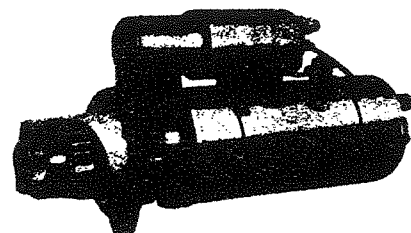
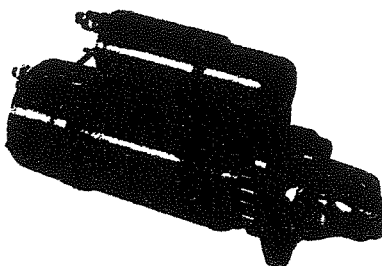
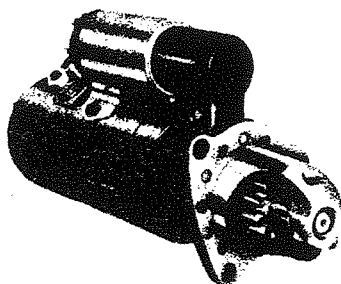


12, 24, & 32 Volt
**Cranking
Motors**

Maintenance Instructions

This form replaces forms 3543, 3779, and 4231

File: Cranking Motor
Maint. Section



**The Following MA, MB, MC, ME, and MX Style Starter Motors
And Motor Packages Are Covered:**

CRANKING MOTOR NO.	VOLTS	CRANKING MOTOR NO.	VOLTS	CRANKING MOTOR NO.	VOLTS
7268M	12	7312M	12	7500M	24 & 32*
7269M	12	7314M	12	7502M	24 & 32*
7276M	12	7318M	12	7504M	24 & 32*
7277M	12	7324M	12	7506M	24 & 32*
7278M	12	7400M	24 & 32*	7508M	24 & 32*
7279M	12	7402M	24 & 32*	7510M	24 & 32*
7280M	12	7404M	24 & 32*	7600M	12
7282M	12	7406M	24 & 32*	7602M	12
7284M	12	7408M	24 & 32*	7604M	12
7288M	12	7412M	24 & 32*	7606M	12
7304M	12	7422M	24 & 32*	7608M	12
7308M	12	7424M	24 & 32*		

PACKAGE NUMBER	VOLTS	PACKAGE NUMBER	VOLTS	PACKAGE NUMBER	VOLTS	PACKAGE NUMBER	VOLTS
93070, 94070	12	93110	24 & 32*	93136, 94136	12	94160	12
93072, 94072	12	93111, 94111	24 & 32*	93137, 94137	12	94161	24 & 32*
93073, 94073	12	93112	12	93138, 94138	24 & 32*	94162	12
93074, 94074	12	93113, 94113	12	93139, 94139	12	94163	12
93076, 94076	12	93118, 94118	24 & 32*	93140, 94140	24 & 32*	94164	24 & 32*
93077, 94077	12	93120, 94120	24 & 32*	93141, 94141	12	94165	12
93078, 94078	12	93121, 94121	24 & 32*	93144, 94144	12	94166	12
93079, 94079	12	93122, 94122	24 & 32*	93148, 94148	12	94167	12
93080, 94080	12	93123, 94123	24 & 32*	93149, 94149	24 & 32*	94168	12
93083	12	93125, 94125	24 & 32*	93150, 94150	12	94169	12
93085, 94085	24 & 32*	93126, 94126	24 & 32*	93151, 94151	12	94170	12
93086, 94086	24 & 32*	93127	24 & 32*	94153	12	94173	12
93089, 94089	24 & 32*	93128, 94128	24 & 32*	94154	12	94174	12
93097	24 & 32*	93129, 94129	24 & 32*	94155	12	94178	12
93098	12	93132, 94132	12	94156	12	94183	12
93100	24 & 32*	93133, 94133	12	94157	24 & 32*	94184	24 & 32*
93103, 94103	24 & 32*	93134	24 & 32*	94158	12	94186	24 & 32*
93107	12	93135, 94135	12	94159	12	94187	24 & 32*
						94188	24 & 32*

*LEECE-NEVILLE 24 volt cranking motors are also used in 32 volt systems.

DESCRIPTION

These maintenance instructions cover 12 volt, 24 volt, and 32 volt cranking motors including the MA and MB styles (adjustable timing motors) and the MC, ME, AND MX style (fixed timing) motors. The MC, ME, and MX motors are recognized by the rounded edges of the switch bracket. Figure 1.

The difference between the adjustable and fixed timing motors is in the way the switch plunger is attached to the shift lever. On MA and MB motors the plunger is screwed on a link screw which is pinned to the shift lever. On MC, ME and MX motors the switch plunger has a link spool that hooks into the fork of the shift lever.

ME and MX motors have a simplified commutator end (C.E.) housing and brush rigging design, which eliminates many parts, making servicing easier and, at the same time, increases motor life.

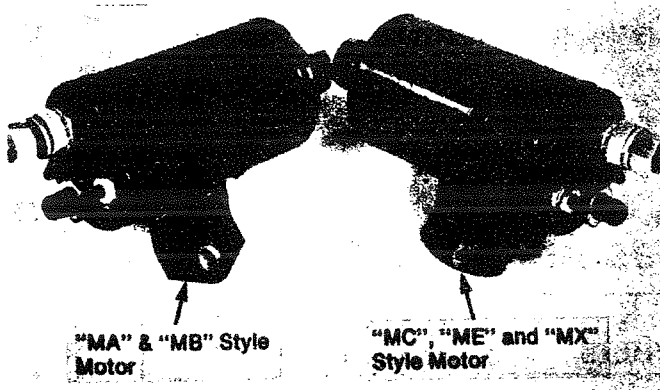


Figure 1

MODE OF OPERATION

(See figure 2)

When the start switch is closed, the coils in the solenoid are energized creating a magnetic field. This field pulls in the plunger which causes the shift lever to push the drive assembly in mesh with the ring gear in the engine. At this time the plunger closes the circuit between the "BATTERY" terminal and the field coil.

The current passes through the field coil, then through the brushes it reaches the armature. The current forms counteracting magnetic fields around the field coil and the armature, causing the armature to turn. The armature turns the drive assembly which cranks the engine through the ring gear.

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 back to its original position. As this happens, the shift lever disengages the drive assembly from the ring gear teeth. The contact from the "BATTERY" to the field coil is also broken by the returning plunger, which causes the armature to stop turning.

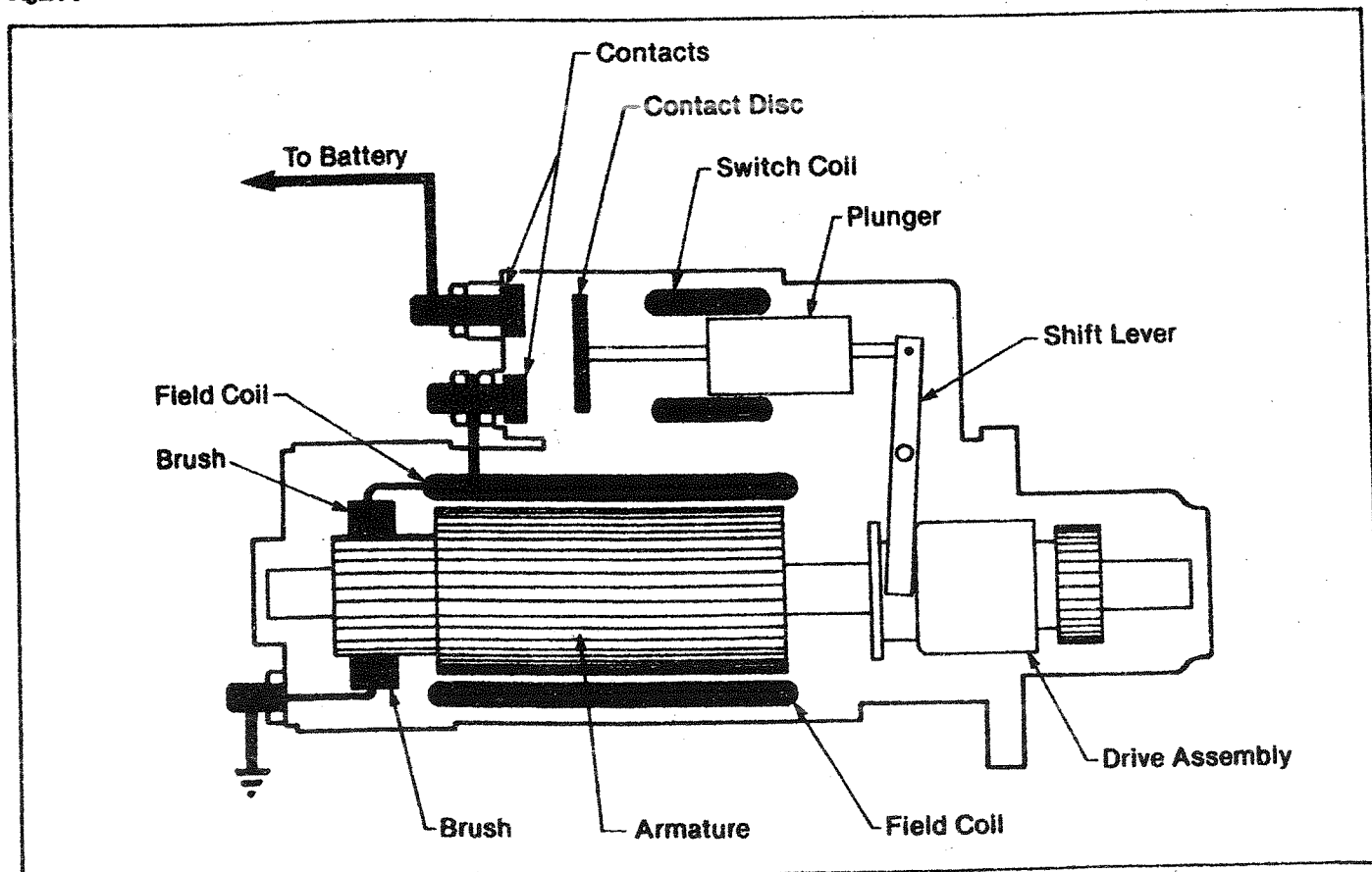


Figure 2

CRANKING MOTOR TROUBLE-SHOOTING

1. Check specific gravity of batteries. Minimum allowed is 1.230 SP GR (or 75% charged).

NOTE: A digital voltmeter can be used to establish state of battery charge. Before any voltage measurements are taken, the engine must be turned off and the battery surface charge must be removed by turning on the headlights for 5-10 minutes. If voltmeter shows a rapid increase in voltage to about 12.45 volts or higher, then the surface charge has not been removed completely; repeat the headlights on procedure. When measured voltage increases SLOWLY to 12.45 or higher, then the battery surface charge has been removed and the battery is at least 75% charged.

2. Connect a jumper to switch terminals #1 and #2 for approximately 2-3 seconds. Jumper must be made of at least 12 gage insulated wire with insulated clips.

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

IF the switch activates and the motor spins, but the engine is not cranked, then the drive assembly is faulty. Remove cranking motor for service.

IF the switch activates and the motor does not spin, then the problem is in the switch. Remove cranking motor for service.

IF switch does not activate see step 3.

3. With the jumper connected to terminals #1 and #2 connect a second jumper to terminal #4 and to ground for 2-3 seconds.

IF the switch activates and motor cranks, then ground jumper at switch terminal #4 is defective and must be replaced. Motor and switch are OK.

IF the switch does not activate, then switch is defective and must be replaced or removed for service.

DISASSEMBLY AND TESTING

NOTE: Disconnect battery ground cable.

1. Remove cranking motor from engine.
2. Remove switch from field ring as follows:
 - 2.1 Remove ground jumper from terminal #4.
 - 2.2 Pre-heat terminal #3 and remove nut.

NOTE: If terminal is not heated the plastic base may be damaged during disassembly.

- 2.3 Remove nut and jumper strap from field coil stud.

CAUTION: Use an open wrench to hold the bottom nut while removing the top nut. Failure to do this may damage the field coil. Figure 3.

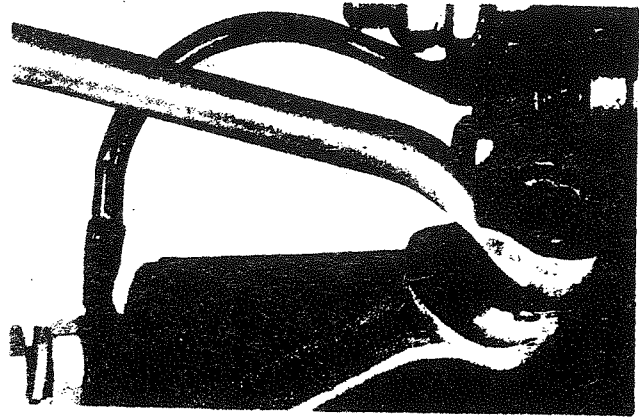


Figure 3

- 2.4 Remove 2 hex head screws from switch bracket, which secure the switch to the field ring.

- 2.5 On MC, ME, and MX motors, pull the switch away from the shift housing and turn the switch so the mounting legs face away from the field ring. Lift the switch up and pull it away from the shift housing. Figure 4.

On MA and MB motors, pull the switch away from the shift housing and wrap a strip of emery cloth twice around the plunger to avoid nicks. Grip the plunger with a pair of channel lock pliers and unscrew the plunger about 3 turns. Remove the rubber plug from the plastic end base and insert a 1/4" deep well socket (Snap-On Tool Co. STMD-8) in the access hole. Engage the socket with the 1/4" nut inside the switch and unscrew the plunger to separate the switch from the shift housing.

CAUTION: If the plunger surface is nicked then the plunger must be replaced.

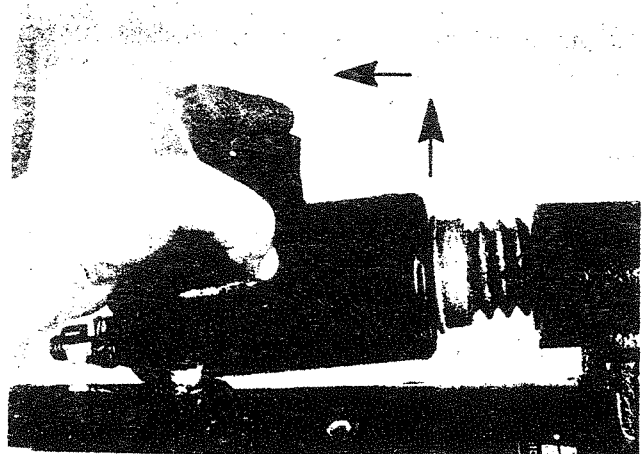


Figure 4

3. Switch Disassembly performed as follows:

- 3.1 Remove nuts, lockwashers, and "O" rings from #1 and #4 terminals.
- 3.2 Pull plastic end base just enough to expose the interior connection of the #3 terminal and remove screw to disconnect the lead. Then remove the plastic end base.

On MC style motors, push the rubber boot back so the plunger is exposed and wrap a strip of emery cloth twice around the plunger to avoid nicks. Grip the plunger with a pair of channel lock pliers and unscrew the link spool with a wrench. See figure 5.

Inspect rubber boot for cracks or other types of damage. If found in good condition, reuse the boot.

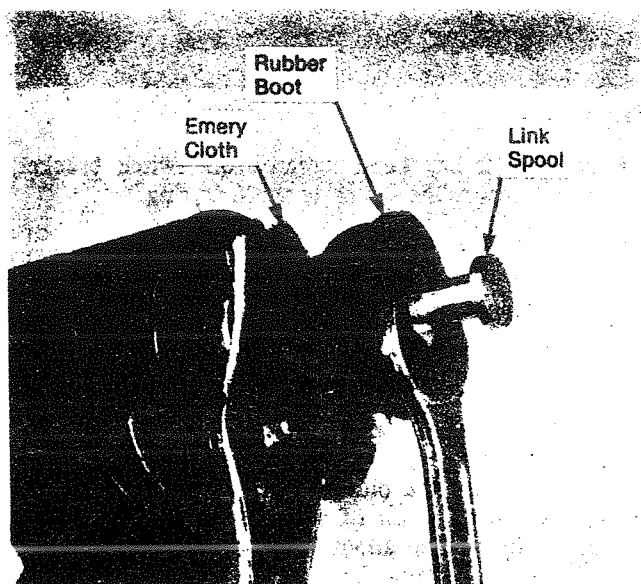


Figure 5

- 3.3 Grip the plunger in a brass jaw vise (to avoid nicks) and heat the 1/4" nut with a propane torch.
 - 3.4 Remove the rubber plug from the plastic end base and place the base on the switch. Insert a 1/4" deep well socket (Snap-On Tool Co. STMD-8) in access hole and remove the nut.
 - 3.5 Inspect all insulation washers and bushing. Broken, cracked or burned insulators must be replaced with new ones.
 - 3.6 Inspect conical contact spring. If spring is collapsed replace it with a new one.
 - 3.7 Inspect plunger outer diameter. If nicks, burrs, or corrosion are found, then the plunger must be replaced.
4. Switch Coil Ground Test.

Connect one ohmmeter test lead to terminal #1 and the second test lead to a bare metal surface on the housing. Figure 6.

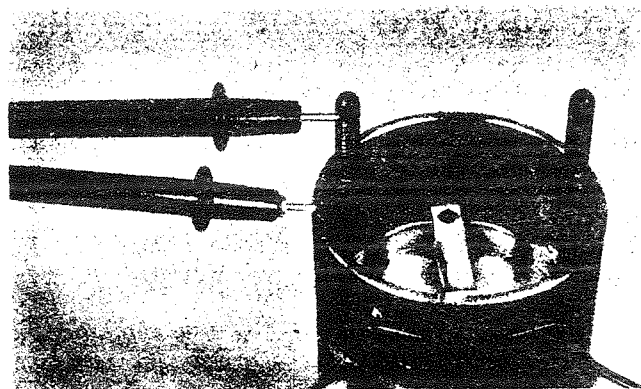


Figure 6

LOW resistance - coil is grounded; switch assembly must be replaced.

HIGH resistance - coil is not grounded; continue with step 5.

5. Switch Coil Resistance Test.

Connect one ohmmeter test lead to terminal #3 and the second test lead to terminal #4, see figure 7.

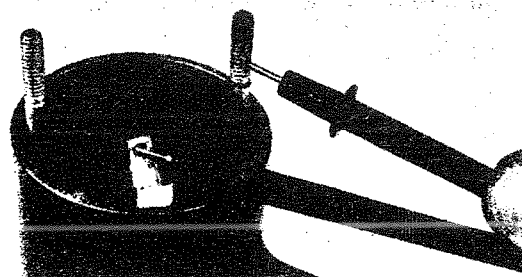


Figure 7

If readings fall outside values shown in chart below, then switch must be replaced with a new one.

Volts	Switch #	Resistance
12	77510	.82 - .94 ohm
12	77510B*	.62 - .76 ohm
24	77452	4.01 - 4.51 ohms
24	77452B*	3.34 - 4.08 ohms

*Latest design switches with upgraded coils. Part number is stamped on each switch.

MA, MB, and MC Motor CE Housing and Brush Rigging Disassembly and Testing:

1. Remove two #10 screws and brush opening band assembly.
2. Remove screws from brush leads (8 total) and lock-plates.
3. Pull springs upward with tool shown in figure 8, and remove the brushes.

CAUTION: DO NOT pull brush leads while springs exert pressure on the brushes.

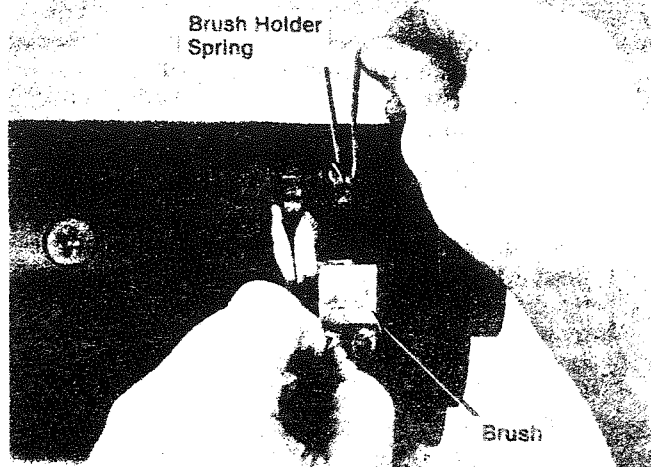


Figure 8

4. Inspect brushes for wear. Brushes less than 5/8" in length must be replaced.
5. Mark CE housing (commutator end housing) in relation to the field ring with a punch.
6. Remove four hex head screws and remove CE housing.
7. Remove ground jumper. If burns or faulty insulation (if so equipped) is noticed, then the jumper must be replaced.
8. Insert a new brush in each brush slot in each of the four brush holders. If the brush does not move freely in one of the slots, then that brush holder must be replaced.
9. Inspect each of the four brush holders. Discoloration, burns or signs of high temperatures indicate defective or improperly assembled insulators.
10. Brush Holder Insulation Test.

Connect ohmmeter test leads to two brush holders that share a common mounting post. See figure 9.

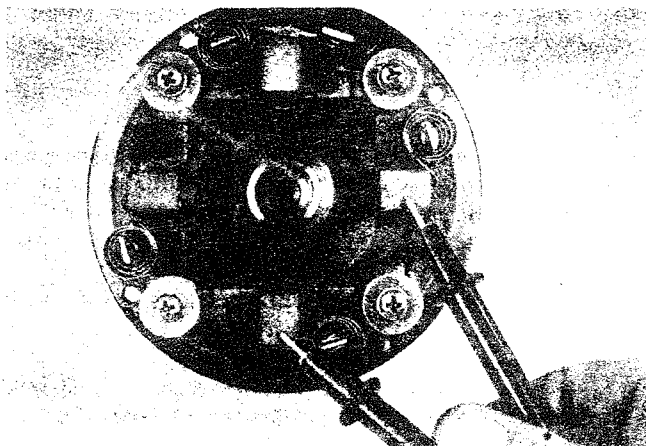


Figure 9

A LOW resistance reading indicates that an insulation bushing or washer is defective and must be replaced. Repeat this test at each of the four mounting posts.

11. Brush Holder Assembly Ground Test.

Connect one ohmmeter test lead to a bare metal surface on CE housing and the second test lead to each of the four brush holders. LOW resistance indicates a grounded brush holder caused by defective insulator(s). Figure 10.

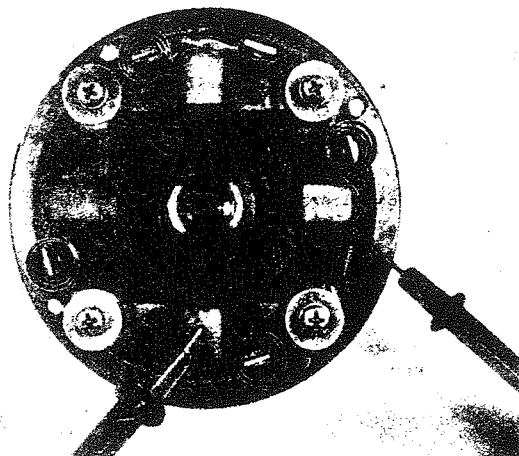


Figure 10

12. Visually inspect insulators at each of the four mounting posts. Broken, cracked, burned or charred insulators must be removed and replaced.
13. Ground Stud Insulation Test for MA, MB and MC motors:

Connect ohmmeter test leads to a bare metal surface on CE housing and ground stud. LOW resistance indicates a defective insulation bushing(s) or washer(s).

NOTE: Before removing ground stud for service, mark the position of stud in relation to CE housing (use an awl or a scribe).

14. Inspect bronze bushing in CE housing. If inside diameter is greater than .756", then bushing must be replaced (see "Assembly" section for specific instructions).

ME and MX Motor CE Housing, and Brush Support Disassembly and Testing:

1. Remove hardware and insulators from ground stud.
2. Remove 6 screws, lockwashers and sealing rings from CE (commutator end) housing and remove housing. Remove and inspect bushing and square insulator for damage.

3. Check CE housing for damage. Inspect the bronze bushing in the center of the housing. If inside diameter is greater than .756", then bushing must be replaced (see "Assembly" section for specific instructions).
4. Remove 4 socket head screws from field coil contact tabs and pull the brush support plate assembly off the motor.
5. Remove the socket head screws to remove ground stud and jumper assembly and the 4 brushes. Inspect for any physical damage and replace as necessary. If brushes are worn to less than 5/8", then replace brushes. Insure that brush contact leads are in good working condition.
6. Visually inspect brush support plate assembly for physical damage. Insure that insulators are secure and free of cracks. Each of the four brush supports must be secure. Insure that brushes slide freely through each brush slot. Replace brush support plate assembly if any of the above conditions are not met.

Using an ohmmeter check for open circuits (high resistance) between each brush support and the plate. A closed circuit (low resistance) indicates a defect (ground) and the brush support plate assembly must be replaced. Figure 11.

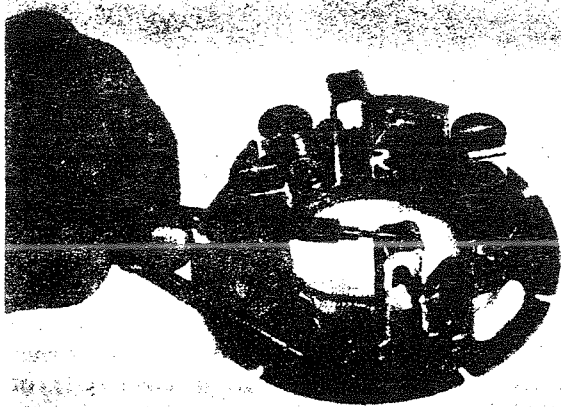


Figure 11

Motor Disassembly and Testing Continued:

NOTE: Mark nose housing, shift housing, and field ring with a punch to aid proper positioning at reassembly.

1. Remove six socket head screws from nose housing. Tap flange from field ring side and remove housing.
2. Inspect nose housing bushing. Maximum diameter allowed is .753".
3. Pull armature out of motor and remove drive assembly and brake washer.
4. Inspect drive.

If drive pinion rotates in both directions or if it does not move freely in and out of the assembly,

then a new drive must be installed. If ID spline slots are excessively worn or damaged then a new drive assembly must be installed.

5. Remove five socket head screws and remove shift housing.
6. Inspect shift housing bushing and seal. Replace bushing if diameter is larger than .878".
7. On MA and MB motors remove rubber boot and inspect for cracks or other damage. If found in good condition reuse boot.
8. Later design shift housings use a shorter shift lever shaft which is held in place with a brass plug. To remove the shaft, first remove the brass plug, then screw a 1/4-20 screw in the shift lever shaft. Grip the screw and pull out shaft. One of the five screws used to fasten the shift housing to the field ring can be used for this task.

Inspect shift lever shaft and replace if grooves worn into its outer diameter are found.

Older design shift housings use a longer shift lever shaft sealed with an "O" ring and held in place with a flat washer and a 10-32 socket head screw. (Figure 12). The newer design, short shaft is now the recommended service part. See "Assembly" section for proper assembly procedures.

To remove "long" shift lever shaft, first remove the 10-32 socket head screw and flat washer, then remove shaft. Inspect "O" ring and replace if damaged. If shift lever shaft surface is undamaged, then shaft may be reused.

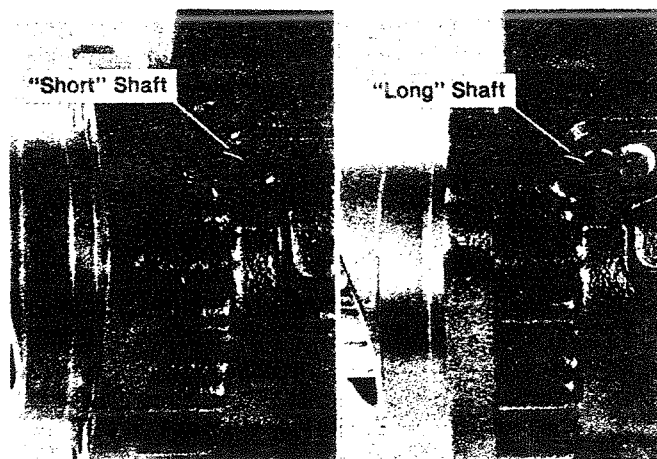


Figure 12

9. On MA and MB motors remove the shift lever and link screw assembly and inspect the shift lever pivot hole. If the hole is elongated then the shift lever must be replaced.

Remove roll pin which attaches link screw to the shift lever and replace it with a new one.

10. On MC, ME and MX motors remove shift lever from shift housing and inspect pivot hole. If hole is elongated, then shift lever must be replaced.

11. Check armature shaft splines. If splines are worn or damaged then armature must be replaced.

12. Armature Ground Test.

Connect one ohmmeter test lead to the armature shaft (on the spline end) and run the second test lead across all commutator contacts. LOW resistance indicates a ground and armature must be replaced.

13. Perform armature growler test to insure that armature is not shorted.

14. Check commutator surface. If commutator is pitted, rough, scored, burned or coated with hard carbon or oil then the surface must be turned in a lathe. Minimum diameter after turning is 2-1/16". Maximum runout is .003" TIR.

15. Field Coil Ground Test.

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

NOTE: *It is recommended that a "high pot" test be performed on the field coil by a qualified electrical shop. The field coil must be left in its original position in the field ring to perform this test.*

WARNING !!!

This test (high pot) may cause severe injury or death !

This test is restricted to qualified personnel only !

16. Inspect the interior of the field ring and field coil. If burn marks are noticed, then the field coil must be replaced. If pole pieces and armature show wear signs due to armature rubbing against pole piece(s), then the CE housing bushing must be replaced. Also, shift housing and nose housing bushings must be inspected for proper dimensions.

COMPONENT CLEANING

1. Solenoid switch, armature, field coil and drive assembly must be cleaned with a cloth dipped in a solvent which does not leave a greasy film. Dry parts with compressed air.

CAUTION: DO NOT dip above items in any solvents.

2. Clean all other metal parts with cleaning solvent and a wire brush where necessary.

3. Brush holder assembly, insulation washers, bushings and spacers must be cleaned by dipping in solvent, then dry with compressed air.

NOTE: *Brush holder insulators can usually be cleaned without removal.*

ASSEMBLY

1. Install field coil in field ring as follows:

- 1.1 Insure that field ring is free of dirt and varnish.

- 1.2 Place pole pieces in field coil openings to insure proper fit.

- 1.3 Bend field coil sections so outside diameter is slightly smaller than field ring ID.

- 1.4 Insert field coil in field ring so field coil stud lines up with hole provided in field ring.

- 1.5 Use a pair of pliers with taped jaws to bend field coil back to its original shape (as much as possible).

- 1.6. On field coils with welded field coil studs, place square insulation washer on field coil stud and pass stud through the field ring. See figure 13.

On motors with separate field coil studs, place the square insulation washer between the field coil jumper and the field ring and pass the stud through the holes in the field coil jumper, the insulation washer and the field ring.

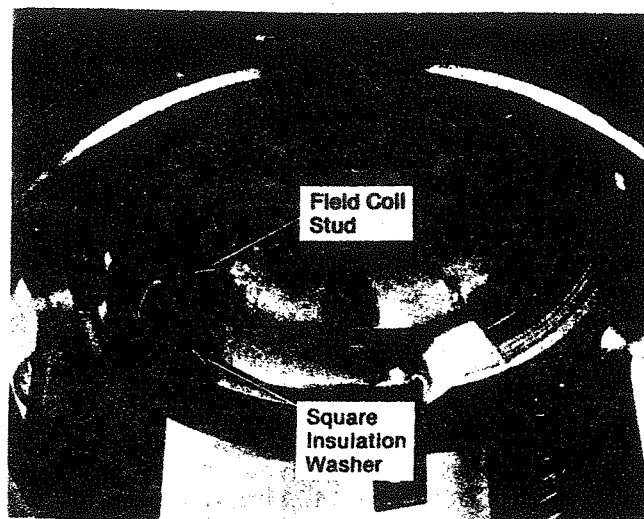


Figure 13

- 1.7 Place a pole piece in one of the four coils and align as close as possible to a set of two mounting holes in the field ring. Use a punch with a taped point to pry pole piece mounting holes in alignment with the holes in the field ring. Install screws finger-tight.

CAUTION: Pole piece must be installed so the slot clears the coil contact tab. See figure 14.

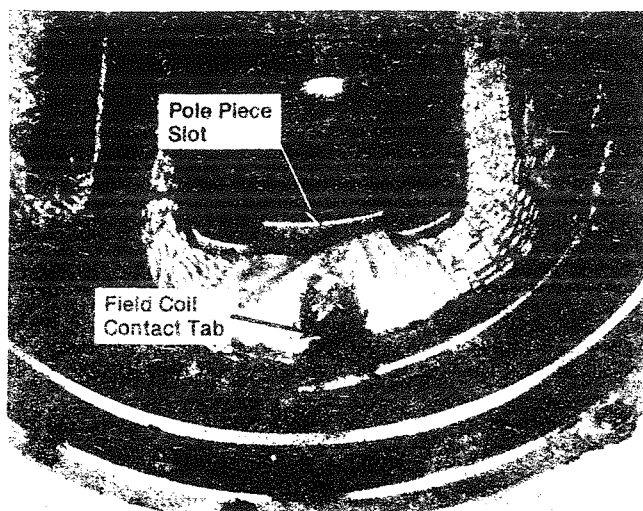


Figure 14

On ME and MX motors the pole pieces must be installed so pole pieces #1 and #3 are positioned with lip (overhang) pointing to the field coil stud end of field ring. Pole pieces #2 and #4 must be installed with lip pointing away from field coil stud end of field ring. Figure 15.

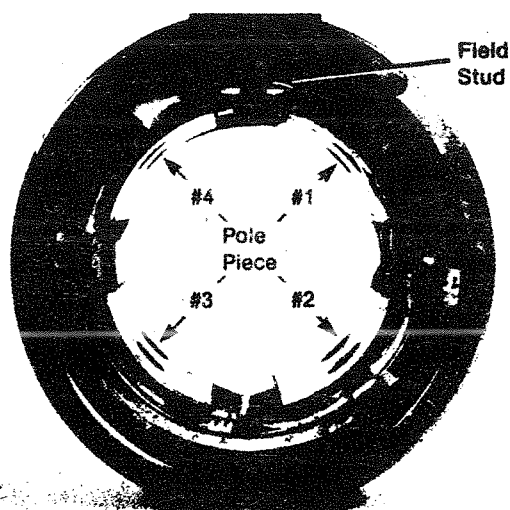


Figure 15

- 1.8 Repeat step 1.7 to install pole piece in section of field coil opposite from the pole piece already installed.
- 1.9 Use field coil spreader to force the two pole pieces against the inside wall of the field ring. Tighten the screws to 18-22 lbs. ft. on MA, MB and MC motors. On ME and MX motors torque to 23-27 lbs. ft.
- 1.10 Repeat steps 1.7, 1.8 and 1.9 to install the remaining two pole pieces.
2. Press 5/8" OD insulation bushing on field coil stud as far as it will go. Slide the "O" ring on the field coil stud so it fits flush with the field ring. Figure 16.

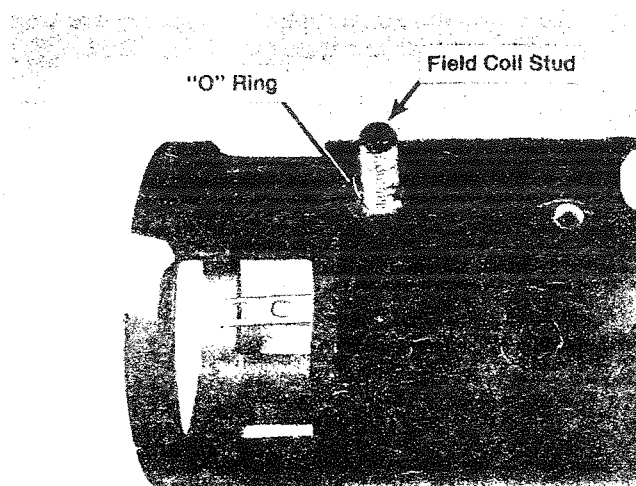


Figure 16

3. Slide square insulator on the filed coil stud so the radius side rests against the field ring. Figure 17.

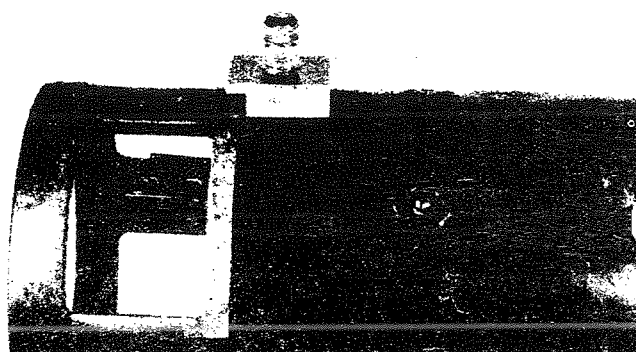


Figure 17

4. Install guard washer and nut on field coil stud. Torque to 18-22 lbs. ft.
5. Apply varnish to field coil, except on ME motors.

CAUTION: DO NOT varnish pole pieces.

6. Insert armature in field ring. Insure that the armature moves freely inside the field ring.

MA, MB and MC Motor CE Housing Assembly Performed as Follows:

1. Assemble CE housing as follows:
 - 1.1 Ream bushing ID to .754" and press bushing flush with CE housing center hole.
 - 1.2 Slide guard washer and insulation washer on the ground stud and insert it in the CE housing. Align the ground stud with the markings made at disassembly and complete installation as shown in figure 18. Torque nut to 33-37 lbs. ft.

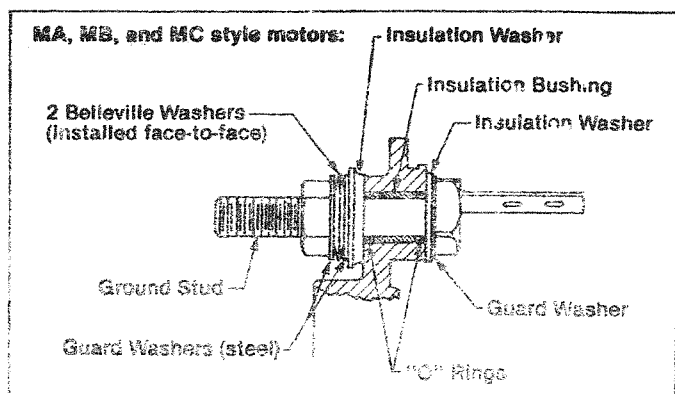


Figure 18

1.3 Install brush holders on CE housing as follows:

1.3.1 Insert four guide pins in each of the four CE housing mounting posts and slide an insulation bushing and an insulation washer on each of the four guide pins. Insulation bushings must be installed so they pass through the washers and fit flush against the mounting posts. See figure 19.

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

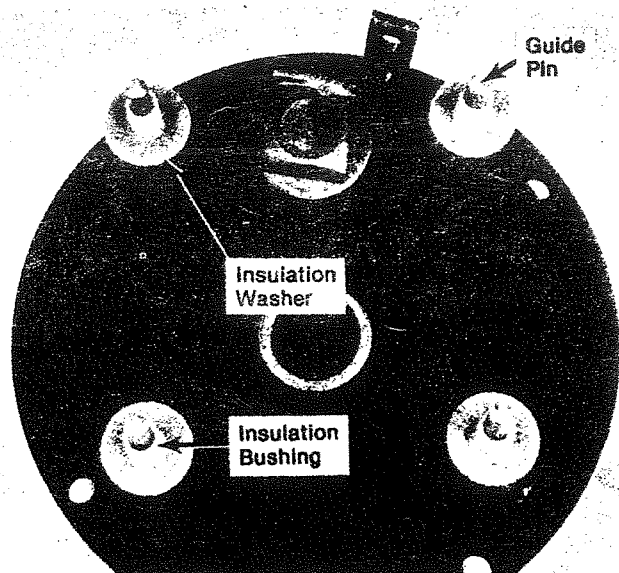


Figure 19

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 jumper installation, see step 2 on page 10.

1.3.2 Place jumper on CE housing and position it along with a brush holder as shown in figure 20.

1.3.3 Install brush holders on mounting posts with insulation washers, guard washers, lockwashers, and screws, as shown in figure 21. Install an 8-32 x .62

long self tapping screw to secure ground jumper between the ground stud tab and the brush holder contact plate. Figure 22 shows a correctly assembled CE housing.

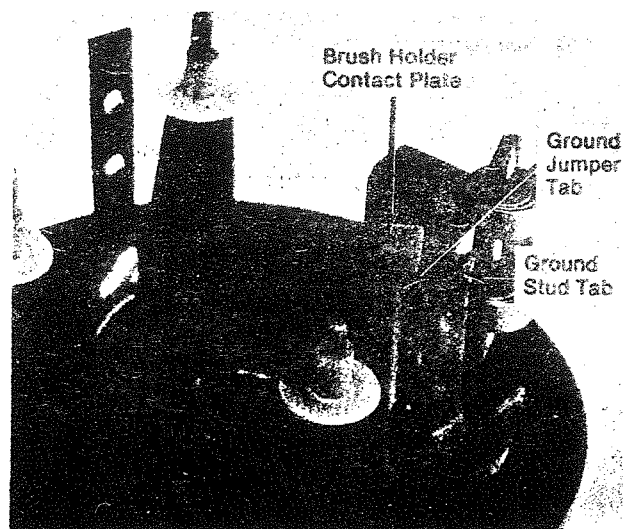


Figure 20

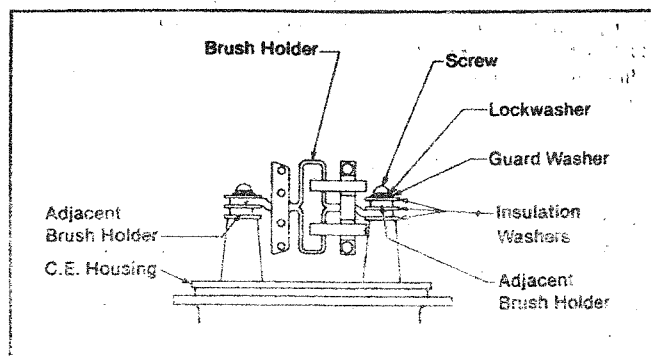


Figure 21

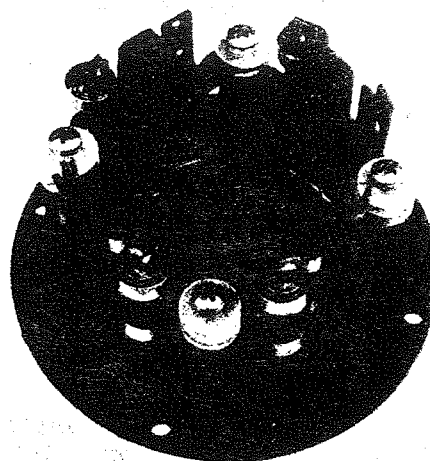


Figure 22

1.4 Install "O" ring in the groove provided in the CE housing.

2. Install old style ground jumper between the field ring and the field coil so the jumper tabs are positioned approximately at 90° from the field coil tabs. Insure that the jumper clears the field coil stud and that the jumper fits snugly between the field coil and the field ring. See figure 23.



Figure 23

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

3. Slide steel thrust washer and fiber thrust washer on the commutator end of the armature. The steel washer must be installed first.
4. Match the CE housing to the field ring according to the marks made at disassembly and align the ground stud jumper with the ground jumper tab. Press the CE housing flush with the field ring.

When installing an old style ground jumper insure that the ground jumper tab meshes with the ground stud jumper and the brush holder contact plate. See figure 24.

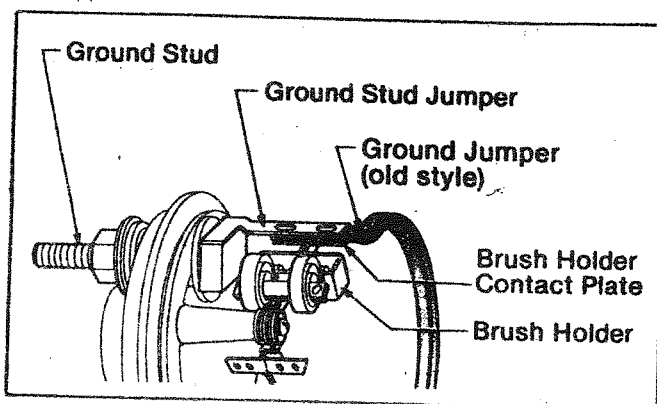


Figure 24

5. Apply 1-2 drops of Loctite #2114 on four 1/4-20 hex head screws. Use these screws plus 1/4" lockwashers to secure the CE housing to the field ring. Torque to 62-66 lbs. in.

ME and MX Motor CE Housing and Brush Rigging Assembly Performed as Follows:

1. Ream bushing to .754" ID and press flush into CE housing.
2. Saturate wick in Citgo grade 80 oil and install in CE housing, then install brass plug to seal opening.
3. Pass a brush contact plate through one of the brush slots in the brush support plate assembly from the inside out. Press brush into brush slot until the brush spring is pushed out of the way. Repeat for the remaining 3 brushes. Secure each brush contact plate with a socket head screw. Torque to 25-35 lbs. in. See figure 25.

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



Figure 25

4. Install ground stud and jumper assembly to brush support plate assembly with 4 socket head screws. Torque to 25-35 lbs. in. See figure 26 and note the position of jumper assembly.

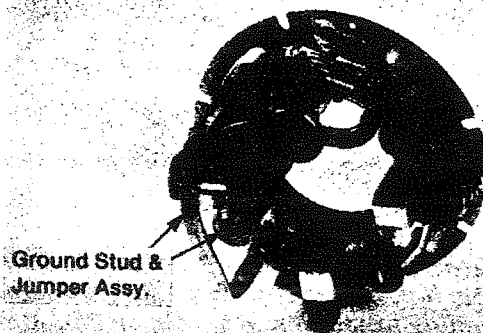


Figure 26

5. Slide armature in field ring so commutator extends approximately 1 1/4" out of field coil stud end of field ring.
6. Install two roll pins in commutator end of field ring.

7. Place brush support plate flush on field ring so roll pins pass through locating holes. Figure 27.

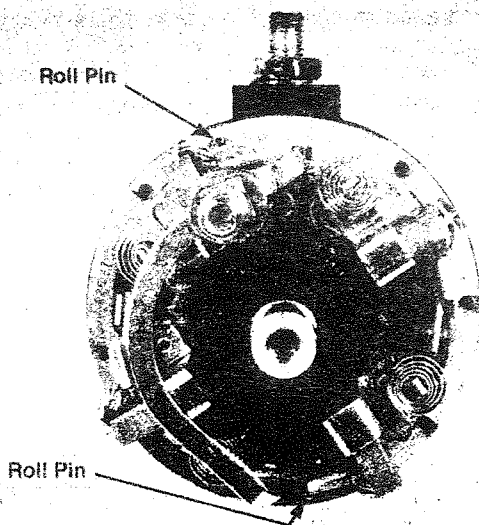


Figure 27

8. Secure field coil contact tabs to brush support plate with 4 socket head screws. Torque to 25-35 lbs. in.
9. Press each of the 4 brushes inward to bring them in contact with the commutator. It may be necessary to pry the springs away from each brush to relieve tension for easier brush insertion in brush slot. Insure that each of the 4 springs are properly seated on each brush.
10. Install "O" ring in groove provided on the outside diameter of field ring.
11. Slide a square insulation washer and insulation bushing on ground stud.
12. Slide a steel thrust washer on commutator end of shaft. Slide a fiber washer (soaked in Citgo grade 80 oil) on shaft so it fits flush against steel thrust washer.
13. Install commutator end housing on field ring with six 10-32 x 3 7/16" screws, lockwashers and sealing rings. Torque to 40-50 lbs. in.
14. Install insulation washer, guard washers, belleville washers, and nut on ground stud as shown in figure 28. Torque to 23-27 lbs. ft.

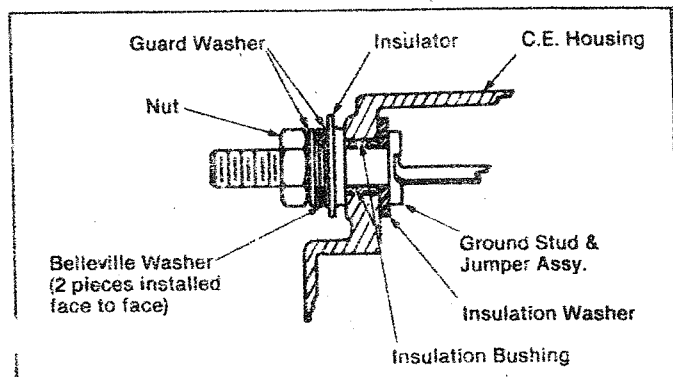


Figure 28

MA, MB, MC, ME, and MX Motor Assembly Performed as Follows:

1. Press bushing flush with the drive side of the shift housing.
2. Press seal in protruding side of the shift housing center hole, so the flat side of the seal fits flush with the housing. Install "O" ring in the groove provided around the outer edge of the housing.
3. On MA and MB motors, assemble the link screw to the shift lever with a roll pin and insert the assembly in the shift housing.

CAUTION: Inspect the shift lever and link screw assembly and insure that the two shift lever linkage lobes on each side of the link screw are parallel.

Inspect the rubber boot and (if in good condition) slide it (with closed end first) on the link screw as far as possible. Insure that the boot lip seats properly in the groove provided in shift housing.

NOTE: On MC, ME, and MX motors the rubber boot is installed in a manner described later in these instructions.

4. Long shift lever shaft installation performed as follows:

Assemble "O" ring in the shift lever shaft inner groove and press the shaft through the shift housing and the shift lever. Slide a flat washer in the shift lever shaft outer groove and fasten it with a 10-32 socket head screw (with 1-2 drops of Permatex #1 or #2 applied to threads) to the shift housing.

5. Short shift lever shaft installation for all LEECE-NEVILLE motors performed as follows:

Press shaft through housing and shift lever as far as it will go, then press a brass plug in hole to retain shaft.

When installing a short shift lever shaft in an older shift housing, then install the 10-32 socket screw (with 1-2 drops of Permatex #1 or #2 applied to threads) in threaded hole located next to the shift lever shaft hole to seal the hole.

6. Slide thrust washer on the armature shaft.
7. Apply a film of SAE-10 grade oil on armature shaft and splines.
8. Hold field ring (with the armature inside the field ring) in a vise and slide the shift housing on the armature shaft so the shaft sticks out about 1" on the shift lever side of the housing.

9. Slide the 2" OD brake washer on the armature shaft and place it against the housing.
10. Apply a small amount of bearing grease to the holes in the shift lever cams and to the long sides of the cams (the long sides of the cams make contact with the drive assembly and require a small amount of lubrication).
11. Slide a cam on each of the two shift lever arms.
12. On MA and MB motors, with one hand pull the link screw out forcing the shift lever to swivel the cams out of the housing. Adjust the angle of the two cams so they both point in the same direction. Slide the drive assembly on the cams so the two cams are riding in the drive channel. See figure 29. Slide the drive assembly on the armature shaft and slide the shift housing towards the field ring to pass the armature shaft through the drive assembly.

On MC, ME, and MX motors, insert a finger in the shift housing and pull the top of the shift lever to swivel the cams out of the housing. To complete shift housing and drive assembly, perform procedures described above for MA and MB motors.

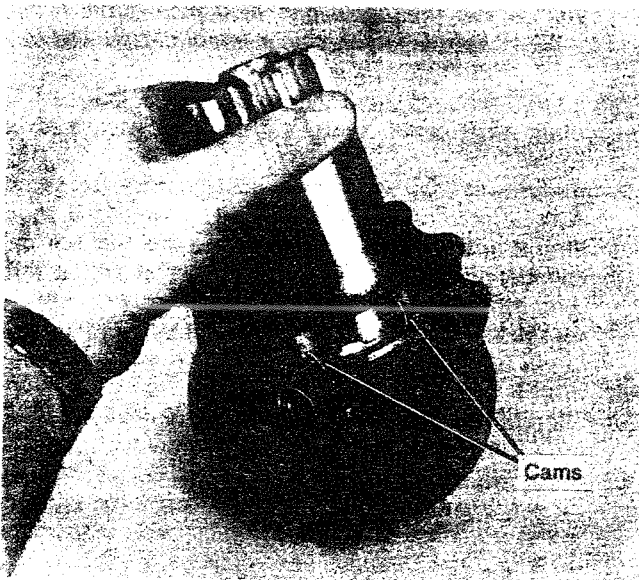


Figure 29

13. Press the shift housing in field ring. Insure that the housing and field ring are aligned according to the marks made at disassembly.

Apply 1-2 drops of Loctite #2114 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 lbs. in.

14. Install nose housing as follows:
 - 14.1 Slide 1/8" thick thrust washer on the armature shaft and place it against the drive pinion.
 - 14.2 Install "O" ring in nose housing groove and slide the nose housing on the armature shaft. Match

- 14.3 Match the alignment markings made at disassembly and secure nose housing to shift housing with 6 socket head screws (with 1-2 drops of Loctite #2114 applied to threads). Torque to 13-17 lbs. ft.

NOTE: The shift housings used on these motors have 12 tapped holes to allow the nose housing to be "indexed" (positioned) in a variety of positions. Only 6 screws are used to mount the nose housing, and when the top hole (figure 30) is not used, then a socket set screw with 1-2 drops of Loctite #2114 must be installed to keep out moisture and other contaminants. On MC, ME and MX motors, a button head screw is used.

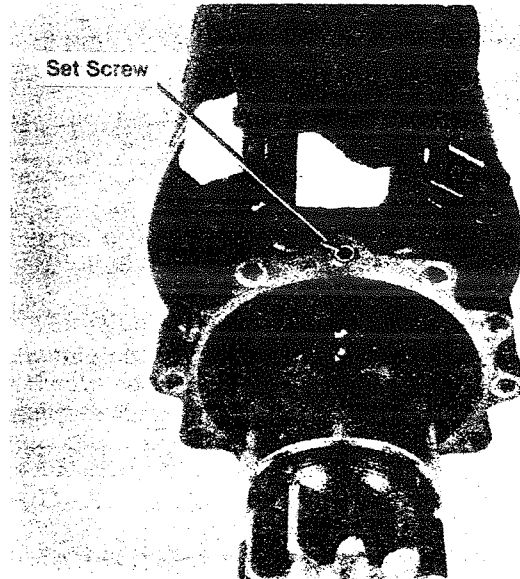


Figure 30

- 14.4 Install rubber plugs in the six nose housing holes not used.
15. MA, MB, and MC motor brush installation performed as follows:
 - 15.1 Pass two 8-32 x 5/8" self tapping screws through a lockplate and slide a brush terminal on each of the two screws. Fasten the brushes to the brush holder contact plate.
 - 15.2 Using the tool shown in figure 31, pull the inside brush holder spring up and insert the brush in the slot. Repeat this step to install the outer brush.

CAUTION: Insure that the brush leads are routed as shown in figure 31.

- 15.3 Repeat steps 15.1 and 15.2 to install the remaining brushes.
- 15.4 Wrap the brush opening band around the four brush openings according to the paint outline and secure the band with two 10-24 x .88" screws.

Before installing the band, insure that dirt, oil, or any other foreign matter is removed from the brush opening areas to insure proper sealing.



Figure 31

16. Assemble switch as follows:

- 16.1 Slide the return spring on the plunger shaft and insert the shaft in the switch housing through the smaller opening so the shaft sticks out on the other end of the switch housing.

NOTE: Insure that the plunger surface is smooth and free of any nicks, burrs, or corrosion. If any of these conditions exist, then a new plunger must be installed.

- 16.2 Place the switch with the plunger pointing down 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 in the housing. With both mounting legs facing one of the two jaws, clamp the switch housing in the vise. Use only enough pressure to hold the switch in place to avoid bending the bracket.

- 16.3 Slide the 1/4" ID steel washer on the shaft so it fits flush with the shoulder.

- 16.4 Slide the 1/4" ID insulation washer on the shaft and place it against the steel washer.

- 16.5 Slide the 1/4" ID insulation bushing on the shaft and place it against the insulation washer.

- 16.6 Place the small end of the conical spring against the insulation washer.

- 16.7 Place the 2" OD copper contact disc on the conical spring and depress the spring so the insulation bushing passes through the disc.

- 16.8 While depressing the contact disc, place the 3/8" ID insulation washer on the disc so the insulation bushing passes through the washer.

- 16.9 Place the 1/8" ID steel washer on the insulation washer.

- 16.10 Apply a drop of Loctite #2114 on the shaft threads and install 1/4" locknut finger-tight to hold contact disc assembly together. Grip the plunger in a brass jaw vise and torque the nut to 55-60 lbs. in. See figure 32 for proper contact disc assembly.

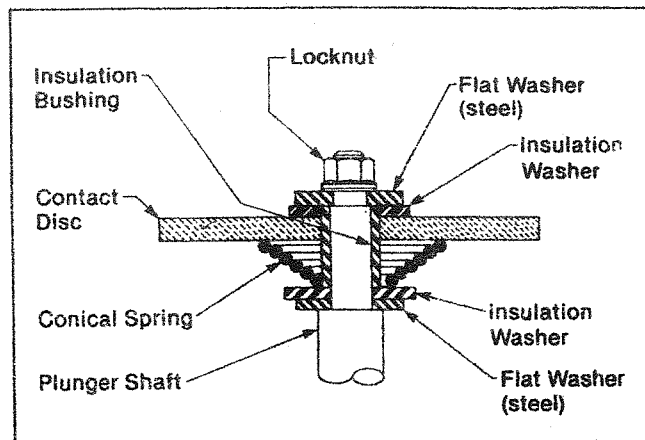


Figure 32

- 16.11 Install the #2 and #3 contact studs in the plastic end base. Insert the 2-1/4" long contact stud in the #2 terminal hole and slide a sealing ring, flat washer, and a lockwasher on the contact stud. On switches equipped with #10-32 threads on the #1 and #4 switch terminals, the 2 1/4" long contact stud is installed with two "O" rings, a flat washer, and lockwasher. Apply 2 drops of Loctite #2114 to the stud threads and secure with jam nut torqued to 23-27 lbs. ft. Install the #3 terminal stud in the same manner insuring that the tapped hole in the stud head faces to the outside of the plastic end base.

- 16.12 Place the sealing ring on the outside edge of the switch housing.

- 16.13 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 self tapping screw. See figure 33. Insure that the short contact stud is on the bracket side of switch.

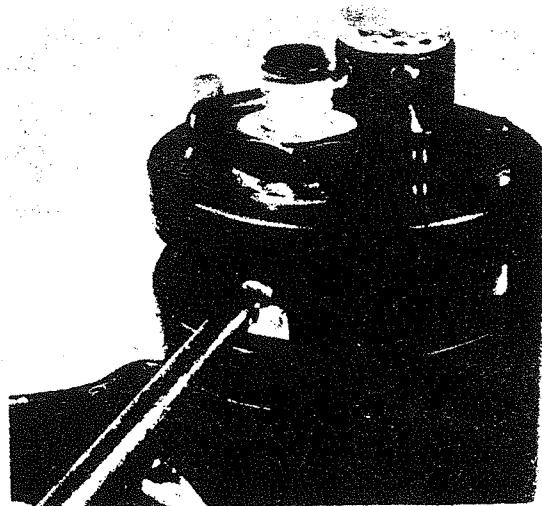


Figure 33

16.14 Press the plastic end base on the switch housing and slide a rubber washer, flat washer, and lockwasher on each of the two terminals. Secure with 1/4" nuts torqued to 43-47 lbs. in. On switches with #10 terminals, use two "O" rings, a spacer bushing, a flat washer and lockwasher on each of the two terminal screws. Torque 10-32 nuts to 28-34 lbs. in.

16.15 On MC, ME and MX motors, inspect the rubber boot and slide the closed end against the hex shoulder of the link spool. Install the link spool in the switch plunger and torque to 27-33 lbs. in. See figure 34. Insure that the plunger is not damaged during this procedure.

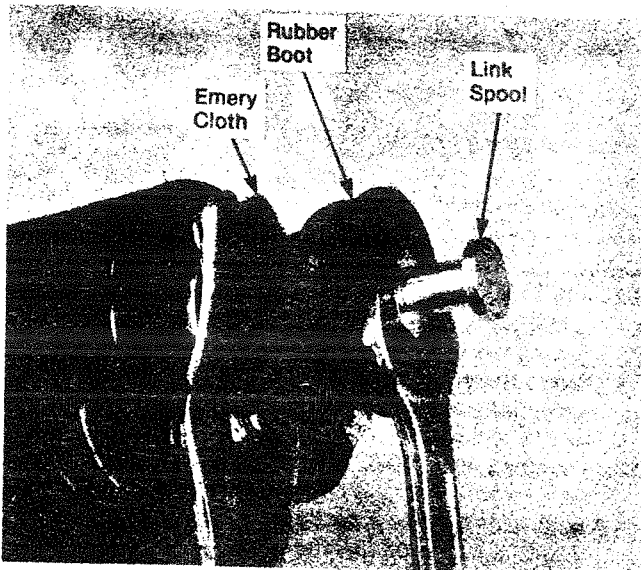


Figure 34

SWITCH INSTALLATION AND TIMING INSTRUCTIONS FOR "MA" AND "MB" STYLE MOTORS:

1. Apply a bead of Loctite #2114 to the first 1/2" of the link screw threads. See figure 35.

NOTE: Link screw must be free of dirt, grease or oil.

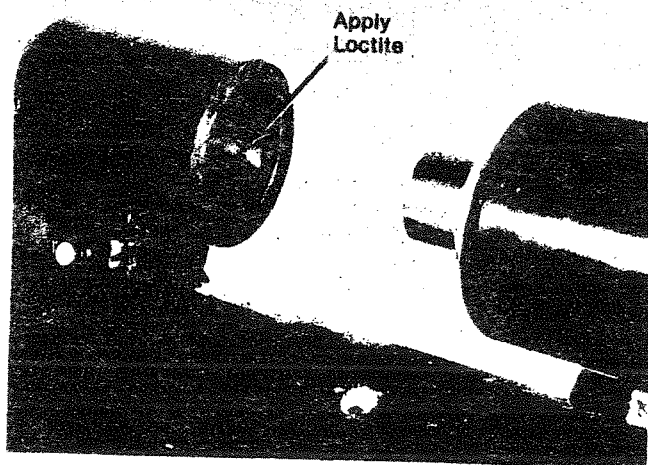


Figure 35

2. Apply a thin film of Citgo grade 80 oil to the switch area that surrounds the plunger.
3. Insert a 1/4" deep well socket in the access hole in the plastic end base and engage it with the 1/4" locknut on the end of the plunger shaft.
4. Position the switch (with the two mounting legs pointing away from the field ring) in alignment with the link screw and screw the plunger on by turning the 1/4" deep well socket 5 complete turns (360°).
5. Turn the switch so the mounting legs rest on the field ring and continue turning the 1/4" socket an additional 10 complete turns.
6. Push the switch toward the shift housing so the switch fits flush with the shift housing.

CAUTION: The cranking motor must be timed within 15 minutes after the switch is installed on the motor because the Loctite is still soft enough to make adjustments. If this is not done the motor will fail.

7. Apply 1-2 drops of Loctite #2114 to the threads of the two 3/8-24 x .38" hex head screws to secure the switch to the field ring. Torque to 23-27 lbs. ft.
8. Apply 2 drops of Loctite #2114 to the last 1/4" of the #3 switch terminal and the field coil stud. Secure jumper strap to these terminals with jam nuts. Torque nut on #3 terminal to 21-29 lbs. ft. and the field coil nut to 18-22 lbs. ft.

CAUTION: Use an open wrench to support the bottom nut while fastening the jumper to the field coil stud.

9. Install ground lead to switch terminal #4 and to the ground stud with lockwashers and nuts. If terminal #4 has 1/4-20 threads, then torque nut to 43-47 lbs. in. If terminal #4 has 10-32 threads, then torque nut to 28-34 lbs. in. Ground stud connection is made finger-tight only.
10. Switch timing performed as follows:
 - 10.1 Connect a 12 volt battery with an "on-off" switch to terminals #1 and #4 (with switch in the "off" position).

NOTE: On 24 volt motors connect 24 volts of battery power to the switch #1 and #4 terminals.

- 10.2 Turn the switch on and measure the gap between the face of the pinion and the thrust washer. Proper gap is 3/16" (.187"). See figure 36. To perform these procedures the cranking motor is not wired as on a

vehicle and in some cases the switch does not have the normal strength to push the drive in the "engagement" position. In such a case, pry the pinion with a screwdriver until the switch takes over.

NOTE: An appropriate gage can be made from a 3/16" bar stock or a 3/16" drill shank.

CAUTION: Switch must not be energized for more than 30 seconds at a time.

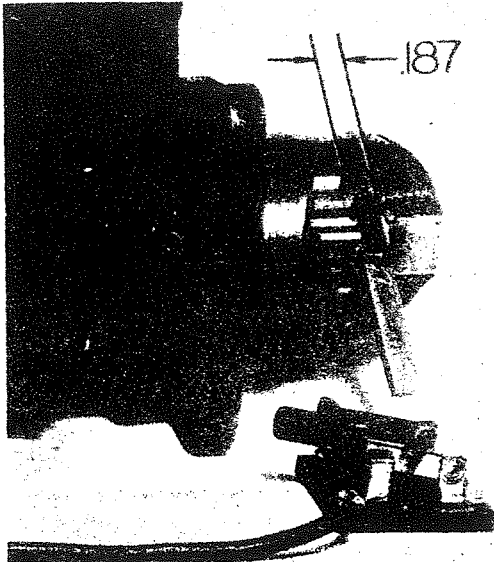


Figure 36

- 10.3 If the gap is greater or smaller than 3/16", then turn off battery power. Insert the 1/4" deep well socket in the access hole and turn the 1/4" nut **CLOCKWISE** to **DECREASE** the gap or **COUNTERCLOCKWISE** to **INCREASE** the gap.

CAUTION: Switch must not be energized while adjustments are made.

- 10.4 Install rubber plug in switch access hole.

1. Turn switch assembly so the two mounting legs face away from the field ring and insert link spool in the shift housing.
2. Hook the link spool in the fork of the shift lever.
3. Turn the switch assembly so the mounting legs rest on the field ring and press the switch flush in the shift housing.
4. Apply 1-2 drops of Loctite #2114 to the threads of two 3/8-24 x .38" hex head screws and secure the switch to the field ring. Torque to 23-27 lbs. ft.
5. Apply 2 drops of Loctite #2114 to the last 1/4" of the switch #3 terminal and the field coil stud. Secure the jumper strap with jam nuts. Torque the #3

terminal nut to 21-29 lbs. ft. and the field coil nut to 18-22 lbs. ft.

CAUTION: Use an open wrench to support the bottom nut while tightening the top nut.

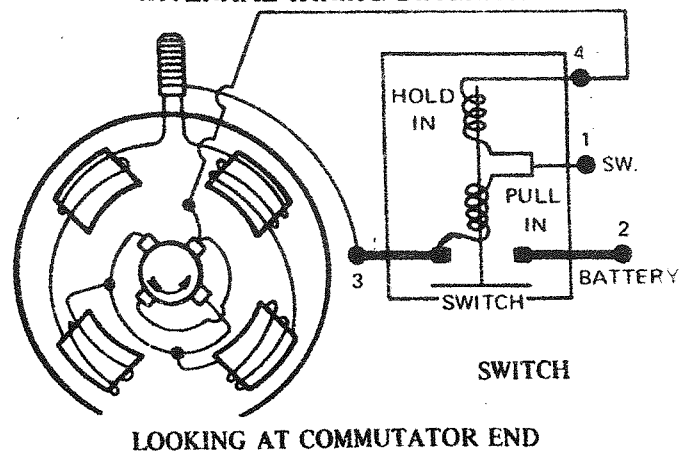
6. Install ground lead to switch terminal #4 and to the ground stud with lockwashers and nuts. If terminal #4 has 1/4-20 threads, then torque nut to 43-47 lbs. in. if terminal #4 has 10-32 threads, then torque nut to 28-34 lbs. in. Ground stud connection is made finger-tight only.
7. Install rubber plug in the plastic end base access hole.

WIRING INSTALLATION

1. Install battery cable to #2 terminal. Torque nut to 30 lbs. ft.
2. Install "start" switch lead to #1 terminal. Torque nut to 31 lbs. in.
3. Install ground cable to motor ground stud. Torque nut to 30 lbs. ft.

CAUTION: Support the inner nut with a thin open end wrench while tightening the outer nut. If this is not done, internal components may be damaged resulting in motor failure.

INTERNAL WIRING DIAGRAM



See page 16 for External Wiring Diagram.

EXTERNAL WIRING DIAGRAM
STARTER LOCKOUT RELAY OR SWITCH

