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This section is for the following models:

All Electric Lift Trucks

## General

This section describes disassembly and assembly, brush installation, inspection, and checks for malfunctions of DC motors. Inspect the commutator and brushes every 350 hours of operation. The commutator is the rotating electric connection between the armature and the electric power supplied by the battery. Brushes made of carbon compounds slide on the rotating commutator and are the path for electricity from the battery to the commutator and the armature. The maintenance of the commutator and the brushes is important to the good operation of a DC motor.

Traction motors and hydraulic pump motors are similar in design. The hydraulic pump motors are smaller than the traction motors, but the disassembly and maintenance of these motors are similar.

The cooling fan in the traction motors is fastened to the armature and can be removed from the armature. The cooling fan can be removed during disassembly of the traction motor.

The cooling fan in the hydraulic pump motors can be a press fit on the armature shaft and is not easily removed during disassembly of the motor. The armature and cooling fan must be removed from the drive end of the motor during disassembly.

The assembly and disassembly of the motor used for the power steering pump is described in the **Steering System** section. This motor is a permanent magnet motor.

## Brush and Commutator Inspection

### HYDRAULIC PUMP MOTOR AND TRACTION MOTOR

**NOTE:** When inspecting brush conditions and motor commutator conditions for head damage or abnormal wear, the battery maintenance and condition should be eliminated as a cause first. See **Industrial Battery** 2240 SRM 1.

**NOTE:** The brushes and commutator can be inspected, the brushes can be replaced, and Stoning the Commutator can be done with the motor installed in the truck.

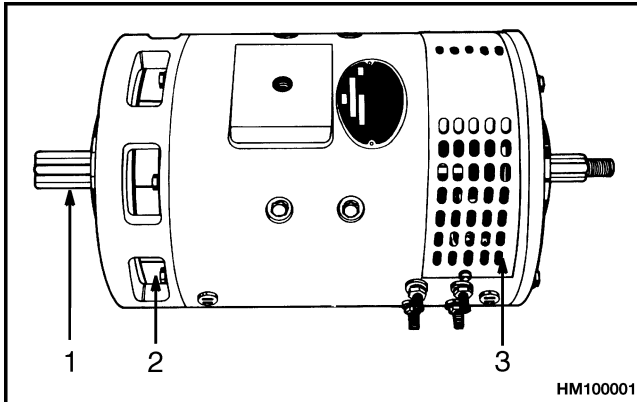
**NOTE:** Inspect the brushes and commutator every 350 hours for best operation and to prevent motor damage. The hydraulic pump motor normally has more start cycles than other motors, so it can have more wear and possible damage.

**NOTE:** The following procedure is for inspecting the brushes and commutator with the motor installed in the lift truck. The same inspections can be done with the motor removed. If the motor is removed, start at Step 3.

1. To rotate the commutator of the traction motor without moving the truck, the drive wheels must be raised. See Figure 1. Raise drive wheels so commutator of the traction motor can be rotated without moving lift truck. See **How To Raise Drive Wheels** in the **Operating Manual** or the **Periodic Maintenance** SRM section for your lift truck.

**NOTE:** For some models of lift trucks, the battery does not need to be removed to access the electric motors. Other models will require the removal of the battery before gaining access to the electric motors. To remove the battery, either raise the hood panels or unfasten the floor plate, depending on which motor needs to be accessed.

2. Remove battery. See **How to Remove Battery** in the **Operating Manual** or the **Periodic Maintenance** SRM section for your lift truck. Remove access plate to motors. If the battery in your lift truck does not need removal for access to the motors, go to Step 3.



- |                              |                |
|------------------------------|----------------|
| 1. ARMATURE<br>(DRIVE) SHAFT | 2. COOLING FAN |
|                              | 3. BRUSH COVER |

**Figure 1. Traction Motor**

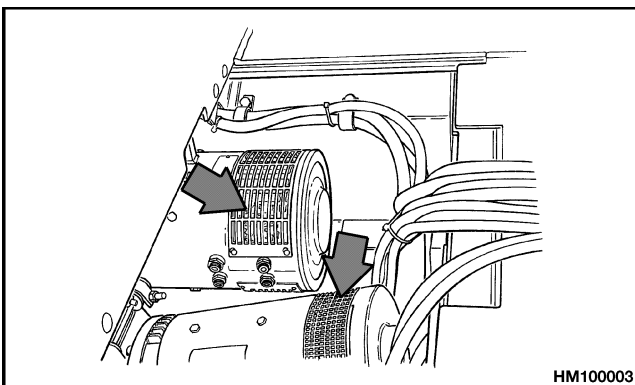


### WARNING

Compressed air can move particles so that they cause injury to the user or to other personnel. Make sure that the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

**NOTE:** Vacuum cleaning, when possible, is the recommendation of manufacturers of electric motors. The use of compressed air can send dirt particles into the bearings and other areas of the motor that can cause possible damage.

- Remove brush covers at rear of motor. See Figure 2. Wear eye protection. Use a vacuum cleaner or compressed air to remove dirt and brush dust from commutator area.



**Figure 2. Brush Cover Removal From Motor**

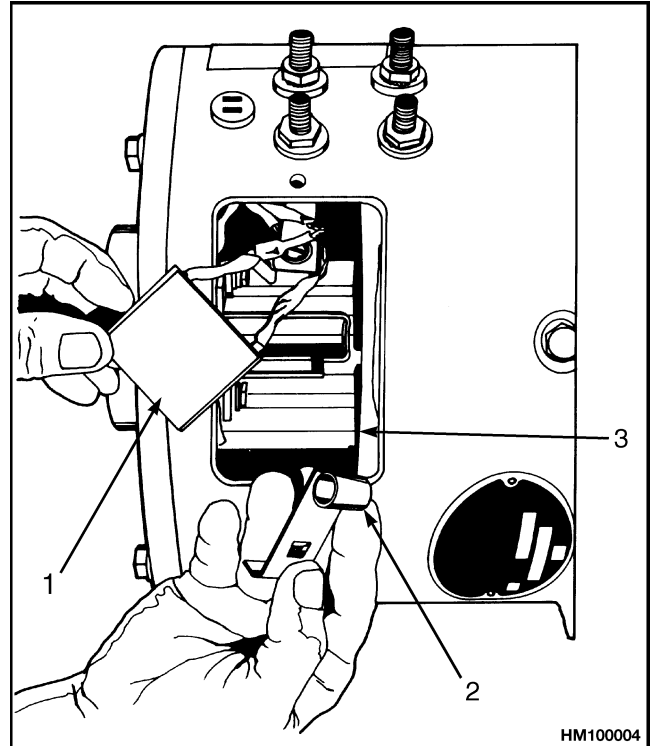
- Remove and inspect brushes for damage or uneven wear. Replace all brushes if any brush is worn or damaged. The brushes must be at least half their original length. Move brush springs away from top of each brush and pull brushes from their holders to inspect surface that rides on commutator. See Figure 3. That surface must have the same shape as the commutator and must not have cracks or defects. Some brushes have wear sensor wires attached, even if they are not connected to an indicator. Replace these brushes if brushes are worn enough to see sensor at commutator end of brush.
- Inspect commutator surface. See Table 1 and Table 2. Carefully rotate armature. **DO NOT** damage commutator if you use a tool to rotate armature.

The commutator wears slowly in normal service. The mica must be cut below the surface of the commutator bars after a long service period or after a commutator has been turned in a lathe.

A commutator that has been in service will have a smooth and polished surface with a darker brown color where it rotates under the brushes. A variation of color on the commutator surface between light brown and darker brown is normal. The surface condition is the lubrication between the commutator and the brushes. The brushes will wear rapidly if this surface condition does not develop during the first 6 to 10 hours of operation after a commutator with a new surface is installed. If the commutator has deep grooves, rough edges of the bars, or a few bars that are black or raised above the others, the motor must be removed for service.

- Inspect white or gray insulation (mica) between commutator bars. The mica must not touch the brushes or the brushes will wear very rapidly.
- To replace a brush set, remove screw that holds brush wires to bus. Pull brush end of springs from brushes, and pull brushes from holders. Lift brush springs away from holders, and install new brushes so brush commutator surface fully touches commutator. Make sure the springs are pushing on each brush. Install and tighten screws for brush wires and bus connectors.

8. Carefully install brush covers so sparks are kept inside motor housing. Install battery as described in **Operating Manual** or the **Periodic Maintenance SRM** section for your lift truck.



1. BRUSH
2. BRUSH SPRING
3. MICA

**Figure 3. Brush Removal and Inspection**

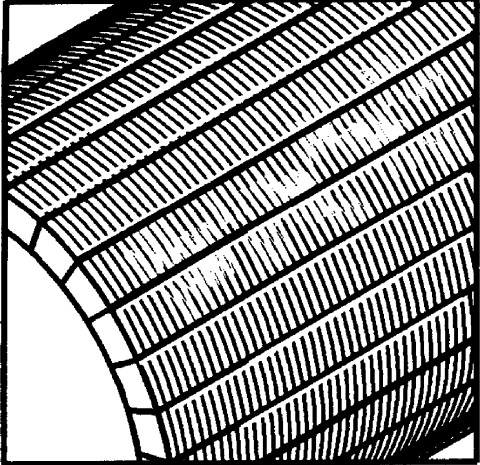
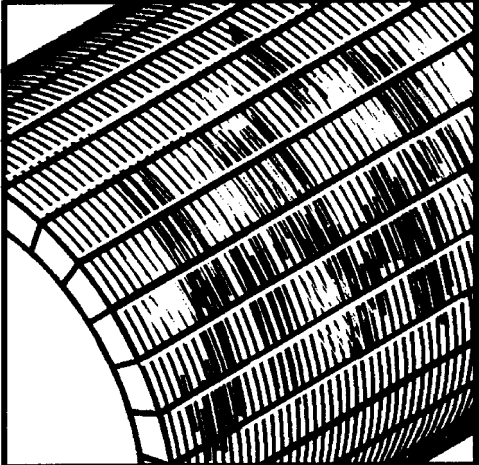
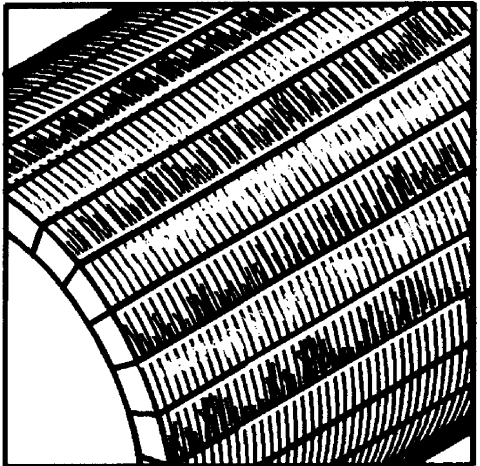
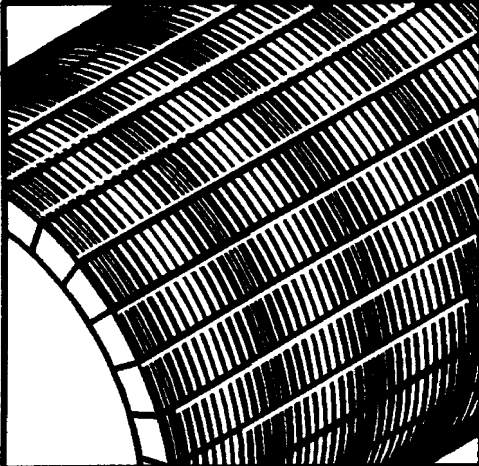
(More Content includes: Brake system, Capacities, and specifications, Frame, Hydraulic, System, Industrial battery, Main control, Valve, Mast repair, Fasteners, Schematics diagrams, Steering axle, Steering system, Wire harness repair And more)

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*Table 1. Normal Commutator Surfaces*

<p>A light brown surface of the commutator where it rotates on the brushes is a normal condition. The surface of the commutator must be smooth.</p>  <p style="text-align: right;">HM100005</p>	<p>Variations between light brown and dark brown colors are also normal. The surface of the commutator must be smooth.</p>  <p style="text-align: right;">HM100007</p>
<p>A condition called slot bar marking is also normal if the commutator surface is smooth. The variable color occurs in a pattern according to the number of conductors per slot.</p>  <p style="text-align: right;">HM100006</p>	<p>A very dark surface is also a normal and an acceptable condition if the commutator surface is smooth.</p>  <p style="text-align: right;">HM100008</p>

**STEERING PUMP MOTOR**

**NOTE:** Some electrical trucks use a steering pump motor. Refer to your truck model's service manual for instructions on removal and installation of steering pump motors.

1. Disconnect battery connector. Remove floor plate from lift truck for access to steering pump motor. Open hood for access to motor. Remove screws

that hold two brush cover plates to motor housing.

2. Inspect brushes and commutator as described in previous paragraphs for traction and hydraulic pump motors. The brush replacement procedure is also the same, although there are only two brushes for the steering pump motor. See Table 3.

3. Install brush covers and screws. Install floor plate or close hood and connect battery connector.

**NORMAL COMMUTATOR SURFACE**

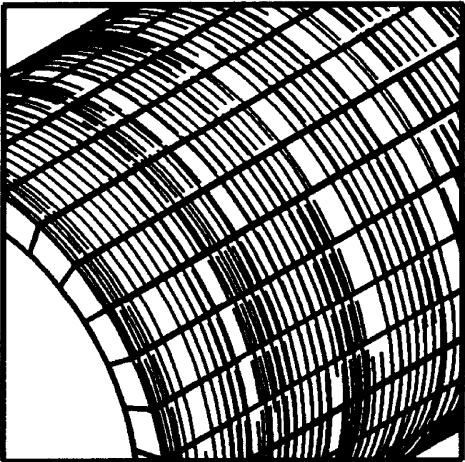
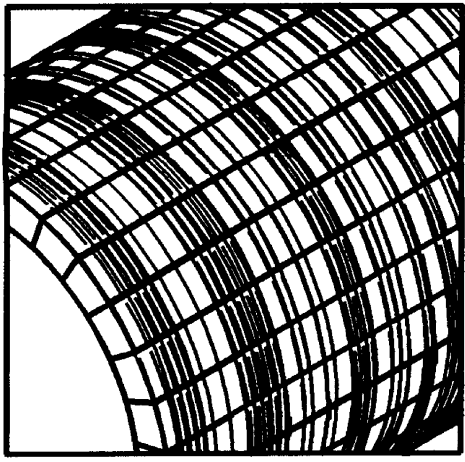
A commutator that has been in service will have a smooth and polished surface with a darker brown color where it rotates under the brushes. See Table 1. A variation of color on the commutator surface between light brown and darker brown is normal.

This surface condition is the lubrication between the commutator and the brushes. The brushes will wear rapidly if this surface condition does not develop during the first 6 to 10 hours of operation after a commutator with a new surface is installed.

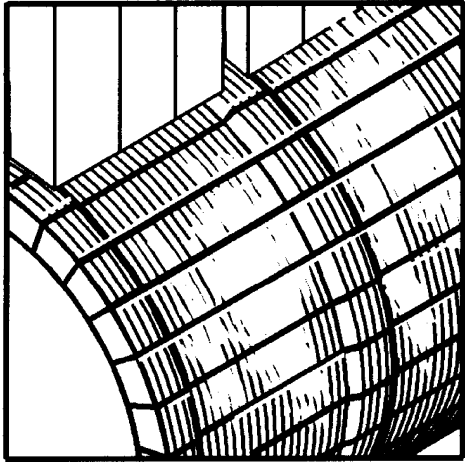
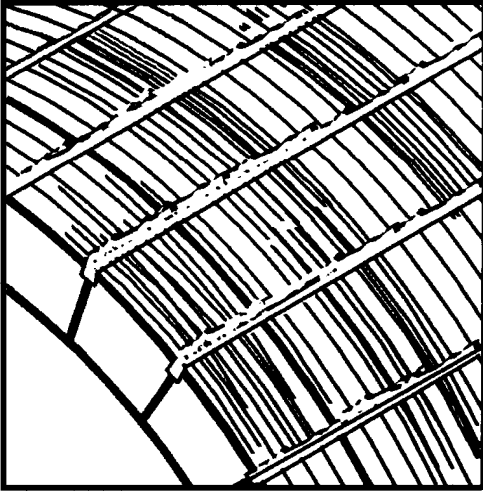
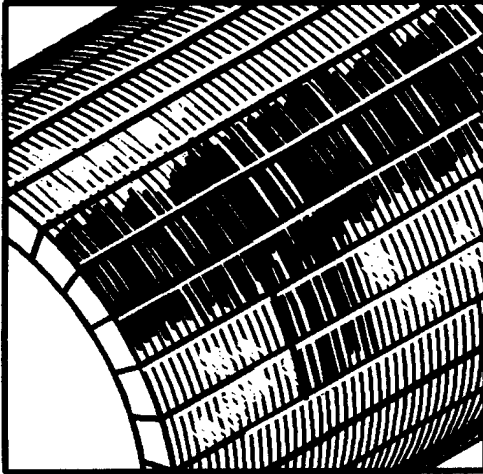
**COMMUTATOR PROBLEMS**

Commutator and motor problems and are shown in Table 2.

*Table 2. Commutator Problems*

Problem	Possible Cause	Illustration
<p>Heavy streaks and fine grooves indicate the beginning of damage to the commutator.</p>	<ul style="list-style-type: none"> <li>• Operation of the motor in dirty and abrasive conditions.</li> <li>• Continuous operation of a motor with a light load.</li> <li>• Brush pressure is too low.</li> <li>• Worn brushes.</li> </ul>	 <p style="text-align: right; font-size: small;">HM100009</p>
<p>Grooves and lines that have followed the heavy streaks and fine grooves shown above. The armature must be removed from the motor so the commutator can be repaired. A commutator with this condition will cause the brushes to wear rapidly.</p>	<ul style="list-style-type: none"> <li>• Operation of the motor in dirty and abrasive conditions.</li> <li>• Continuous operation of a motor with a light load.</li> <li>• Brush pressure is too low.</li> <li>• Worn brushes.</li> </ul>	 <p style="text-align: right; font-size: small;">HM100010</p>

*Table 2. Commutator Problems (Continued)*

Problem	Possible Cause	Illustration
<p>Grooves that are the width of the brushes.</p>	<ul style="list-style-type: none"> <li>• Operation of the motor in dirty and abrasive conditions.</li> <li>• Wrong type of brushes for this motor and operation.</li> <li>• Brush pressure is too high.</li> </ul>	 <p style="text-align: right; font-size: small;">HM100011</p>
<p>A condition called copper drag occurs when copper from the commutator bar is pulled into the slot between the commutator bars. This condition will cause a short circuit between the commutator bars if it is not corrected. The brushes will wear rapidly.</p>	<ul style="list-style-type: none"> <li>• Operation of the motor in dirty and abrasive conditions.</li> <li>• Brush holder is not adjusted electrically correct for the motor.</li> <li>• Wrong type of brushes for this motor and operation.</li> <li>• Brush pressure is wrong (too high or too low).</li> </ul>	 <p style="text-align: right; font-size: small;">HM100012</p>
<p>Electrical burns on commutator bars on opposite sides of the commutator.</p>	<ul style="list-style-type: none"> <li>• Open armature winding.</li> <li>• Motor has been stalled.</li> </ul>	 <p style="text-align: right; font-size: small;">HM100013</p>