dissolving solvents, since these would dissolve the lubricant in the drive and damage the insulation in the armature and field coils. All parts except the drive should be cleaned with mineral spirits and a brush. The drive can be wiped with a clean cloth.

If the commutator is dirty it may be cleaned with No. 00 sandpaper. NEVER USE EMERY CLOTH TO CLEAN COMMUTATOR.

Brushes and Holders

Inspect the brushes for wear. If they are worn excessively when compared with a new brush, they should be replaced. Make sure the brush holders are clean and the brushes are not binding in the holders. The full brush surface should ride on the commutator to give proper performance. Check by hand to insure that the brush springs are giving firm contact between the brushes and commutator. If the springs are distorted or discolored, they should be replaced.

ARMATURE SERVICING

If the armature commutator is worn, dirty, out of round, or has high insulation, the armature should be put in a lathe so the commutator can be turned down. The insulation should then be undercut 1/32 of an inch wide and 1/32 of an inch deep, and the slots cleaned out to remove any trace of dirt or copper dust. As a final step in this procedure, the commutator should be sanded lightly with No. 00 sandpaper to remove any burrs left as a result of the undercutting procedure. **NOTE**: The undercut operation must be omitted on cranking motors having Test Specifications 2412, 2415, 3501, 3564, 3574 and 3599 as listed in Delco Remy Service Bulletin 1M-188. **Do not** undercut commutators on motors having these specifications.

The armature should be checked for opens, short circuits and grounds as follows:

1. Opens—Opens are usually caused by excessively long cranking periods. The most likely place for an open to occur is at the commutator riser bars. Inspect the points where the conductors are joined to the commutator bars for loose connections. Poor connections cause arcing and burning of the commutator bars as the cranking motor is used. If the bars are not too badly burned, repair can often be effected by resoldering or welding the leads in the riser bars (using rosin flux), and turning down the commutator in a lathe to remove the burned material. The insulation should then be undercut except as noted above.
2. Short Circuits—Short circuits in the armature are located by use of a growler. When the armature is revolved in the growler with a steel

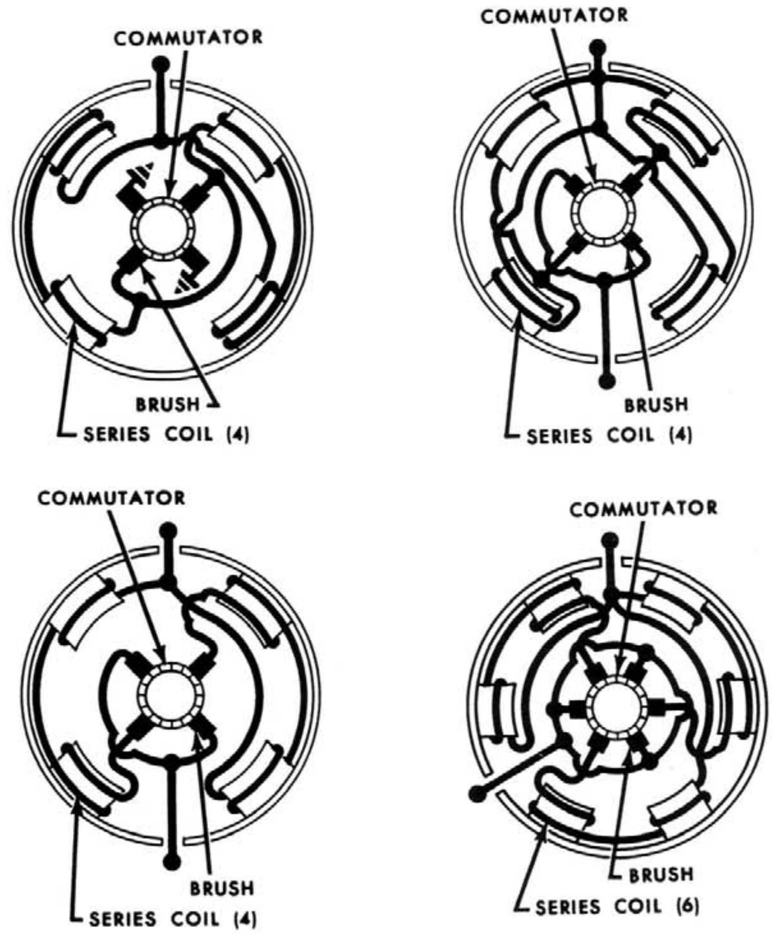

Figure 7—Internal motor circuits

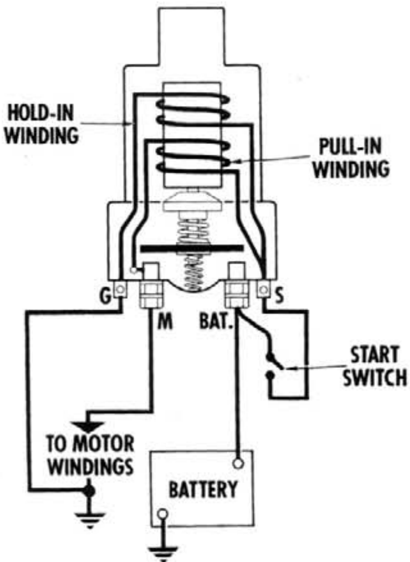

Figure 8—Internal solenoid circuit. ("G" and "S" terminals moved to clarify illustration.)

strip such as a hacksaw blade held above it, the blade will vibrate above the area of the armature core in which the short circuit is located. Shorts between bars are sometimes produced by brush dust or copper between the bars. These shorts can be eliminated by cleaning out the slots.

3. Grounds—Grounds in the armature can be detected by the use of a 110-volt test lamp and test points. 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 is often brought about by overheating of the cranking motor produced by excessively long cranking periods or by accumulation of brush dust between the commutator bars and the steel commutator ring.

FIELD COIL CHECKS

The various types of circuits used are shown in the wiring diagrams of Figure 7. The field coils can be checked for grounds and opens by using a test lamp.

Grounds—If the motor has one or more coils normally connected to ground, the ground connections must be disconnected during this check. Connect one lead of the 110-volt test lamp to the field frame and the other lead to the field connector. If the lamp lights, at least one field coil is grounded which must be repaired or replaced. This check cannot be made if the ground connection cannot be disconnected.

Opens—Connect test lamp leads to ends of field coils. If lamp does not light, the field coils are open.

FIELD COIL REMOVAL

Field coils can be removed from the field frame assembly by using a pole shoe screwdriver. A pole shoe spreader should also be used to prevent distortion of the field frame. Careful installation of the field coils is necessary to prevent shorting or grounding of the field coils as the pole shoes are tightened into place. Where the pole shoe has a long lip on one side and a short lip on the other, the long lip should be assembled in the direction of armature rotation so it becomes the trailing (not leading) edge of the pole shoe.

SOLENOID CHECKS

A basic solenoid circuit is shown in Figure 8. Solenoids may differ in appearance but can be checked electrically by connecting a battery of the specified voltage, a switch, and an ammeter to the two solenoid windings. With all leads disconnected from the solenoid, make test connections as shown to the solenoid switch terminal and to the second switch terminal, (G), to check the hold-in winding (Fig. 9). Use the carbon pile to decrease the battery voltage to the value specified in Service Bulletin 1S-188 and compare the ammeter reading with specifications. A high reading indicates a shorted hold-in winding, and a low reading excessive resistance. To check the pull-in winding connect from the solenoid switch terminal (S) to the solenoid motor (M or MTR) terminal (Fig. 10).

To check for grounds, move battery lead from "G" (Fig. 9) and from "MTR" (Fig. 10) to solenoid case, (not shown). Ammeter should read zero. If not, winding is grounded.

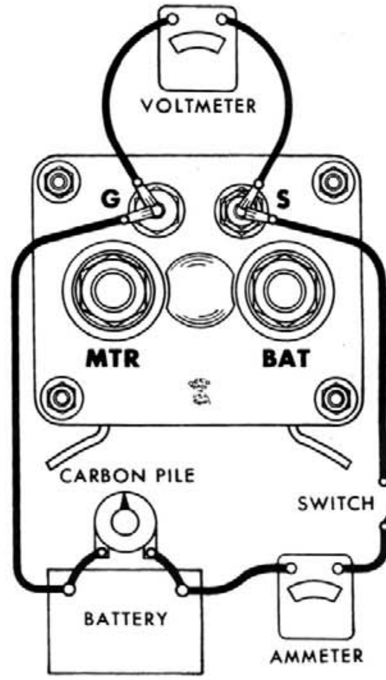

Figure 9—Checking solenoid **hold-in** winding

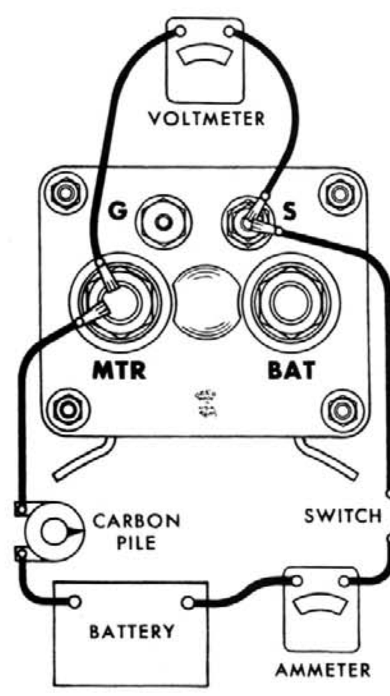

Figure 10—Checking solenoid **pull-in** winding

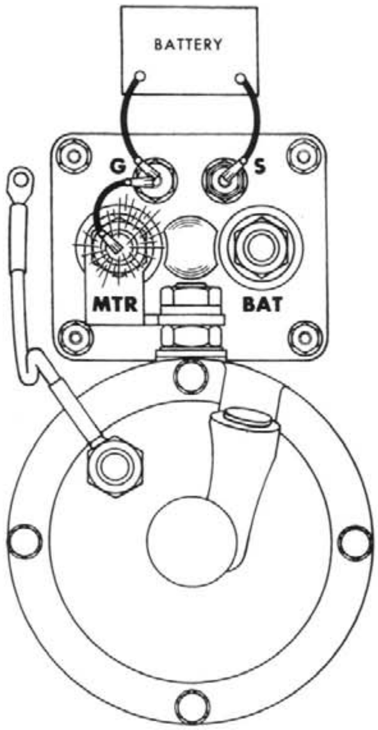

Figure 11—Checking pinion clearance circuit

Figure 12—Measuring pinion clearance

NOTE: If needed to reduce the voltage to the specified value, connect the carbon pile between the battery and the "MTR" terminal as shown. If the carbon pile is not needed, connect a jumper directly from the battery to the "MTR" terminal.

CAUTION: To prevent overheating, do not leave the pull-in winding energized more than 15 seconds. The current draw will decrease as the winding temperature increases.

A magnetic switch can be checked in the same manner by connecting across its winding.

REASSEMBLY

To reassemble the end frame with brushes onto the field frame, pull the armature out of the field frame just far enough to permit the brushes to be placed over the commutator. Then push the commutator end frame and the armature back against the field frame.

LUBRICATION

All bearings, wicks and oil reservoirs should be saturated with SAE No. 20 oil. Place a light coat of lubricant Delco Remy No. 1960954 on the washer located on the shaft between the armature and shift lever housing.

Sintered bronze bearings used in these motors have a dull finish, as compared to the early type machined, cast bronze bearings which had a shiny finish.

Before pressing the bearing into place, dip it in SAE No. 20 oil. Also, tangent wicks (if present) should be soaked with SAE No. 20 oil. Insert the wick into place first, and then press in the bearing.

DO NOT DRILL, REAM OR MACHINE sintered bearings in any way! These bearings are **supplied to size.** If drilled or reamed, the I.D., (inside diameter) will be too large, also the bearing pores will be sealed over.

It is not necessary to cross-drill a sintered bearing when used with a tangent wick. Because the bearing is so highly porous, oil from the wick touching the outside bearing surface will bleed through and lubricate the shaft.

Middle bearings are **support** bearings and prevent armature deflection during cranking. As compared to end frame bearings, the clearance between middle bearing and shaft is large and the clearance provides a loose fit when assembled.

PINION CLEARANCE

To check pinion or drive clearance follow the steps listed below.

1. Make connections as shown in Figure 11.
2. **Momentarily** flash a jumper lead from terminal G to terminal MTR. (Fig. 11). The drive will now shift into cranking position and remain so until the battery is disconnected.
3. Push the pinion or drive back towards the commutator end to eliminate slack movement.
4. Measure the distance between drive and housing (Fig. 12).
5. Adjust clearance by removing plug and turning shaft nut (Fig. 12). **Although typical specifications are shown, always refer to 1M-188 for specifications applying to specific models.**

NOTES

CO: 1.2, 1 WDS & PS, 1.2X, 131, 132: 16, 1.2-52 1FD

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