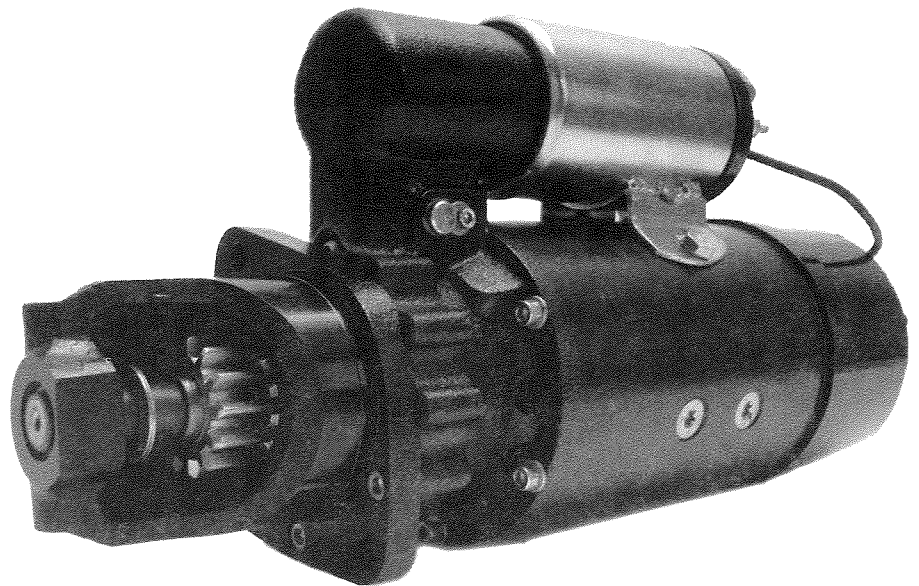


# MAINTENANCE INSTRUCTIONS

## 12, 24 & 32 VOLT CRANKING MOTORS

File: Cranking Motor Maintenance Section



### THE FOLLOWING CRANKING MOTORS ARE COVERED:

7072 MC	7260 MD	7264 ME
7072 MD	7260 ME	7296 MD
7072 ME	7264 MA	7296 ME
7260 MA	7264 MD	

### THE FOLLOWING RELATED MOTOR PACKAGES ARE COVERED:

93064	(BASED ON 7072 MC)
93115	(BASED ON 7260 MA)
94064	(BASED ON 7072 MD)
94115	(BASED ON 7260 MD)

**Leece-Neville**  
HEAVY DUTY SYSTEMS

These maintenance instructions cover 24 volt ordnance cranking motors including the MA, MB, and MC styles which are adjustable timing motors, and MD and ME style motors which are fixed timing motors.

**NOTE:** The difference between the MD/ME style motor and the MA/MB/MC style motor is the way the switch plunger is connected to the shift lever. On MD and ME style (fixed timing) motors, the switch plunger has a link spool that hooks to the shift lever. On MA, MB and MC style (adjustable timing) motors, the switch plunger is screwed on a link that is attached to the shift lever.

ME motors have a simplified commutator end (C.E.) housing and brush rigging assembly design, which eliminates many parts, making servicing easier, especially brush changing, and achieving the same level of sealing as factory built units after field service.

## MODE OF OPERATION

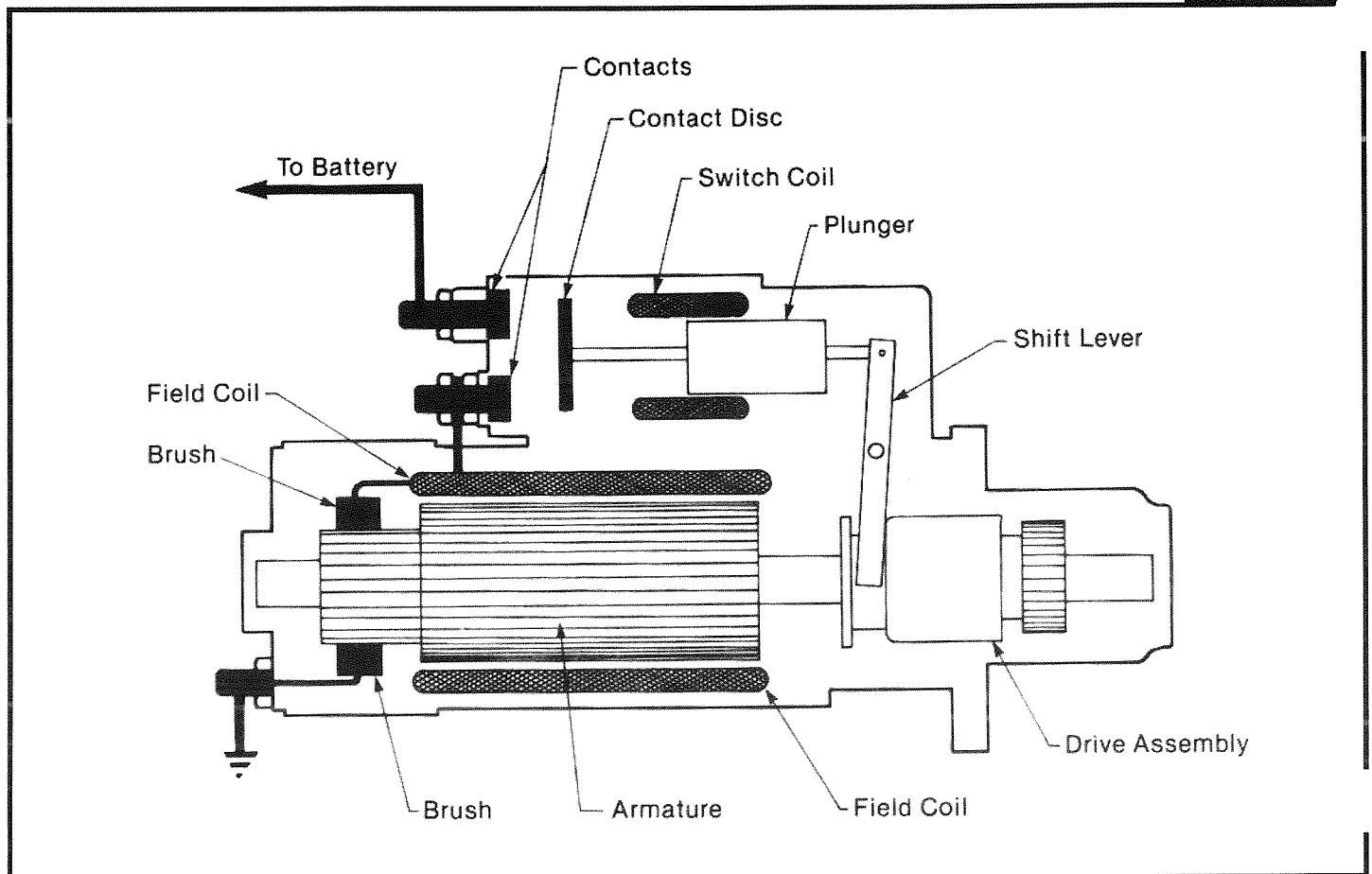
[See figure 1]

When the start switch is closed, the coils in the solenoid are energized, creating a magnetic field. The field pulls the plunger inward, which causes the shift lever to push the drive assembly into mesh with the ring gear on the engine flywheel. Once the pinion is in mesh, the plunger pushes the contacts closed, and closes the circuit between the battery and the motor.

The current passes through the field coil then through the brushes to the armature commutator. The current forms interacting magnetic fields around the field coil pole pieces and the armature lamination pack, and causes the armature to turn. The armature turns the drive pinion, which turns the ring gear, cranking the engine.

When the engine starts, the start switch is released. This causes the magnetic field in the solenoid to collapse, and a return spring forces the plunger outwards. This opens the contacts, and then disengages the drive assembly from the ring gear.

**FIGURE 1**



## CRANKING MOTOR TROUBLESHOOTING

1. Check specific gravity of batteries. Minimum allowed is 1.230SP GR (75% charged). NOTE. A digital voltmeter can be used to establish the state of battery charge. Before any voltage measurements are taken, the engine must be turned off and battery surface charge be removed by turning on the headlights or similar load for 5-10 minutes. If voltage shows a rapid increase in voltage to about 12.45V or higher on turning off the load, then the surface charge has not been fully removed, repeat operation. When voltage rises slowly to 12.45V or higher, the surface charge has been fully removed, and the state of battery charge is at least 75%.
2. Connect a jumper from switch terminal #2 to #1 for 2-3 seconds. (Jumper must be at least 12 gage, and have insulated clips. ENSURE THAT THE VEHICLE TRANSMISSION IS NOT IN GEAR, AND THE PARKING BRAKE IS APPLIED IF THIS IS PERFORMED ON A VEHICLE ENGINE.

If the switch activates and the motor spins and the motor cranks the engine, then motor and switch are OK. Check wiring, terminals, start and/or ignition switches and start relay if used.

If the switch activates and the motor spins, but then engine does not crank, then the drive assembly or shift mechanism is faulty, and the starter should be removed for further diagnosis.

If the switch activates but the motor does not spin, the problem may be the switch contacts, or the motor. Check with a voltmeter the voltage at the #3 terminal. If battery voltage is found, the motor has a break in the circuit within the case, if there is less than 1V at the terminal, then the switch contacts are not closing. In either case, it is best to remove the cranking motor for further diagnosis.

If the switch does not activate, see step 3

3. With the jumper connected from terminals #2 to #1, ground terminal #4 using a jumper between #4 terminal and the ground terminal on the back of the motor. If the switch activates and the motor cranks, the ground jumper wire is defective and must be replaced. If the switch does not activate, then switch is defective and must be removed for service or replacement.

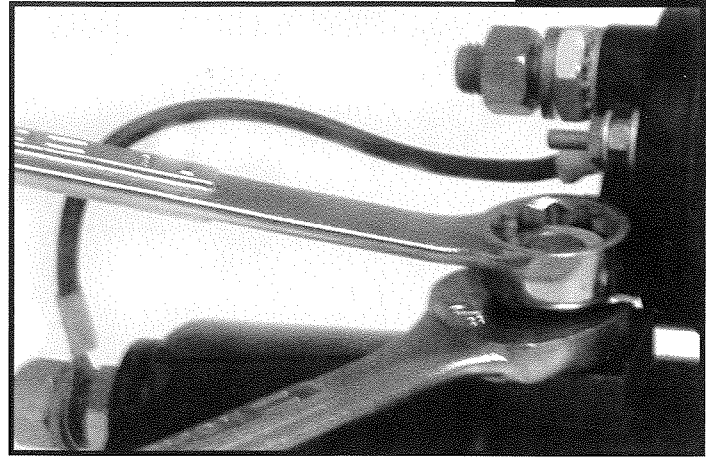
## DISASSEMBLY AND TESTING

Note: Disconnect battery ground cable.

1. Remove cranking motor from engine.
2. Remove switch from field ring as follows:
  - 1 Remove ground lead from terminal #4

- 2.2 Remove nut from terminal #3. Apply no more than 35 lb-ft. If the nut will not come loose due to presence of locking compound, heat the nut with a small blowtorch.
- 2.3 Remove nut and jumper strap from motor and field stud.

FIGURE 2

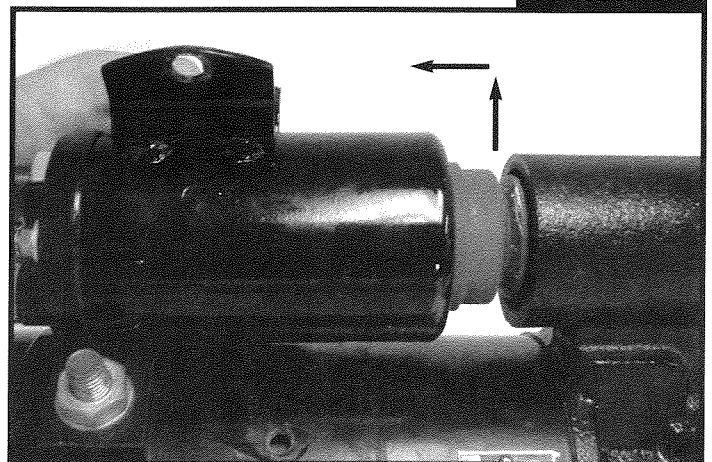


- 2.4 Remove the two hex head screws retaining the switch bracket to the field ring.
- 2.5 On MD, ME models, pull the switch away from the shift housing, and rotate the body so that the switch brackets are away from the motor. Lift the switch up and pull it away from the shift housing.

ON MA and MB motors, pull the switch away from the shift housing, and hold the plunger with a strap wrench, or wrap a strip of emery cloth around the plunger to avoid nicks, and grip with a pair of channel lock pliers, and unscrew the spool from the plunger for a few turns. Remove the rubber plug from the base of the solenoid, between terminals #1 and #3, and using a 1/4" deep well socket, unscrew the plunger to separate the switch from the shift housing.

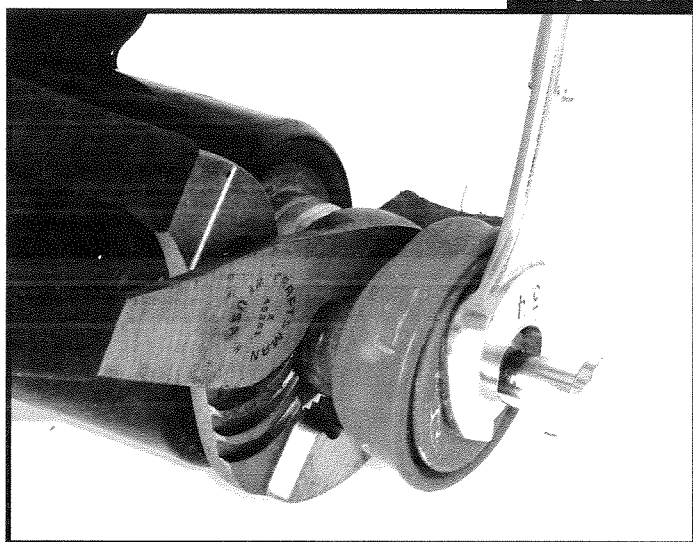
**Caution:** If the plunger surface is nicked, the high points must be cleaned up to prevent damage to the bushing in the solenoid, or the plunger replaced.

FIGURE 3



3. Switch disassembly performed as follows:
  - 3.1 Remove nuts, lockwashers, spacers and o-rings from the #1 and #4 terminals.
  - 3.2 Pull plastic end base out just enough to expose the internal connection to the #3 terminal, and remove the screw to disconnect the lead. Then remove the base from the solenoid.

On fixed timing motors, inspect the boot for tears or seals. If in good condition, re-use the boot, otherwise grip the plunger as in 2.5 and unscrew the spool to replace the boot, as in figure 4.



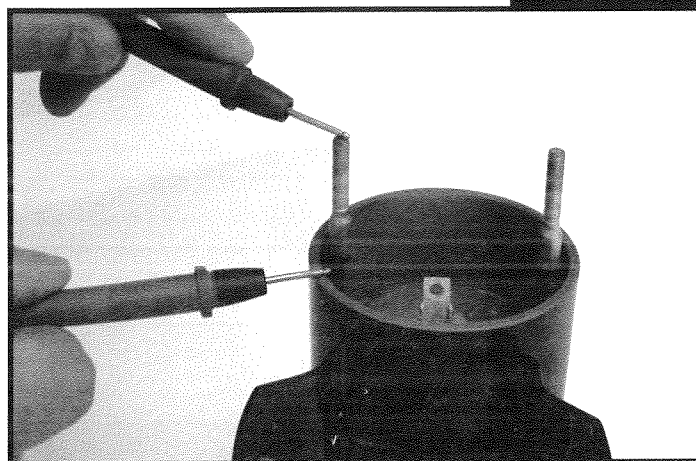
**FIGURE 4**

- 3.3 Holding the plunger, either by gripping in a vise, or as in 2.5, heat the 1/4" nut on the contact disc shaft with a small flame propane torch to soften the locking compound.
- 3.4 Unscrew the nut a few turns. Either hold down the contact disc against the spring pressure, or place the base back on the switch before completing removal of the nut to prevent the disc and other components from flying off.
- 3.5 Inspect all insulation washers and bushing. Broken, cracked or burned insulators must be replaced with new ones.
- 3.6 Inspect conical spring. If it is collapsed, or shows signs of heat, then replace with new.
- 4 Switch Coil Ground Test

Connect one ohmmeter lead to terminal #1, and the second test lead to a bare metal surface on the housing. (figure 5)

LOW resistance (<10kiloohms) - coil is grounded: switch assembly must be replaced.

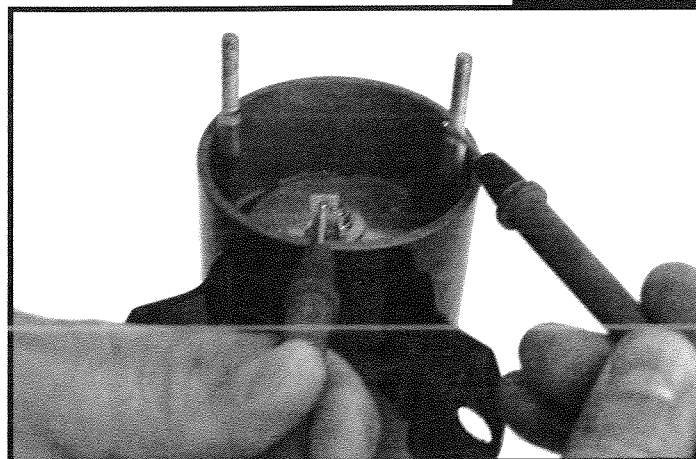
HIGH resistance (>10kiloohms) - Coil is OK: continue with step 5



**FIGURE 5**

#### 5. Switch Coil Resistance

Connect one ohmmeter lead to terminal #3 and #4. Resistance readings should be 3.5 to 4.5 ohms. If resistance readings fall outside these values, the switch must be replaced. See figure 6

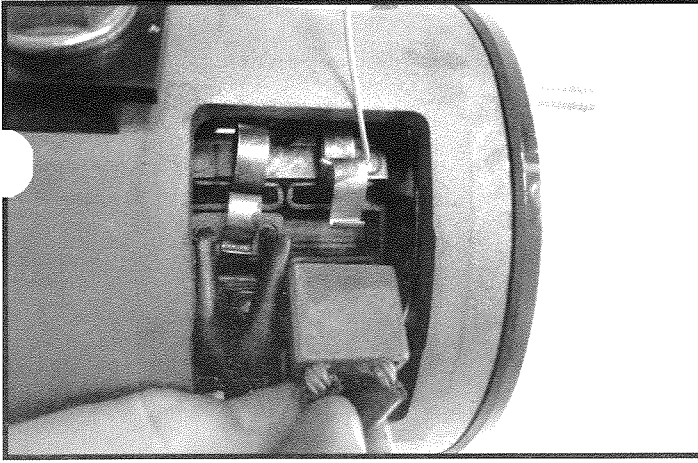


**FIGURE 6**

#### MA, MB, MC motor CE housing

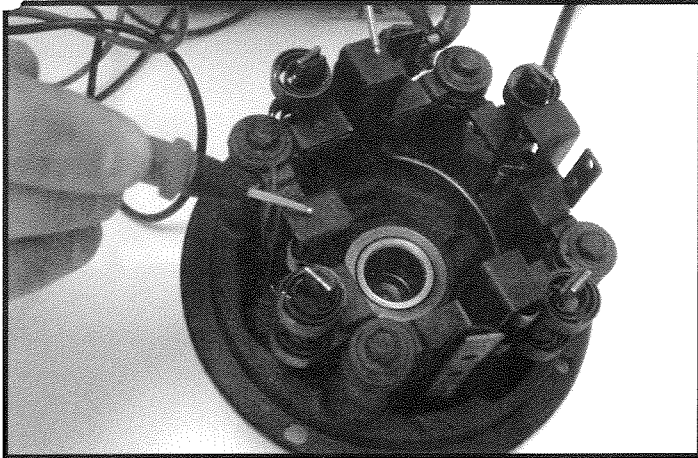
1. Remove two #10 screws and brush opening band assembly.
2. Remove screws from the brush leads and lock plates.
3. Pull springs upward with tool shown in fig. 7, and remove the brushes.
4. Inspect brushes for wear. Brushes less than 5/8" in length must be replaced.
5. Mark CE housing in relation to field ring with a punch or paint marker.
6. Remove four hex head screws and remove CE housing.
7. Remove ground jumper if fitted to the field coil side of the brushholders. If the insulation is burned or damaged, #1 jumper must be replaced.



**FIGURE 7**

8. Insert a new brush in each brush slot (with the spring held out of the way). If the brush does not move freely on one of the slots, then that brushholder must be replaced.
9. Inspect each of the four brushholders. Discoloration, burns or distortion indicate defective or improperly assembled insulators
10. Brush Holder Insulation Test

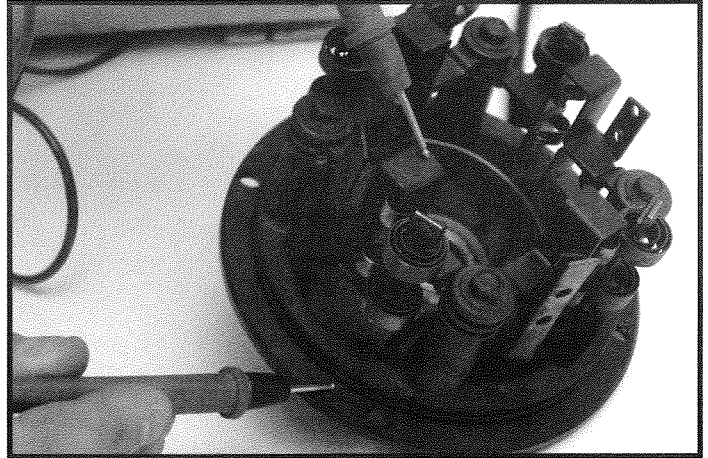
Connect an ohmmeter test lead to each of two adjacent brushholders. (figure 8) A LOW resistance reading indicates that an insulation bushing or washer is defective and must be replaced.

**FIGURE 8**

#### 11. Brush Holder Assembly Ground Test

On later CE assemblies which have the ground strap connecting the two negative brush holders positioned between the brushholder and CE housing casting, position the strap to ensure that it is not touching the casting at any point (it is easiest to loosely replace the brush screws to hold it in position). Connect one ohmmeter test lead to a bare metal surface on the CE housing, and the second test lead it turn to each of the four brush holders. LOW resistance indicates

a grounded brush holder caused by defective insulator(s). (figure 9). On later CE assemblies this could also be caused by the ground stud insulators - separate the ground stud jumper from the brushholder, and re-test to determine which is responsible for the short.

**FIGURE 9**

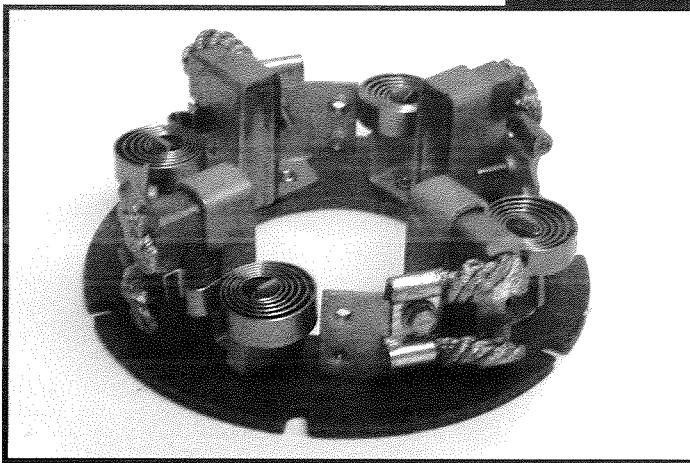
12. Visually inspect insulators at each of the four mounting posts. Broken, cracked, burned or charred insulators must be replaced.
13. Ground Stud insulation test.  
Ensure that the ground stud jumper is not touching the brushholder. Connect one ohmmeter test lead to a bare metal surface on the CE housing, and the second test lead to the ground stud. LOW resistance indicates a defective insulation bushing or washer.
14. Inspect bronze bushing in CE housing. If inside diameter is greater than 0.756", or there is evidence of heat, or rotation of the bushing in the housing (look for misalignment between the crossdrilling and the oilwick hole), then bushing must be replaced (see Assembly section for specific instructions).

### **ME model CE Housing and Brush Plate Disassembly and Testing**

1. Remove hardware and insulators from ground stud.
2. Remove 6 screws and sealing rings from CE housing, and remove housing (tap underside of housing with soft-faced mallet to ease housing off o-ring seal). Remove and inspect bushing and inner insulator for damage.
3. Check CE housing for damage including scoring or corrosion of the sealing surface, distortion or cracking of the casting. If inside diameter is greater than 0.756", or there is evidence of heat, or rotation of the bushing in the housing (look for misalignment between the crossdrilling and the oilwick hole), then bushing must be replaced (see Assembly section for specific instructions).

4. Remove the four screws holding the field coil connecting tabs to the brushholders, and lift the brush plate off the motor.
5. Remove the four screws holding the ground stud and jumper assembly to the brushholders, and remove it and the brushes from the brush plate assembly. Brushes less than 5/8" in length must be replaced. Ensure that the brush flexible leads are not melted or have broken strands.
6. Visually inspect brush plate. Ensure that the rivets are holding the brushholders securely to the plate, and that the plate is not cracked, charred, or has material broken away from the clamping areas around the periphery. See figure 10
7. On MA and MB motors, remove rubber boot from shift housing, and inspect for damage. If found in good condition, reuse boot.
8. Unscrew the #10 screw and remove the flat washer, then remove shaft (pry out using screwdriver in slot for washer). If shift lever shaft surface has grooves worn by the shift lever, or is corroded, replace. Inspect o-ring for damage.
9. Remove the shift lever from the housing and inspect the shift lever pivot hole for elongation. If worn oval (over .508") shift housing must be replaced. On MA, MB and MC motors, remove the roll pin from the arm and link assembly, check the aperture on the link screw for wear, and replace the roll pin with a new part.

**FIGURE 10**



## Motor Disassembly and Testing Continued

Note: Mark nose housing and shift housing with a punch or paint marker to aid proper positioning at reassembly.

1. Remove the six socket head screws from the nose (pinion) housing. Tap the flange to ease the nose out of the shift housing.
2. Inspect the nose housing bushing. If inside diameter is greater than .753", or there is evidence of heat, or rotation of the bushing in the housing (look for misalignment between the crossdrilling and the oilwick hole), then bushing, or assembly must be replaced.
3. Pull armature out of motor, and remove drive assembly and brake washer.
4. Inspect drive.  
If drive pinion rotates in both directions or does not push smoothly into the assembly, then a new drive must be installed.
5. Remove the five socket head screws, and remove shift housing.
6. Inspect shift housing bushing and seal. Replace bushing if diameter is larger than 0.878".

10. Check the armature shaft splines for twist, wear or corrosion. If damaged, the armature must be replaced.
11. Armature ground Test  
Connect one ohmmeter test lead to the armature shaft, and the second test lead to the commutator. LOW resistance indicates a ground, and the armature must be replaced.
12. Perform armature growler test to ensure armature is not shorted.
13. Check commutator surface. If commutator is pitted, rough scored, burned, or coated with hard carbon or oil, the commutator must be turned. Minimum diameter is 2.06" and concentricity between the commutator surface and the bearing diameters that fit in the CE and shift housing should be 0.003" or better.
14. Field Coil Ground Test

Connect one ohmmeter test lead to a bare metal surface on the field ring, and the second to either of the two field coil/brush jumpers. LOW resistance indicates a ground, and the field coil must be replaced.

Note: It is recommended that a hi-pot test be performed, on the intact field coil and frame assembly by a qualified electrical shop. THIS TEST CAN CAUSE INJURY OR DEATH. ONLY TO BE PERFORMED BY QUALIFIED PERSONNEL

15. Inspect the interior of the field ring and field coil. If burn marks are noticed on the field coil insulation, the field coil must be replaced. If there are rub marks on the pole pieces and armature stack, check the condition of the CE housing and shift housing bushings, and replace as necessary.

## COMPONENT CLEANING

1. Solenoid switch, armature field coil, ME brush plate and drive assembly should not be immersed in solvents, and can be cleaned using a cloth with a little solvent on it. Remove brush dust from armature and field ring assembly using compressed air.

2. Clean all other metal parts with cleaning solvent, and a wire brush where appropriate.
3. MA/MB/MC style brushholder assemblies, insulation washers, bushing and spacers can be cleaned by dipping in solvent and drying off using compressed air.

Note: Brushholder insulators can usually be cleaned without removal.

## ASSEMBLY

1. Install field coil in field ring as follows:
  - 1.1 Ensure that the field ring is free of dirt and varnish.
  - 1.2 Place pole pieces in field coils, to check the fit.
  - 1.3 Squeeze field coil assembly inwards so outside diameter is slightly smaller than the ID of the field ring.
  - 1.4 Insert field coil in field ring so that the hole in the jumper for the field stud lines up with the hole in the frame.
  - 1.5 Place pole pieces in field coils, aligning the notches to the bump in the coil caused by the inner termination of the field coil. Align pole piece holes with the holes in the frame using a round bar, taking care not to damage the threads. Install the pole screws finger tight.
  - 1.6 Use an expanding mandrel or similar to force the pole pieces out against the inside of the field ring, and tighten the screws to 18-22 lbf-ft. for the MA/MB/MC/MD motors and 23-25 lbf-ft. for the ME motors.
  - 1.7 Slide the square insulation washer between the field coil header and the field ring, so that the holes align.
  - 1.8 Insert the stud in the hole in the jumper, insulation and through the field ring.
  - 1.9 Push the 5/8" OD insulation bushing over the terminal stud and into the field ring hole. Slide the o-ring down after so it is in flush with the OD of the frame.(figure 11)

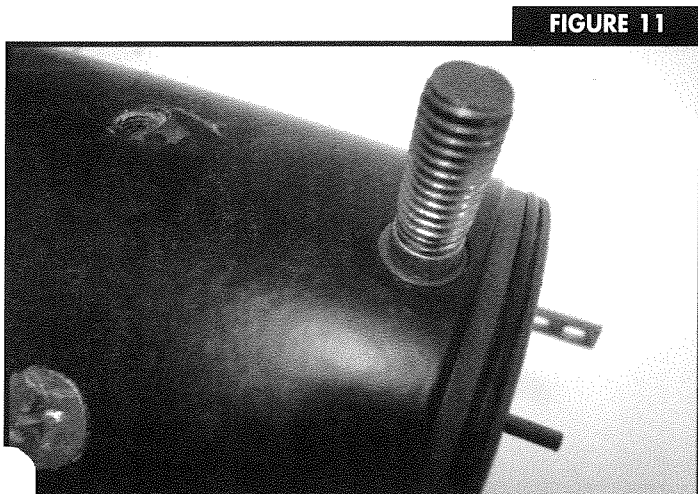


FIGURE 11

2. Slide square insulator down onto the field stud so the radius side rests against the field ring.(figure 12)

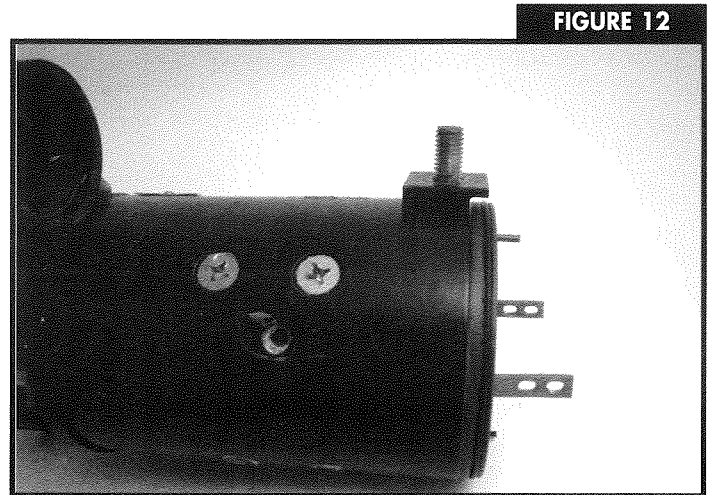
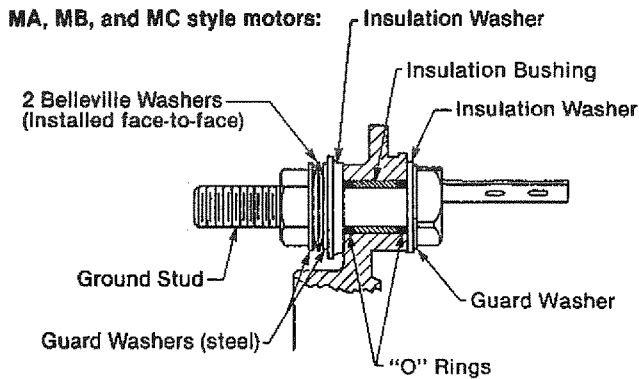


FIGURE 12

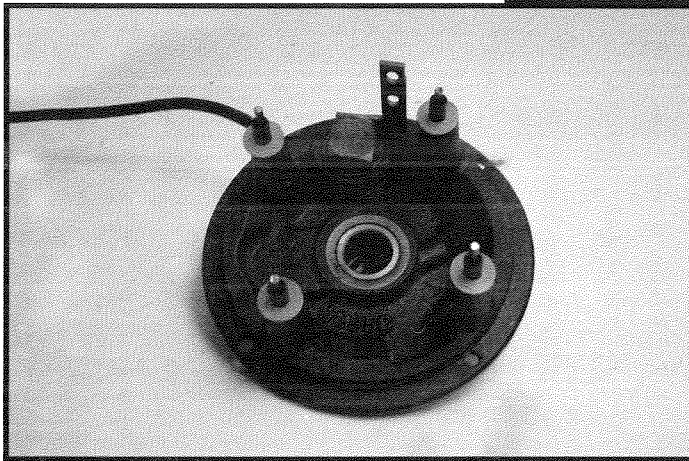
3. Install guard washer, belleville washers open face to open face if fitted, and nut. Torque to 18-22 lbf-ft.
4. Apply varnish to field coils. Do not leave more than a thin film on the ID of the pole pieces.
5. Insert armature into field ring assembly, and ensure that it moves freely within the pole pieces.

## MA, MB MC and MD Motor CE housing Assembly:

1. Assemble CE housing as follows -
  - 1.1 If suitable machining facilities are available, it is possible to replace an oversize bushing in the CE housing. Press a new bushing into the housing after pulling the old bushing out using an expanding bearing puller. Cross drill the bushing through the existing hole using a 11/32" drill then ream bushing to 0.754", checking that there are no remaining burrs from the drilling. However, given the difficulty of ensuring that concentricity is maintained, a replacement CE housing is recommended if facilities are limited.
  - 1.2 Slide guard washer and insulating washer on the ground stud and insert it in the terminal bore in the CE housing. Align the ground stud in its correct position (if needed, assemble a brushholder temporarily in place to indicate the correct location for the jumper on the ground stud) and complete installation as shown in figure 13. Tighten to 18-22 lbf-ft. Hold square head of bolt with a wrench to prevent rotation.
  - 1.3 Install brushholders on CE housing as follows:
    - 1.3.1 Insert four guide pins, one in each of the housing mounting posts, and slide an insulation bushing and an insulation washer on each of the pins. Insulation bushings must be positioned flush to the face of the mounting post. (figure 14)

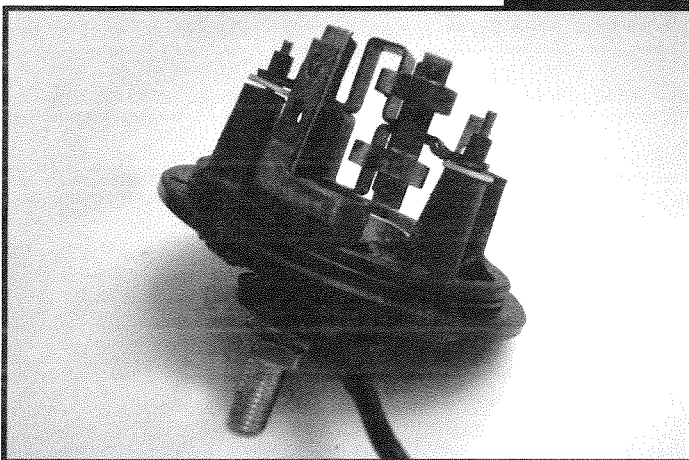
**FIGURE 13**

NOTE: A 1-1/2 in. piece of 1/8 in. diameter rod may be used to make the guide pins.

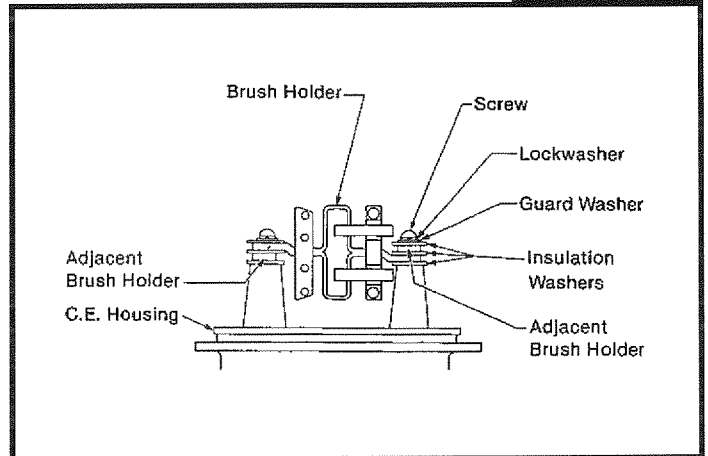
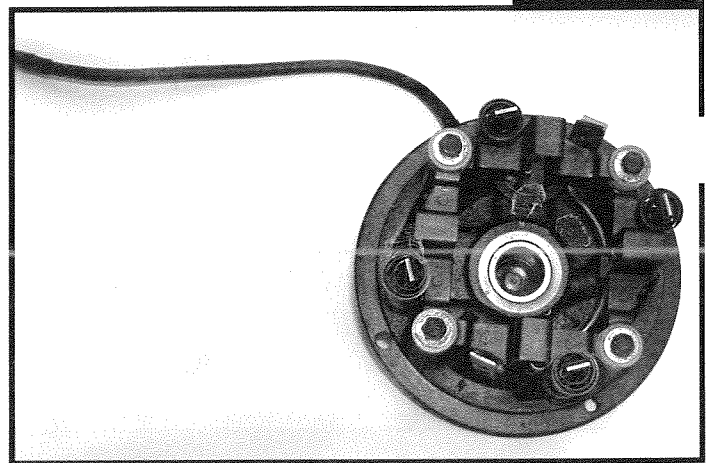
**FIGURE 14**

NOTE: Steps 1.3.2, 1.3.3 and 1.3.4 below cover the installation procedures for new style ground jumpers on MA, MB and MC style motors. For old style ground jumpers, see step 2 on page 8

1.3.2 Place jumper on CE housing and position it along with a brushholder as in figure 15

**FIGURE 15**

1.3.3 Install brushholders on mounting posts with insulation washers, guard washers lockwashers and screws as shown in figure 16. Install an 8-32 x .62" long screw to secure ground jumper between the ground stud jumper and the brushholder contact plate. Figure 17 shows a correct assembled CE housing.

**FIGURE 16****FIGURE 17**

1.4 Install o-ring in the groove provided in the CE housing

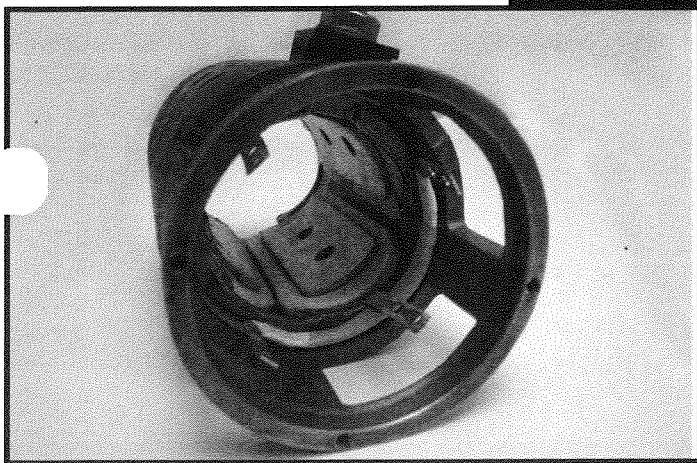
2. Install old style ground jumper between the field ring and field coil so that the jumper tabs are positioned approximately at 90° to the field coil tabs. Ensure that the jumper fits snugly in place. See figure 18.

Slide the armature through the field ring and align the commutator with the cutouts in the ring.

3. Slide steel, then fiber thrust washer onto the commutator end of the armature shaft. The steel washer must be first, against the shoulder on the shaft.

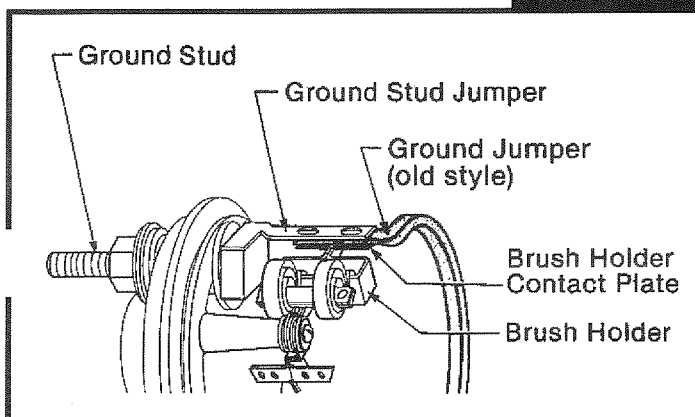
4. Match the CE housing to the field ring according to the marks made on disassembly, and align the ground stud jumper with the ground jumper tab (old style jumper only,



**FIGURE 18**

Press the CE housing flush with the field ring.

When installing an old style ground jumper, ensure that the ground jumper tab meshes with the ground stud jumper and brush holder contact plate. See figure 19.

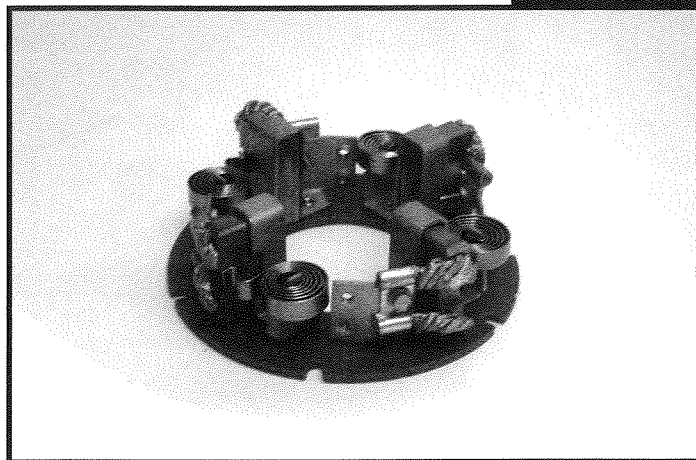
**FIGURE 19**

5. Apply 1-2 drops of Loctite 242 on four 1/4-20 hex head screws. Use these screws plus four lockwashers to secure the CE housing to the field ring. Torque to 62-66 lbf-in.

### ME motor CE housing and brush rigging assembly

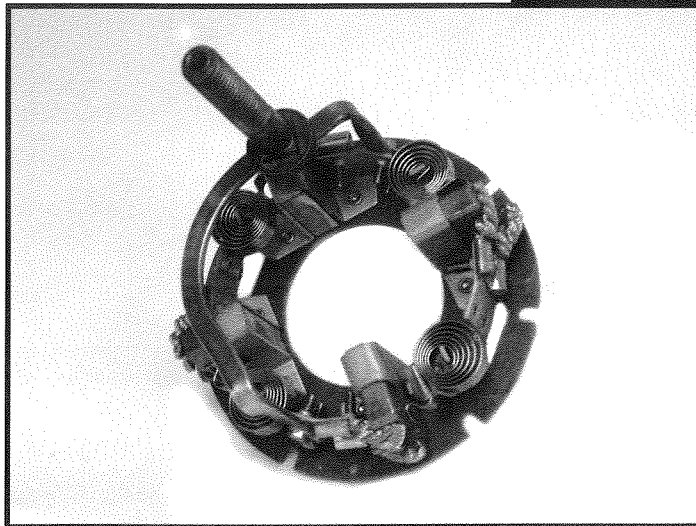
1. If suitable machining facilities are available, it is possible to replace an oversize bushing in the CE housing. Press a new bushing into the housing after pulling the old bushing out using an expanding bearing puller. Cross drill the bushing through the existing hole using a 11/32" drill then ream bushing to 0.754", checking that there are no remaining burrs from the drilling. However, given the difficulty of ensuring that concentricity is maintained, a replacement CE housing is recommended if facilities are limited.
2. Saturate CE wick in 80 grade oil, then install in CE housing, and screw pipe plug in to 75 lbf-in. to retain.
3. Pass a brush contact plate through one of the brush holder slots in the brush plate from the inside out. Press brush

through holder until the brush spring is pushed out of the way and snaps down the side of the brush. Repeat for the remaining 3 brushes. Screw each brush contact plate in with a socket head screw. Torque to 25-35 lbf-in. See figure 20.

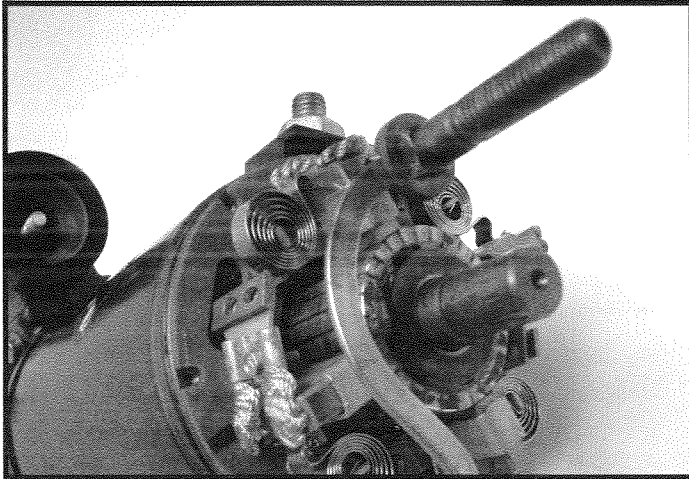
**FIGURE 20**

NOTE: If original brushes are less than 5/8" long, then install new brushes.

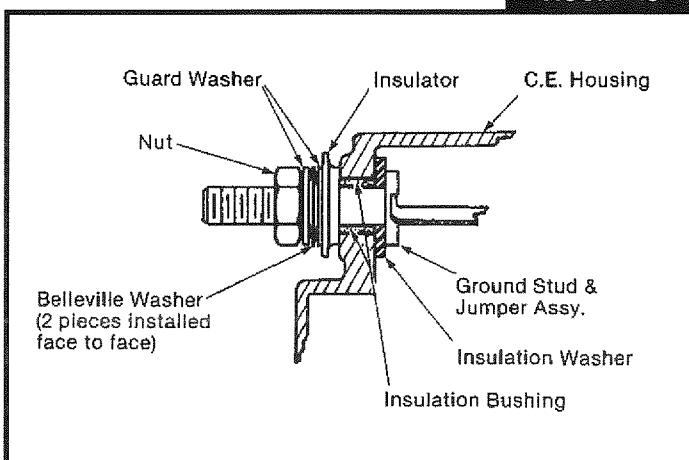
4. Install ground stud and jumper assembly to brush plate with 4 screws, torqued to 25-35 lbf-in. See figure 21. If not sure of correct position of assembly, place the jumper inside the CE housing through the hole, and align the asymmetric pattern of notches with the bolt holes to see the correct orientation.

**FIGURE 21**

5. Slide armature in field ring so commutator extends approximately 2" out of field coil stud end of field ring.
6. Install two roll pins in commutator end of field ring if not already present.
7. Place brush plate on field ring so roll pins pass through locating holes. Figure 22

**FIGURE 22**

8. Secure field coil tabs with four screws. Torque to 25-35 lbf-in.
9. Press each of the four brushes inward to bring them into contact with the commutator. It may be necessary to pull the springs out to ease the movement of the brushes. Ensure that the springs are positioned on the recessed face on the back of the brushes, and not in contact with the flexible leads.
10. Install o-ring in groove in OD of field ring, and lightly oil or grease.
11. Slide a square insulation washer, o-ring and insulation bushing on ground stud.
12. Slide a steel thrust washer, then a fiber thrust washer (soaked in 80 grade oil) onto the commutator end of the armature shaft. The steel washer must be first, against the shoulder on the shaft.
13. Install commutator end housing assembly onto field ring with six 10-32 screws and sealing washers. Torque to 40-50 lbf-in.
14. Install insulation washer, guard washer, belleville washers if originally fitted, and nut onto ground stud as shown in figure 23. Torque to 23-27 lbf-ft.

**FIGURE 23**

## Motor Assembly

1. Press bushing flush with the drive side of the shift housing
2. Press seal in protruding side of the shift housing center boss so that the flat side of the seal is facing outwards and flush with the surface of the housing. Install o-ring in the groove around the outside of the housing.
3. On MA and MB motors, assemble the link screw to the shift lever with a new roll pin, and insert the assembly into the shift housing

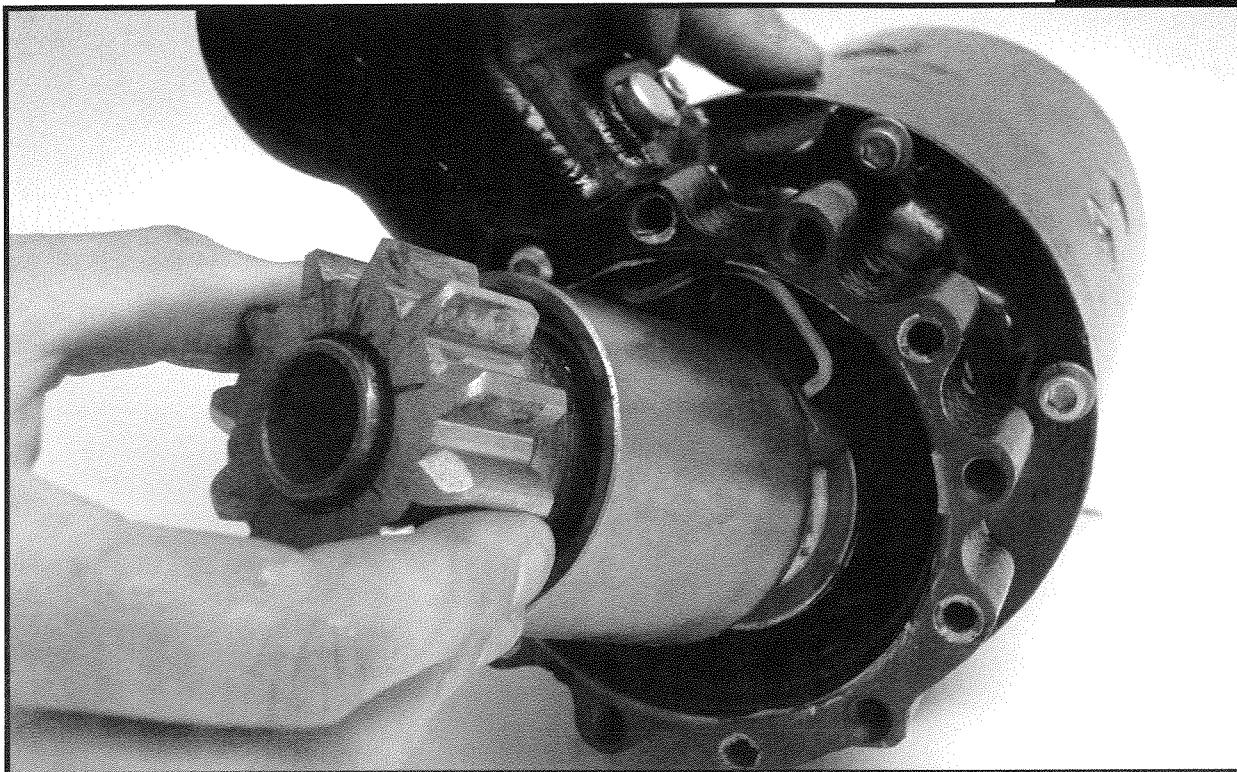
**CAUTION:** Inspect the shift lever and link screw and ensure that the top sections of the lever either side of the link are parallel and not binding on the link screw.

Inspect the rubber boot and (if in good condition) slide it, closed end first, on the link screw up to the shoulder. Position the boot o-ring section into the groove inside the shift housing.

**NOTE:** On MC, MD and ME motors, the boot is installed in a manner described later.

4. Assemble o-ring to shift lever pivot pin inner groove and press the shaft through the shift housing and the shift lever. Slide the flat washer in outer groove of the shift lever pin, and secure with a #10-32 socket head screw (with 1-2 drops of Loctite 242 or similar applied to threads) to the shift housing.
5. Slide thrust washer on armature shaft up to shoulder inside armature endwindings.
6. Apply a film of NLGI 00 grade grease on armature shaft and splines.
7. Hold field ring (with armature inside the ring) in a vise and slide the shift housing on the shaft so that the armature shaft sticks about 1" through the shift housing.
8. Slide the 2" OD brake washer onto the armature, and place it against the housing.
9. Apply a small amount of grease to the holes in the shift lever cams, and to the long sides of the cams (these make contact with the drive collars on the drive).
10. Slide a cam on each of the two shift lever pins.
11. On MA and MB motors, with one hand pull the link screw out forcing the shift lever to swivel the cam end forward to the front of the housing. Adjust the cams so that they are parallel to each other. Slide the drive assembly over the cams, so that the cams are riding in the drive channel. See figure 24. Slide the drive assembly on the armature shaft, and slide the shift housing towards the field ring, passing the armature shaft through the drive at the same time.

FIGURE 24



On MC MD and ME models, insert a finger in the shift housing and pull back the top of the shift lever, then perform the same sequence as above.

Press the shift housing into the field ring. Ensure that the housing and field are aligned.

Apply 1-2 drops of Loctite 242 to the threads of 5 socket head screws (1/4-20 x 1.25"). Use these screws and 1/4" lockwashers to fasten the shift housing to the field ring. Torque to 108-132 lbf-in.

13. Install nose housing as follows:
  - 13.1 Slide 1/8" thick thrust washer on the armature shaft and place against the drive pinion.
  - 13.2 Install o-ring in groove around nose housing.
  - 13.3 Match the alignment markings made at disassembly and secure nose housing the shift housing with 6 socket head screws with 1-2 drops of Loctite 242 applied to the threads. Torque to 13-17 lbf-ft.

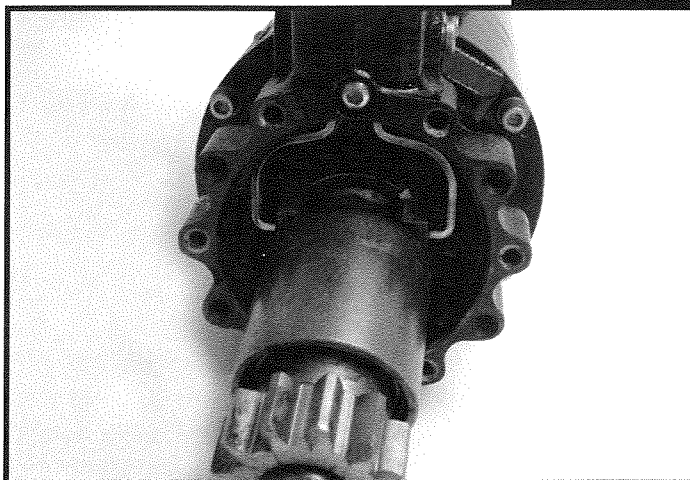
NOTE: The shift housings used on these motors have 12 tapped holes to allow the nose to be "indexed" (positioned) in a variety of positions. Only 6 screws are used to mount the nose, and when the top hole is not used, then a socket head setscrew is used, with 1-2 drops of Loctite 242 applied to the threads, to seal the top hole. On ME motors, a button head screw with an o-ring is used. See figure 25.

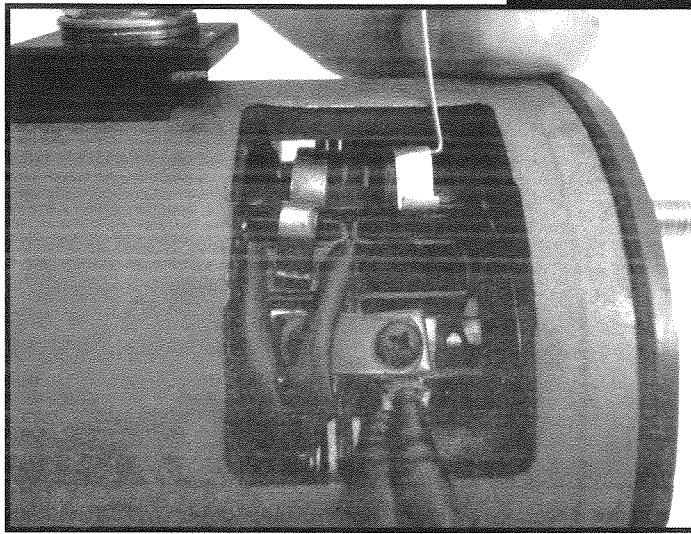
- 13.4 Install rubber plugs on the six holes in the nose housing not used.

14. MA, MB, MC models, motor brush installation performed as follows:

- 14.1 Pass two 8-32 screws through a lockplate, and slide a brush terminal onto each of the screws. Fasten the assembly to the brushholder, with the flexibles positioned away from brushholder tunnel.
- 14.2 Using the hook tool shown in figure 26, pull the inside brushholder spring up and insert the brush on the slot, ensuring that the flexibles are not twisted or trapped (see installed brush in figure 26). Repeat this step for the outer brush.

FIGURE 25



**FIGURE 26**

- 14.3 Wrap the brush opening band around the four brush openings in the position of the paint line, and secure with two #10-32 screws.

Before installing the band, ensure that dirt, oil or any other foreign matter is removed from around the brush openings to ensure proper sealing.

15. Assemble the switch as follows:

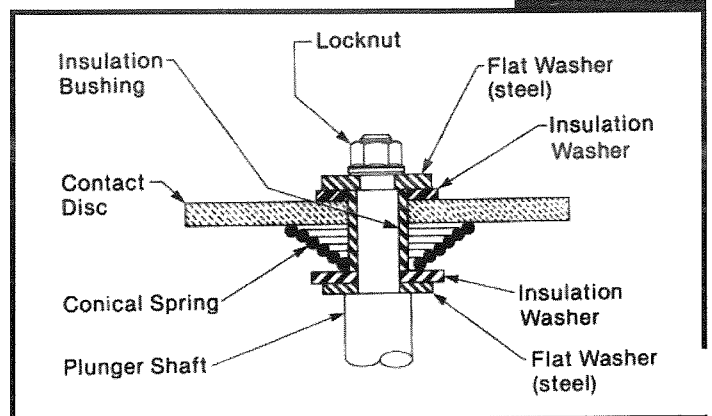
- 15.1 Slide the return spring on the plunger shaft, and insert the shaft through the yoke and through the hole in the stationary core so that the shaft sticks out into the contact cavity.

**NOTE:** Ensure that the plunger is free from any nicks, burrs or corrosion. If not, then a new plunger must be used.

- 15.2 Place the switch with the plunger pointing down (open end of the switch body facing up) in a vise so the plunger rests on the vise slide bar (the part that joins the two jaws together). Press the switch housing down to force the plunger all the way into the switch body against the return spring. With both legs of the switch bracket facing one of the two jaws, clamp the switch housing in the vise with just enough pressure to hold the switch in place, to avoid bending the bracket.
- 15.3 Slide the 1/4" ID steel washer onto the shaft so it fits flush with the shoulder.
- 15.4 Slide the 1/4" ID insulation washer onto the shaft and place it against the steel washer.
- 15.5 Slide the 1/4" ID bushing on the shaft, and place against the insulation washer.
- 15.6 Place the small end of the conical spring against the insulation washer.
- 15.7 Place the 2" OD copper contact disc on the conical

spring, and depress the spring so the disc passes down over the insulation bushing.

- 15.8 While depressing the contact disc, place the 3/8" ID insulation washer on the disc so the insulation bushing passes through the washer.
- 15.9 Place the 1/8" ID steel washer on the shoulder of the shaft.
- 15.10 Apply a drop of Loctite 242 to the shaft threads, and install the 1/4" locknut finger-tight to hold the contact disc. Grip the plunger in a soft jawed vise, and torque the nut to 55-60 lbf-in. See figure 27 for correct assembly. Holding the contact disc and insulator down over the bushing while tightening will ensure that the bushing is not damaged by compressing the washer against the end of it.

**FIGURE 27**

- 15.11 Install the #2 and #3 contact studs in the contact base. Insert the 2-1/4" long stud in the #2 terminal hole, and slide two o-rings, a flat washer and a lockwasher onto the contact stud. Apply a drop of Loctite 242 to the stud threads, and tighten the jam nut to 23-27 lbf-in. Install the shorter terminal stud on the #3 hole in the same manner, ensuring that the tapped hole in the side of the head faces outward.
- 15.12 Place the sealing ring over the outside of the switch housing.
- 15.13 Pass the two terminals through the #1 and #4 terminal holes in the plastic end base and connect the loose terminal to the #3 contact stud with a #6 screw. See figure 28.
- 15.14 Press the plastic contact base on the switch housing and slide two o-rings, a spacer bushing, a flat washer and a lockwasher (if nut/lockwasher assemblies are not used) onto the terminals. Secure with #10-32 nuts and tighten to 28-34 lbf-in.
- 15.15 On MD and ME motors, slide the closed end of the rubber boot against the hex shoulder of the link spool. If

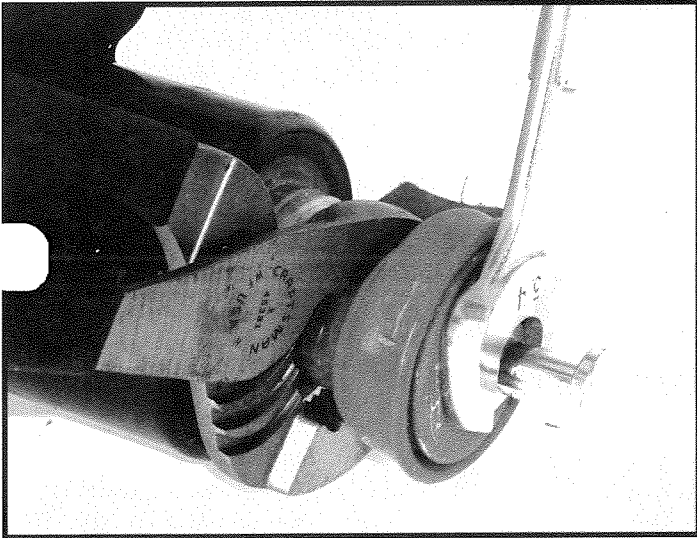


FIGURE 28



the link spool in the switch plunger and torque to 54-66 lbf-in. Grip the plunger either in soft jaws in a vise or using a pipe wrench and a strip of emery cloth to grip the plunger. Ensure that no nicks or burrs are raised during this operation. Figure 29

FIGURE 29

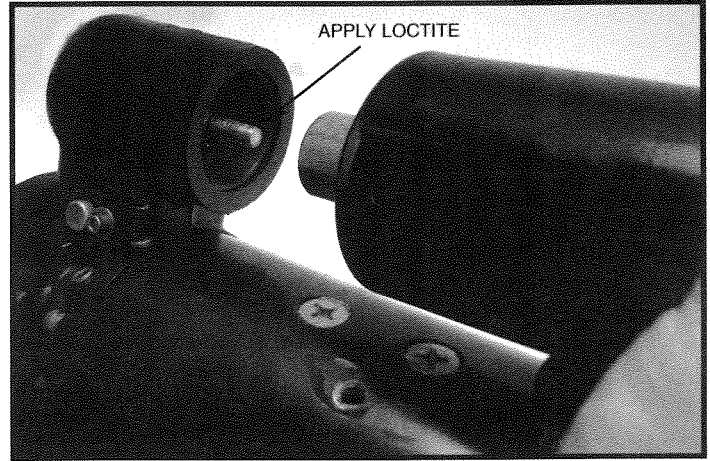


## SWITCH INSTALLATION AND TIMING FOR MA MB AND MC STYLE MOTORS

**NOTE:** Read these instructions through before starting this operation. Once started, the timing procedure must be completed within 15 minutes to avoid the locking compound from setting before the switch is in place and correctly adjusted.

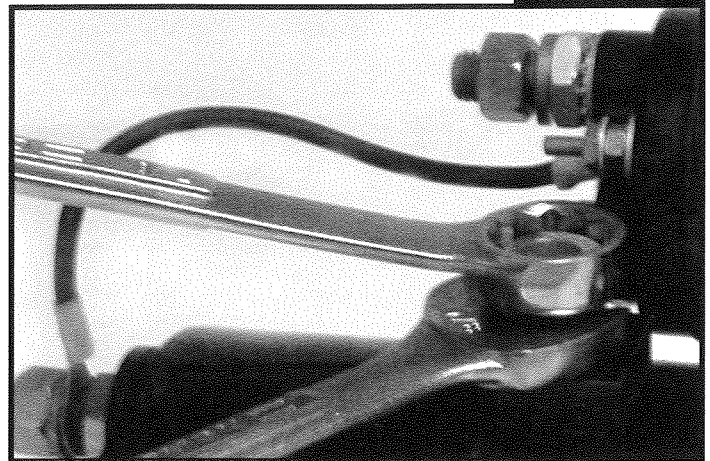
1. Apply a bead of Loctite 2114 to the first 1/2" of the link screw threads. **NOTE** Link screw must be free of dirt, oil or grease. See figure 30.
2. Apply a thin film of SAE 10-30 grade oil or NLGI 00 grade grease around the 'nose' of the switch yoke that will fit inside the shift housing.

FIGURE 30



3. Insert a 1/4" deep well socket in the access hole in the plastic end base, and engage with the 1/4" locknut.
4. Position the switch (with two mounting legs away from the field ring) in alignment with the link screw, and screw the plunger by turning the socket five complete turns.
5. Turn the switch so the mounting legs rest on the field ring and continue turning the socket an additional 10 turns.
6. Press the switch assembly flush with the shift housing.
7. Apply 1-2 drops of Loctite 242 to the threads of the two 3/8-24 x .38" hex head screws, and secure the switch to the field ring. Torque to 20-24 lbf-ft.
8. Place the jumper strap over the #3 terminal and the field stud, and torque the jam nut on the #3 terminal to 21-29 lbf-ft and the one on the field stud to 18-22 lbf-ft. **CAUTION:** Use an open wrench to support the bottom nut while tightening the nut holding the jumper to the field coil stud. See Figure 31.

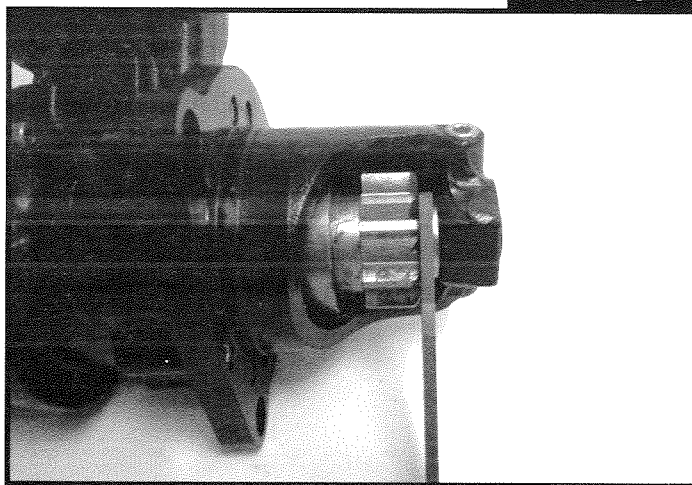
FIGURE 31



- 9.1 Connect 24 volts from a battery through a switch to terminals #1 and #4. (switch initially on off position).

- 9.2 Turn the switch on, and measure the gap between the pinion face and the thrust washer. Proper gap is .187" (3/16"). See figure 32. To perform these procedures the cranking motor is not wired as on a vehicle, and in most cases the solenoid will not have sufficient strength to pull the drive forward to the "engagement" position. In such a case, pry the pinion with a screwdriver until the solenoid takes over. Alternatively, "flash" the switch closed by momentarily touching the #4 terminal with the ground lead or other jumper lead connected to the motor negative terminal (assuming that the motor is now complete and provides a circuit for the pull-in current through the motor windings). CAUTION: Switch must not be energized for more than 30 seconds at a time.

**FIGURE 32**



- 9.3 If the gap is greater or smaller than 3/16", then turn off battery power. Insert the 1/4" socket in the access hole and turn the nut **CLOCKWISE** to decrease the gap, or **COUNTERCLOCKWISE** to increase the gap. CAUTION: Switch must not be energized while adjustments are being made.

- 9.4 Install rubber plug in switch access hole.

10. Install ground lead to switch terminal #4 with lockwasher and nut, or captive washer and nut assembly, torque nut to 28-32 lbf-in.

## SWITCH INSTALLATION ON "MD" AND "ME" STYLE MOTORS

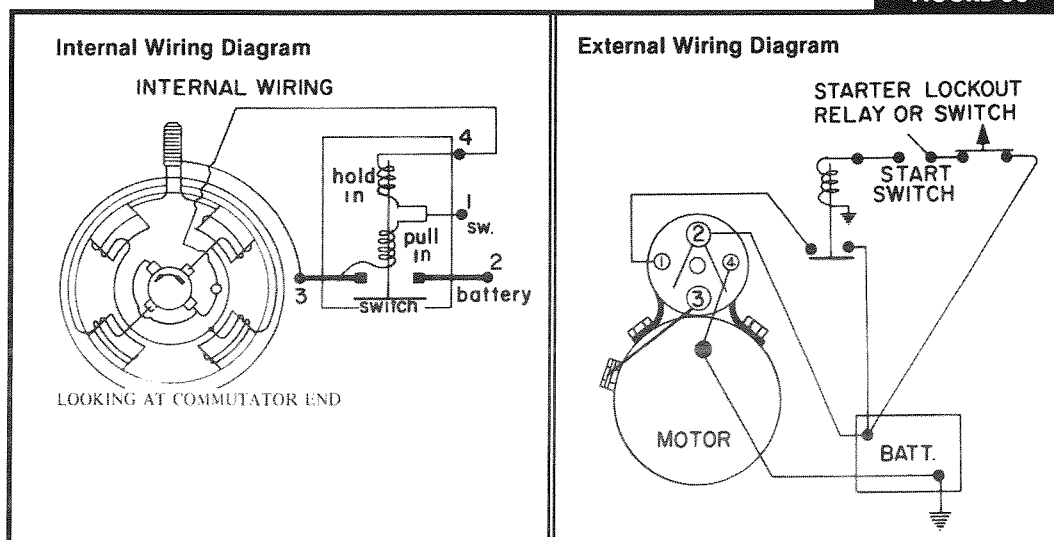
1. Pull the drive fully forward, and, while holding it there, position the switch with two mounting legs away from the field ring, and hook the link spool over the top of the shift lever. CAUTION: Take care not to apply any pressure between the solenoid boot and the edge of the shift housing aperture, or the boot may be damaged.
2. Turn the switch so the mounting legs rest on the field ring, and press the switch assembly flush with the shift housing.
3. Apply 1-2 drops of Loctite 242 to the threads of the two 3/8-24 x .38" hex head screws, and secure the switch to the field ring. Torque to 22-27 lbf-ft.
4. Place the jumper strap over the #3 terminal and the field stud, and torque the jam nut on the #3 terminal to 21-29 lbf-ft and the one on the field stud to 18-22 lbf-ft. CAUTION: Use an open wrench to support the bottom nut while tightening the nut holding the jumper to the field coil stud.
5. Install ground lead to switch terminal #4 with lockwasher and nut, or captive washer and nut assembly, torque nut to 28-32 lbf-in.
6. Install rubber plug in switch access hole.

## WIRING INSTALLATION

1. Install battery cable to #2 terminal. Torque nut to 30 lb.
2. Install start switch lead to #1 terminal. Torque nut to 30 lbf-in.
3. Install ground cable to motor ground stud. Torque nut to 30 lbf-ft.

CAUTION: Use an open wrench to support the bottom nut while tightening the nut holding the ground lead. If this is not done, internal component failure may result.

**FIGURE 33**





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