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## General

This section has the description, operation, and repair procedures for the masts used on this series of lift trucks: Information on the lift cylinders, lowering control valves, carriage, and tilt cylinders is also described in this section.

## Description

The vertical frames of a mast are called weldments. See Figure 10. Load rollers and bearing blocks are installed on the inner and outer weldments. The channels are the vertical parts of the weldments that have the tracks for the load rollers and bearing blocks. The load rollers and bearing blocks guide the weldments as the mast lifts and lowers.

The mast can tilt forward and backward. Tilt cylinders are installed between the frame of the lift truck

and the outer weldment. The pivot mounts are at the bottom of the outer weldment and connect the mast to the lift truck. During the tilt operation the mast rotates on the pivot pins in the frame.

The mast has a carriage. The carriage is a separate section that moves within the vertical channels of the inner weldment on load rollers. The forks and fork positioner cylinders are attached to the carriage.

## Operation

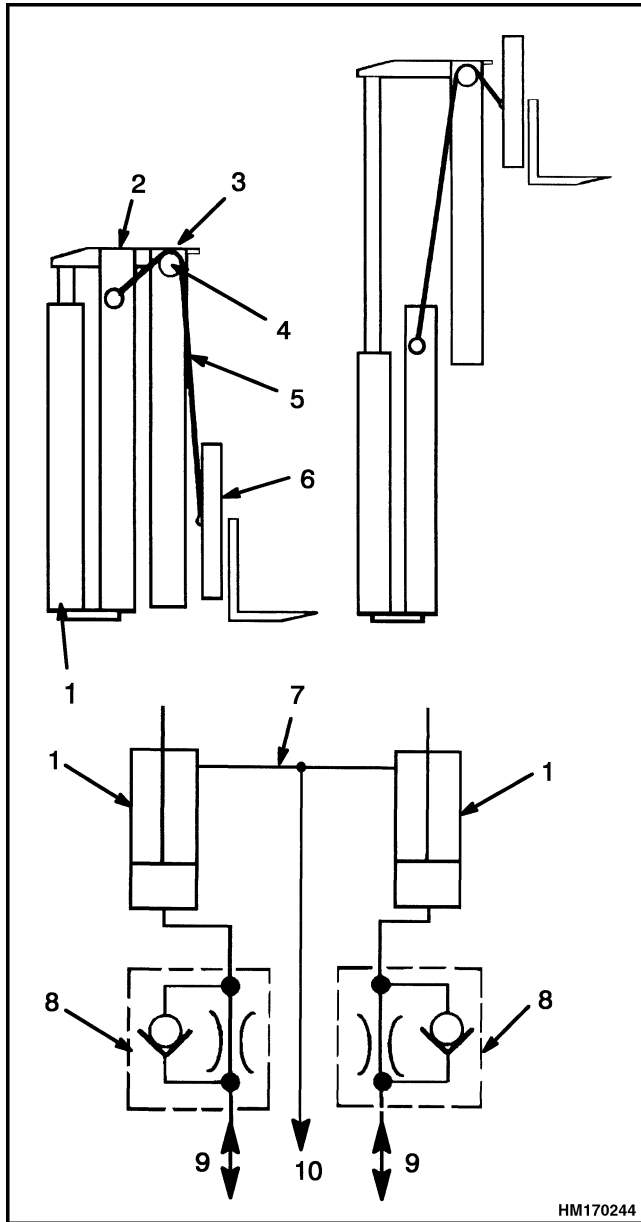
The mast has an outer weldment and an inner weldment. See Figure 1. The outer weldment is connected to the lift truck by the pivot pins and the tilt cylinders. The top of the outer weldment has two sets of bearing blocks to control movement of the inner weldment. The inner weldment has two load rollers and a bearing block on each side. These parts travel along the channels of the outer weldment and control the movement between the inner and outer weldments.

The mast has two single-stage lift cylinders. The lift cylinders are installed at the back of the mast. The base of each lift cylinder is held to the mount plate at the bottom of the outer weldment. The hydraulic fitting and external lowering control valve for each lift cylinder go through a hole in the mount plate. The

cylinder rod of each lift cylinder is held in position at the top of the inner weldment.

Two lift chains control the movement of the carriage. The chains are fastened to mounts near the top of the outer weldment. The chains go up and over the chain sheaves on the inner weldment and then connect to the carriage. When a load on the carriage is raised by the lift cylinders, the weight of the load and carriage assembly is transferred from the carriage through the chains to the outer weldment.

When the lift cylinders retract, the weight of the load, the carriage, and inner weldment push the oil from the lift cylinders. The oil flows from the lift cylinders, through the lowering control valves, main control valve, and then to the hydraulic tank.



- 1. LIFT CYLINDER (2)
- 2. OUTER WELDMENT
- 3. INNER WELDMENT
- 4. CHAIN SHEAVE
- 5. LIFT CHAIN (2)
- 6. CARRIAGE
- 7. BREATHER LINE
- 8. EXTERNAL LOWERING CONTROL VALVE
- 9. FROM MAIN CONTROL VALVE
- 10. TO HYDRAULIC TANK

**Figure 1. Mast Operation**

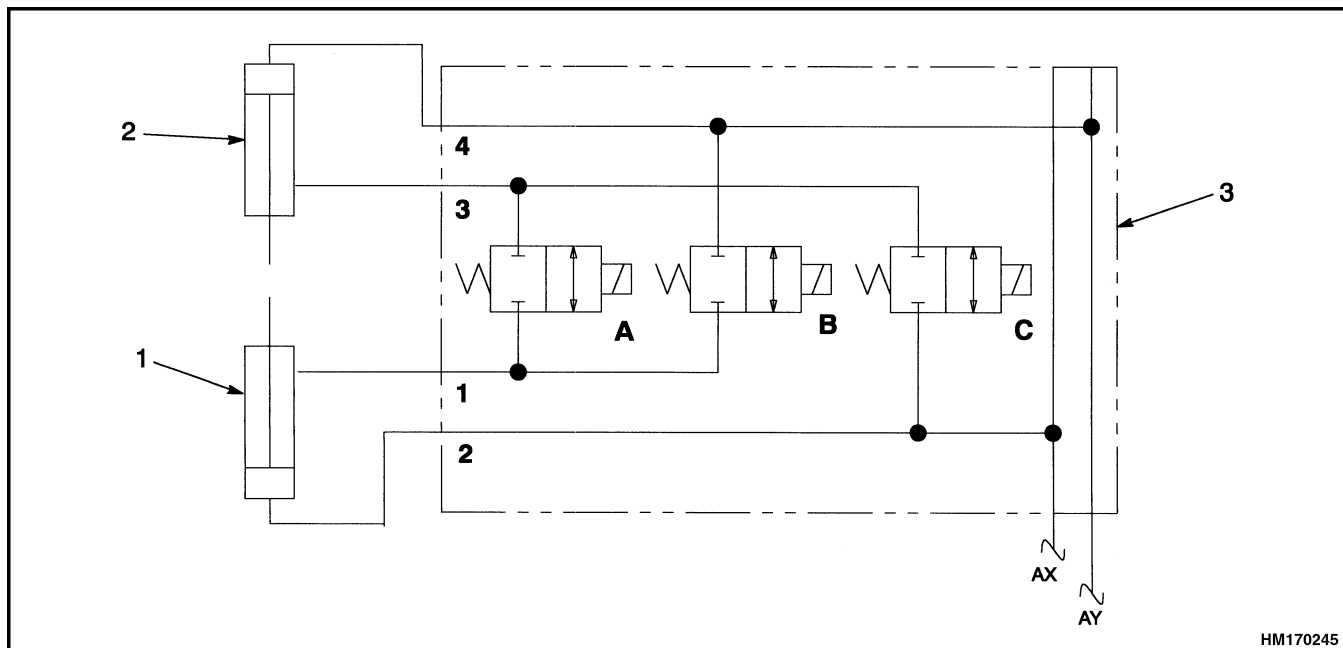
### CONTROL VALVE, CARRIAGE/ATTACHMENT

The hydraulic functions for the carriage and attachment are controlled by the auxiliary control valve. The operator actuates the auxiliary control valve with switches in the operator's compartment. The oil from the auxiliary control valve is used to move the auxiliary spool in the main control valve. Oil from the auxiliary spool flows to the selector valves for the functions at the carriage, such as fork positioners.

When the operator pushes a switch, one solenoid on the auxiliary control valve and a solenoid on the selector valve are energized at the same time. The solenoid on the auxiliary control valve opens and lets oil flow through the pilot line to move the auxiliary spool. The opposite end of the auxiliary spool is open to drain through the other solenoid on the auxiliary control valve. When the auxiliary spool moves, it lets oil from the hydraulic pump flow to the selector valve as required.

### SELECTOR VALVE

A selector valve opens and closes a hydraulic circuit for one function. See Figure 2. Each valve has one solenoid that operates one spool. Selector valves are mounted on a common hydraulic manifold on the carriage. The control valve for the carriage and attachment starts and stops the flow of oil to the manifold. A selector valve lets the oil flow to the cylinder or cylinders for a specific function. The operator controls the selector valves with separate switches for each of the hydraulic functions. Each of the switches operates the control valve and a selector valve at the same time.



**NOTE: PORTS:** 1 = LEFT-HAND CYLINDER (ROD END), 2 = LEFT-HAND CYLINDER (PISTON END), 3 = RIGHT-HAND CYLINDER (ROD END), 4 = RIGHT-HAND CYLINDER (PISTON END). **SOLENOIDS:** SOLENOID A (SIDESHIFT), SOLENOID B (RIGHT FORK), SOLENOID C (LEFT FORK).

1. LEFT-HAND CYLINDER (MOVES RIGHT-HAND FORK)
2. RIGHT-HAND CYLINDER (MOVES LEFT-HAND FORK)
3. SELECTOR VALVE

*Figure 2. Hydraulic Schematic (Selector Valve)*

## 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 can move. Distances between parts are small. Serious injury or death 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. Also make sure that the power is off and the key is removed. 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:

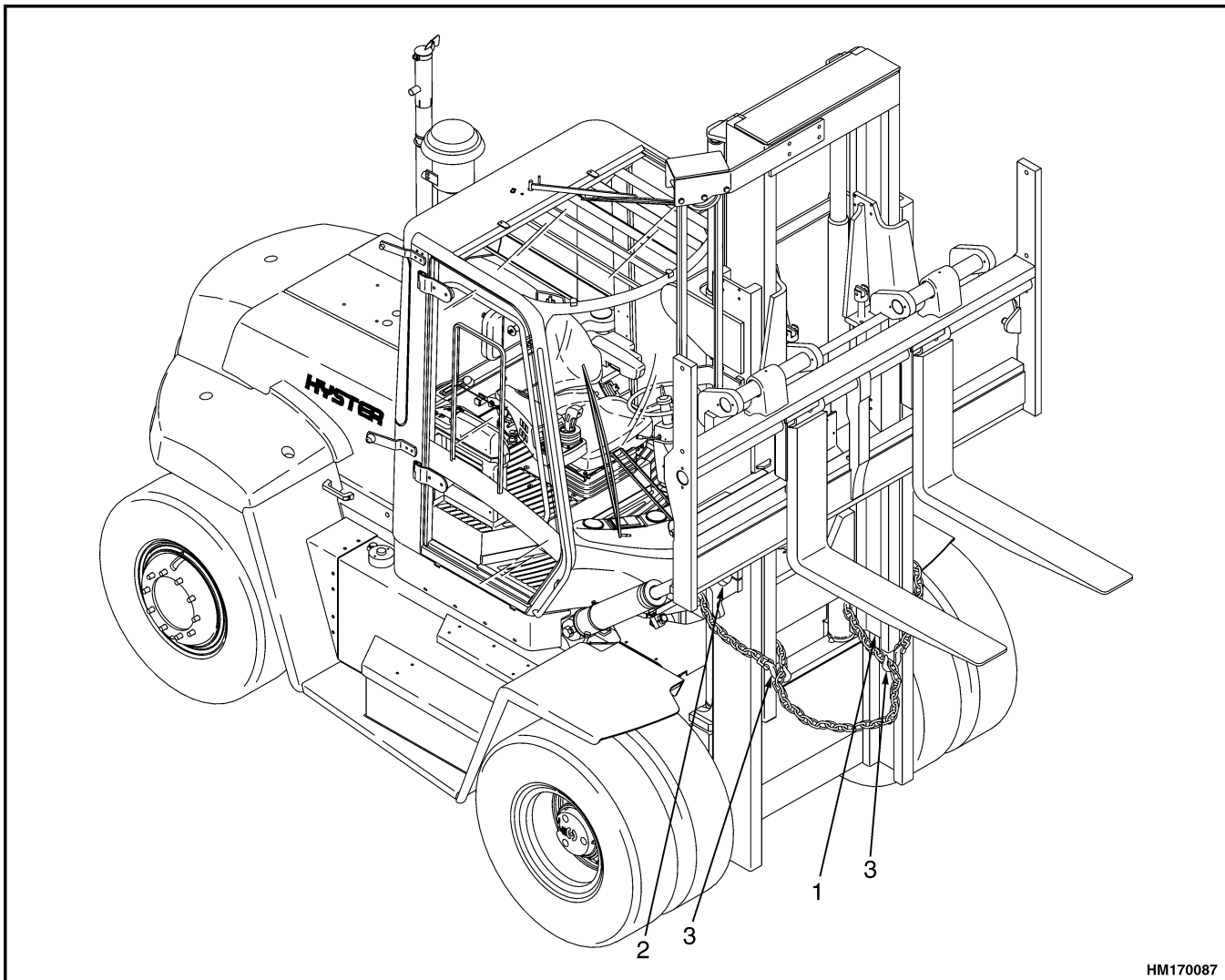
1. Lower the mast and carriage completely. Push the lift/lower control lever forward and make sure there is no movement in the mast. Make sure that all parts of the mast that move are fully lowered.

OR

2. If parts of the mast must be in 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:
  - a. Put the mast in a vertical position.
  - b. Raise the mast to align the bottom of the inner weldment to below the anchor for the tilt cylinders. See Figure 3.
  - c. Use a 1/2 inch minimum safety chain with a hook to fasten the weldments together so

that the inner weldment cannot lower. Install the chain on both sides of the mast. Make sure the hooks are completely engaged with a link in the chain.

- d. Lower the mast until there is tension in the safety chain. If the engine is running, stop the engine. Apply the parking brake. Install a **DO NOT REMOVE** tag on the safety chain. Put a **DO NOT OPERATE** tag in the operator's compartment.



1. INNER WELDMENT

2. TILT CYLINDERS

3. HOOK

**Figure 3. Mast**

## Carriage Repair

### REMOVE



#### WARNING

The mast assembly and its components are heavy. To avoid causing damage or an injury, a lifting device must be used during all service procedures. See Table 1 for the approximate weight of the components.



#### WARNING

When working on or near the mast see Safety Procedures When Working Near Mast in this section.

1. Lower the carriage and forks on blocks so that the lift chains are loose. See Figure 4.
2. Disconnect the electrical connectors and hydraulic lines at the carriage. Put caps on the open lines.



#### WARNING

Keep control of the lift chains when disconnecting them from the carriage. Use wire to temporarily connect the ends of the lift chains to a crossmember on the inner weldment. (Make sure the wire(s) will not break when raising the inner weldment.) This procedure will prevent the lift chains from falling and causing an injury or damage.

3. Remove the pin from each chain anchor at the carriage. Disconnect the lift chains from the carriage. Use wire to connect the ends of the chains to the inner weldment.



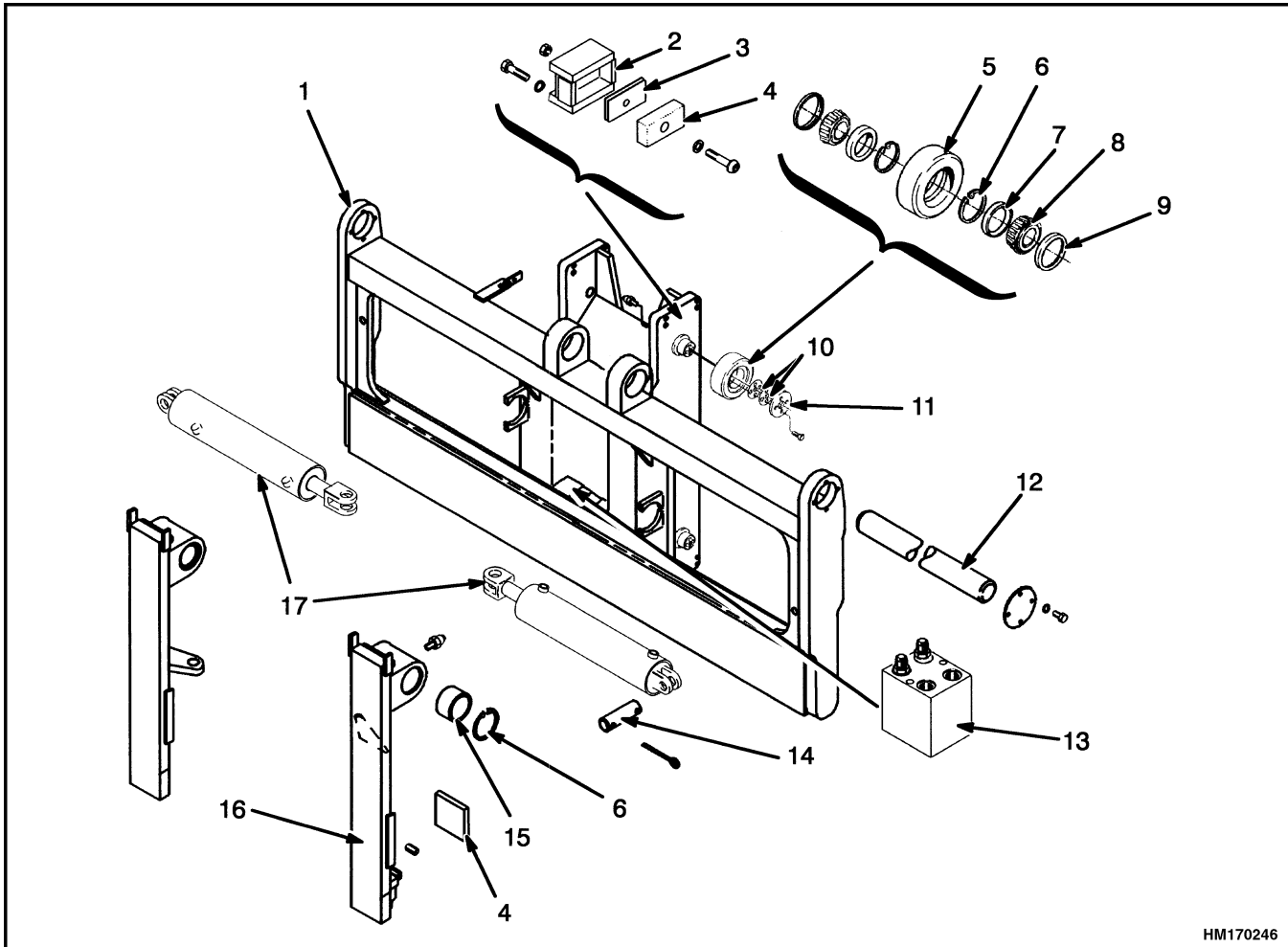
#### WARNING

When the carriage is not connected to the mast, it can fall and cause an injury. Make sure that the carriage has stability and will not fall over when the inner weldment is raised above the carriage.

4. Put a weight of approximately 454 kg (1000 lb) on the forks. This weight on the forks will give stability to the carriage so that it will not fall when it is disconnected from the mast.
5. Use the lift cylinders to raise the inner weldment until it is above the top of the carriage. If the hydraulic system cannot be used, connect a lifting device to the top of the inner weldment. Carefully raise the inner weldment until it is above the top of the carriage.
6. Move the lift truck from the carriage and connect a lifting device to the carriage. [The carriage can weigh up to 2270 kg (5000 lb). The forks can weigh up to 680 kg (1500 lb) each.] Make sure the carriage has stability.

### DISASSEMBLE

1. Remove the fork positioner cylinders, fork pins, forks, and fork guides or fork carriers. See Figure 4 and Figure 5. Put the carriage on blocks so that the load rollers are not on the ground.
2. Remove the load rollers and bearing blocks as necessary.
3. Remove the selector valves if necessary.
4. Disassemble a fork positioner cylinder as follows:
  - a. Remove the retainer. Pull the rod assembly and retainer from the cylinder shell.
  - b. Remove the nut from the rod and remove the piston.
  - c. Remove the seals and O-rings.
  - d. Clean the cylinder using the same procedures as described for the tilt cylinders.

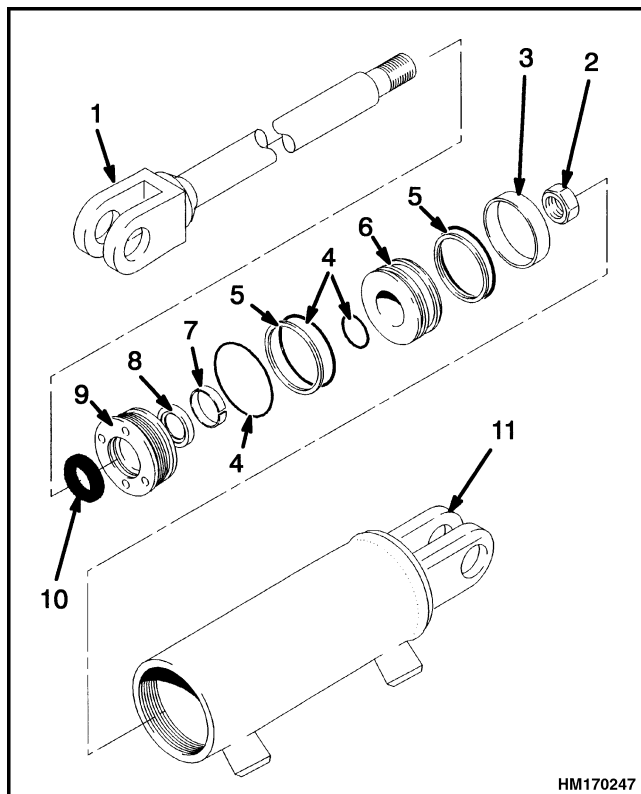


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**NOTE:** QUICK DISCONNECT, HOOK-TYPE FORK ARRANGEMENT SHOWN.

- |                  |                              |
|------------------|------------------------------|
| 1. CARRIAGE      | 10. SHIM                     |
| 2. BRACKET       | 11. RETAINER                 |
| 3. SHIM          | 12. FORK PIN                 |
| 4. BEARING BLOCK | 13. SELECTOR VALVE           |
| 5. LOAD ROLLER   | 14. ANCHOR PIN               |
| 6. SNAP RING     | 15. BUSHING                  |
| 7. BEARING CUP   | 16. FORK CARRIER             |
| 8. BEARING CONE  | 17. FORK POSITIONER CYLINDER |
| 9. SEAL          |                              |

*Figure 4. Carriage*



- |                 |               |
|-----------------|---------------|
| 1. CYLINDER ROD | 7. GUIDE RING |
| 2. NUT          | 8. ROD SEAL   |
| 3. WEAR RING    | 9. RETAINER   |
| 4. O-RING       | 10. WIPER     |
| 5. PISTON SEAL  | 11. SHELL     |
| 6. PISTON       |               |

**Figure 5. Fork Positioner Cylinder**

## ASSEMBLE

1. Assemble a fork positioner cylinder as follows (Figure 4 and Figure 5):
    - a. Lubricate the seals and O-rings with clean hydraulic oil. Install the O-ring and backup ring in the groove of the retainer. Install the rod seal, guide ring and wiper in the bore of the retainer. Install the retainer on the rod.
    - b. Install the O-ring and piston on the rod. Use Loctite® 277 on the threads of the rod. Tighten the nut for the rod to 990 to 1090 N•m (732 to 805 lbf ft).
    - c. Install the piston seal and wear ring on the piston. Install the rod and piston in the shell.
    - d. Install the retainer.
2. Install the load rollers on the carriage as follows:
    - a. Lubricate the bearings with multipurpose grease.
    - b. Install the load roller on the shaft. Install the retainer and capscrews. (Do not add shims at this time.) Tighten the capscrews to 26 N•m (19 lbf ft).
    - c. Measure the clearance between the retainer and the outer bearing. Add shims under the retainer so that there will be zero clearance. Install the retainer and tighten the capscrews to 53 N•m (39 lbf ft). Check that the load roller rotates freely.
  3. Install the mounts for the bearing blocks and tighten the capscrews for the mounts to 53 N•m (39 lbf ft). Install the bearing blocks and shims on the mounts. Lubricate the surface of the bearing blocks with multipurpose grease. See Mast Adjustments, Bearing Blocks at the end of this section.

## INSTALL

1. Use the hydraulic system of the lift truck or a lifting device to raise the inner weldment. Raise the inner weldment until it is above the top of the carriage. Carefully lower the inner weldment until it engages all of the load rollers.
2. Check the clearance of the bearing blocks. See Carriage Adjustments, Bearing Blocks in this section.
3. Connect the lift chains to the chain anchors. Install the pins using new cotter pins.



### WARNING

**Do not try to move a fork without a lifting device. The forks can weigh up to 680 kg (1500 lb) each.**

4. Install the fork positioner cylinders and fork guides or fork carriers. Install the forks and fork pins. Install the retainers for the fork pins.
5. Connect the electrical connectors and hydraulic lines as necessary. Check the lift chains as described in Carriage Adjustments, Lift Chain Adjustments.

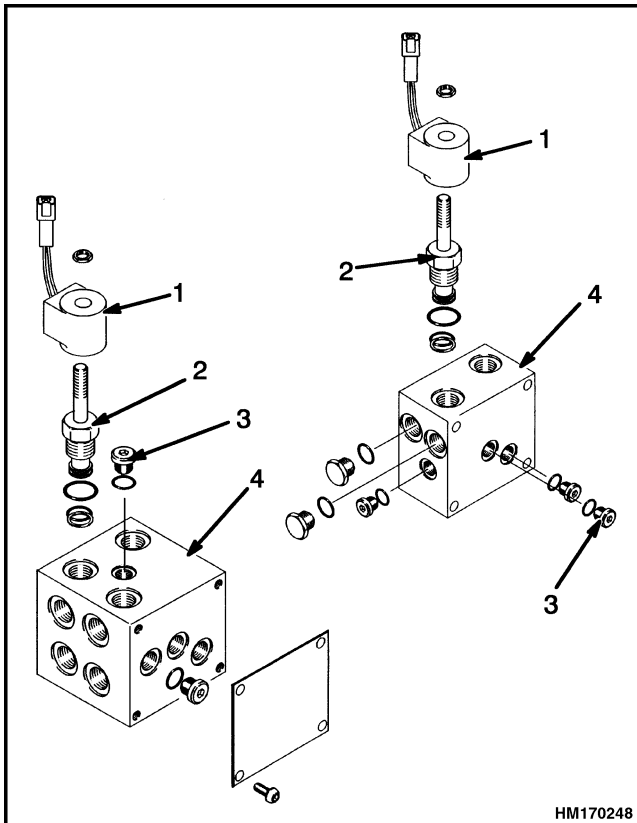


## SELECTOR VALVE

### Remove and Disassemble

**NOTE:** The selector valves are installed on the carriage.

1. Disconnect the electrical wires at the selector valve(s). See Figure 4 and Figure 6.



- |              |                    |
|--------------|--------------------|
| 1. SOLENOID  | 3. PLUG AND O-RING |
| 2. CARTRIDGE | 4. VALVE BODY      |

**Figure 6. Selector Valves**

2. Disconnect the hydraulic lines at the selector valve(s).
3. Remove the capscrews that hold the selector valves to the carriage.

4. Remove the nut and the solenoid coil from the housing. Remove the spool and O-rings.

### Clean and Inspect

#### **WARNING**

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety precautions.

#### **WARNING**

Compressed air can move particles so that they cause injury to the user or to other personnel. Make sure that the compressed air path is away from all personnel. Wear eye protection.

Use solvent to clean the metal parts. Carefully dry the parts with compressed air. Inspect the other parts and replace parts that are damaged.

### Assemble

1. Lubricate the cartridge with clean hydraulic oil. See Figure 6. Install the O-rings on the cartridge, then install the cartridge in the valve body. Install the solenoid coil and nut.
2. Install the O-rings and plugs in the valve body.
3. Install the selector valves together with new O-rings. Tighten the through bolts.

### Install

1. Put the selector valve assembly on the carriage. Install the capscrews and washers that hold the valves in position. See Figure 4 and Figure 7.
2. Connect the hydraulic lines to the valve body.
3. Connect the wires to the solenoids.

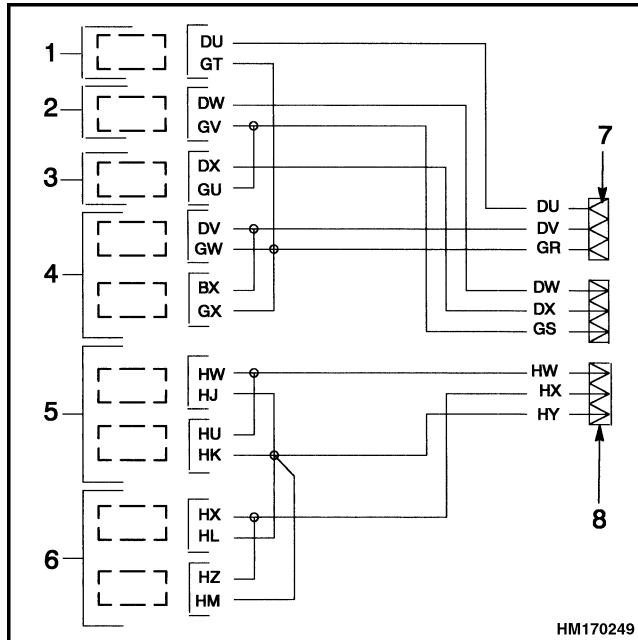


Figure 7. Selector Valve Wiring

*Legend for Figure 7*

1. SOLENOID A (SIDESHIFT)
2. SOLENOID B (RIGHT FORK)
3. SOLENOID C (LEFT FORK)
4. SELECTOR VALVE (AUXILIARY FUNCTION)
5. SELECTOR VALVE (AUXILIARY FUNCTION)
6. SELECTOR VALVE (AUXILIARY FUNCTION)
7. SELECTOR VALVE HARNESS
8. SELECTOR VALVE HARNESS (AUXILIARY)

## Tilt Cylinders Repair

### REMOVE



#### WARNING

Before removing the tilt cylinder(s), tilt the mast forward. Use a chain to hold the mast to the frame and prevent the mast from moving forward.

1. Disconnect the hydraulic lines at the tilt cylinder. Install caps on the hydraulic lines and ports.



#### WARNING

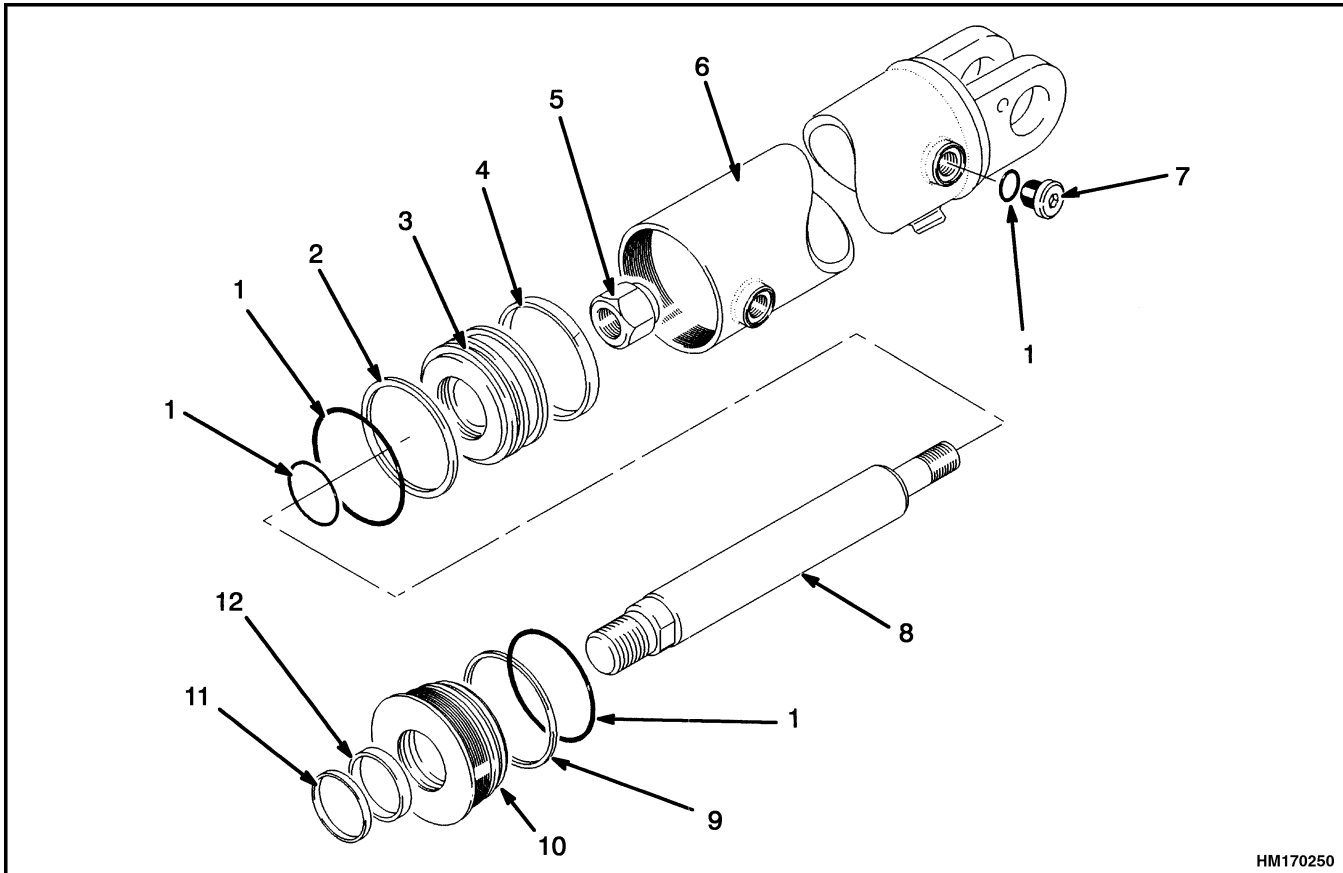
Do not push the pivot pins out of the rod end with your fingers.

Do not permit the tilt cylinders to drop and cause damage.

2. Remove the retainers for the pivot pins. Push the pivot pins out of the rod end with a tool.
3. Use a lifting device to move the tilt cylinders. Remove the retainer and pivot pin from the frame mount. Remove the tilt cylinder.

### DISASSEMBLE

1. Remove the rod end from the rod. See Figure 8.
2. Remove the retainer from the shell. Remove the rod and piston assembly.
3. Disassemble the tilt cylinder as necessary.



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- |              |              |                |                |
|--------------|--------------|----------------|----------------|
| 1. O-RING    | 4. WEAR RING | 7. PLUG        | 10. RETAINER   |
| 2. SEAL RING | 5. NUT       | 8. ROD         | 11. WIPER SEAL |
| 3. PISTON    | 6. SHELL     | 9. BACKUP RING | 12. ROD SEAL   |

**Figure 8. Tilt Cylinder**

## CLEAN



### WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety procedures.

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.

Clean all parts in solvent and dry with compressed air.

## ASSEMBLE

**NOTE:** Always use new seals and O-rings. Make sure all parts are clean. Lubricate all parts with clean hydraulic oil.

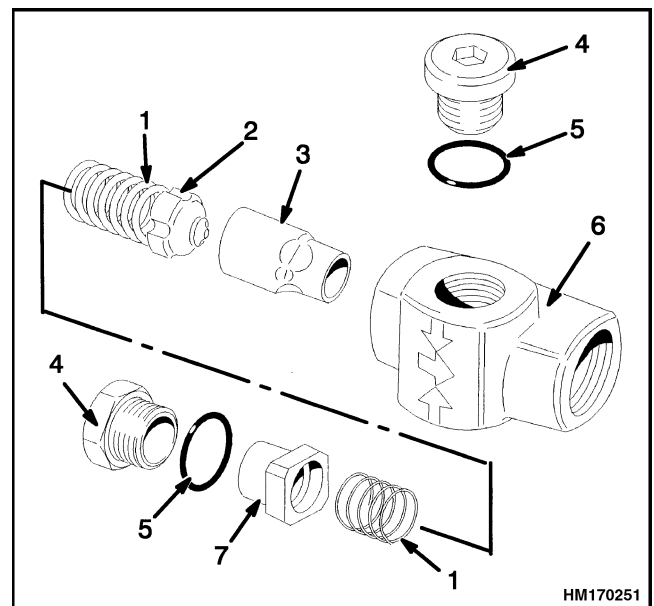
1. Install the O-ring inside the piston bore. See Figure 8. Install the piston on the piston rod. Make sure the O-ring is not damaged. Tighten the nut on the piston rod to 1500 to 1600 N•m (1100 to 1180 lbf ft).
2. Install the O-ring, seal ring, and wear ring on the piston. The seal ring must be heated before installation. After heating, it must be pushed into its groove using a ring compressor. Let the seal ring cool and return to its normal shape.

3. Install the O-ring and the backup ring on the outside of the retainer. Install the rod seal and wiper seal in the retainer.
4. Install the retainer on the piston rod. Install the piston and rod assembly and the retainer in the cylinder shell. Tighten the retainer to 450 to 550 N•m (330 to 400 lbf ft).
5. Install the plug and O-ring in the port that is not used.

## INSTALL

1. Install the rod end on the rod as described in Tilt Cylinder Stroke and Backward Tilt Angle Adjustments.
2. Use a lifting device to move the tilt cylinders. Put the tilt cylinder in position on the lift truck. Lubricate the pivot pin, then install it in the frame. Make sure the grease fitting is toward the outside. Install the retainer pin.
3. Install the pivot pin at the mast mount. Install the retainer pin. Tighten the capscrews for the retainer pins.
4. Install the relief valves at the rod end ports. Connect the hydraulic lines to the tilt cylinder. See Figure 9.

5. Operate the tilt cylinders. Check for correct operation and leakage. Adjust the tilt cylinders as described in Lift and Tilt System Leaks Check.



- |           |           |
|-----------|-----------|
| 1. SPRING | 5. O-RING |
| 2. POPPET | 6. BODY   |
| 3. SEAT   | 7. GUIDE  |
| 4. PLUG   |           |

*Figure 9. Tilt System Relief Valve*

## Mast Repair

### REMOVE



### WARNING

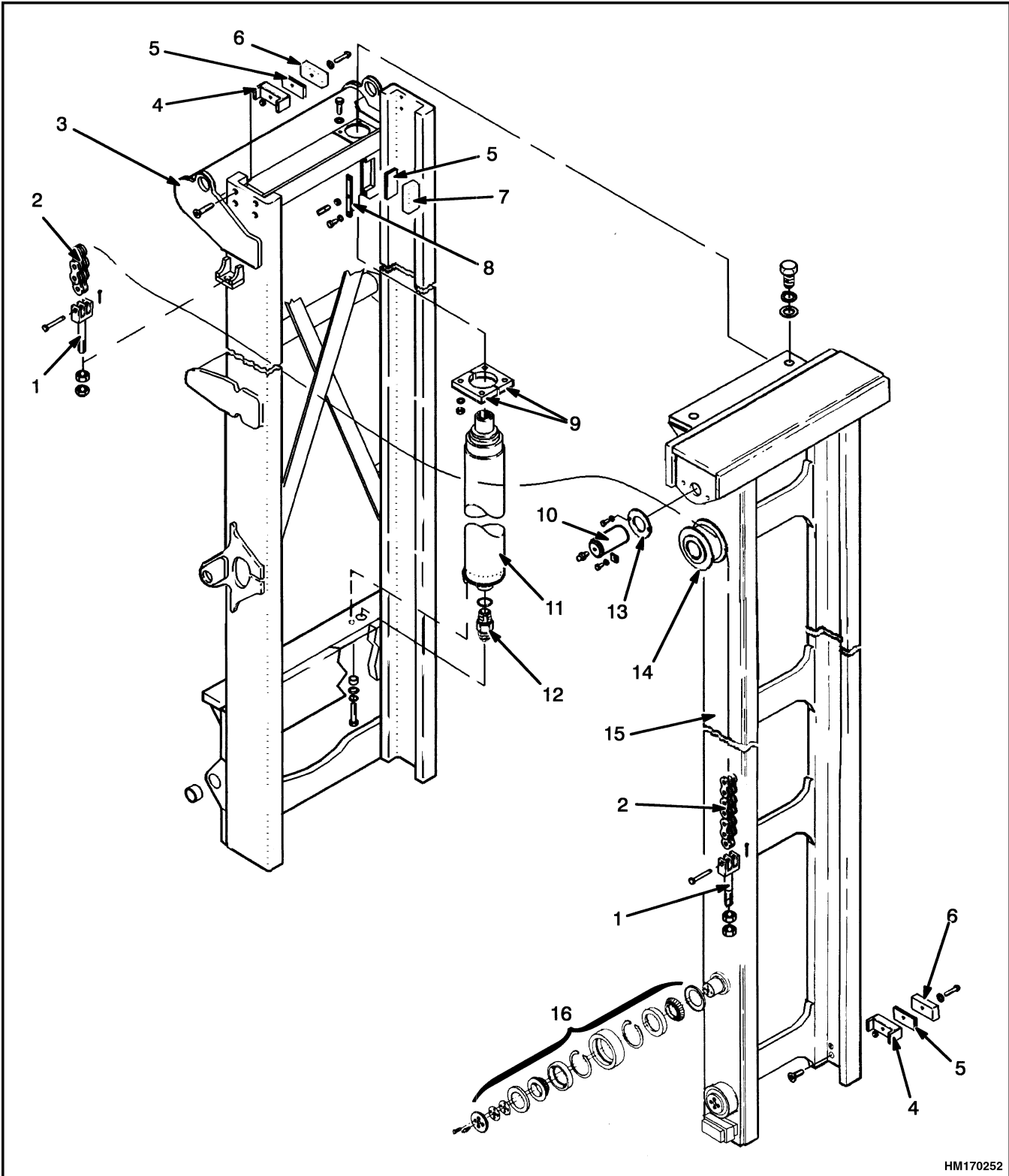
**Lower the lift mechanism completely. Never allow anyone under a raised carriage. Do not put any part of your body in or through the lift mechanism unless all parts of the mast are completely lowered and the engine is STOPPED.**

**Before making any repairs, use blocks and chains on the inner weldment and carriage so that they cannot move. Make sure the moving parts are attached to a part that does not move.**

**Do not try to locate hydraulic leaks by putting hands on pressurized hydraulic components.**

**Hydraulic oil can be injected into the body by pressure.**

1. Fully lower the inner weldment. See Figure 10 and Figure 14. If the mast must be disassembled, remove the forks and carriage. If the carriage is not removed, it must be fastened to a crossmember on the mast. Use a chain or straps to keep the carriage from moving when the mast is removed.
2. See Table 1 and connect a lifting device to the lifting eyes at the top of the outer weldment. Make sure the lifting device has the capacity to hold the mast. Raise the lifting device so that the mast has stability.



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Figure 10. Mast

**Legend for Figure 10**

- |                   |                            |
|-------------------|----------------------------|
| 1. CHAIN ANCHOR   | 9. RETAINERS               |
| 2. LIFT CHAIN     | 10. SHAFT                  |
| 3. OUTER WELDMENT | 11. LIFT CYLINDER          |
| 4. BRACKET        | 12. LOWERING CONTROL VALVE |
| 5. SHIMS          | 13. COVER                  |
| 6. BEARING BLOCK  | 14. CHAIN SHEAVE           |
| 7. WEAR PLATE     | 15. INNER WELDMENT         |
| 8. PLATE          | 16. LOAD ROLLER ASSEMBLY   |

**Table 1. Lift Height and Mast Weights**

Unit	Lift Height	Weight
H14.00-20.00XM (H360-450H) [A214]	2900 mm (114 in.)	3300 kg (7275 lb)
H16.00-18.00XM/XMS-12 (H400-450HD/HDS) [A236]	3650 mm (144 in.)	N/A
H14.00-20.00XM (H360-450H) [A214] H16.00-18.00XM/XMS-12 (H400-450HD/HDS) [A236]	4500 mm (177 in.)	3800 kg (8378 lb)
H16.00-18.00XM/XMS-12 (H400-450HD/HDS) [A236]	5300 mm (209 in.)	N/A
H14.00-20.00XM (H360-450H) [A214] H16.00-18.00XM/XMS-12 (H400-450HD/HDS) [A236]	6100 mm (240 in.)	4600 kg (10141 lb)
H16.00-18.00XM/XMS-12 (H400-450HD/HDS) [A236]	6600 mm (260 in.)	N/A
H14.00-20.00XM (H360-450H) [A214] H16.00-18.00XM/XMS-12 (H400-450HD/HDS) [A236]	6900 mm (272 in.)	5000 kg (11023 lb)
<b>NOTE:</b> The weight of the mast does not include the carriage or attachment.		

3. Clean the area around the hydraulic fittings for the lift cylinders. Disconnect the hydraulic lines at the bottom of the lift cylinders and put caps on the open lines.
4. Disconnect the header hoses and electrical cable. See Figure 15.
5. If the carriage and forks are installed, remove them as described in the procedures for the Carriage Repair.
6. Put the mast in a vertical position. Remove the capscrews from the mast mounting pins.
7. Raise the mast a small amount with the lifting device and put small blocks under the tilt cylinders, between the cylinders and the fenders. Remove the anchor pins for the tilt cylinders at the mast.
8. Operate the lifting device and remove the mast from the lift truck. Put the mast in a position so that the crossmembers are facing up.

(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)

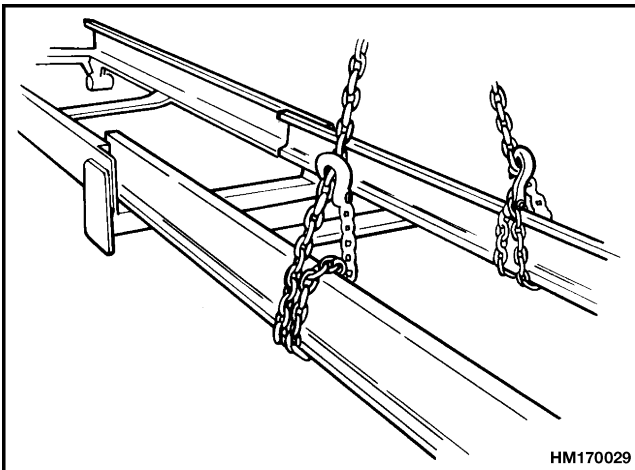
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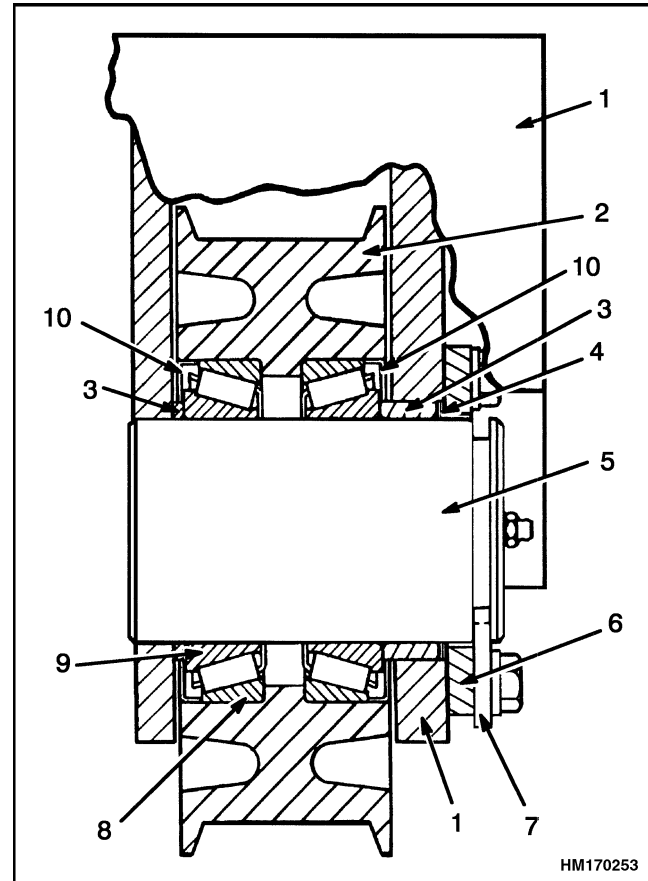
## DISASSEMBLE

1. Remove the pins for the lift chains at the chain anchors. See Figure 10 and Figure 11. Remove the capscrew and washers from the top of each lift cylinder. Remove the retainers for the lift cylinders at the top of the outer weldment. Remove the capscrew and washers at the bottom mount for each lift cylinder.



*Figure 11. Inner Weldment Removal*

2. Slide the inner weldment from the outer weldment approximately 15 cm (6 in.) to disengage the lift cylinders from the inner weldment. Use a lifting sling and remove the lift cylinders from the mount plates at the bottom of the outer weldment. See Lift Cylinders Repair for disassembly and assembly instructions.
3. Remove the bearing block assemblies at the top of the outer weldment. Remove the wear plates from the outer weldment.
4. Slide the inner weldment halfway out of the outer weldment. Connect a lifting device to the center of the inner weldment. See Figure 11. Slide the inner weldment completely out of the outer weldment.
5. Remove the load rollers as necessary for cleaning and repair. Remove the bearing blocks.
6. Remove and disassemble the chain sheaves as necessary for cleaning and repair. See Figure 12.



- |                   |                 |
|-------------------|-----------------|
| 1. INNER WELDMENT | 6. RETAINER     |
| 2. CHAIN SHEAVE   | 7. LOCK PLATE   |
| 3. SPACER         | 8. BEARING CUP  |
| 4. SHIMS          | 9. BEARING CONE |
| 5. PIN            | 10. SHIELD      |

*Figure 12. Chain Sheave Arrangement*

## CLEAN AND INSPECT

1. Inspect the sheaves and load rollers for wear or damage. DO NOT use steam to clean the lift chains, sheaves, or load rollers. The bearings in the load rollers are sealed and lubricated. Lubricate the bearings in the sheaves and load rollers with multipurpose grease before installation. The parts of the chain sheaves and load rollers can be replaced.

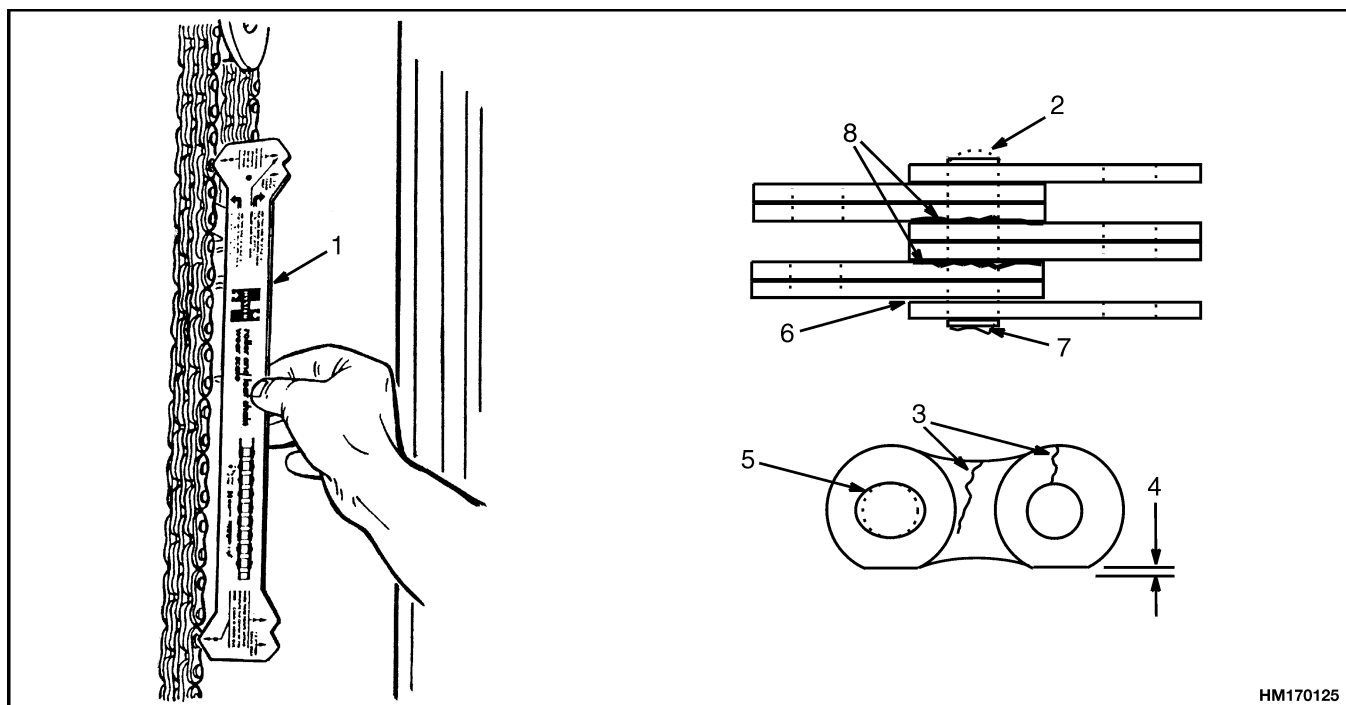


**⚠ WARNING**

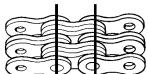
Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the recommendations of the manufacturer.

2. Clean the lift chains with solvent. Inspect the lift chains for wear or damage. See Figure 13. A lift

chain becomes longer when it is worn. If a chain is 3% longer than a new lift chain, the lift chain must be replaced. Use a chain scale to measure the chains. If a chain scale is not available, check the lift chains with the measurements given in Figure 13. Lubricate the chains with SAE 30 engine oil. The best procedure is to remove the chains from the lift truck and soak them in oil.



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<p><b>Pitch</b></p> 	<p><b>Total Length of 20 Links (Pitch) of New Chain</b></p>	<p><b>Wear Limit The Maximum Length of 20 Links</b></p>
<p>44.5 mm (1.75 in.) 50.8 mm (2.00 in.)</p>	<p>889.0 mm (35.0 in.) 1016.0 mm (40.0 in.)</p>	<p>915.7 mm (36.1 in.) 1046.5 mm (41.2 in.)</p>

**NOTE:** INSTRUCTIONS FOR MEASURING CHAIN WEAR ARE SHOWN ON CHAIN WEAR SCALE.

- |                     |                 |
|---------------------|-----------------|
| 1. CHAIN WEAR SCALE | 5. HOLE WEAR    |
| 2. WORN PIN         | 6. LOOSE LEAVES |
| 3. CRACKS           | 7. DAMAGED PIN  |
| 4. EDGE WEAR        | 8. RUST         |

**Figure 13. Lift Chains Check**

 **WARNING**

**Never replace just the worn section of a chain. Replace the complete chain. Never replace just one chain of a chain pair. Replace both chains.**

3. Inspect the chain anchors and pins. Replace any parts that are worn or damaged.
4. Clean the mast with steam or solvent.
5. Inspect the sliding and rolling surfaces for damage. Inspect all welds for cracks.

**ASSEMBLE**
 **WARNING**

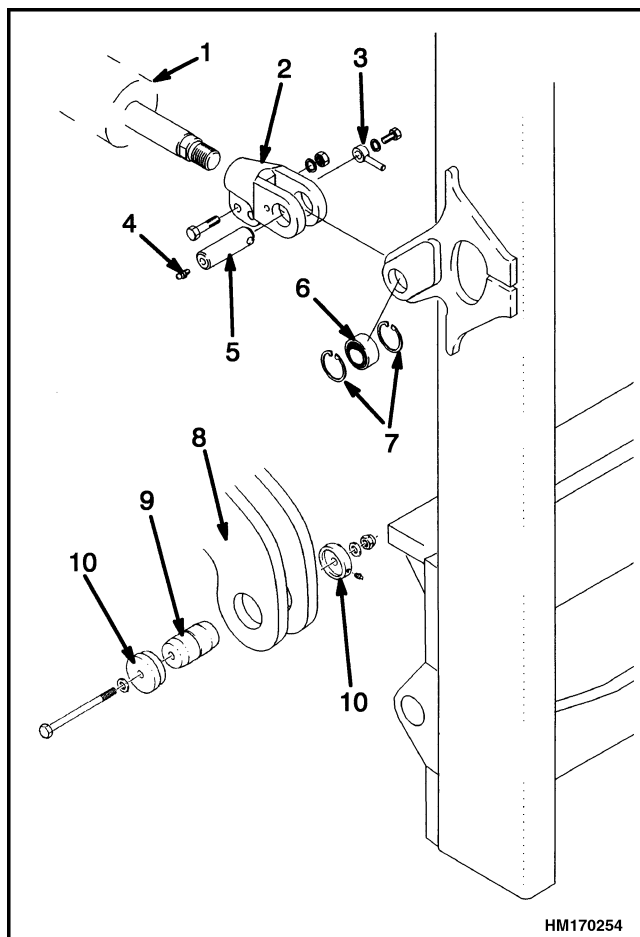
**DO NOT weld on any part of the mast assembly including the forks or carriage. Get information from your dealer for Hyster lift trucks before welding on the mast.**

**NOTE:** The shims for the bearing blocks and wear plates keep the inner and outer weldments parallel and give correct clearance. During assembly, the location of the shims will be approximately the same as they were before disassembly. Check the clearance and adjust the shims for wear or changes because of repairs.

1. Install the load rollers as follows (see Figure 10):
  - a. Lubricate the bearings with multipurpose grease.
  - b. Install the load roller on the shaft. Install the retainer and capscrews. (Do not add shims at this time.) Tighten the capscrews to 26 N•m (19 lbf ft).
  - c. Measure the clearance between the retainer and the outer bearing. Add shims under the retainer so that there will be zero clearance. Install the retainer and tighten the capscrews to 53 N•m (39 lbf ft). Check that the load roller rotates freely.
2. Install the mounts for the bearing blocks and tighten the capscrews for the mounts to 53 N•m (39 lbf ft). Install the bearing blocks and shims on the inner weldment. Install the bearing blocks and shims on the outer weldment. Install the nuts and bolts for the bearing blocks. Lubricate the surface of the bearing blocks with multipurpose grease.
3. Connect a lifting device to the center of the inner weldment. See Figure 11. Put the load rollers into the end of the outer weldment. Slide the inner weldment into the outer weldment until the inner and outer weldments are aligned.
4. Install the bearing block assemblies at the top of the outer weldment using the procedures in Step 2.
5. Lubricate the back of the inner weldment for its entire length with multipurpose grease. Install the wear plates and the shims at the back of the outer weldment.
6. Adjust the bearing blocks and wear plates as described in Mast Adjustments.
7. Use a lifting device to install the lift cylinders. Install the washers and capscrews at the bottom of the lift cylinders. Push the inner weldment to engage the rods of the lift cylinders. Install the capscrews and washers to hold the top of the cylinder rods in position. Install the retainers for the cylinders at the top of the outer weldment
8. Make sure the lowering control valves are installed at the bottom of both lift cylinders.
9. Install the chain sheaves as follows:
  - a. Lubricate the bearings with multipurpose grease. Install the bearings in the chain sheave.
  - b. Install the chain sheave and inner spacer in the bracket, then install the shaft. Install spacer and the retainer. (Do not add shims at this time.) Tighten the capscrews to 26 N•m (19 lbf ft).
  - c. Measure the clearance between the bearing and the outer spacer. Add shims under the retainer so that there will be zero clearance. Install the retainer and tighten the capscrews to 53 N•m (39 lbf ft). Check that the chain sheave rotates freely.
10. Connect the lift chains to the outer weldment. Attach wires between the ends of the lift chains and the crossmember on the inner weldment to control the lift chains during installation of the mast.

## INSTALL

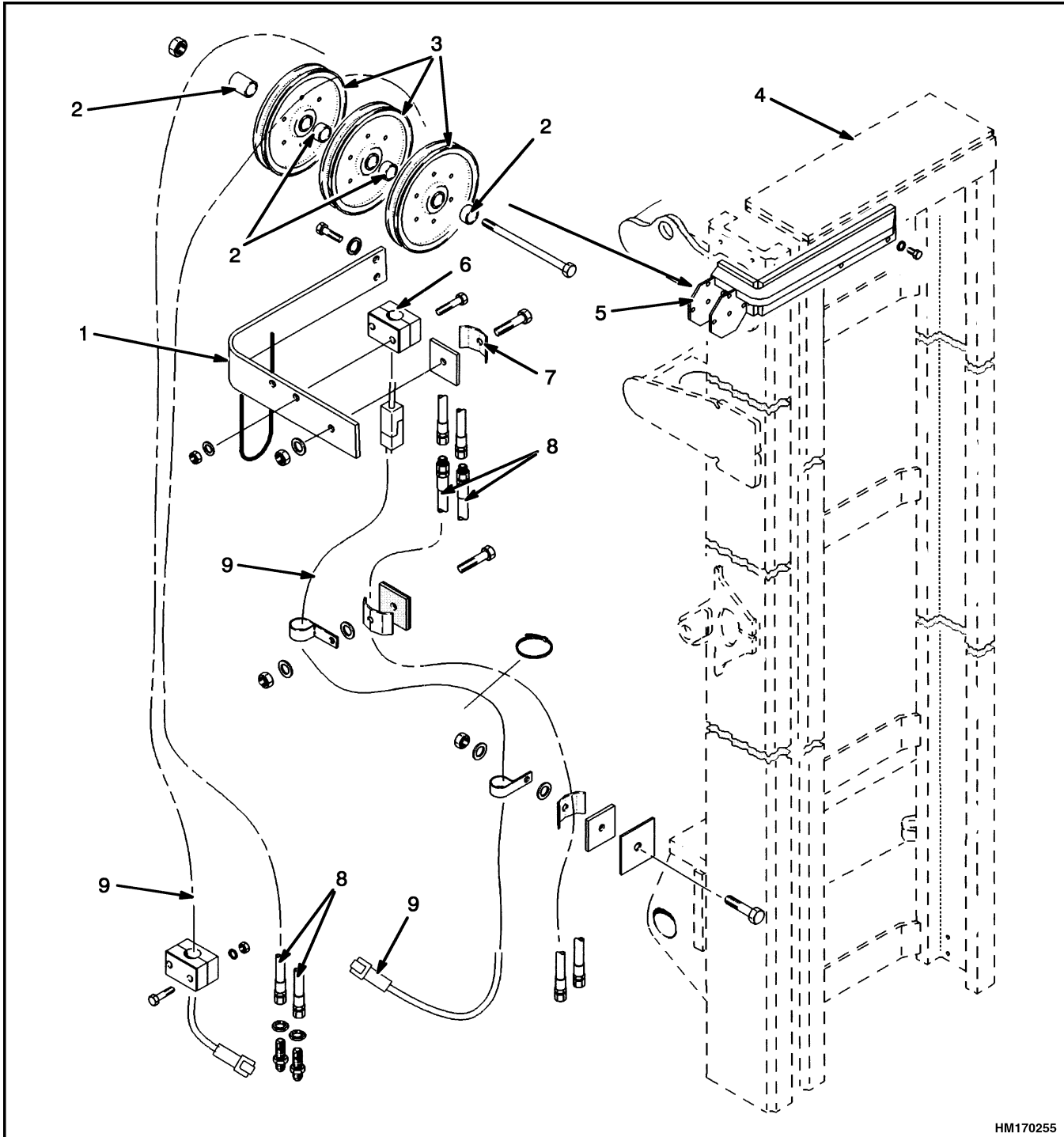
1. Make sure the bushings and snap rings for the tilt cylinder pins are installed in the frame and outer weldment. See Figure 14. Install the tilt cylinders to the frame mounts. Install the pivot pins and anchor pins. Make sure the grease fittings are toward the outside of the lift truck.



- |                      |                   |
|----------------------|-------------------|
| 1. TILT CYLINDER     | 6. GREASE FITTING |
| 2. ROD END           | 7. SNAP RING      |
| 3. ANCHOR PIN        | 8. LIFT TRUCK     |
| 4. SPHERICAL BUSHING | 9. PIVOT PIN      |
| 5. PIN               | 10. CAP           |

**Figure 14. Mast Installation**

2. See Table 1 and connect a lifting device to the top of the mast assembly. Make sure the inner and outer weldments are fastened together. Make sure that the chains do not damage any of the hydraulic lines or other parts.
3. Raise the mast assembly to a vertical position. Move the mast assembly into position on the lift truck.
4. Lubricate the mast mounting pins and bushings with multipurpose grease. Install the mast mounting pins through the frame and into the mast. Install the caps and nuts and bolts. Make sure the grease fitting on the cap is toward the front of the lift truck. Tighten the bolt to 176 N•m (130 lbf ft).
5. Connect the tilt cylinders to the outer weldment. Install the pivot pins and anchor pins. Make sure the grease fittings are toward the outside of the lift truck.
6. Install the carriage and forks as described in the procedures for the Carriage Repair.
7. Connect the hydraulic lines to the mast assembly. Install connection hoses, header hoses and electrical cable as shown in Figure 15. If the hose sheaves for the header hoses were disassembled, assemble them as follows:
  - a. Install the sheaves in the bracket. Install the bolt, spacers, sheaves, and nut. Tighten the nut until there is no clearance, then tighten an additional 1/4 turn.
  - b. Install the three bolts that hold the brackets together. Tighten the bolts by hand, then install the nuts and tighten them to 38 N•m (28 lbf ft).
8. Adjust the lift chains, carriage, and tilt cylinders as described in Carriage Adjustments and Tilt Cylinder Stroke and Backward Tilt Angle Adjustments.



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- |                 |                   |                     |
|-----------------|-------------------|---------------------|
| 1. HOSE BRACKET | 4. OUTER WELDMENT | 7. HOSE CLAMP       |
| 2. SPACER       | 5. SHEAVE BRACKET | 8. HEADER HOSE      |
| 3. SHEAVES      | 6. CABLE CLAMP    | 9. ELECTRICAL CABLE |

**Figure 15. Header Hose Arrangement**

## Lift Cylinders Repair

### DESCRIPTION AND OPERATION

The lift cylinders are piston type, single-action cylinders. When hydraulic oil enters the base of the cylinder, the hydraulic force extends the rod. When the oil is allowed to drain from the cylinder, the weight of the carriage and inner weldment cause the cylinder rods to retract.

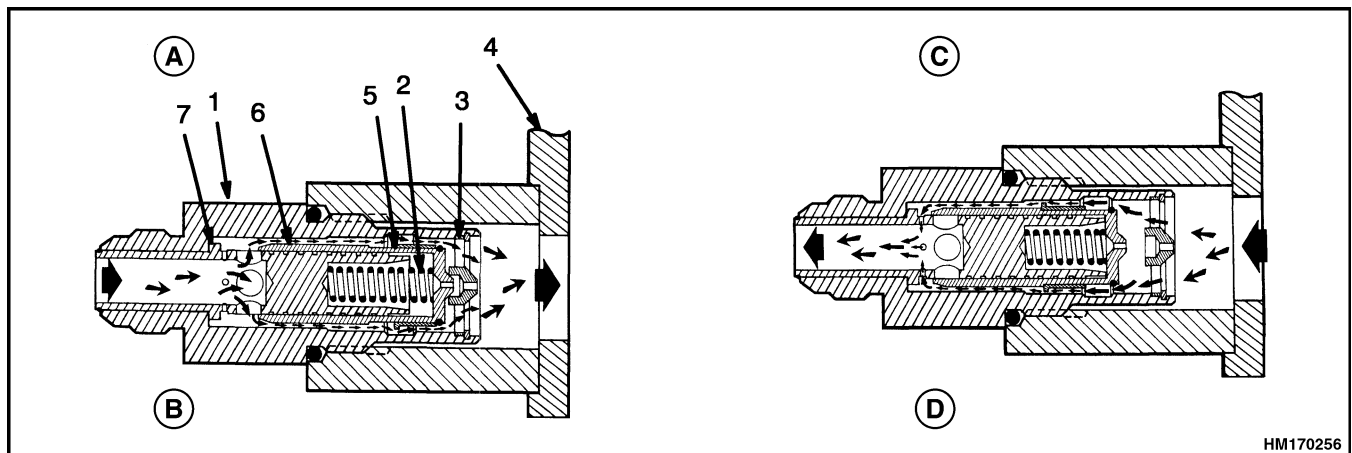
During lifting, oil from the main control valve flows to the bottom of the lift cylinders. As the cylinder rods extend, the air and any leakage on top of the pistons is forced through the breather lines back to the hydraulic tank.

The lift cylinders have a single lip seal on the piston to prevent hydraulic oil leaks past the piston and retainer. During operation, some hydraulic oil can leak past the piston area to the rod end of the lift cylinder. Small internal leaks are permitted if the internal leak rate of the hydraulic system is not greater than the specification.

A lowering control valve (see Figure 16) is installed in the base of the lift cylinders. The lowering control valve permits easy entry of hydraulic oil into the cylinders, but gives 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 valve is shown in Figure 16. The position of the orifice sleeve is controlled by oil flow. The position of the plunger is controlled by oil pressure and spring tension. During lifting, oil entering the cylinder goes through the center of the main sleeve to the large holes. The oil continues between the plunger and bore to move the orifice sleeve to the end of the plunger. The flange of the orifice sleeve is then aligned with the large part of the bore in the body. This alignment lets the oil flow around the orifice sleeve to the inlet port of the cylinder.

During the lowering operation, oil from the cylinder moves the orifice sleeve. The sleeve moves away from the larger area of the bore in the valve body. This movement makes a restriction to the oil flow. When the pressure increases, the plunger begins to move against the spring. The movement begins to close the openings of the large holes in the main sleeve. Additional pressure will push the plunger against the main sleeve to close the large holes completely. All the oil must go through the small holes to the center of the main sleeve. This restriction limits cylinder rod lowering to a maximum controlled speed.



A. FREE FLOW

B. LIFTING

C. RESTRICTED FLOW

D. LOWERING

1. VALVE BODY  
2. SPRING

3. WASHER  
4. CYLINDER

5. ORIFICE SLEEVE  
6. PLUNGER

7. MAIN SLEEVE

*Figure 16. Lowering Control Valve*

## REMOVE

Remove the lift cylinders while disassembling the mast. See the procedures in Mast Repair, Disassemble.

## DISASSEMBLE

**NOTE:** The most 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.

### WARNING

The lift cylinders are very heavy. Use slings and a lifting device to handle and disassemble the lift cylinders. Make sure that the lifting device and slings have the capacity and can lift the load correctly.

1. Loosen the retainer with a spanner. Remove the retainer from the shell. See Figure 17.
2. Carefully pull the rod and piston assembly from the shell. Drain the hydraulic oil into a container.
3. Remove and discard the O-rings, seals, wiper ring, and wear ring.

## CLEAN AND INSPECT

### WARNING

Cleaning solvents can be flammable and toxic and can cause skin irritation. When using cleaning solvents, always follow the recommendations of the manufacturer.

Clean all the parts in solvent. Check the sliding surfaces for damage. Repair or replace any damaged parts.

## ASSEMBLE

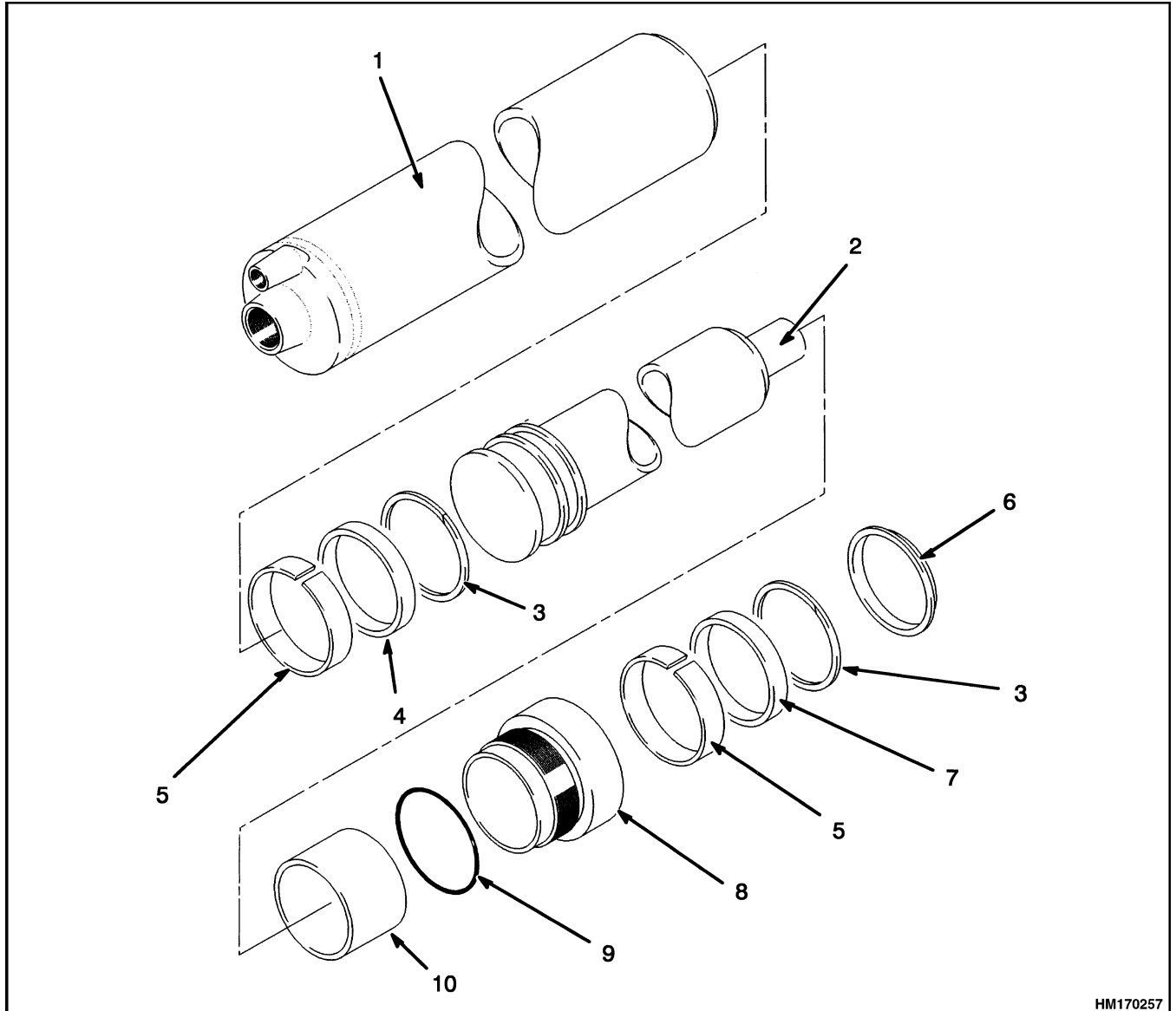
**NOTE:**

- Lubricate all internal parts of the cylinder with clean hydraulic oil during assembly.
- Use new O-rings, seals, and wear rings.
- Make sure the single-lip seal assemblies are installed with the O-ring toward the base of the cylinder.

### CAUTION

An important step in assembling cylinders is the correct installation of the seals. Seals that are not installed correctly can be damaged and cause leaks. Special tools are available from Hyster Parts and Service. See Parts-Service Gram L-A-2 (Latest Revision) for the available tools.

1. Install the backup ring, single lip seal, and wear ring on the piston assembly. See Figure 17.
2. Install the spacer on the rod. Make sure the spacer is correct for the cylinder.
3. Use shim material as a guide to move the single-lip seal past the threads of the shell. Carefully push the piston and rod assembly into the shell. Release the clamp on the seal when the seal travels past the threads of the shell.
4. Install the wiper, backup ring, single-lip seal, and wear ring in the retainer. Install the O-ring on the outside of the retainer.
5. Carefully install the retainer on the rod. Engage the threads and tighten the retainer in the shell. The correct torque is 550 to 625 N•m (400 to 450 lbf ft). Use a correct spanner. Do not hit the retainer with a hammer and driver.
6. Install the lowering control valve. Make sure the special washer and the spring are installed correctly in the base of the cylinders. A wrong installation can cause the load to lower too fast.



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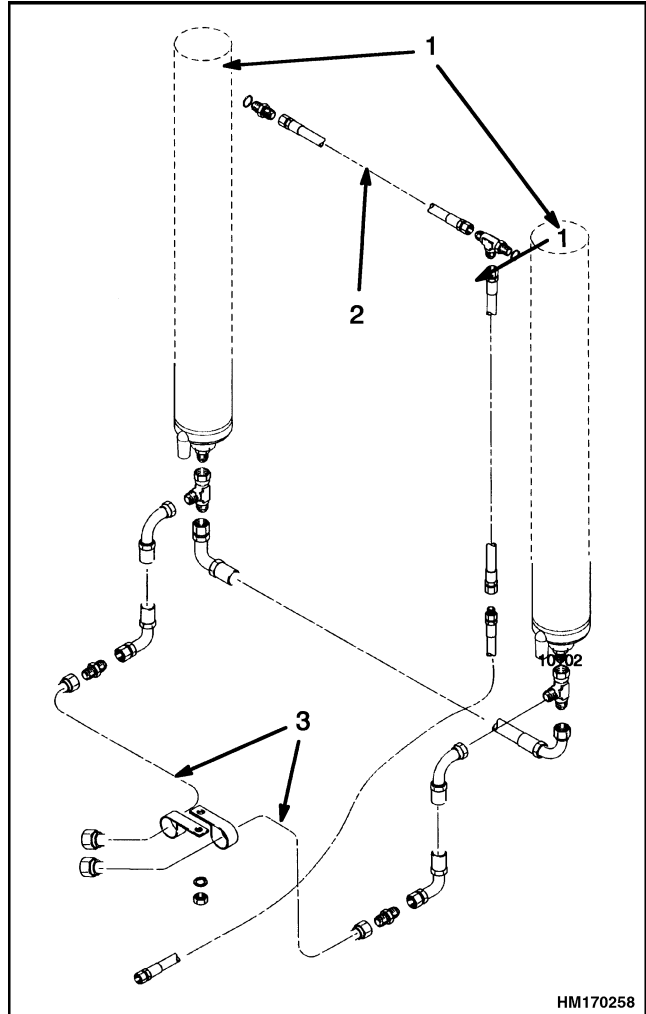
- 1. SHELL
- 2. ROD AND PISTON
- 3. BACKUP RING
- 4. PISTON SEAL
- 5. WEAR RING

- 6. WIPER
- 7. ROD SEAL
- 8. RETAINER
- 9. O-RING
- 10. SPACER

**Figure 17. Lift Cylinder**

**INSTALL**

Install the lift cylinders while assembling the mast. See the procedures in Mast Repair, Assemble. See Figure 18.



- 1. LIFT CYLINDER
- 2. BREATHER LINE
- 3. SUPPLY LINE

*Figure 18. Lift Cylinder Connections*



## Mast Operation Check



### WARNING

**Lower the lift mechanism completely. Never allow anyone under a raised carriage. Do not put any part of your body in or 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 inner and outer weldments and carriage so that they cannot move. Make sure the moving parts are attached to a part that does not move.**

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

1. Check for leaks in the hydraulic system. Check the condition of the hydraulic hoses and tubes.
2. Slowly raise and lower the mast several times without a load. The mast components must raise and lower smoothly in the correct sequence.

**NOTE:** Some parts of the mast move at different speeds during raising and lowering.

3. The inner weldment and the carriage must lower completely.
4. Check that the controls for the attachment operate the functions of the attachment. (See symbols by each of the controls.) Make sure all of the hydraulic lines are connected correctly and do not leak.

## Lift and Tilt System Leaks Check

### LIFT SYSTEM

1. Slowly raise and lower the mast several times without a load. Put a capacity load on the forks and raise and lower the load several times. Lower the load and tilt the mast forward and backward several times. Check for leaks and repair as necessary.
2. Raise the carriage and the capacity load 1 m (3 ft). If the carriage lowers slowly with the control valve in the Neutral position, there are leaks inside the hydraulic system. The maximum speed that the carriage is allowed to lower is shown in Table 2 and Table 3.
3. Check the lift cylinder for internal leaks. Remove the load from the forks. Install a gate valve in each of the supply lines between the main control valve and the mast. Put a capacity load on the forks again. Raise the carriage 1 m (3 ft). Close both gate valves. If the carriage or inner weldment lowers slowly, the seals in the lift cylinders have leaks.
4. If the carriage does not move, open both gate valves and check the movement again. If the carriage lowers when the gate valves are open, check for leaks in the hydraulic lines and fittings. If no leaks are found, the main control valve can have damaged parts. Remove the load from the forks.

### TILT SYSTEM

1. Put a capacity load on the forks and raise the forks approximately 30 cm (12 in.). Slowly tilt the mast forward. If the mast continues to slowly tilt forward when the control valve is in the Neutral position, there are leaks inside the hydraulic system. The maximum speed that the mast is allowed to tilt forward is shown in Table 2 and Table 3.
2. If the leak rate is greater than specified, remove the load from the forks. Install a gate valve between the port at the front of each tilt cylinder and the hydraulic line. Put the load on the forks again. Close one valve. If the mast tilts slowly forward, the cylinder connected to the closed gate valve has leaking seals. Check the other cylinder using the same procedure.
3. If the mast does not move, open one of the gate valves and check for movement again. If the mast moves forward with the valve open, check for leaks in the hydraulic lines or fittings. Check the other tilt cylinder using the same procedure. If no leaks are found, the main control valve can have damaged parts. Remove the load from the forks.