Service Bulletin 1M-153

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Reference: 1B-115, 1B-116
1M-186, 1M-187, 1M-188
1S-180, 1S-186, 1S-187, 1S-188

Delco Remy

CRANKING MOTORS

30-MT, 35-MT, 40-MT, 50-MT Series

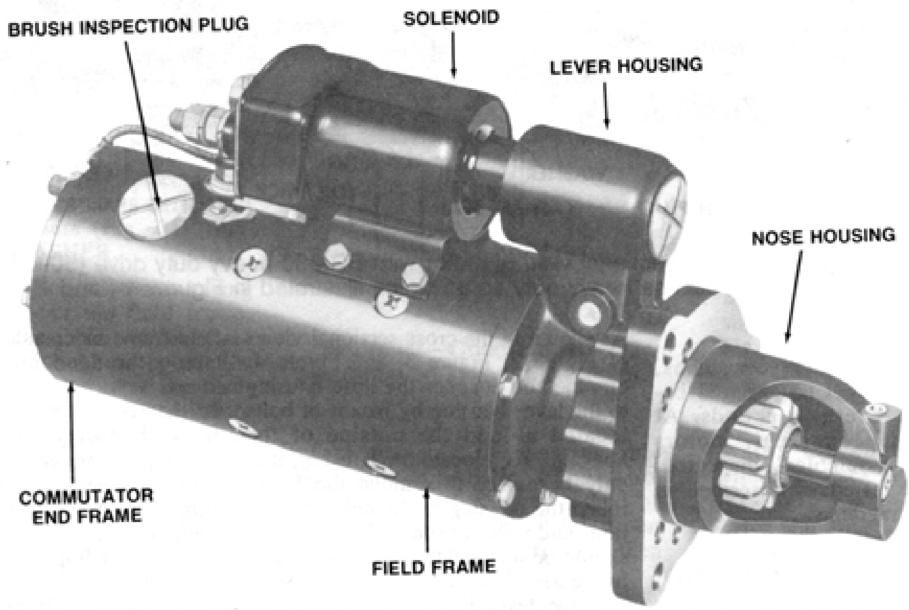

Figure 1—Typical 50-MT Series heavy duty cranking motor.

The heavy duty cranking motors covered in this bulletin 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, which is a feature that makes these motors universally adaptable to a wide variety of different mounting applications.

Positive lubrication is provided to the bronze bushings by an oil saturated wick that projects through the bushings and contacts the armature shaft. Oil can be added to each wick by removing a pipe plug which is accessible on the outside of the motor.

Available as an optional feature are oil reservoirs for the bronze bearings which makes available a larger oil supply thereby extending the time required between lubrication periods. Another optional feature is "O" rings which can be added to resist entry of dirt and moisture into the entire motor assembly. When the oil reservoirs and "O" rings are included, the motor will provide long periods of attention-free operation.

Many models feature a seal between the shaft and lever housing and all models have a rubber boot or linkage seal over the solenoid plunger. The seal and the boot, when used together, prevent entry of oil into the motor main frame and solenoid case, allowing the motor to be used on wet clutch applications.

Four kinds of clutches, a heavy duty sprag, a Positork drive, an intermediate duty type and a splined drive, may be used with enclosed heavy duty type cranking motors. All four types are moved into mesh with the ring gear by the action of the solenoid. The pinion remains engaged until starting is assured and the solenoid circuit is interrupted. In case of a butt engagement with the heavy duty sprag clutch or Positork drive, the motor will not be energized to prevent damage to the pinion and gear teeth. The spline drive is normally used on gas turbine applications, and can be engaged into the turbine spline gear before the turbine gear has coasted to a stop.

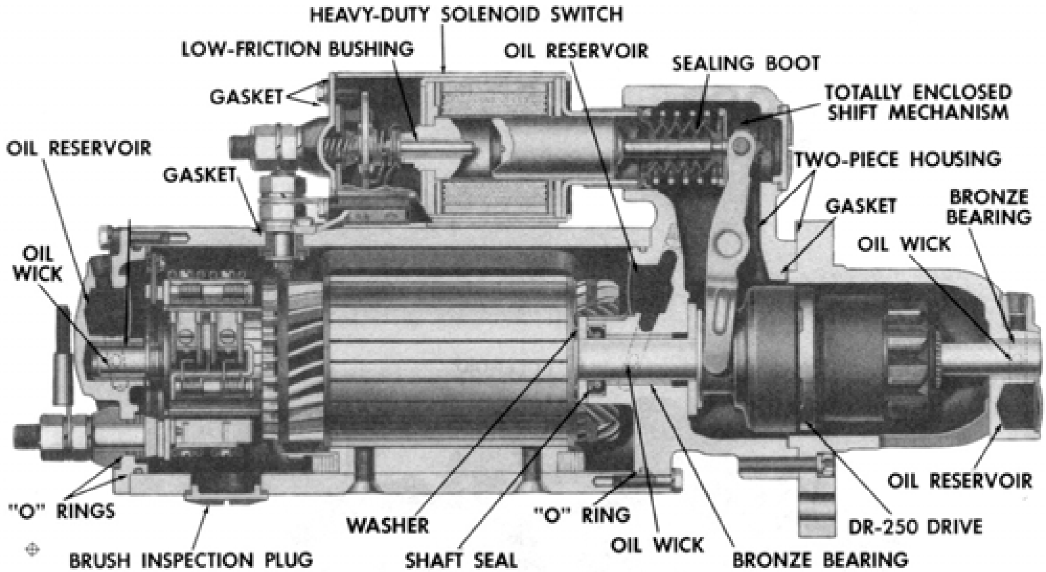

Figure 2—Cross-sectional view of motor with DR-250 heavy duty drive (50-MT). (Some models use heavy duty sprag clutch illustrated in Figures 14 and 15.)

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

Two methods are employed to attach the nose housing to the lever housing. As shown in the cross-sectional views of Figure 2, Figure 3, and Figure 4, one method attaches the nose housing 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.

In the second method, where the intermediate duty clutch is used, the lever housing and commutator end frame are held to the field frame by thru-bolts extending from the commutator end frame to threaded holes in the lever housing. The nose housing is held to the lever housing by internal attaching bolts extending from the lever housing to threaded holes in

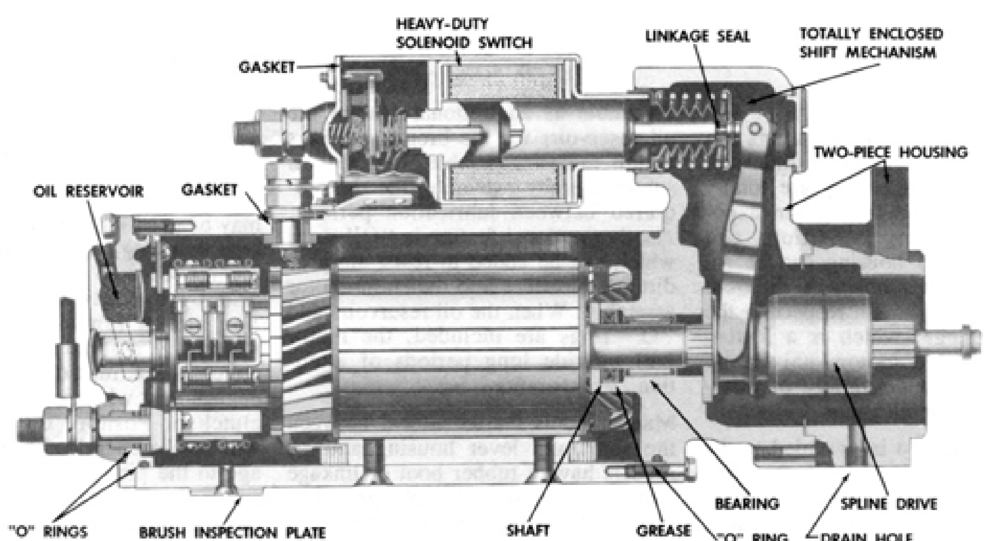

Figure 3—Cross-sectional view of motor with spline drive (50-MT).

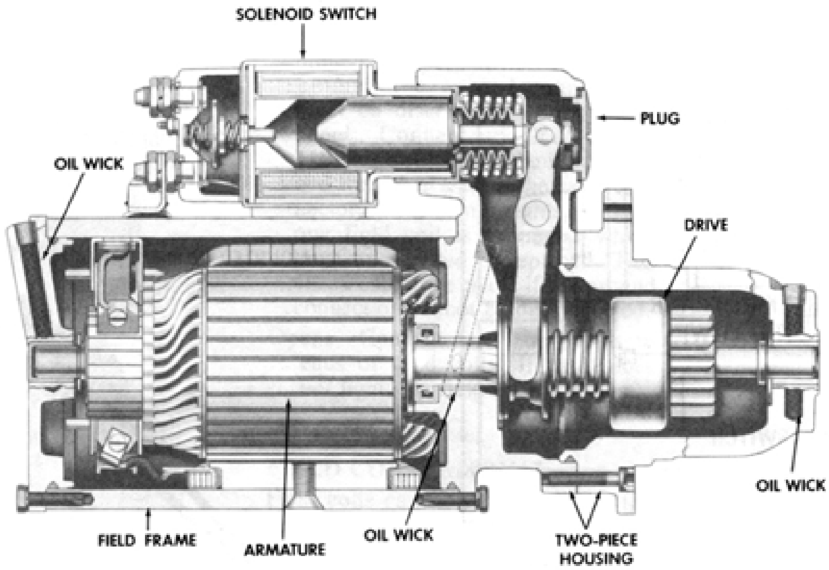

Figure 4—Cross-sectional view of motor with intermediate duty clutch. (35-MT) Note different attaching bolt construction than Figure 5.

the nose housing (Fig. 5). With this arrangement, it is necessary to partially disassemble the motor to provide access to the attaching bolts when relocating the nose housing.

To accomplish this, remove the electrical connector and the screws attaching the solenoid assembly to the field frame and then remove the thru-bolts from the commutator end frame. Separate the field frame from the remaining assembly, and pull the armature away from the lever housing until the pinion stop rests against the clutch pinion. This will clear the nose housing attaching bolts so they can be removed with a box or open end wrench, permitting relocation of the nose housing. During reassembly, torque the nose housing attaching bolts to 11-15 lb. ft.

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 "ALDO" relay.

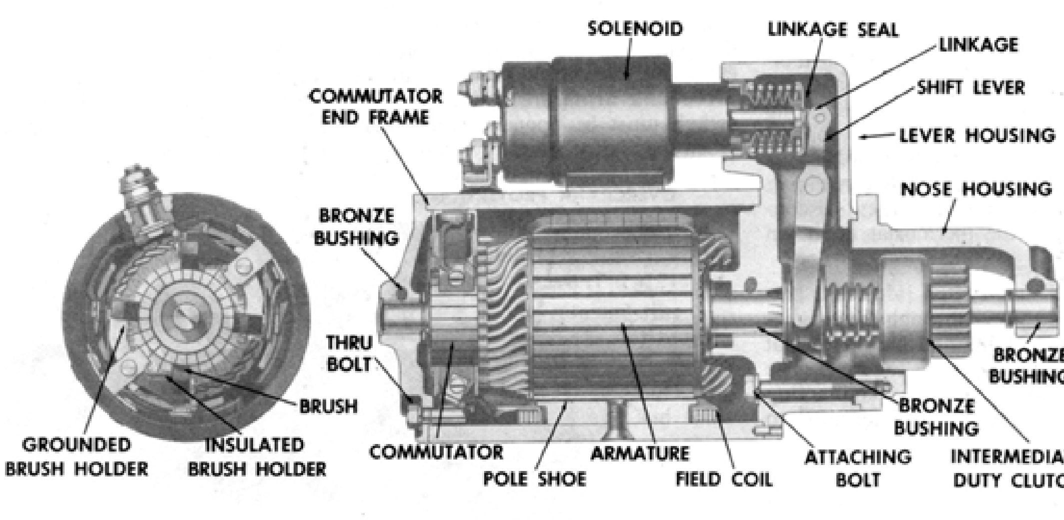

Figure 5—Cross-sectional view of motor with intermediate duty clutch. Note different attaching bolt construction than Figure 4.

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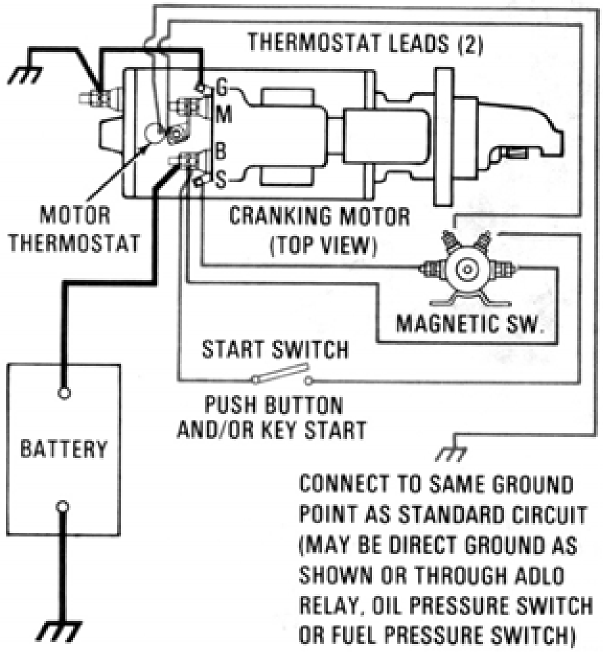

Figure 6—Basic wiring circuit.

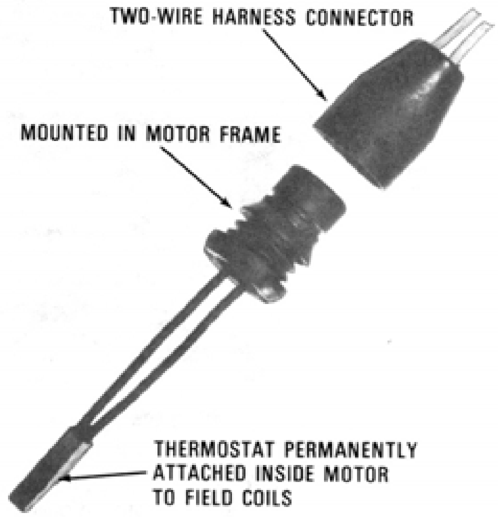

Figure 7—Typical thermostat.

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

A typical circuit is shown in Figure 6. 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 7. Also a motor with harness disconnected from the thermostat is shown in Figure 8.

When the start switch is closed, battery current flows through the magnetic switch winding and the thermostat to ground, as shown in Figure 6. 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 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 6, except the magnetic switch winding terminal would be grounded directly to the point noted in Figure 6, without passing through a thermostat.

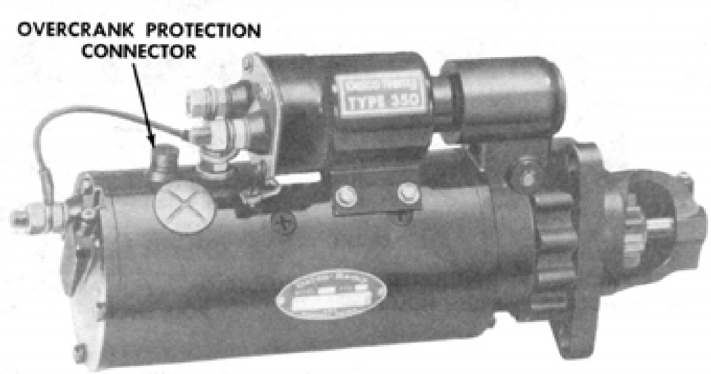

Figure 8—Typical motor showing thermostat connector.

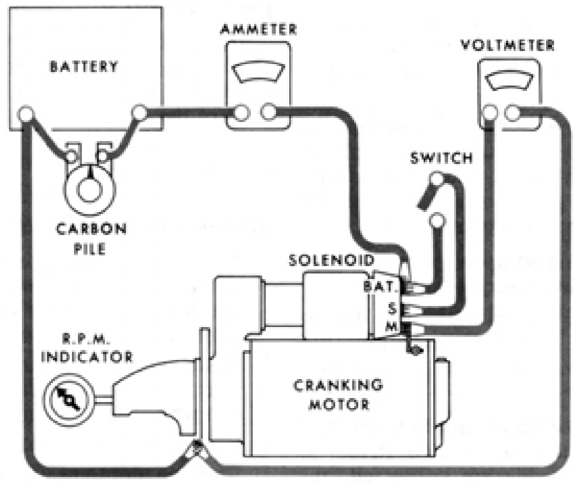

Figure 9—No-load test circuit.

TROUBLESHOOTING THE CRANKING CIRCUIT

Before removing any unit in a cranking circuit for repair, the following checks should be made:

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.

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.

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. 8). 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.

CRANKING MOTOR TESTS

Regardless of the construction, never operate the cranking motor more than 30 seconds at a time without pausing to allow it to cool at least two minutes. On some applications, 30 seconds may be excessive. Overheating, caused by excessive cranking will seriously damage the cranking motor (without thermostat).

With the cranking motor removed from the engine, the armature should 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. 9)

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-186, 1M-187, or 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.

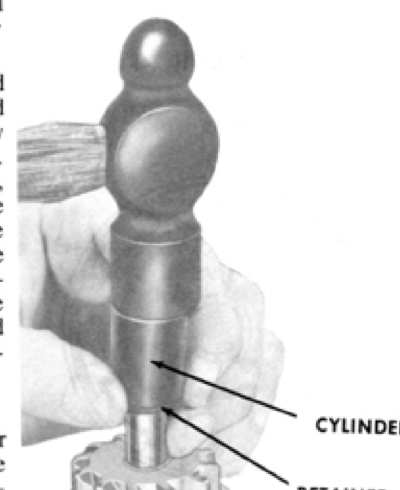

Figure 10—Removing retainer from snap ring.

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.

Intermediate Duty Clutch 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 remove solenoid mounting screws.
3. Remove thru-bolt or cap screws.
4. Remove commutator end frame from field frame and field frame from lever housing.

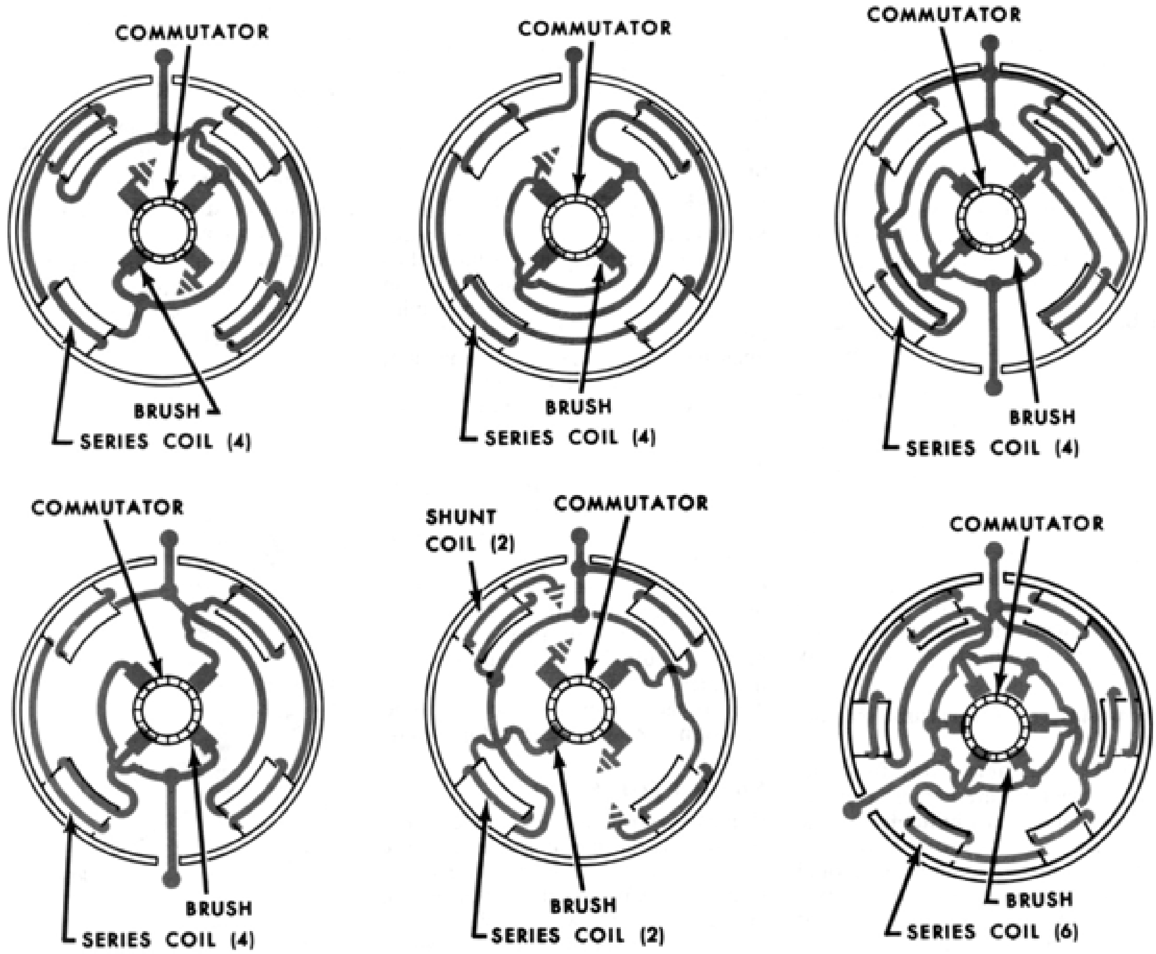

Figure 11—Typical motor circuits.

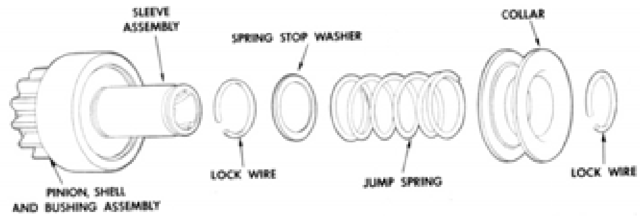

Figure 12—Disassembled view of early type intermediate duty sprag clutch drive assembly.

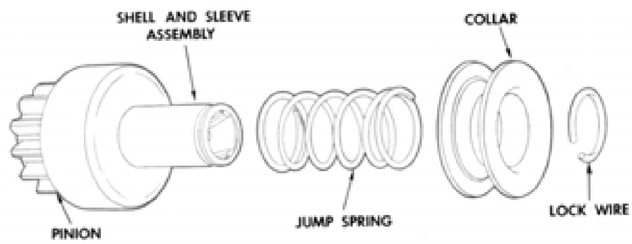

Figure 13—Disassembled view of late type intermediate duty sprag clutch drive assembly.

5. Remove nose housing attaching bolts and separate nose housing from lever housing.
6. Slide a standard half-inch pipe coupling or other metal cylinder of suitable size (an old pinion of suitable size can be used if available) onto shaft so end of coupling or cylinder butts against edge of retainer. Tap end of coupling with hammer, driving retainer towards armature and off snap ring (Fig. 10).
7. Remove snap ring from groove in shaft using pliers or other suitable tool. If snap ring is too badly distorted during removal it may be necessary to use a new one when reassembling clutch.
8. Remove the armature and clutch from the lever housing.
9. Separate the solenoid from the lever housing.

Heavy Duty Clutch, Positork Drive, and Spline Drive Motors

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.

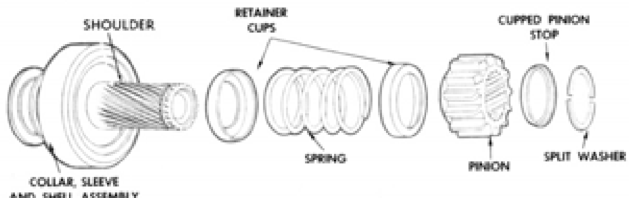

Figure 14—Disassembled view of early type heavy duty sprag clutch drive assembly.

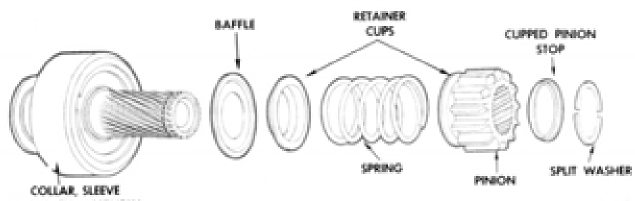

Figure 15—Disassembled view of late type heavy duty sprag clutch drive assembly.

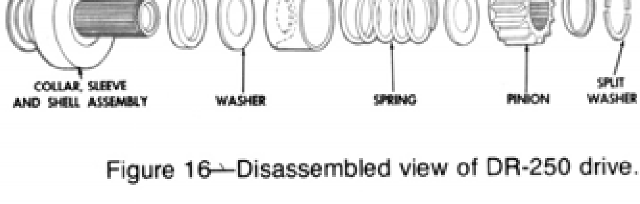

Figure 16—Disassembled view of DR-250 drive.

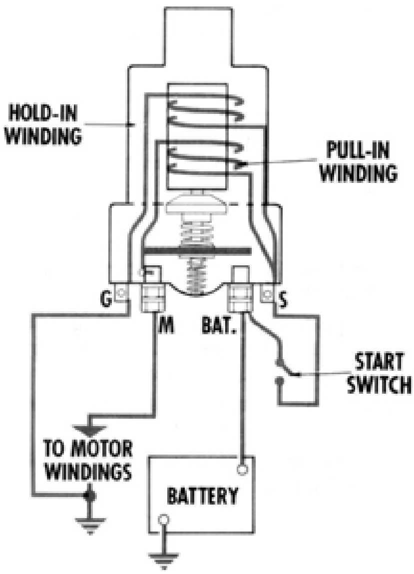

Figure 17—Basic solenoid circuit. (Types shown in Figures 1, 2, and 3.)

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.

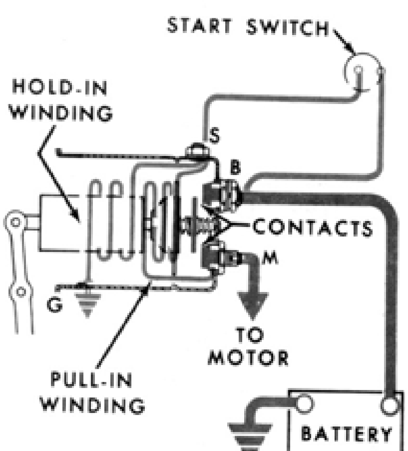

Figure 18—Basic solenoid circuit. (Types shown in Figures 4 and 5.)

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 Bulletins 1M-186, 1M-187, and 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 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.

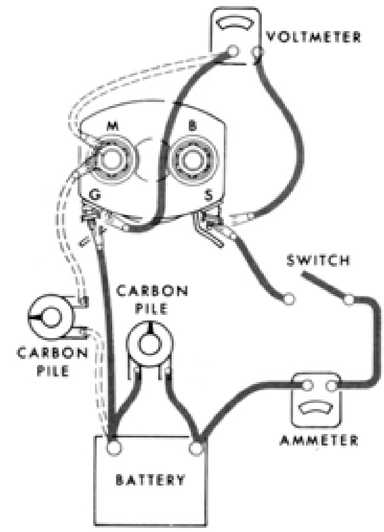

Figure 19—Checking solenoid hold-in and pull-in windings. (Note: Terminal locations may vary.)

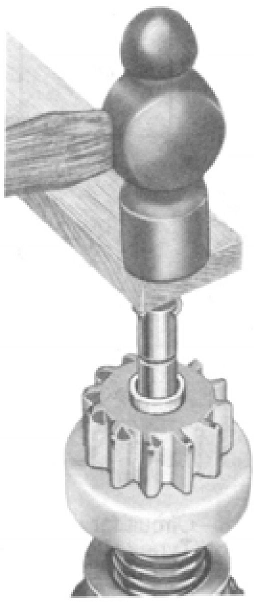

Figure 20—Forcing snap ring over shaft.

FIELD COIL CHECKS

The various types of circuits used are shown in the wiring diagrams of Figure 11. The field coils can be checked for grounds and opens by using a test lamp.

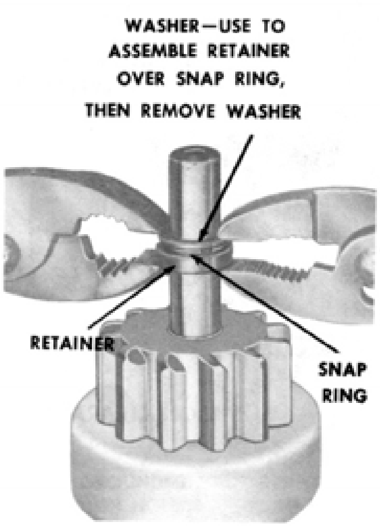

Figure 21—Forcing retainer over snap ring.

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.

CLUTCH ASSEMBLY

Diassembly procedures for the various types of clutches are outlined below.

A. Intermediate Duty Sprag Clutch.

An early type clutch and late type clutch are shown in Figures 12 and 13.

1. Remove the lock wire, collar, and jump spring from the sleeve assembly.
2. Remove the spring stop washer and second lock wire from the early type clutch (Fig. 12).
3. Remove the retainer ring and large washers. Do not remove the sleeve assembly or sprags from the shell assembly.
4. Lubricate the sprags and saturate the felt washer with No. 5W20 oil. Heavier oil must not be used.
5. Assembly is the reverse of disassembly.

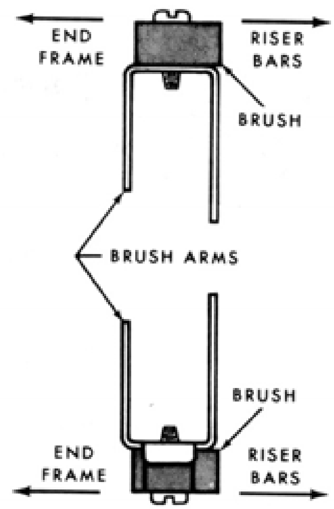

Figure 22—Brush with offset hole assembled to brush arm.

B. Heavy Duty Sprag Clutch and DR-250 Drive.

An early type and a late type heavy duty sprag clutch are shown in Figures 14 and 15 and the DR-250 drive is shown in Figure 16.

1. Remove the cupped pinion stop and split washer. In removing the cupped pinion stop, it will probably be damaged. A new one will be required at time of reassembly.
2. Remove the other parts as illustrated.
3. **Do not** lubricate the sprags on heavy duty clutches, as they are lubricated for life with special oil at the factory.
4. Assembly is the reverse of disassembly.

C. Spline Drive and Positork Drive.

These types of drive assemblies are serviced by complete replacement only.

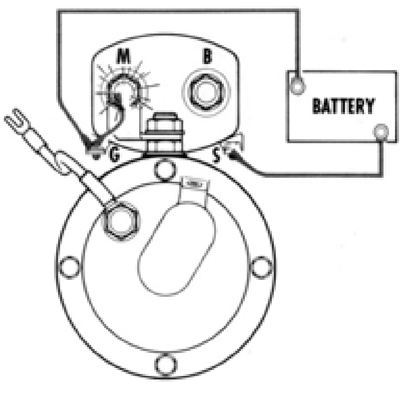

Figure 23—Circuit for checking pinion clearance. (Types shown in Figures 1, 2 and 3.)

SOLENOID CHECKS

A basic solenoid circuit is shown in Figures 17 and 18. 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 (S or SW) terminal and to ground, or to the second switch terminal, (G), if present, to check the hold-in winding (Fig. 19). Use the carbon pile to decrease the battery voltage to the value specified in Service Bulletins 1S-180, 1S-186, 1S-187 and 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 MOT) terminal. To check for grounds, move battery lead from "G" terminal to solenoid case, and from "M" terminal to solenoid case. (Fig 19, not shown) Ammeter should read zero for both windings. If not solenoid is grounded.

NOTE: If needed to reduce the voltage to the specified value, connect the carbon pile between the battery and the "M" terminal as shown in dashed red instead of across the battery as shown in solid red lines. If the carbon pile is not needed, connect a jumper directly from the battery to the "M" terminal as shown by the dashed red line.

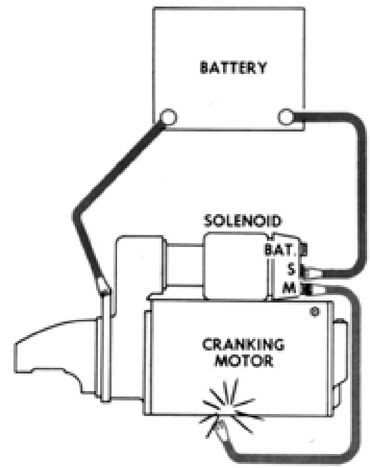

Figure 24—Circuit for checking pinion clearance. (Types shown in Figures 4 and 5.)

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.

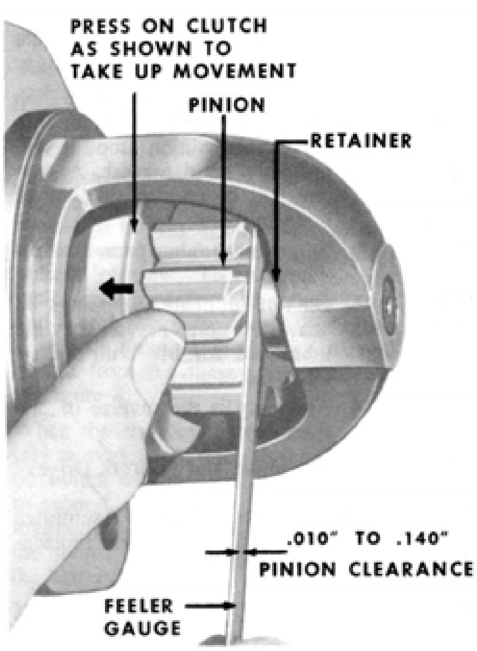

Figure 25—Checking pinion clearance on intermediate duty clutch motor.

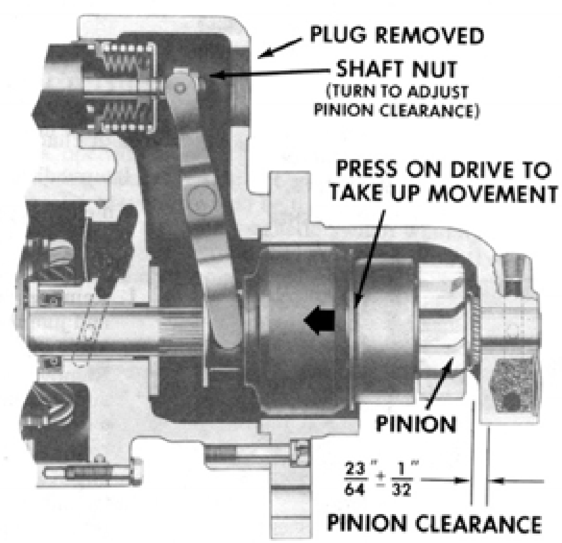

Figure 26—Checking pinion clearance on heavy duty motor.

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

REASSEMBLY

The reassembly procedure for each type of motor is the reverse of disassembly.

On motors using a snap ring and retainer on the shaft as a pinion stop, the ring and retainer can be assembled in the manner shown in Figures 20 and 21. With the retainer placed over the shaft with the cupped surface facing the end of the shaft, force the ring over the shaft with a light hammer blow and then slide the ring down into the groove (Fig. 20). To force the retainer over the snap ring, place a suitable washer over the shaft and squeeze with pliers (Fig. 21). REMOVE THE WASHER.

To reassemble the end frame having eight 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.

On intermediate duty clutch motors, be sure to assemble all brushes to the brush arms so the long side of the brush is toward the riser bars. See Figure 22.

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. Washer is identified in Figure 2.

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.

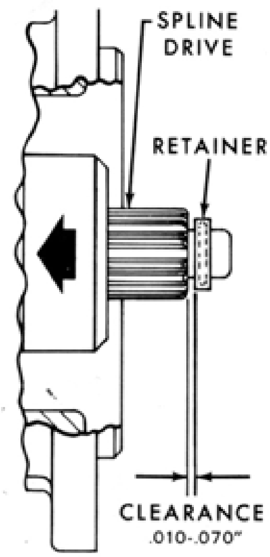

Figure 27—Checking pinion clearance on spline drive motor.

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

There are no provisions for adjusting pinion clearance on motors using the intermediate duty clutch (Fig. 5). However, all types should be checked after reassembly to make sure the clearance is within specifications. Incorrect clearance where not adjustable indicates excessive wear, and worn parts should be replaced.

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

1. Make connections as shown in Figure 23 or Figure 24.
2. **Momentarily** flash a jumper lead shown in blue color in Figure 23 or Figure 24. 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 drive stop (Figs. 25, 26, and 27).
5. Adjust clearance by removing plug and turning shaft nut (Figs. 26 and 27). **Although typical specifications are shown, always refer to 1M-188, 1M-187, or 1M-186 for specifications applying to specific models.**

NOTES

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