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This section is for the following models:

E3.50-5.50XL<sub>3</sub> (E70-120XL<sub>3</sub>) [C098];  
H3.50-5.50XM (H70-120XM) [K005, L005];  
S3.50-5.50XM (S70-120XM) [E004, F004];  
E3.50-5.50XL, E4.50XLS (E70-120Z, E100ZS) [D098]

## Safety Procedures When Working Near Mast

The following procedures **MUST** be used when inspecting or working near the mast. Additional precautions and procedures can be required when repairing or removing the mast.



### WARNING

**Mast parts are heavy and may shift. Distances between parts are small. Serious injury can result if part of the body is hit by parts of the mast or the carriage.**

- **Never put any part of the body into or under the mast or carriage unless all parts are completely lowered or a safety chain is installed. Make sure the power is OFF and the battery is disconnected. Put a DO NOT OPERATE tag in the operator's compartment.**
- **Be careful of the forks. When the mast is raised, the forks can be at a height to cause an injury.**
- **DO NOT climb on the mast or lift truck at any time. Use a ladder or personnel lift to work on the mast.**
- **DO NOT use blocks to support the mast weldments nor to restrain their movement.**
- **Mast repairs require disassembly and removal of parts and can require removal of the mast or carriage. Follow the repair procedures in the correct Service Manual for the mast.**

### WHEN WORKING NEAR THE MAST ALWAYS:

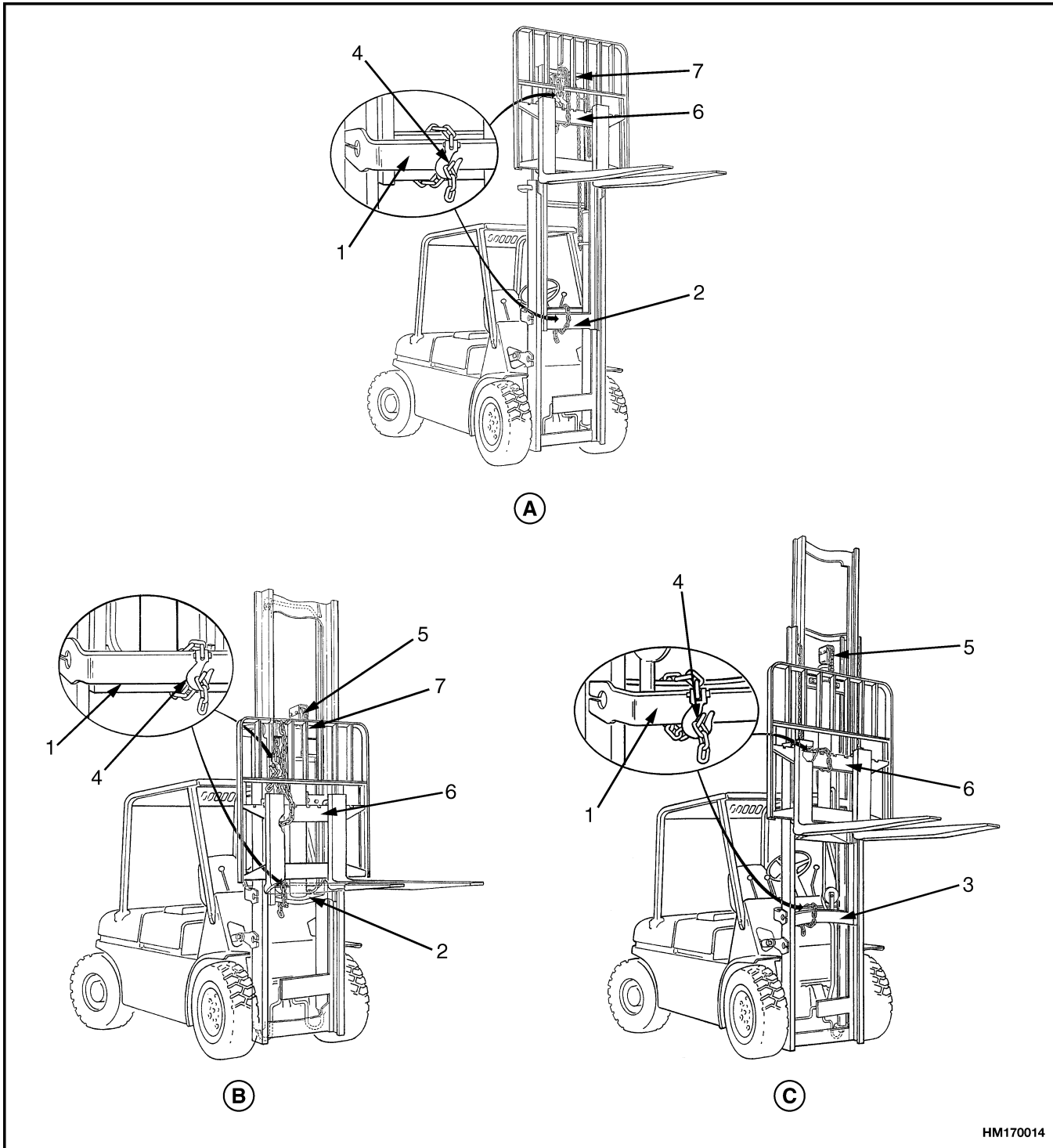
- **Lower the mast and carriage completely. Push the lift/lower control lever forward and make sure there is no movement in the mast. Make sure all parts of the mast that move are fully lowered.**

### OR

- **If parts of the mast must be in a raised position, install a safety chain to restrain the moving parts of the mast. Connect moving parts to a part that does not move. Follow these procedures:**

1. Put mast in a vertical position.
2. Raise mast to align bottom crossmember of weldment that moves in outer weldment with a crossmember on outer weldment. On two-stage and free-lift mast, the moving part is the inner weldment. On three-stage mast, it is the intermediate weldment. See Figure 1.
3. Use a 3/8-inch minimum safety chain with a hook to fasten cross members together so the movable member cannot lower. Put hook on back side of mast. Make sure hook is completely engaged with a link in the chain. Make sure safety chain does not touch lift chains or chain sheaves, tubes, hoses, fittings, or other parts on the mast.
4. Lower mast until there is tension in safety chain, and free-lift cylinder (two-stage full free-lift and three-stage masts only) is completely retracted. If running, stop engine. Apply parking brake. Install a DO NOT REMOVE tag on safety chain(s).
5. Install another safety chain (3/8 inch minimum) between top or bottom crossmember of carriage and a crossmember on outer weldment.

**NOTE:** After lowering or restraining the mast, shut off the power and remove the key. Put a DO NOT OPERATE tag in the operator's compartment.



HM170014

**A. TWO-STAGE LFL MAST**

**B. TWO-STAGE FFL MAST**

**C. THREE-STAGE FFL MAST**

- 1. OUTER WELDMENT
- 2. INNER WELDMENT
- 3. INTERMEDIATE WELDMENT

- 4. HOOK
- 5. FREE-LIFT CYLINDER
- 6. CROSSMEMBER

- 7. CROSSMEMBER

**Figure 1. Safety Chain the Mast**

(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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much.**

## General

This section has the description for lift cylinders used on the masts for model lift trucks S3.50-5.50XM (S70-120XM), H3.50-5.50XM (H70-120XM), E3.50-5.50XL<sub>3</sub> (E70-120XL<sub>3</sub>) and E3.50-5.50XL, E4.50XLS (E70-120Z, E100ZS) [D098] and the instructions for their repair. The operation and repair procedures for the different lift cylinders are similar. See the section **Lift Cylinders** 4000 SRM 135 for lift cylinders used on other units.

## Description

All lift cylinders for the masts are single-action hydraulic cylinders. The hydraulic force is applied only in one direction. When hydraulic oil enters one end of the lift cylinder, the hydraulic force extends the piston rod. When the force is removed, the weight of the carriage and inner mast causes the piston rod to retract.

A common maintenance problem is the repair of oil leaks. If the bore of the shell of the lift cylinder is damaged and cannot be repaired, the lift cylinder must be replaced.

The two-stage and three-stage masts have two main lift cylinders. The free-lift mast has two main lift cylinders and a shorter free-lift cylinder. See Figure 2 and Figure 3.

Spacers are used in some cylinders to limit the stroke of the piston rod. Worn spacers must be replaced with the same size spacer.

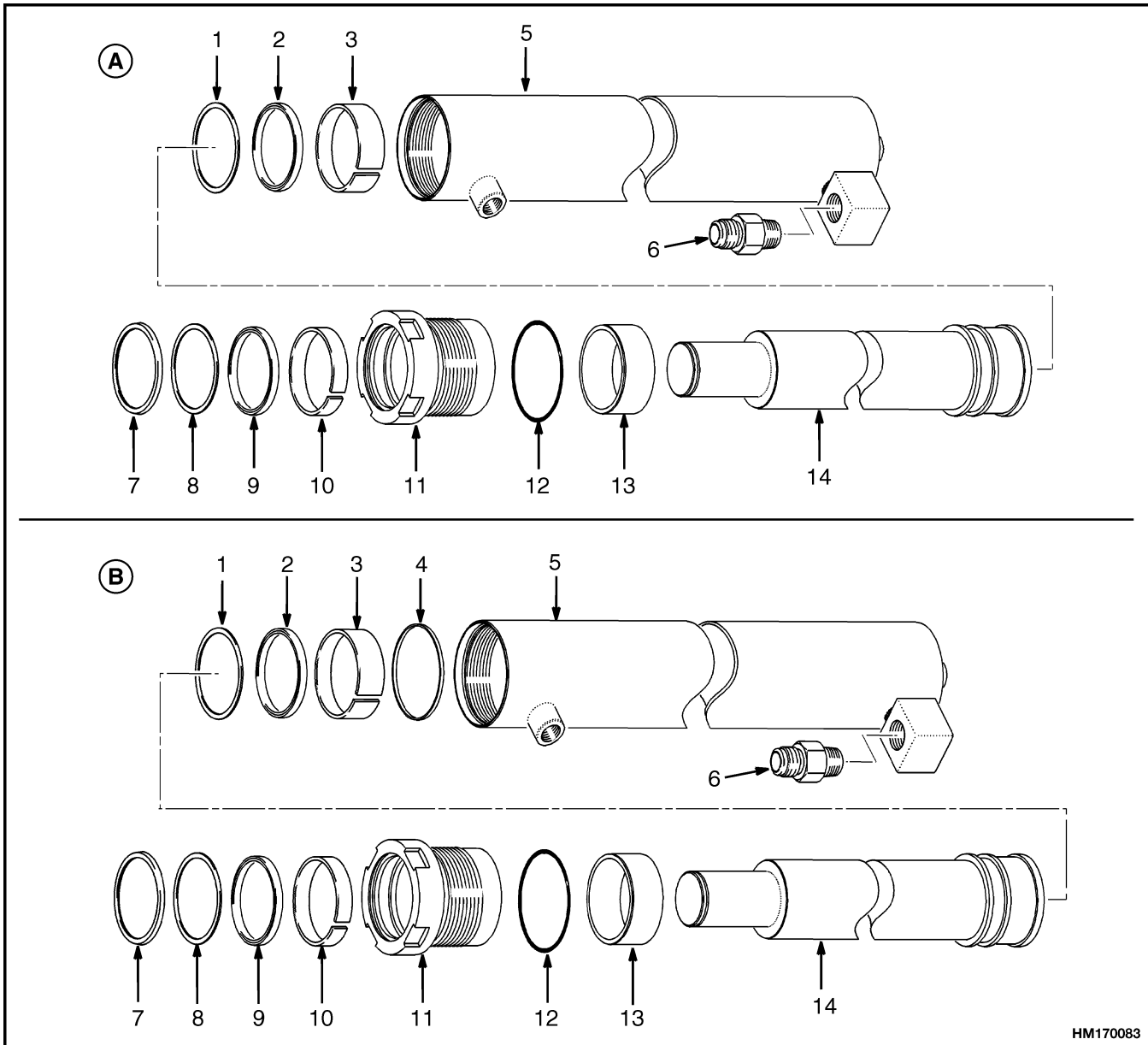
The free-lift cylinder has a single-lip seal on the piston to prevent hydraulic oil leaks past the piston and retainer. The piston rod has a smaller diameter than the piston.

During operation, some hydraulic oil will leak past the piston area to the rod end of the lift cylinder.

Small leaks are permitted if the internal leak rate of the hydraulic system is not greater than the specification. An internal check valve is installed in the piston of the free-lift cylinders. When the piston rod extends, the pressure increases more quickly on any oil in the rod end of the lift cylinder. The hydraulic oil transfers through the check valve to the piston end of the free-lift cylinder. This action prevents hydraulic damage to the single-lip seal and the wiper ring. See Figure 4.

### LOWERING CONTROL VALVE (VELOCITY FUSE)

A lowering control valve is installed in the hydraulic line to the bases of the main lift cylinders and at the inlet port of each lift cylinder. The lowering control valves (velocity fuses) permit easy entry of hydraulic oil into the cylinders, but give a restriction when the rods retract. This restriction controls the maximum speed at which a load on the forks can be lowered. The lowering control valves (velocity fuses) prevent a load on the forks from freely falling if a hydraulic hose breaks.



HM170083

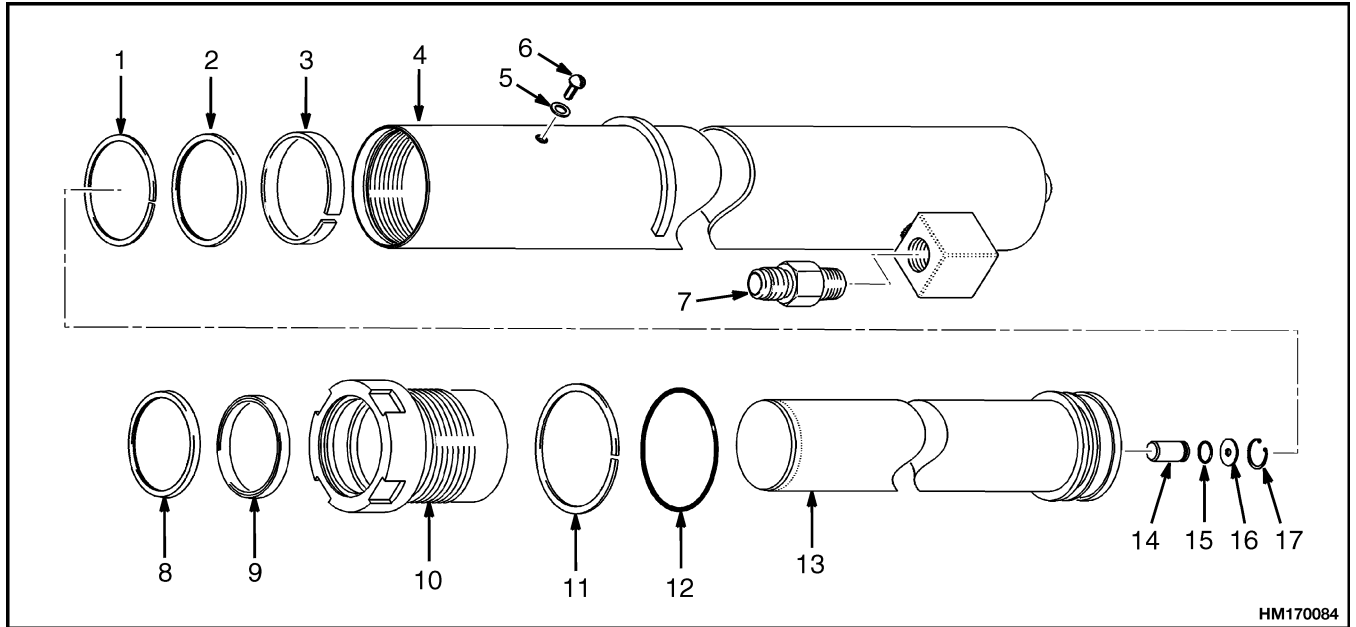
**A. TWO-STAGE MAST**

- 1. PISTON U-CUP SEAL
- 2. BACKUP RING
- 3. WEAR RING
- 4. PISTON RING
- 5. SHELL
- 6. LOWERING CONTROL VALVE (VELOCITY FUSE)
- 7. WIPER RING, ROD

**B. THREE-STAGE MAST**

- 8. BACKUP RING
- 9. ROD SEAL
- 10. WEAR RING
- 11. RETAINER
- 12. O-RING
- 13. SPACER
- 14. ROD ASSEMBLY

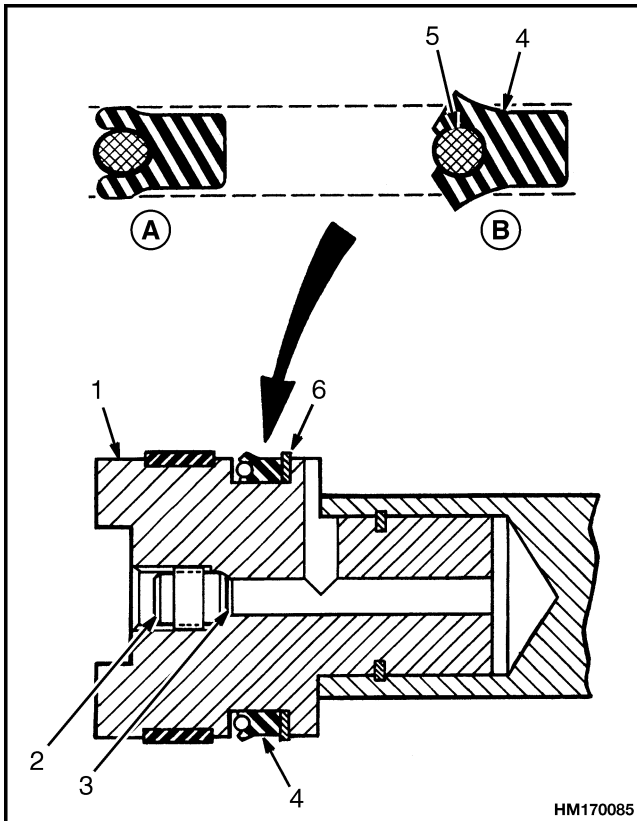
**Figure 2. Main Lift Cylinders**



HM170084

- |   |                  |
|---|------------------|
| 1. BACKUP RING                            | 9. SEAL, ROD     |
| 2. SEAL                                   | 10. RETAINER     |
| 3. WEAR RING                              | 11. BACKUP RING  |
| 4. SHELL                                  | 12. O-RING       |
| 5. WASHER, SEAL                           | 13. ROD ASSEMBLY |
| 6. SCREW, BUTTON HEAD                     | 14. CHECK VALVE  |
| 7. LOWERING CONTROL VALVE (VELOCITY FUSE) | 15. O-RING       |
| 8. WIPER, ROD                             | 16. WASHER       |
|   | 17. SNAP RING    |

**Figure 3. Free-Lift Cylinder**

*Legend for Figure 4*

- |                            |                         |
|----------------------------|-------------------------|
| <b>A.</b> INSTALLED        | <b>B.</b> NOT INSTALLED |
| 1. PISTON AND ROD ASSEMBLY | 4. SINGLE-LIP SEAL      |
| 2. CHECK VALVE             | 5. O-RING               |
| 3. O-RING                  | 6. BACKUP RING          |

**Figure 4. Internal Check Valve and Single Lip Seal**

## Lift Cylinder Repair

### REMOVE

#### WARNING

Connect slings and a crane to the top of the inner mast (and intermediate mast, if it is a three-stage mast) using chains. If it is a three-stage mast, make sure all masts are fastened together. Make sure the chains will not damage the sheaves, tubing, or other parts of the mast. Make sure the crane and slings can lift the load correctly.

**NOTE:** Remove the carriage before removing the lift cylinders. See the procedure described in the **Mast** section. If the mast assembly must be removed for repairs, then remove the lift cylinders when the mast assembly is disassembled. When only the lift cylinder must be removed for repairs, remove the lift cylinders from the mast as described in the following paragraphs.

1. Clean area around lift cylinder hydraulic fittings. Disconnect fittings at the lift cylinders and put caps on open lines.
2. On free-lift mast, remove pins for the lift chains at chain anchors, and remove capscrews, washers, and clamp that hold free-lift cylinder to inner weldment. Remove free-lift cylinder.
3. Remove snap rings and washers from top of each main lift cylinder. Remove cylinder clamps near top of each lift cylinder. Two capscrews and washers are used to fasten each cylinder clamp to outer mast top crossmember.
4. Remove capscrews, washers, and brackets from mounts at bottom of each lift cylinder.
5. Support cylinder. Connect a crane to top of inner mast using chains. Raise inner mast from outer mast approximately 30 cm (12 in.). Disengage piston rod ends of lift cylinders from top



crossmember of inner mast. Remove lift cylinders from mount plates at bottom of outer mast.

## DISASSEMBLE



### WARNING

Use slings and a crane to handle and disassemble the lift cylinders of most lift trucks. Make sure the crane and slings can lift the load correctly.



### CAUTION

Carefully disassemble and assemble the lift cylinders so the piston rods and sliding surfaces are not damaged.

**NOTE:** Disassembly of the main lift cylinders and the free-lift cylinder is similar. All lift cylinders are disassembled from the rod end of the cylinder shell.

1. Loosen retainer with a spanner. See Figure 2 and Figure 3.
2. Remove retainer from shell. Remove and discard wiper ring, backup ring, rod seal, wear ring, and O-ring.
3. Remove protective cap from inlet and slide rod and piston assembly from shell. Drain hydraulic oil into a container.
4. Remove wear ring, single-lip seal, and backup ring from rod assembly.
5. Remove internal check valve, if installed, from base of the lift cylinder.
6. Remove lowering control valve (velocity fuse).
7. Clean all parts. Check sliding surfaces for damage. Repair or replace any damaged parts.

## ASSEMBLE

Refer to Figure 2 and Figure 3 for the following steps.



### CAUTION

A difficult and important step in assembling lift cylinders is the correct installation of the seals. Most lift cylinder maintenance is caused

by seal leaks. Special tools are available from Hyster Parts and Service. See Parts-Service Gram L-A-2 (Latest Revision) for the available tools.

### NOTE:

- Lubricate all internal parts of the lift cylinder with hydraulic oil during assembly.
- Use new O-rings and seals. Apply lubricant (hydraulic oil) during assembly. Packing lubricant (Part No. 186061) is also available.
- Make sure the single-lip seal assemblies are installed with the O-ring toward the base of the lift cylinder. See Figure 4.

1. Install internal check valve if removed. Make sure arrow on internal check valve is toward base of piston.
2. Install wear ring, single-lip seal, and backup ring onto rod assembly. If a spacer sleeve is used, install it. Use shim material and a clamp as a guide to move single-lip seal over threads of shell.

**NOTE:** Do not use an adhesive on the threads of the piston rod and piston.

3. Carefully push rod assembly into shell. Release clamp on seal when seal has travelled past threads of shell.
4. Install seal, backup ring, O-ring, wear ring, and wiper ring in retainer. The wiper side of the wiper seal must be toward base of the lift cylinder. See Figure 4.
5. Carefully install retainer on piston rod.
6. The retainer for the free lift cylinder used on S3.50-5.50XM (S70-120XM) and E3.50-5.50XL<sub>3</sub> (E70-120XL<sub>3</sub>) [C098], and E3.50-5.50XL, E4.50XLS (E70-120Z, E100ZS) [D098] lift truck is tightened to 340 to 410 N•m (250 to 300 lbf ft).
7. Engage threads and tighten retainer to 340 to 410 N•m (250 to 300 lbf ft) for the main lift cylinder and 542 to 644 N•m (400 to 475 lbf ft) on the free-lift cylinder. Use a correct spanner. Do not hit the retainer with a hammer and driver.
8. Install lowering control valve (velocity fuse).

**INSTALL** **WARNING**

Connect slings and a crane to the top of the inner mast (and intermediate mast, if it is a three-stage mast) using chains. If it is a three-stage mast, make sure all masts are fastened together. Make sure the chains will not damage the sheaves, tubing, or other parts of the mast. Make sure the crane and slings can lift the load correctly.

**NOTE:** The clamp blocks used to hold the free-lift cylinder are designed to conform to different cylinder diameters depending on which side contacts the cylinder. Be sure the blocks conform properly to the cylinder shell.

1. Install main lift cylinders to mounts at base of outer mast. Use a crane and lower inner mast to engage piston rods of lift cylinders to holes in top crossmember of inner mast. Install washers and snap rings, or other locking device, at top of

lift cylinders. Install cylinder clamps to brackets mounted to outer weldment near top of each cylinder and tighten nuts to 18 N•m (13 lbf ft).

2. Install brackets, capscrews, and washers on bottom mounts of each main lift cylinder.
3. When inner mast is lowered, install free-lift cylinder in inner mast. A pin in the base of the lift cylinder will fit into the cylinder mount at the base of the inner mast. Fasten upper end of cylinder to center crossmember with clamp blocks, washers, and capscrews. Tighten capscrews to 121 N•m (89 lbf ft). Install chain sheave and brackets to the top of free-lift piston rod.
4. Connect hydraulic lines and fittings at the lift cylinders.
5. Install chain sheaves and brackets. Connect lift chains to chain anchors on inner mast. Fasten wires between ends of the lift chains so they can be controlled during installation of carriage.
6. Install carriage. Connect the lift chains.

**Lift System Leak Check** **WARNING**

Never allow anyone under a raised carriage. Do not put any part of your body through the lift mechanism unless all parts of the mast are completely lowered and the engine is stopped.

Before making any repairs, use blocks and chains on the mast and carriage so they cannot move. Make sure the moving parts are attached to the parts that cannot move.

Do not try to find hydraulic leaks by putting hydraulic components under pressure or putting hands on pressurized components. Hydraulic oil can be injected into the body by pressure.

During the test procedures for the hydraulic system, fasten the load to the carriage with chains to prevent it from falling. Keep all personnel away from the lift truck during the tests.

**NOTE:** See the procedures in the mast repair sections for lift chain adjustments, mast adjustments, carriage adjustment, and header hose roller adjustment.

1. Operate hydraulic system. Put a capacity load on forks and raise and lower load several times. Lower load and tilt mast forward and backward several times. Check for leaks.
2. Raise carriage and load 1 m (3 ft). If carriage lowers slowly with control valve in a **NEUTRAL** position, there are leaks inside the hydraulic system. Maximum speed the carriage is allowed to lower is 50 mm (2 in.) per 10 minutes when hydraulic oil is 30°C (90°F). If oil temperature is 70°C (160°F), maximum speed the carriage can lower is 150 mm (6 in.) per 10 minutes.
3. Check lift cylinder for internal leaks. Remove load from forks. Install a gate valve in supply line between main control valve and mast. Put a capacity load on forks again. Raise carriage 1 m (3 ft). Close gate valve. If carriage or mast lowers slowly, seals in the lift cylinders have leaks.
4. If carriage does not move, open gate valve and check for movement again. If carriage lowers when gate valve is open, check for leaks in hydraulic lines and fittings. If no leaks are found, the main control valve can have a defect. Remove load from forks.

## Troubleshooting

PROBLEM	POSSIBLE CAUSE	PROCEDURE OR ACTION
No movement of the lift cylinders.	Pilot line(s) to the control valve are disconnected or leaking.	Tighten or connect fittings.
	No oil or not enough oil in the hydraulic tank.	Fill tank. Check for leaks.
	Relief valve(s) not set correctly.	Adjust or install new relief valve.
	Hydraulic pump does not operate or has damage.	Repair or install new pump.
	Remote control valve does not operate.	Check and repair valve.
Slow movement of the lift cylinders.	No oil or not enough oil to the lift cylinders.	Fill tank. Check for leaks.
	Cylinders have internal or external leaks.	Repair leaks. Install new parts.
	Relief valve is not set correctly.	Adjust or install new relief valve.
	There is a restriction in a hydraulic line.	Remove restriction. Install new parts.
	Load is more than capacity.	Reduce load.
Rough movement of the mast assembly.	There is air in the hydraulic system.	Remove air. Check for loose connections or breaks in lines.
	Lift cylinder(s) is damaged.	Repair or install new lift cylinder.
	Mast weldments are damaged or not aligned.	Align weldments. Install new parts.
	Mast weldments are not lubricated correctly.	Lubricate correctly.
	Load rollers or bearing blocks are damaged or not adjusted correctly.	Replace or adjust load rollers or bearing blocks.
	Lift chains are damaged.	Replace lift chains.

PROBLEM	POSSIBLE CAUSE	PROCEDURE OR ACTION
Lift or tilt cylinders extend or retract when the control valve lever (spool) is in the <b>NEUTRAL</b> position.	Load check valves and spools have damage.	Repair or install new load check valve and spool.
	Cylinder seals have leaks.	Install new seals.
	Hydraulic lines have leaks.	Repair leaks. Install new parts. Remove air from system.
	Leaks between spool and bore.	Install new spool and O-ring seals.