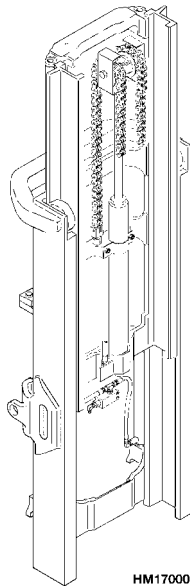


# MAST

## DESCRIPTION

H/S/E1.50-1.75XM (H/S/E25-35XM) [C010, D001, D010, D114, E001];  
H/S/E2.00XMS (H/S/E40XMS) [C010, D001, D010, D114, E001];  
H/S/E/2.00-3.20XM (H/S/E/40-65XM) [D177, D187, F108];  
J2.00-3.20XM (J40-60XM, J40-60XM<sub>2</sub>) [A216];  
J2.00-3.20XM (J40-60Z) [A416];  
S/E/J2.00-3.00XL With Mast S/N C507-509 and C562-564  
(S/E/J40-60XL) [A187, B168, B187, C108, C187];  
J1.60-2.00XMT (J30-40XMT) [C160, F160];  
H2.00-3.20XM (H45-65XM) [H177];  
J30-40XMT<sub>2</sub> [H160];  
E1.50-2.00XM (E25-35Z, E40ZS) [E114];  
E2.00-3.20XM (E40-65Z) [G108];  
J1.60-2.00XMT (J30-40ZT) [J160]



# **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!**

## TABLE OF CONTENTS

General .....	1
Description and Operation .....	1
Carriages .....	1
Mast Mounts .....	3
Two-Stage Mast, Limited Free-Lift (LFL) .....	4
Description and Operation .....	4
Two-Stage Mast, Full Free-Lift (FFL) .....	6
Description and Operation .....	6
Three-Stage Mast, Full Free-Lift (FFL) .....	8
Description and Operation .....	8
Cylinder Cushion During Lifting Sequence .....	11
Cylinder Cushion During Lowering Sequence .....	12

This section is for the following models:

H/S/E1.50-1.75XM (H/S/E25-35XM) [C010, D001, D010, D114, E001];  
 H/S/E2.00XMS (H/S/E40XMS) [C010, D001, D010, D114, E001];  
 H/S/E/2.00-3.20XM (H/S/E/40-65XM) [D177, D187, F108];  
     J2.00-3.20XM (J40-60XM, J40-60XM<sub>2</sub>) [A216];  
     J2.00-3.20XM (J40-60Z) [A416];  
 S/E/J2.00-3.00XL With Mast S/N C507-509 and C562-564 (S/E/J40-60XL)  
     [A187, B168, B187, C108, C187];  
 J1.60-2.00XMT (J30-40XMT) [C160, F160];  
     H2.00-3.20XM (H45-65XM) [H177];  
     J30-40XMT<sub>2</sub> [H160];  
 E1.50-2.00XM (E25-35Z, E40ZS) [E114];  
     E2.00-3.20XM (E40-65Z) [G108];  
 J1.60-2.00XMT (J30-40ZT) [J160]

**"THE  
QUALITY  
KEEPERS"**

**HYSTER  
APPROVED  
PARTS**

## General

This section has the description and operation of the masts. Repair procedures for the masts are described in the section **Mast Repairs** 4000 SRM 522. The description and repairs for the tilt cylinders are described in the section **Tilt Cylinders** 2100 SRM 103.

The mast is used to lift a load vertically. The mast has two movements controlled by hydraulic cylinders: forward and backward tilt, and the lifting and lowering of the mast weldments and carriage. The outer weldment can move on the pivot pins at the mast mounts. The operation of the tilt cylinders causes the mast to tilt forward and backward. The

tilt cylinders are fastened between the frame of the lift truck and the outer mast weldment. Hydraulic lift cylinders are installed vertically on the masts. The lift cylinders raise and lower the mast weldments and the carriage.

There are three types of masts available:

- Two-stage, Limited Free-Lift
- Two-stage, Full Free-Lift
- Three-stage, Full Free-Lift

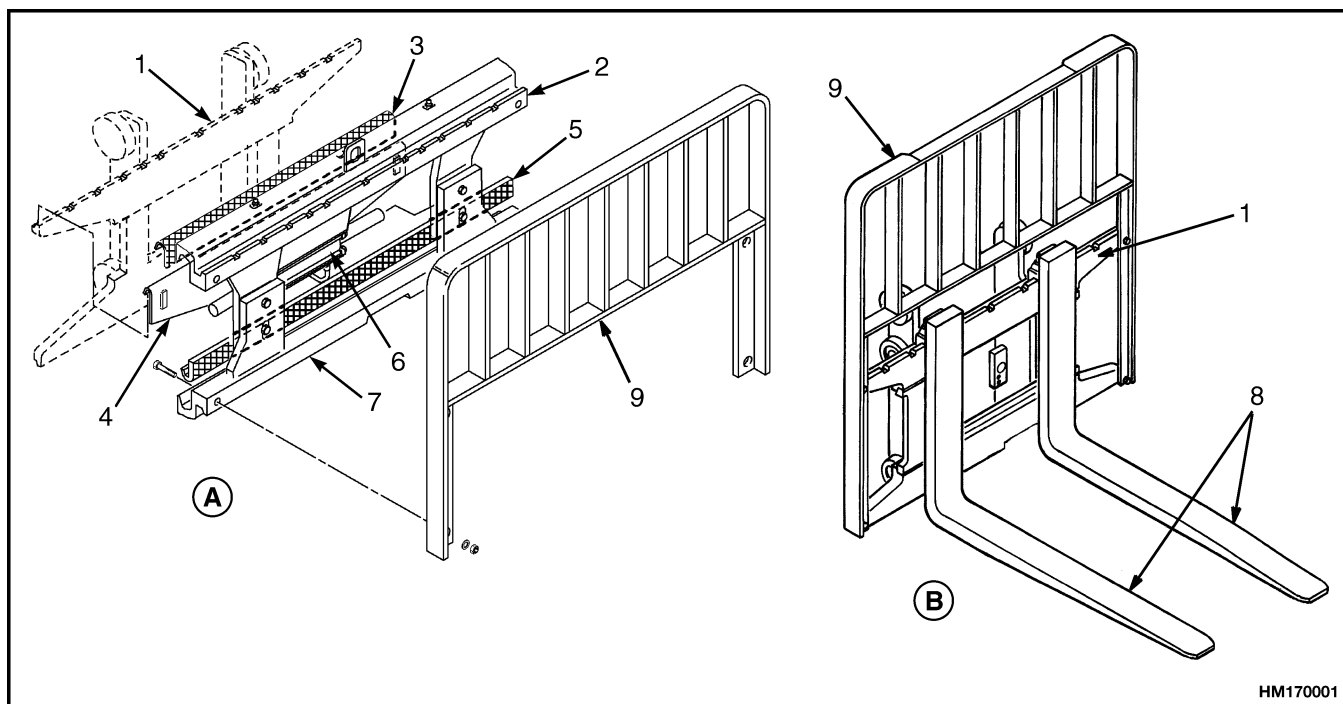
Each type of mast is described separately in this section.

## Description and Operation

### CARRIAGES

The carriage is a part of the mast assembly. Load rollers that are attached to the carriage travel in the inner channels of the inner mast weldment. Forks or

other types of load handling equipment are attached to the carriage. A load backrest extension is attached to the carriage and adds support for a load that has multiple pieces. See Figure 1.



**A. HANG-ON SIDESHIFT CARRIAGE**

**B. STANDARD CARRIAGE WITH FORKS**

1. STANDARD CARRIAGE
2. TOP BAR
3. TOP BEARING

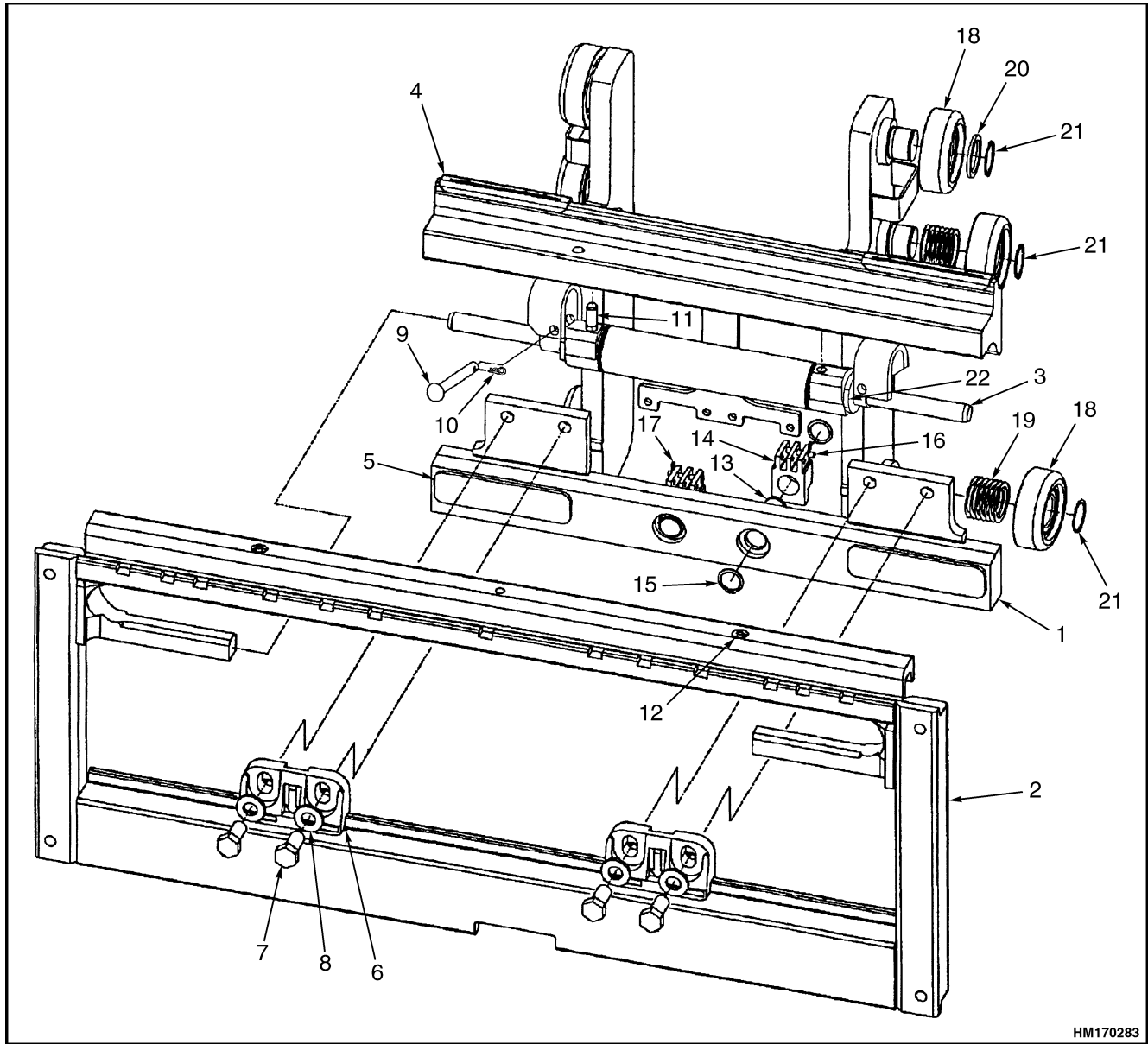
4. CYLINDER MOUNTING BRACKET
5. BOTTOM BEARING
6. SIDESHIFT CYLINDER

7. BOTTOM BAR
8. FORKS
9. LOAD BACKREST EXTENSION

**Figure 1. Carriages**

The hang-on sideshift carriage lets the operator move the forks and load from side to side. This function makes it easier for the operator to align the forks with a load or align the load with a stack. The hang-on sideshift carriage hangs on the fork bars of the standard carriage. Special bushings fit between

the hang-on sideshift carriage and the fork bars. A sideshift cylinder is installed on a plate that fits on the standard carriage. The sideshift cylinder moves the hang-on sideshift carriage on the standard carriage.



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- |                       |                  |                 |
|-----------------------|------------------|-----------------|
| 1. INNER CARRIAGE     | 9. CLEVIS PIN    | 17. COTTER PIN  |
| 2. OUTER CARRIAGE     | 10. HAIRPIN      | 18. LOAD ROLLER |
| 3. SIDESHIFT CYLINDER | 11. PIN          | 19. SHIMS       |
| 4. UPPER BEARING      | 12. LUBE FITTING | 20. SPACER      |
| 5. LOWER BEARING      | 13. PIN          | 21. SNAP RING   |
| 6. LOWER HOOK         | 14. CHAIN ANCHOR | 22. SPACER      |
| 7. CAPSCREW           | 15. SNAB RING    |                 |
| 8. WASHER             | 16. PIN          |                 |

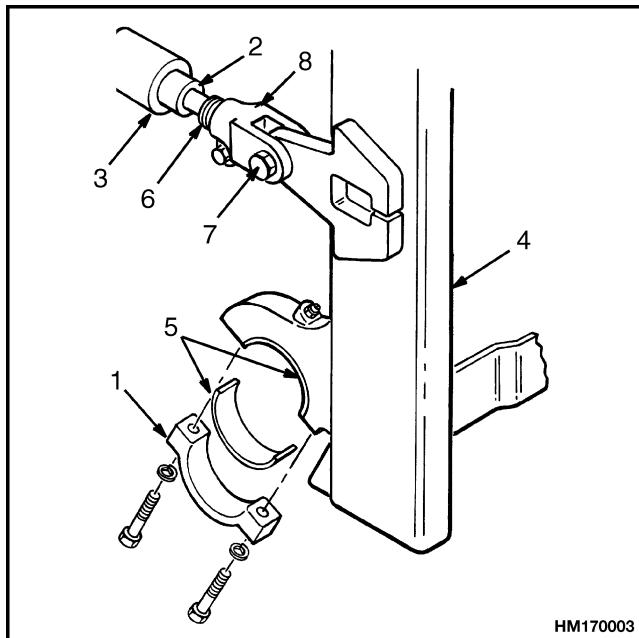
Figure 2. Integral Sideshift Carriage

The integral sideshift carriage lets the operator move the forks and load from side to side. This function makes it easier for the operator to align the forks with a load or align the load with a stack. The integral sideshift carriage is a complete carriage and sideshift assembly. The sideshift cylinder moves the sideshift carriage on the standard carriage. See Figure 2.

**MAST MOUNTS**

The mast can tilt forward and backward. Tilt cylinders are fastened between the frame of the lift truck and the outer mast weldment to change the angle of the mast and forks.

On the S/E/J2.00-3.00XL (S/E/J40-60XL), the mast pivots directly on the drive axle housing. The mounts are part of a casting that includes the lower crossmember for the outer channel. Each mount has a retainer cap that attaches the mast to the axle housing. Each mast mount uses two bushings. See Figure 3.



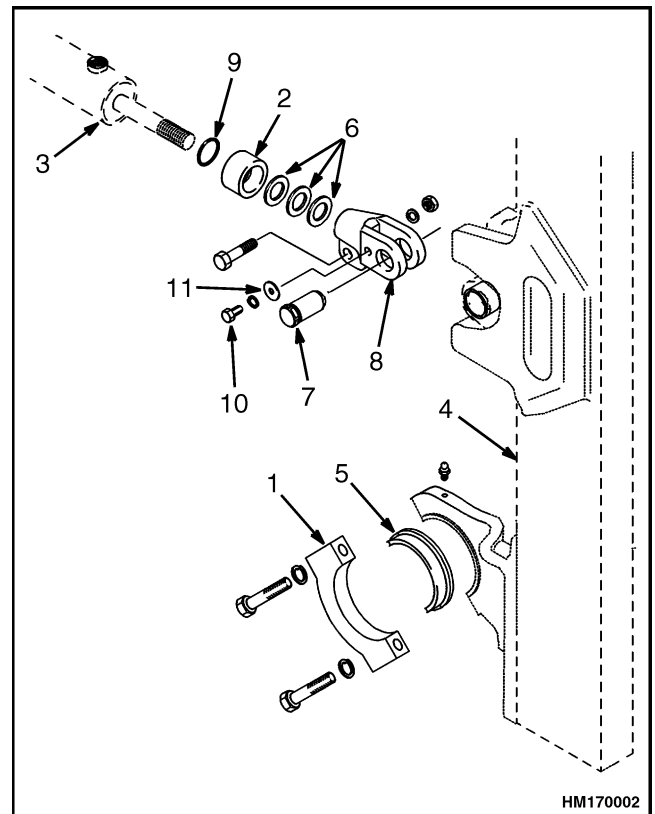
- |                        |            |
|------------------------|------------|
| 1. RETAINER CAP        | 5. BUSHING |
| 2. SPACER              | 6. SHIMS   |
| 3. TILT CYLINDER       | 7. PIN     |
| 4. OUTER MAST WELDMENT | 8. ROD END |

**Figure 3. Mast Mounts**

On H1.50-1.75XM, H2.00XMS (H/S25-35XM, H/S40XMS), E1.50-1.75XM, E2.00XMS (E25-35XM,

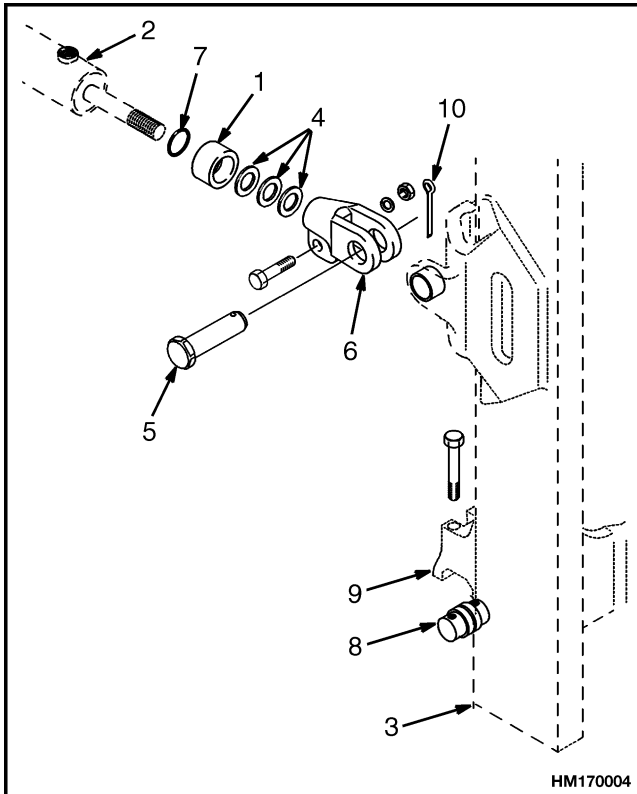
E40XMS) (D114), E1.50-2.00XM (E25-35Z, E40ZS) (E114), and J1.60-2.00XMT (J30-45XMT) trucks, the mast pivots directly on the drive axle housing. The mounts are part of a casting that includes the lower crossmember for the outer channel. Each mount has a retainer cap that attaches the mast to the axle housing. Each mast mount uses one bushing. There are no bushings used in the retainer caps. See Figure 4.

On the H/S/2.00-3.20XM (H/S/40-65XM), E2.00-3.20XM (E40-65XM) (F108), E2.00-3.20XM (E40-65Z) (G108), J2.00-3.20XM (J40-60XM, J40-60XM<sub>2</sub>) (A216), and J2.00-3.20XM (J40-60Z) (A416) trucks, pivot pins are installed in the drive axle hangers. The outer mast weldment has mounts that fit on the pivot pins. Capscrews hold the mast to the pivot pins. See Figure 5.



- |                        |                 |
|------------------------|-----------------|
| 1. RETAINER CAP        | 6. SHIMS        |
| 2. SPACER              | 7. PIN          |
| 3. TILT CYLINDER       | 8. ROD END      |
| 4. OUTER MAST WELDMENT | 9. O-RING       |
| 5. BUSHING             | 10. CAPSCREW    |
|                        | 11. FLAT WASHER |

**Figure 4. Mast Mounts**

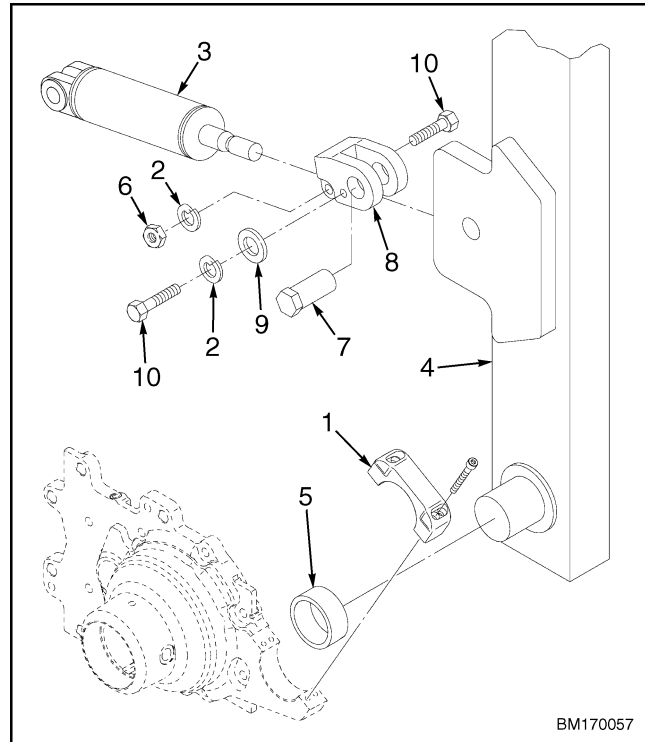


- |                        |                                   |
|------------------------|-----------------------------------|
| 1. SPACER              | 7. O-RING                         |
| 2. TILT CYLINDER       | 8. PIVOT PIN                      |
| 3. OUTER MAST WELDMENT | 9. DRIVE AXLE HANGER (MAST MOUNT) |
| 4. SHIMS               | 10. COTTER PIN                    |
| 5. PIN                 |                                   |
| 6. ROD END             |                                   |

**Figure 5. Mast Mounts**

On J30-40ZT trucks, the mast pivots on two stubshafts welded to the sides of the outer mast weldment. The mast mounts are part of the transmission

housing, which bolt to the truck frame. Each mount uses one bushing. Each mount has a retainer cap that attaches the mast to the mast mount. Each retainer is held in place with four capscrews. See Figure 6.



- |                        |              |
|------------------------|--------------|
| 1. RETAINER CAP        | 6. NUT       |
| 2. LOCKWASHER          | 7. PIN       |
| 3. TILT CYLINDER       | 8. ROD END   |
| 4. OUTER MAST WELDMENT | 9. WASHER    |
| 5. BUSHING             | 10. CAPSCREW |

**Figure 6. Mast Mounts**

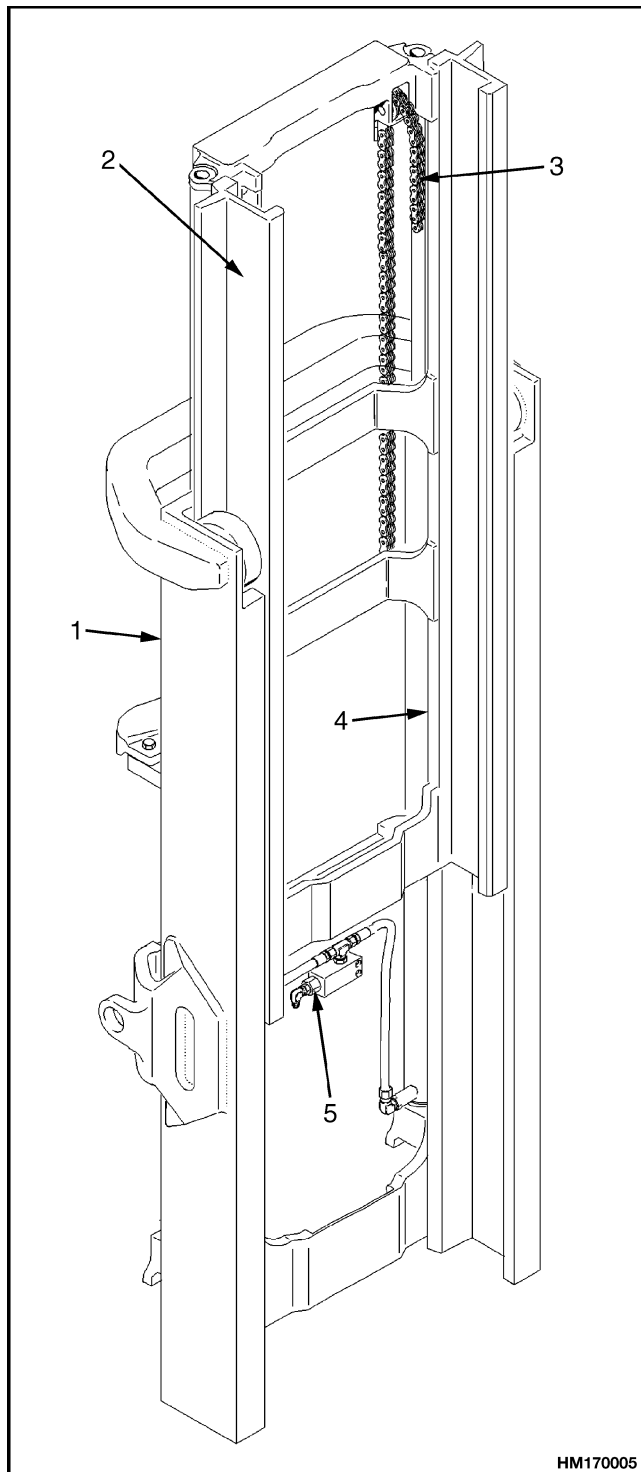
## Two-Stage Mast, Limited Free-Lift (LFL)

### DESCRIPTION AND OPERATION

The two-stage mast with limited free-lift has an outer weldment, an inner weldment, and two lift cylinders. See Figure 7. At the base of the inner weldment there is one load roller on each side. These load rollers travel along the flanges inside the outer weldment. At the top of the outer weldment there is also one load roller on each side. These load rollers travel along

the flanges on the outside of the inner weldment. The angle of the load rollers permits them to control the forces from the front, back, and sides of the mast. The strip bearings are installed at the top of each outer channel. The strip bearings can be adjusted by shims to help keep the correct clearance between the outer weldment and the inner weldment.





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**Figure 7. Two-Stage Mast, Limited Free-Lift (LFL)**

**Legend for Figure 7**

**NOTE:** TYPICAL MAST ASSEMBLY IS SHOWN HERE.

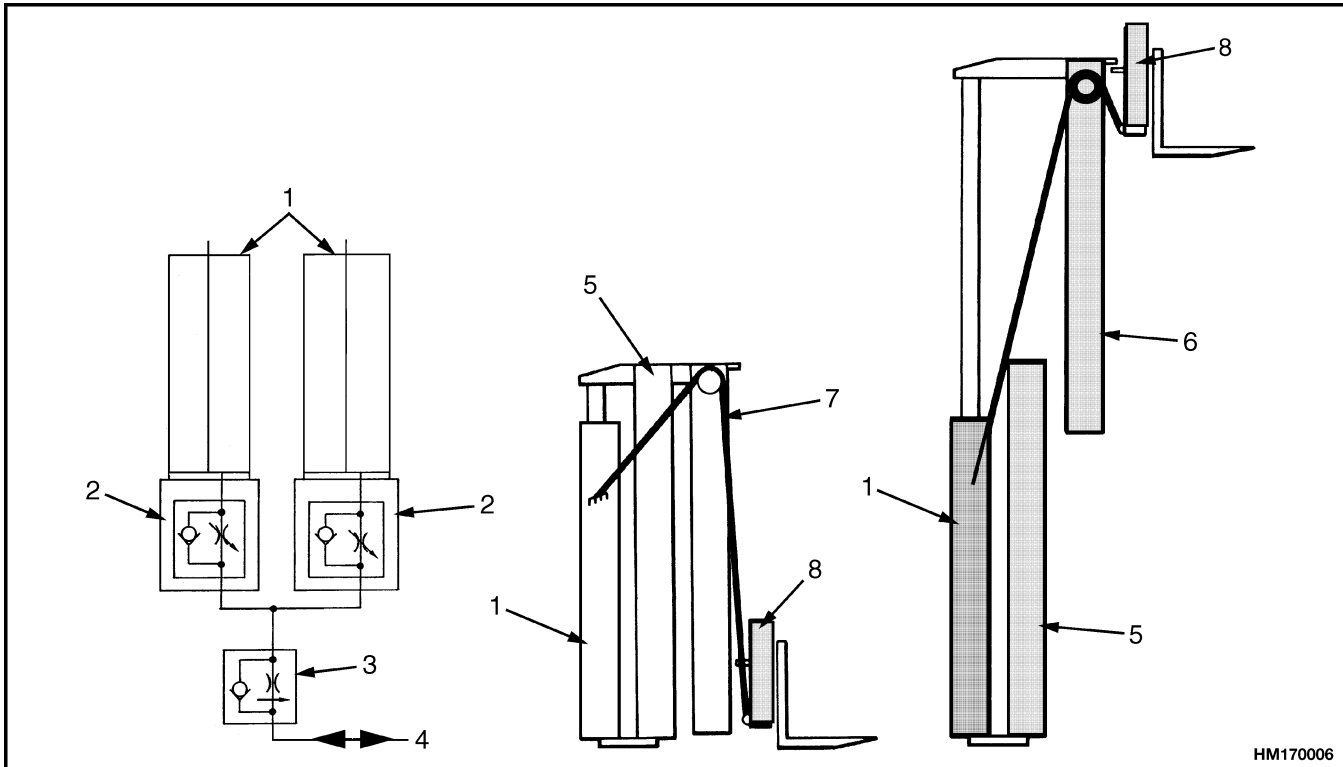
- |                   |                                      |
|-------------------|--------------------------------------|
| 1. OUTER WELDMENT | 4. LIFT CYLINDER(S)                  |
| 2. INNER WELDMENT | 5. LOWERING CONTROL VALVE (EXTERNAL) |
| 3. LIFT CHAIN(S)  |                                      |

The two single-stage lift cylinders are installed at the back of the outer weldment. The base of each lift cylinder sits in a mount at the bottom crossmember on the outer weldment. The top of each lift cylinder (cylinder rods) fits into a guide at the top of the inner weldment. Operation of the lift cylinders extends and retracts the inner weldment. See Figure 8.

Two lift chains move the carriage. The chains fasten to mounts that are near the top of the lift cylinder shells. The chains go up and over the chain sheaves and connect to the carriage. The chain sheaves are installed at the top crossmember of the inner weldment. When the lift cylinders extend, the lift chains transfer the force from the lift cylinders to the carriage. The inner weldment and carriage can raise a small amount before the overall height of the mast increases. During lifting, the inner weldment moves at the same speed as the lift cylinders. The carriage moves at twice the speed of the inner weldment.

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

Each cylinder has a check valve in the bottom of the rod assembly. When the cylinder is fully extended, oil above the piston is forced through the check valve. This action allows the cylinder to fully extend. See Cylinder Cushion During Lowering Sequence.



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- |                                      |                   |
|--------------------------------------|-------------------|
| 1. LIFT CYLINDER                     | 5. OUTER WELDMENT |
| 2. LOWERING CONTROL VALVE (INTERNAL) | 6. INNER WELDMENT |
| 3. LOWERING CONTROL VALVE (EXTERNAL) | 7. LIFT CHAIN     |
| 4. TO/FROM MAIN CONTROL VALVE        | 8. CARRIAGE       |

**Figure 8. Operation of Two-Stage Mast, Limited Free-Lift (LFL)**

## Two-Stage Mast, Full Free-Lift (FFL)

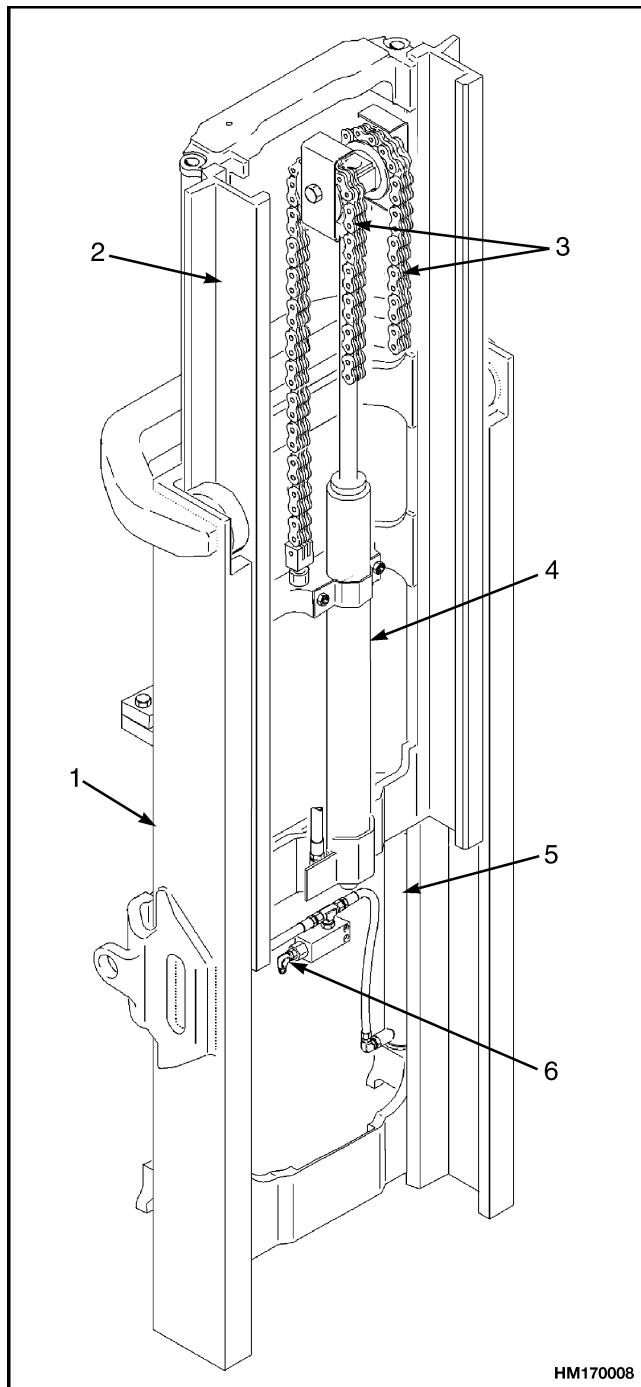
### DESCRIPTION AND OPERATION

The two-stage, full free-lift mast has an inner weldment and an outer weldment. See Figure 9. It is called a full free-lift mast because the carriage can travel to the top of the inner weldment without extending the inner weldment. The full free-lift mast has the same load roller and strip bearing arrangements as the two-stage, limited free-lift mast.

The two main lift cylinders are installed at the back of the outer weldment. The base of each lift cylinder sits in a mount at the bottom crossmember on the

outer weldment. The top of each lift cylinder (cylinder rod) fits into a guide at the top of the inner weldment. The free-lift cylinder is installed in the inner weldment. Each of the lift cylinders has an internal lowering control valve. A single external lowering control valve is connected by tubing to all the lift cylinders.

The free-lift chains connect at one end to the crossmember for the free-lift cylinder. Two chain sheaves are installed on a crosshead on the cylinder rod of the free-lift cylinder. The chains go over sheaves on the crosshead and connect to the carriage.



**Figure 9. Two-Stage Full Free-Lift Mast**

**Legend for Figure 9**

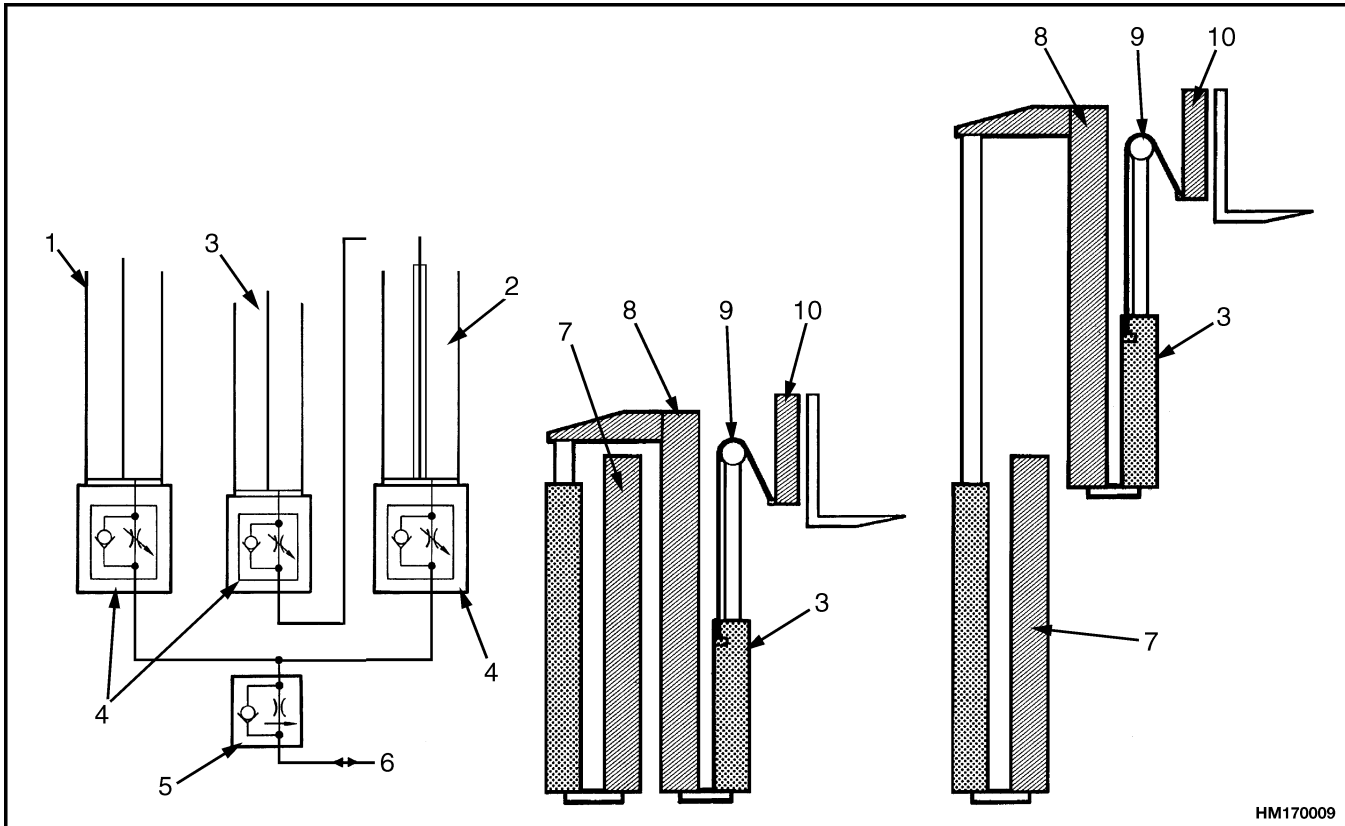
**NOTE:** TYPICAL MAST ASSEMBLY IS SHOWN HERE.

1. OUTER WELDMENT
2. INNER WELDMENT
3. FREE-LIFT CHAIN
4. FREE-LIFT CYLINDER
5. MAIN LIFT CYLINDER(S)
6. LOWERING CONTROL VALVE (EXTERNAL)

The three lift cylinders are connected by hoses and tubing as shown in Figure 10. When the mast is extended, oil flows from the main control valve to the base of the main lift cylinders. The oil flows through the left-hand cylinder rod and through tubing to the base of the free-lift cylinder. The free-lift cylinder raises only the carriage. When the free-lift cylinder is fully extended, the two main lift cylinders extend the inner weldment. The free-lift cylinder extends first because it has less weight to lift. When the load is lowered, the main lift cylinders lower first because they have a greater load. The oil flows from the main lift cylinders, through the lowering control valve to the hydraulic tank. Oil from the free-lift cylinder flows from the cylinder through tubing to the cylinder rod on the left side of the mast. The oil flows from the left-hand lift cylinder to the hydraulic tank.

The free-lift cylinder must have 0.5 liter (0.5 qt) of oil above the piston. This oil provides a hydraulic cushion when the cylinder reaches the top of its stroke. A check valve and orifice system in the bottom of the rod assembly keeps the oil at the correct level. When the cylinder is fully extended, excess oil above the piston is forced through the check valve. This action allows the cylinder to fully extend.

The right hand main lift cylinder has an orifice system in the bottom of the rod assembly. This system provides a hydraulic cushion when the cylinder reaches the bottom of its stroke. See Cylinder Cushion During Lifting Sequence.



- |                                      |                               |
|--------------------------------------|-------------------------------|
| 1. RIGHT-HAND LIFT CYLINDER          | 6. TO/FROM MAIN CONTROL VALVE |
| 2. LEFT-HAND LIFT CYLINDER           | 7. OUTER WELDMENT             |
| 3. FREE-LIFT CYLINDER                | 8. INNER WELDMENT             |
| 4. LOWERING CONTROL VALVE (INTERNAL) | 9. LIFT CHAIN                 |
| 5. LOWERING CONTROL VALVE (EXTERNAL) | 10. CARRIAGE                  |

*Figure 10. Operation of Two-Stage Mast, Full Free-Lift (FFL)*

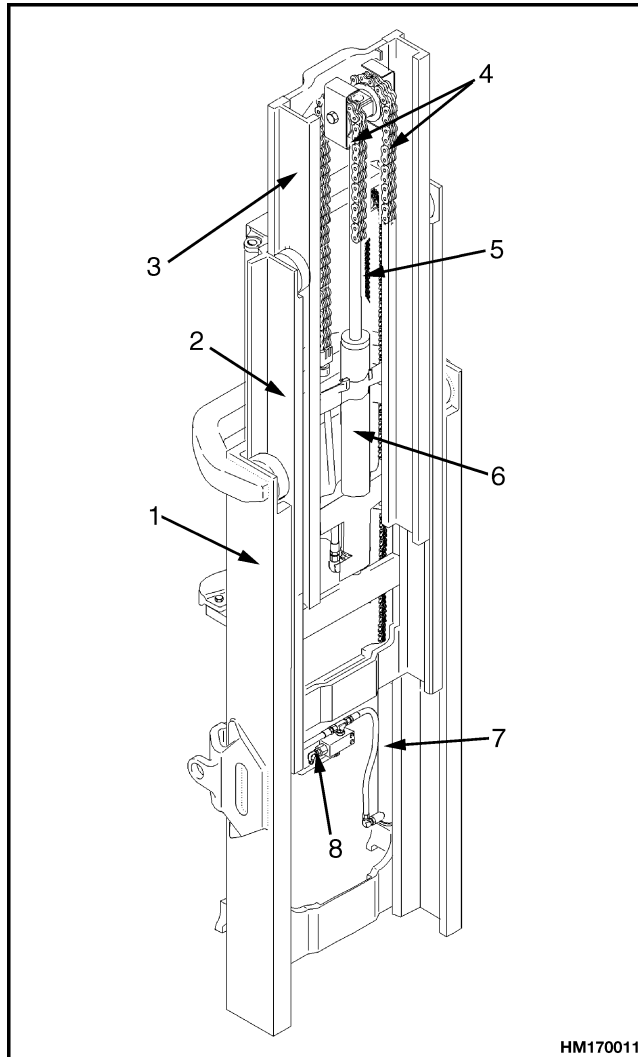
## Three-Stage Mast, Full Free-Lift (FFL)

### DESCRIPTION AND OPERATION

The three-stage mast has three weldments: outer, intermediate, and inner. See Figure 11. Two single-stage main lift cylinders and a free-lift cylinder are used to raise the carriage and extend the mast. It is called a full free-lift mast because the carriage can travel to the top of the inner weldment without extending the inner weldment. The weldments are telescopic and have the load roller and strip bearing arrangements similar to the two-stage mast. The two main lift cylinders are installed at the back of the outer weldment. The base of each lift cylinder sits in a mount at the bottom crossmember of the outer

weldment. The top of each main lift cylinder (cylinder rod) fits into a guide at the top crossmember of the intermediate weldment. The free-lift cylinder is installed to the inner weldment. Each lift cylinder has an internal lowering control valve. A single external lowering control valve is connected by tubing to all of the lift cylinders.

The two main lift chains are connected to mounts that are welded near the top of the lift cylinder shells. The lift chains go over sheaves at the top of the intermediate weldment and fasten at the bottom of the inner weldment.



**NOTE:** TYPICAL MAST ASSEMBLY IS SHOWN HERE.

1. OUTER WELDMENT
2. INTERMEDIATE WELDMENT
3. INNER WELDMENT
4. FREE-LIFT CHAIN
5. MAIN LIFT CHAIN(S)
6. FREE-LIFT CYLINDER
7. MAIN LIFT CYLINDER(S)
8. LOWERING CONTROL VALVE (EXTERNAL)

**Figure 11. Three-Stage Mast**

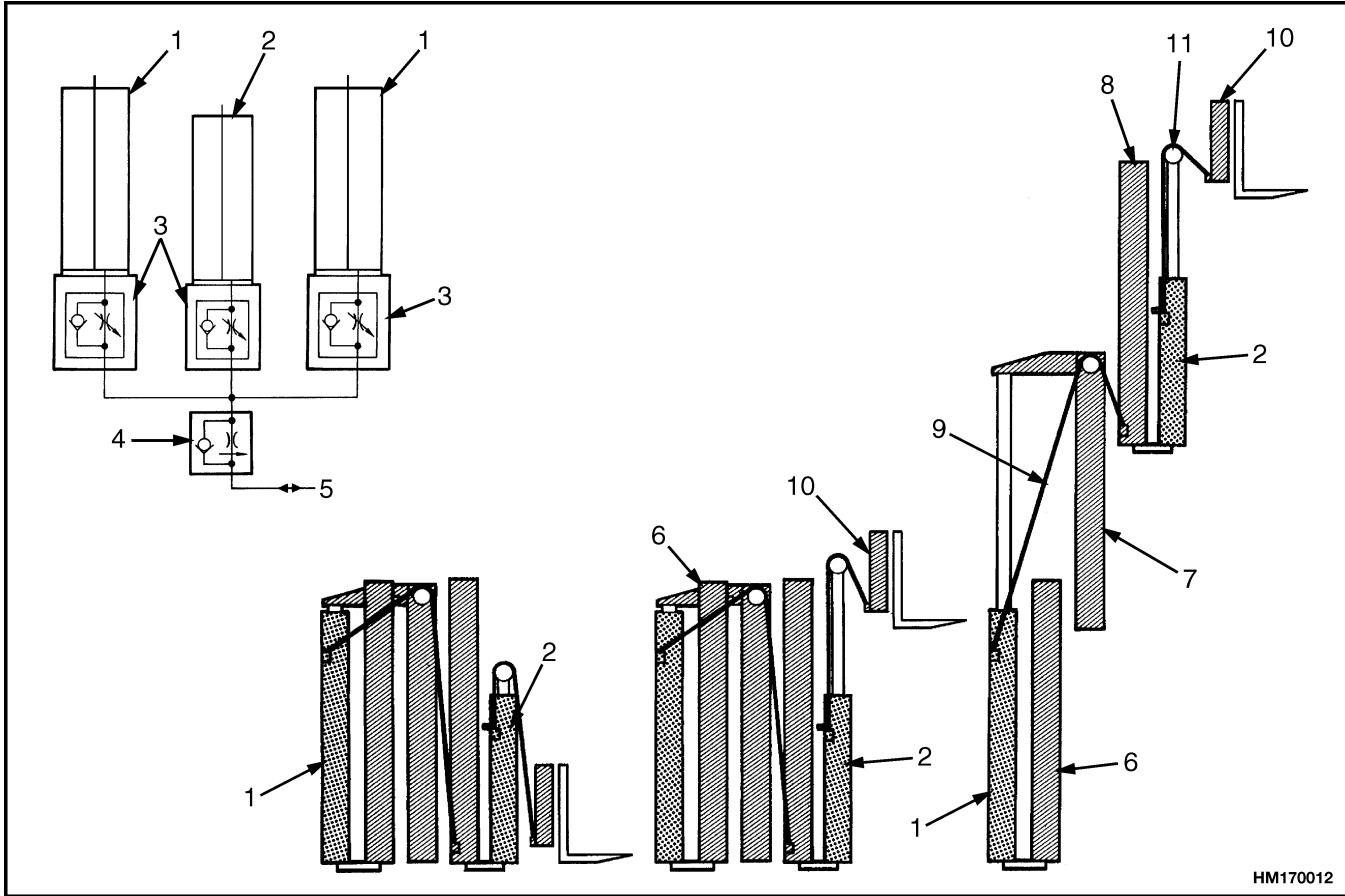
The free-lift chains connect at one end to the cross-member for the free-lift cylinder. Two chain sheaves are installed on a crosshead on the cylinder rod of the free-lift cylinder. The chains go over sheaves on the crosshead and connect to the carriage.

The three hydraulic cylinders are connected by hoses and tubing as shown in Figure 12. To extend the mast, oil from the main control valve flows to all cylinders at the same time. The free-lift cylinder extends first because it lifts the least amount of weight. The free-lift cylinder raises the carriage to the top of the inner weldment. After the free-lift cylinder reaches the end of its stroke, the main lift cylinders begin to extend. As the main lift cylinders extend, the intermediate weldment is raised by the lift cylinders and the inner weldment is raised by the lift chains.

During lowering, the main lift cylinders lower first because they have a greater load. After the main lift cylinders have retracted, the free-lift cylinder lowers. All oil from the lift cylinders flows through the lowering control valves to the hydraulic tank.

The free-lift cylinder must have 0.5 liter (0.5 qt) of oil above the piston. This oil provides a hydraulic cushion when the cylinder reaches the top of its stroke. A check valve and orifice system in the bottom of the rod assembly keeps the oil at the correct level. When the cylinder is fully extended, excess oil above the piston is forced through the check valve. This action allows the cylinder to fully extend. See Cylinder Cushion During Lifting Sequence.

Each main lift cylinder has an orifice system and a check valve in the bottom of the rod assembly. When the cylinder is fully extended, excess oil between the rod end and the gland is forced through the check valve. This action allows the cylinder to fully extend. The orifice system provides a hydraulic cushion when the cylinder reaches the bottom of its stroke. See Cylinder Cushion During Lowering Sequence.



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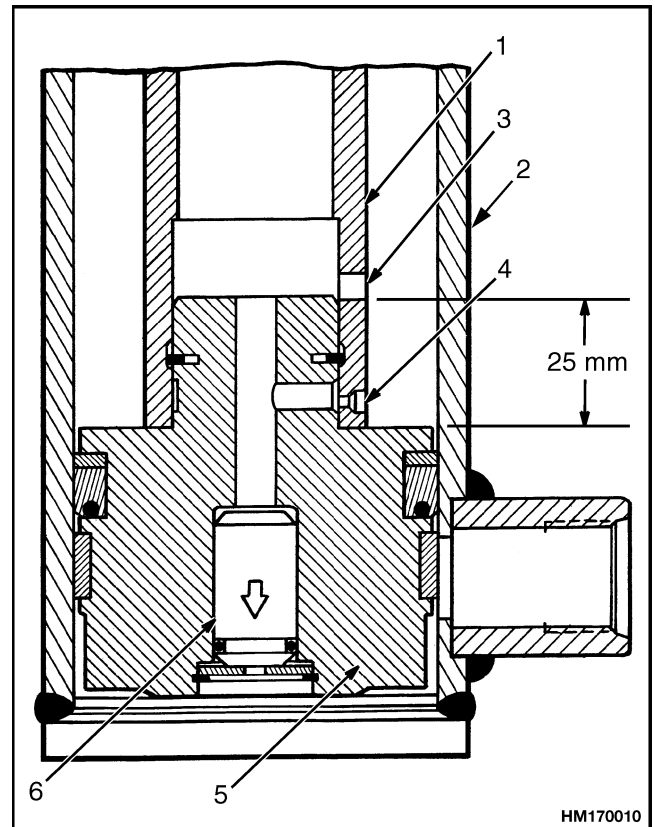
- |                                      |                          |
|--------------------------------------|--------------------------|
| 1. LIFT CYLINDER                     | 7. INTERMEDIATE WELDMENT |
| 2. FREE-LIFT CYLINDER                | 8. INNER WELDMENT        |
| 3. LOWERING CONTROL VALVE (INTERNAL) | 9. MAIN LIFT CHAIN       |
| 4. LOWERING CONTROL VALVE (EXTERNAL) | 10. CARRIAGE             |
| 5. TO/FROM MAIN CONTROL VALVE        | 11. FREE-LIFT CHAIN      |
| 6. OUTER WELDMENT                    |                          |

**Figure 12. Operation of Three-Stage Mast, Full Free-Lift (FFL)**

## Cylinder Cushion During Lifting Sequence

There is hydraulic oil on the rod side of the piston of the free-lift cylinder. As the cylinder rod extends, the hydraulic oil on the rod side flows to the base of the cylinder through the larger hole and the internal check valve. When the cylinder rod extends to the last 25 mm (1 in.) of its stroke, the retainer at the top of the cylinder closes the larger hole. During the last 25 mm (1 in.) of the cylinder stroke, the remainder of the hydraulic oil must flow through the orifice to the internal check valve. This action increases the hydraulic pressure so the main lift cylinders begin to extend. See Figure 13.

The hydraulic action at the end of the free-lift stroke provides a cushion effect for the free-lift cylinder and a smooth transition between the free-lift phase and the channel extension phase. All masts with a free-lift cylinder in this section use this design.



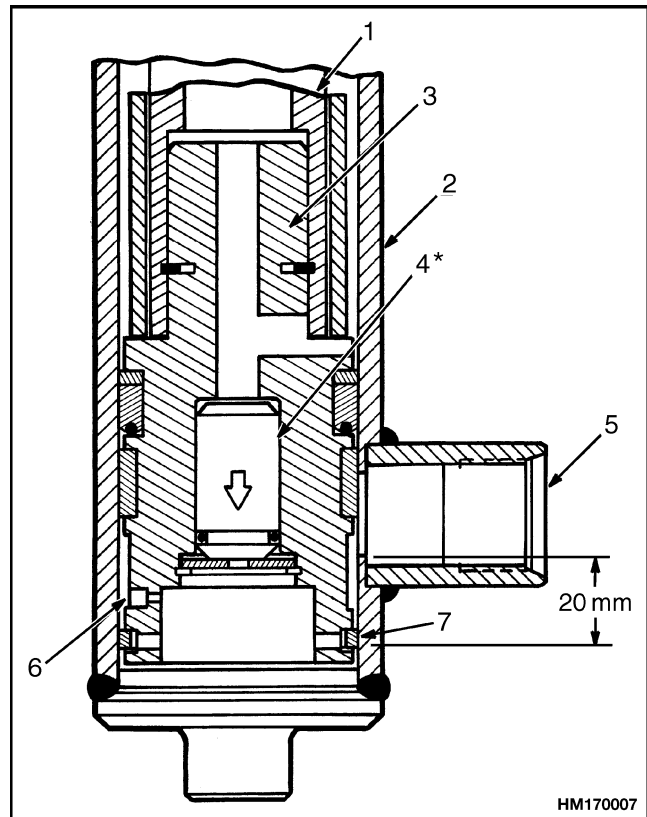
- |                   |                           |
|-------------------|---------------------------|
| 1. CYLINDER ROD   | 4. ORIFICE (SMALLER HOLE) |
| 2. CYLINDER SHELL | 5. PISTON                 |
| 3. LARGER HOLE    | 6. INTERNAL CHECK VALVE   |

**Figure 13. Free-Lift Cylinder Piston**

## Cylinder Cushion During Lowering Sequence

**NOTE:** Internal check valve is not used on the two-stage FFL mast.

When the main lift cylinders retract, the hydraulic oil flows out of the cylinder through the hydraulic port until the piston seal moves past hydraulic port. During the last 20 mm (0.79 in.) of the retraction stroke, the hydraulic oil must flow through the orifice. See Figure 14. This action causes the cylinder rod to move much more slowly at the end of the retraction stroke. This cushion effect prevents a sudden stop at the end of the lowering sequence, which causes smoother operation during lowering. All masts in this section use this design in the main lift cylinders.



- |                         |                   |
|-------------------------|-------------------|
| 1. CYLINDER ROD         | 5. HYDRAULIC PORT |
| 2. CYLINDER SHELL       | 6. ORIFICE        |
| 3. PISTON               | 7. PISTON SEAL    |
| 4. INTERNAL CHECK VALVE |                   |

**Figure 14. Main Lift Cylinder Piston**





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