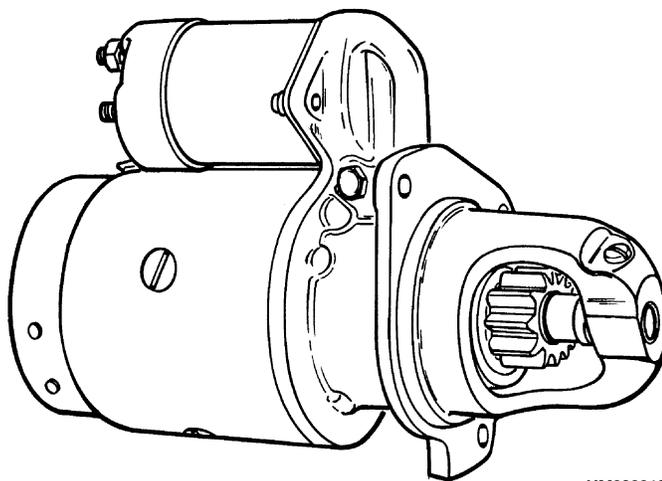


# STARTER

DELCO

DELCO STARTERS USED ON HYSTER  
LIFT TRUCKS



HM080018

# **HYSTER**

# SAFETY PRECAUTIONS

## MAINTENANCE AND REPAIR

- When lifting parts or assemblies, make sure all slings, chains, or cables are correctly fastened, and that the load being lifted is balanced. Make sure the crane, cables, and chains have the capacity to support the weight of the load.
- Do not lift heavy parts by hand, use a lifting mechanism.
- Wear safety glasses.
- **DISCONNECT THE BATTERY CONNECTOR** before doing any maintenance or repair on electric lift trucks.
- Disconnect the battery ground cable on internal combustion lift trucks.
- Always use correct blocks to prevent the unit from rolling or falling. See **HOW TO PUT THE LIFT TRUCK ON BLOCKS** in the **Operating Manual** or the **Periodic Maintenance** section.
- Keep the unit clean and the working area clean and orderly.
- Use the correct tools for the job.
- Keep the tools clean and in good condition.
- Always use **HYSTER APPROVED** parts when making repairs. Replacement parts must meet or exceed the specifications of the original equipment manufacturer.
- Make sure all nuts, bolts, snap rings, and other fastening devices are removed before using force to remove parts.
- Always fasten a **DO NOT OPERATE** tag to the controls of the unit when making repairs, or if the unit needs repairs.
- Be sure to follow the **WARNING** and **CAUTION** notes in the instructions.
- Gasoline, Liquid Petroleum Gas (LPG), Compressed Natural Gas (CNG), and Diesel fuel are flammable. Be sure to follow the necessary safety precautions when handling these fuels and when working on these fuel systems.
- Batteries generate flammable gas when they are being charged. Keep fire and sparks away from the area. Make sure the area is well ventilated.

**NOTE:** The following symbols and words indicate safety information in this manual:



### **WARNING**

Indicates a condition that can cause immediate death or injury!



### **CAUTION**

Indicates a condition that can cause property damage!

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<p>This section is for the following models:</p> <p>Delco Starters used on Hyster Lift Trucks</p>
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**"THE  
QUALITY  
KEEPERS"**

**HYSTER  
APPROVED  
PARTS**

## General

This section has a description and the service procedures for the starter, the solenoid, and the solenoid switch.

**NOTE:** Information on starters manufactured outside the United States is in the SRM sections for lift trucks that use those starters.

## Description and Operation

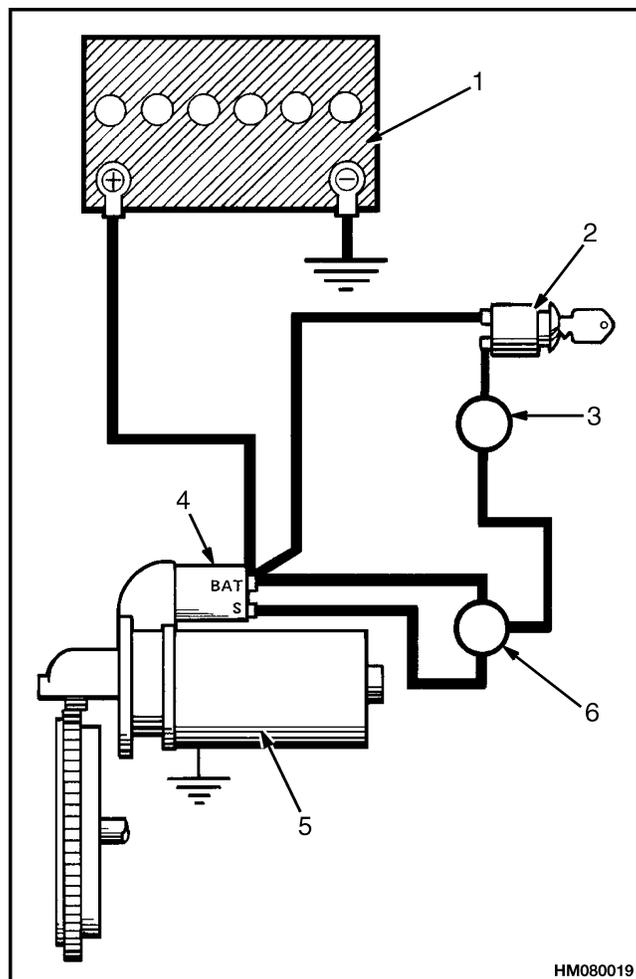
The positive battery cable is connected to the "BAT" terminal on the starter solenoid. See Figure 1, Figure 2, and Figure 3. Battery voltage is not applied to the starter until the ignition switch, the solenoid switch (diesel units only), and the transmission neutral switch close. The solenoid moves the linkage and the drive clutch to engage the starter pinion with the ring gear. At the end of its stroke, the plunger of the solenoid closes the main solenoid contacts. The current then flows to the starter windings. The starter pinion turns the flywheel ring gear.

The starter is a linkage type with a drive clutch mechanism. The solenoid is fastened to the starter. The pinion is part of the drive clutch. The drive clutch is moved on the armature shaft by the linkage connected to the solenoid plunger. When the engine starts, the pinion is still engaged with the ring gear. The pinion turns freely when driven by the ring gear. When the key is released, the pinion moves away from the ring gear and the starter circuit opens.

When energized, the starter solenoid moves the linkage, closes the contacts, and energizes the starter. The solenoid has two windings. When energized, one winding pulls the solenoid plunger to close the contacts. The other winding holds the plunger in that position. The current for the winding that pulls must flow through the starter brushes to a ground. The ground for the winding that holds the plunger in position is the solenoid frame. When the key switch is closed, the current flows through both windings. When the plunger moves the linkage, the contacts close, which causes the winding that pulls to have a short circuit. That winding is deenergized, but the current continues to flow through the winding that holds the plunger. The winding that holds the plunger is deenergized when the key switch is released.

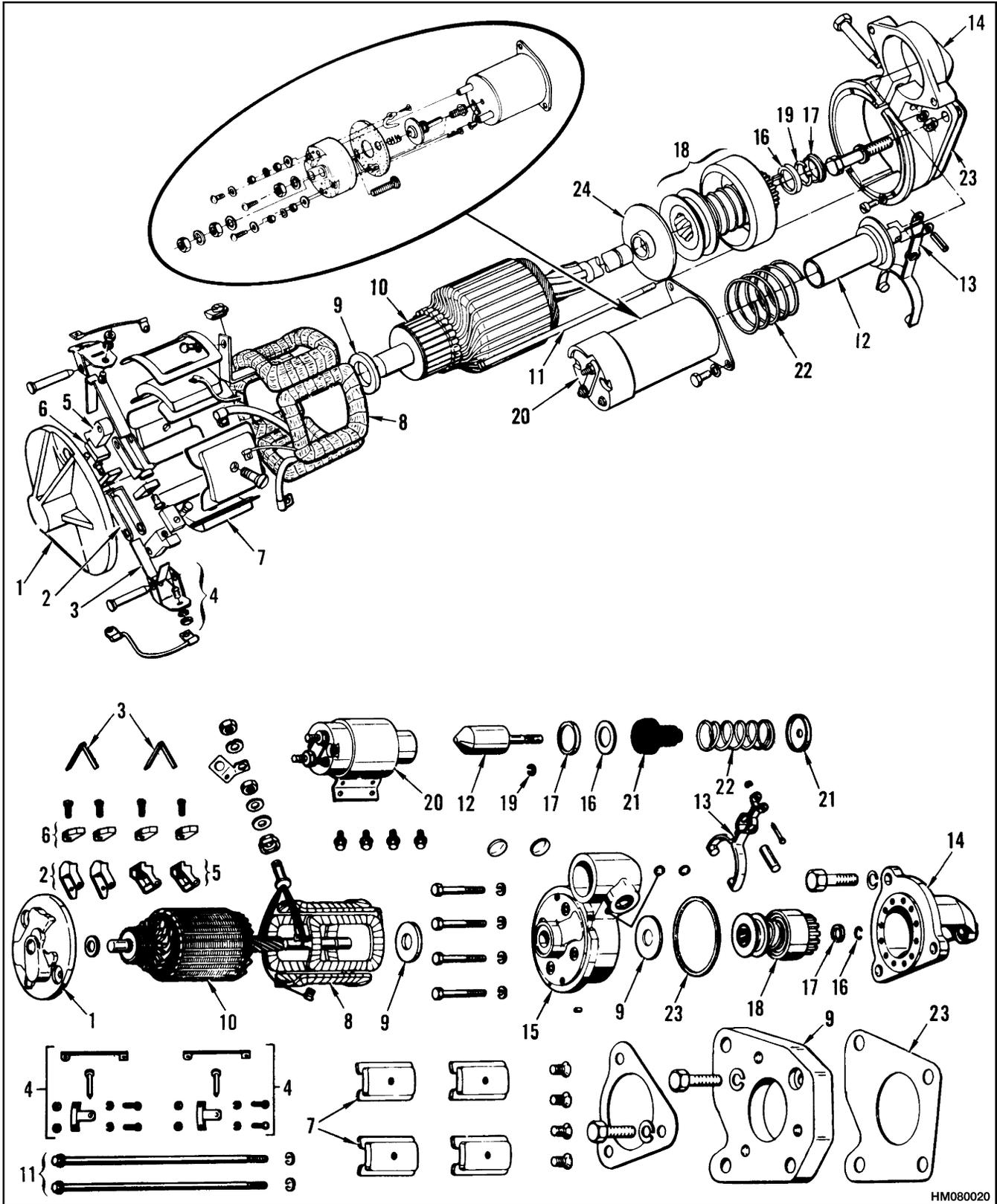
The solenoid switch is a relay that is used in the diesel starter circuit. The solenoid for the starter of the diesel engine uses more current than does the solenoid for the starter of the gasoline engine. The solenoid switch is actuated by turning the key switch to

the START position. The solenoid switch closes the contacts that energize the solenoid of the starter.



1. BATTERY
2. IGNITION SWITCH
3. NEUTRAL START SWITCH (CAN CONSIST OF SEVERAL RELAYS)
4. STARTER SOLENOID
5. STARTER
6. SOLENOID SWITCH (NOT ON ALL UNITS)

*Figure 1. Starting Circuit*

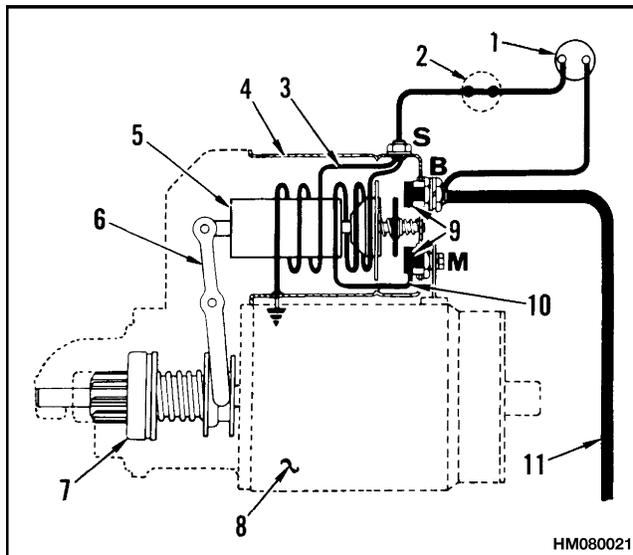


HM080020

Figure 2. Starter

*Legend for Figure 2*

- |                           |                      |                                   |
|---------------------------|----------------------|-----------------------------------|
| 1. END FRAME              | 9. SPACER            | 17. THRUST COLLAR                 |
| 2. GROUND BRUSH HOLDER    | 10. ARMATURE         | 18. DRIVE CLUTCH                  |
| 3. BRUSH SPRING           | 11. THROUGH BOLT     | 19. SNAP RING                     |
| 4. BRUSH SUPPORT          | 12. SOLENOID PLUNGER | 20. SOLENOID                      |
| 5. INSULATED BRUSH HOLDER | 13. LINKAGE          | 21. COVER                         |
| 6. BRUSH                  | 14. DRIVE HOUSING    | 22. SPRING                        |
| 7. POLE SHOE              | 15. LEVER HOUSING    | 23. GASKET                        |
| 8. FIELD COIL             | 16. RETAINER         | 24. CENTER BEARING PLATE AND SEAL |



- |                         |                  |
|-------------------------|------------------|
| 1. KEY SWITCH           | 6. DRIVE LINKAGE |
| 2. NEUTRAL START SWITCH | 7. DRIVE CLUTCH  |
| 3. HOLD WINDING         | 8. STARTER       |
| 4. SOLENOID PLUNGER     | 9. CONTACTS      |
|                         | 10. PULL WINDING |
|                         | 11. TO BATTERY   |

*Figure 3. Solenoid Windings*

## Starter Repair

### REMOVE

**NOTE:** If the starter does not operate correctly, refer to General Checks and Adjustments before beginning any repair procedures.



### WARNING

Always disconnect the battery ground cable before making repairs to prevent possible damage and injury. Install a tag on the battery terminal so that no one connects the cable on the terminal.

1. Install labels on the starter wires and cables for correct connection during installation. Disconnect the wires and the cables to the starter.
2. Remove the capscrews that hold the starter to the flywheel housing.
3. If used, remove the spacers and the gaskets.
4. Remove the starter from the lift truck.

### DISASSEMBLE

1. Remove the screw and lock washer connecting the field coil strap to the "M" terminal of the solenoid. See Figure 2 and Figure 4.

2. Remove the two screws that hold the solenoid to the drive end housing. Turn the solenoid 1/4 turn and remove it from the starter.
3. Remove the two bolts that hold the commutator end frame and the field frame to the drive housing. Make alignment marks on the end frame and on the field frame for easy assembly. Pull the end frame from the field frame. On some models it is necessary to pull the brushes from the holders. Remove the field frame.
4. If used, remove the four screws holding the center bearing plate to the drive end housing.
5. Remove the armature from the drive end housing. Tilt the armature to disengage the linkage from the drive clutch. On some models it is necessary to remove the linkage before removing the armature.
6. Remove the thrust collar from the armature shaft. Put a metal tube with a 13 mm (0.5 in.) inside diameter over the end of the shaft. See Figure 4. Hit the tube to move the retainer. Remove the snap ring. Remove the drive clutch.
7. Remove the center bearing plate. Remove the seal from the plate.

4. Install the shaft assembly in the drive end housing. Make sure the linkage is engaged in the drive clutch. Install and tighten the four screws for the bearing plate.
5. Install the field frame over the armature. Retract the brush springs and slide the brushes on the commutator.
6. Align the marks and install the thrust washer and the commutator end frame. Install and tighten the through bolts.
7. Make sure the solenoid cover is not damaged. Install the plunger spring and the solenoid. Install and tighten the solenoid mount screws. Connect the field coil strap to the "M" terminal with the screw and lock washer.

**CLEAN**



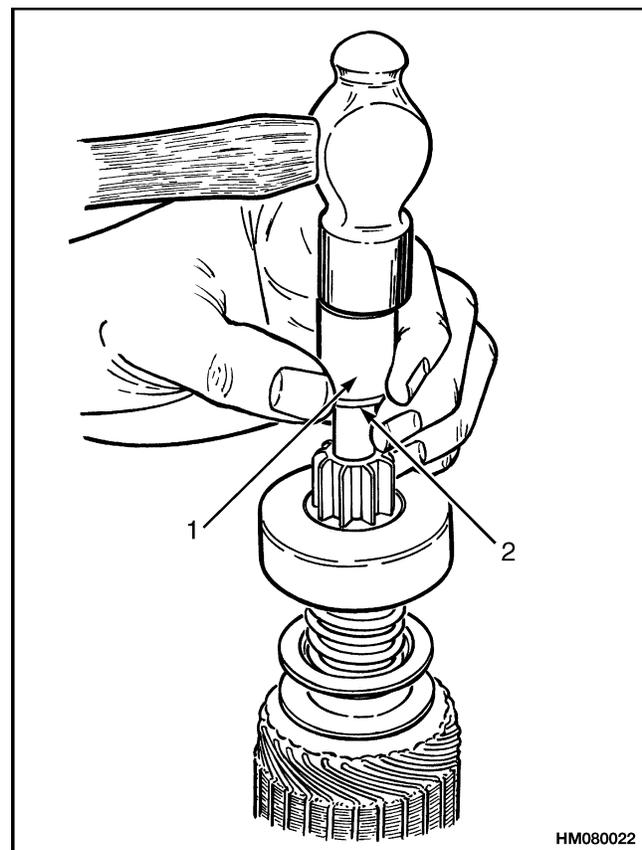
**CAUTION**

Never use solvent on the drive clutch, armature, or field windings. Use a cloth to clean these parts.

Use solvent to clean all parts of the starter, except the windings and the drive clutch. Dry the parts with compressed air.

**ASSEMBLE**

1. Install a new seal in the center bearing plate. See Figure 2 and Figure 5.
2. Lubricate the armature shaft and the bushings with a silicone lubricant.
3. Put the center bearing plate, drive clutch, retainer, snap ring, and thrust washer on the armature shaft. Install the snap ring, thrust washer, and retainer as shown in Figure 5.

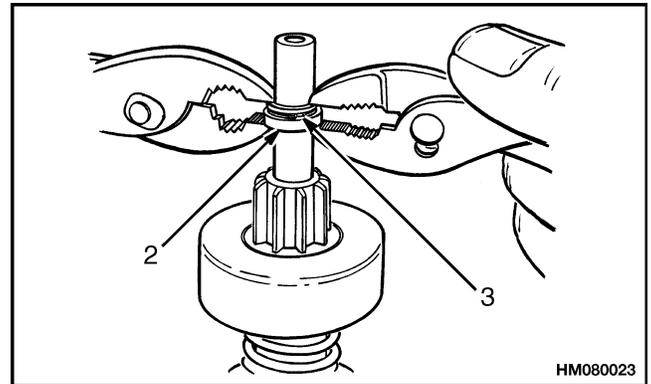


1. METAL TUBE, 13 mm (0.5 in.) INSIDE DIAMETER
2. RETAINER

*Figure 4. Retainer Removal*

**INSTALL**

1. Make sure the surfaces of the flywheel housing, the spacer, and the starter are clean and smooth. Install the gaskets or use a sealant (Hyster part number 264159) that forms a gasket between metal parts.
2. Install the capscrews and washers as necessary. Tighten the capscrews.
3. Connect the wires and the cables to the starter according to the labels made during removal.
4. Connect the ground cable to the battery.



1. THRUST COLLAR
2. RETAINER
3. SNAP RING

*Figure 5. Retainer Installation*

**General Checks and Adjustments**

1. Before removing the starter, see Figure 6 and Figure 7. Make the following checks:
  - a. Check the voltage of the battery.

**CAUTION**

**Do not operate the starter for more than 30 seconds. Be sure to wait at least two minutes between checks.**

- b. Check the voltage at the motor terminal of the solenoid while the key switch is in the "START" position. See Figure 6. The voltage must be more than 9 volts for a 12-volt system or more than 18 volts for a 24-volt system.
- c. Inspect all the connections to the battery, starter solenoid, key switch, and neutral start switch. Clean and tighten, if necessary.
- d. Check the resistance of the connections with a voltmeter. See Figure 7. Each connection must not have more than a 0.5 volt loss for a 12-volt system or 1.0 loss for a 24-volt system.

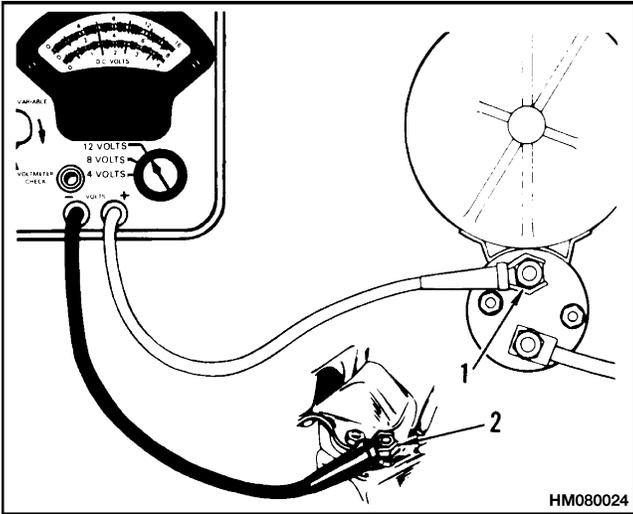
- e. Check the voltage at the "S" terminal of the solenoid. It must be more than 7 volts for a 12-volt system or more than 14 volts for a 24-volt system.

2. After removing the starter, but before disassembly, make the following checks:
  - a. Check the ring gear (on the flywheel) for damage.

**CAUTION**

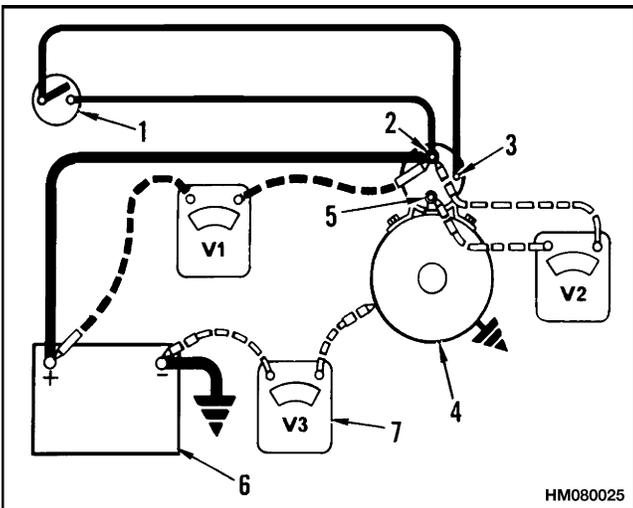
**The pinion will move toward the drive end housing when turned in the locked direction. Do not turn it too far or it will lock in the extended position.**

- b. Check the pinion gear (on the drive clutch) for damage. The pinion must turn in one direction and lock in the other. Replace the complete assembly if any part has damage.
- c. Check the clearance of the armature bushings.
- d. Check for cracks in the drive end housing.



- 1. MOTOR TERMINAL
- 2. GROUND ON ENGINE

Figure 6. Starter Voltage Test



- 1. KEY SWITCH
- 2. "BAT" TERMINAL
- 3. "S" TERMINAL
- 4. STARTER
- 5. "M" TERMINAL
- 6. BATTERY
- 7. VOLTMETER

Figure 7. Resistance Test

- 3. When the starter is disassembled, make the following checks:
  - a. Check that the seals are good on units that use an oil clutch or a powershift transmission.

- b. Check for wear in the linkage.
- c. Test for a ground in the armature windings. See Figure 8. Touch one wire of an ohmmeter to the shaft and the other to each commutator bar. The armature has a short-circuit to ground if the ohmmeter indicates a complete circuit.

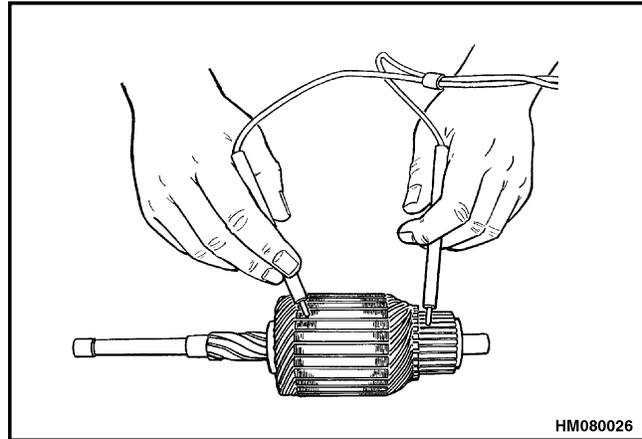
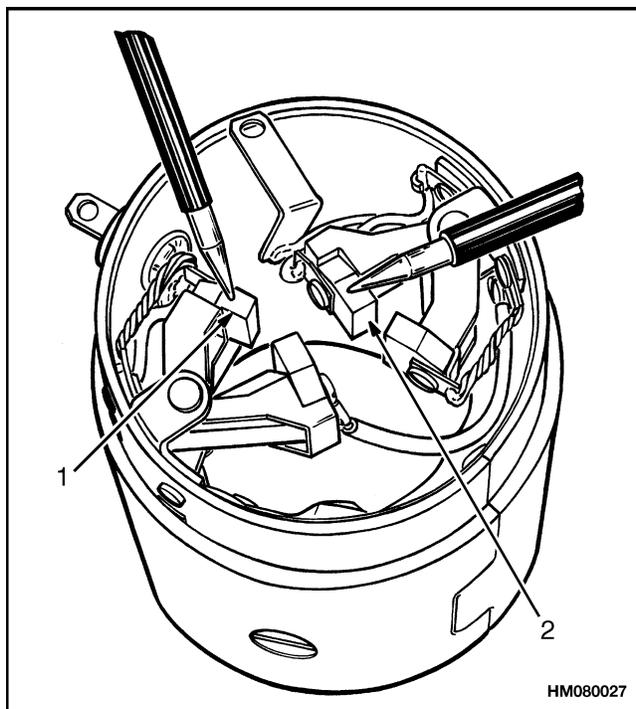


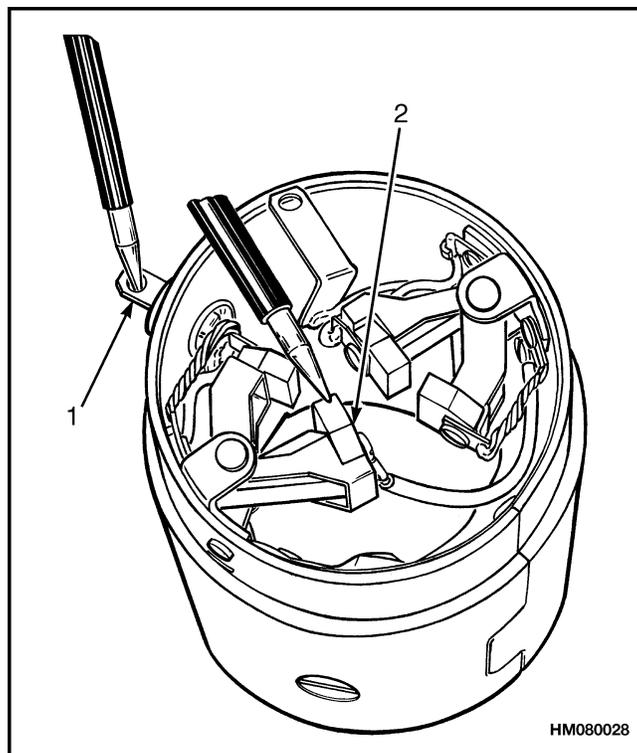
Figure 8. Armature Ground Tests

- d. Test for open circuits in the armature. Put one wire of an ohmmeter on one commutator bar and the other on the bar 180 degrees opposite. The ohmmeter must indicate a complete circuit. Commutator bars that are burned indicate an open circuit.
- e. Test for a ground in the field coil circuit. See Figure 9. Touch one wire of an ohmmeter to the field frame and the other to the field coil brushes. On some models it is necessary to disconnect the field ground strap. The field coils have a short-circuit to ground if the ohmmeter indicates a complete circuit.
- f. Test for an open circuit in the field coils. See Figure 10. Connect the wires of an ohmmeter to the ends of the field coils. The ohmmeter must indicate a complete circuit.
- g. Check that the brush springs have enough tension.
- h. Check the brushes for wear. The brushes must be at least one half the length of new ones.



- 1. INSULATED BRUSH
- 2. GROUND BRUSH

*Figure 9. Field Coil Ground Test*



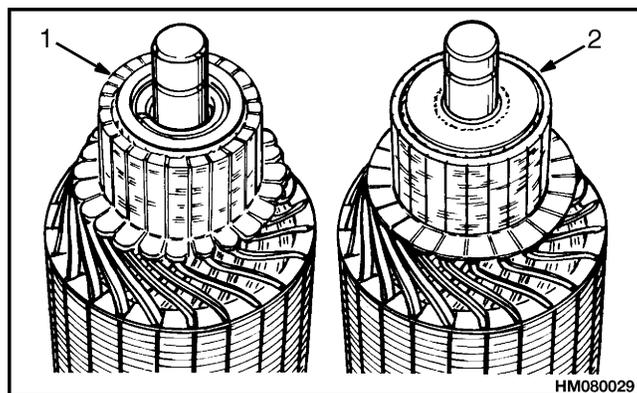
- 1. FIELD COIL STRAP
- 2. GROUND BRUSH

*Figure 10. Field Coil Open Circuit Test*

**CAUTION**

Remove only enough metal to clean the surface on the commutators with the plastic insulation. See Figure 11. Do not cut the insulation between the bars on the commutator. The plastic material is necessary to support the bars. The plastic material is softer than the bars and will wear at the same rate.

- i. If the commutator is rough or is burned, it must be repaired with a lathe.
- j. Check for bad solder connections at the commutator bars. Solder the connections that have damage.



- 1. COMMUTATOR WITH MICA INSULATION
- 2. COMMUTATOR WITH PLASTIC INSULATION (DO NOT CUT INSULATION)

*Figure 11. Two Types of Insulation*

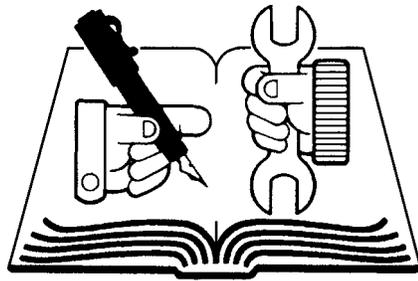
## Troubleshooting

PROBLEM	POSSIBLE CAUSE	PROCEDURE OR ACTION
The starter will not turn; no noise at the solenoid.	Battery is discharged or has damage.	Recharge or replace battery.
	A fuse is burned out.	Replace fuse.
	A wire in the control circuit is disconnected.	Connect wire.
	The key switch has damage.	Install new parts.
	The neutral start switch has damage.	Install new parts.
	The cable connections are bad.	Install new parts.
	The solenoid has damage.	Replace solenoid.
	The starter brushes are worn or dirty.	Replace brushes.
	The solenoid switch has damage.	Replace switch.
The starter will not turn; the solenoid makes noise.	The battery is discharged or has damage.	Recharge or replace battery.
	The starter brushes are worn or dirty.	Replace brushes.
	The contacts in the solenoid are worn.	Install new parts.
	The armature circuit has damage.	Repair or install new parts.
	The cable connections have too much resistance.	Clean or install new parts.
The starter will not turn. The ammeter indicates a large current draw.	The control circuit has a short circuit.	Check wiring for damage and repair.
	The pinion is not engaging the ring gear.	Check the clutch on the starter for damage and repair.
	The solenoid has damage.	Replace solenoid.

PROBLEM	POSSIBLE CAUSE	PROCEDURE OR ACTION
The cables get too hot.	The battery is discharged or has damage.	Recharge or replace the battery.
	The pinion is not disengaging from the ring gear.	Check the clutch on the starter for damage and repair.
	The armature shaft is bent.	Repair or replace armature.
	The cable has a short circuit.	Repair or replace cable.
	The bushings are worn or damaged.	Replace bushings.
	The engine has damage.	Repair or install new parts.
The starter turns too slowly.	The battery is discharged or has damage.	Recharge or replace battery.
	The cable connections have too much resistance.	Repair or install new parts.
	The starter brushes are worn or dirty.	Clean or replace brushes.
	The armature circuit has damage.	Repair or replace armature.
	The field circuit has damage.	
	The starter brushes are worn or dirty.	Clean or replace brushes.
	The ring gear has damage.	Install new parts.
	The engine has damage.	Repair or install new parts.
The ignition timing is not correct.	Recalibrate the ignition timing.	
The starter turns, but the engine will not turn.	The drive clutch has damage.	Install new parts.
	The pinion is not disengaging from the ring gear.	Check the clutch on the starter for damage and repair.
	The ring gear has damage.	Install new parts.

PROBLEM	POSSIBLE CAUSE	PROCEDURE OR ACTION
The starter makes too much noise.	The solenoid has damage.	Replace solenoid.
	The ring gear has damage.	Install new parts.
	The drive clutch has damage.	Install new parts.
	The battery is discharged or has damage.	Recharge or replace battery.
	The starter brushes are worn or dirty.	Replace brushes.





**Hyster Easy Language Program**

***HYSTER*** TECHNICAL PUBLICATIONS

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