

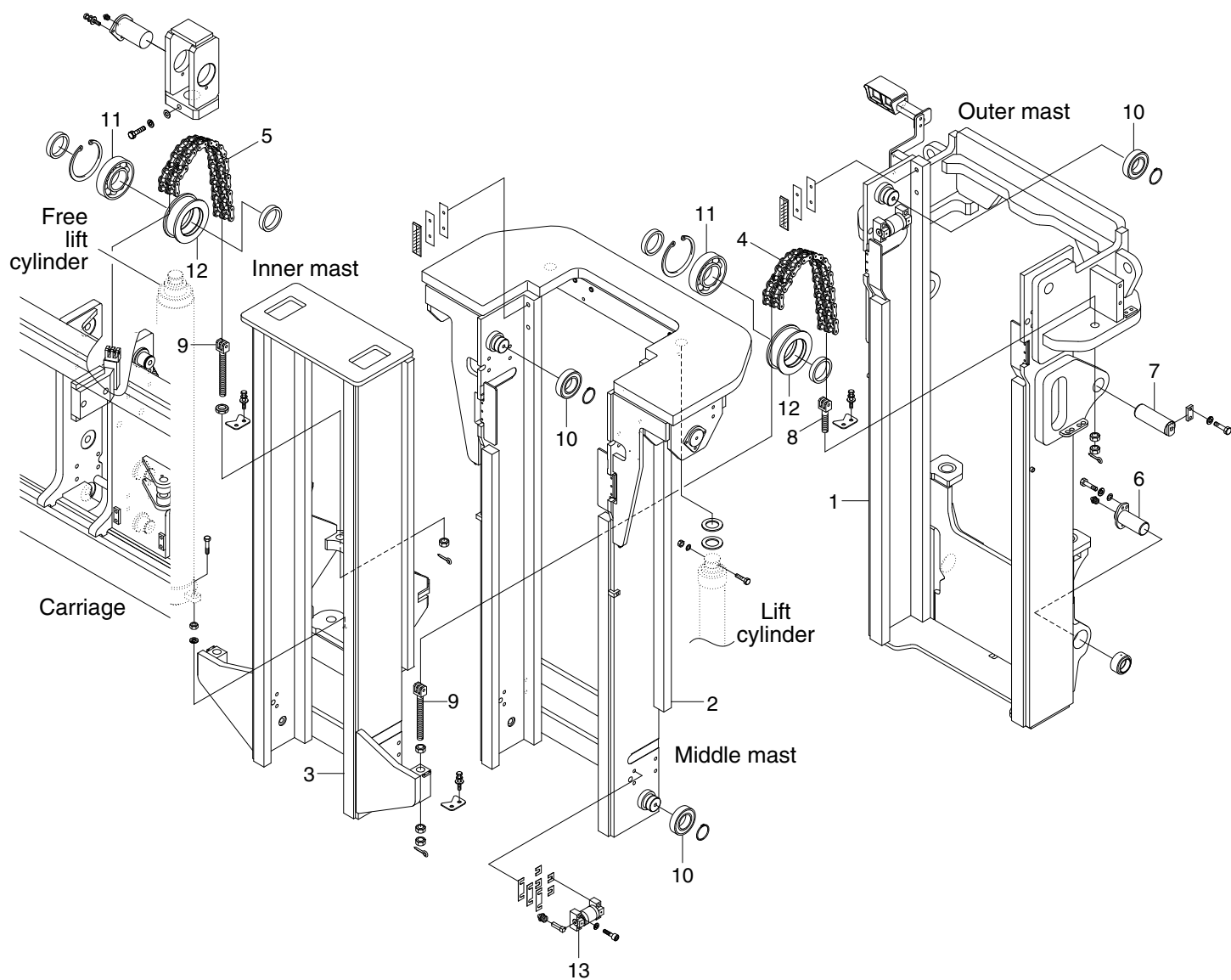
# SECTION 8 MAST

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# SECTION 8 MAST

## GROUP 1 STRUCTURE

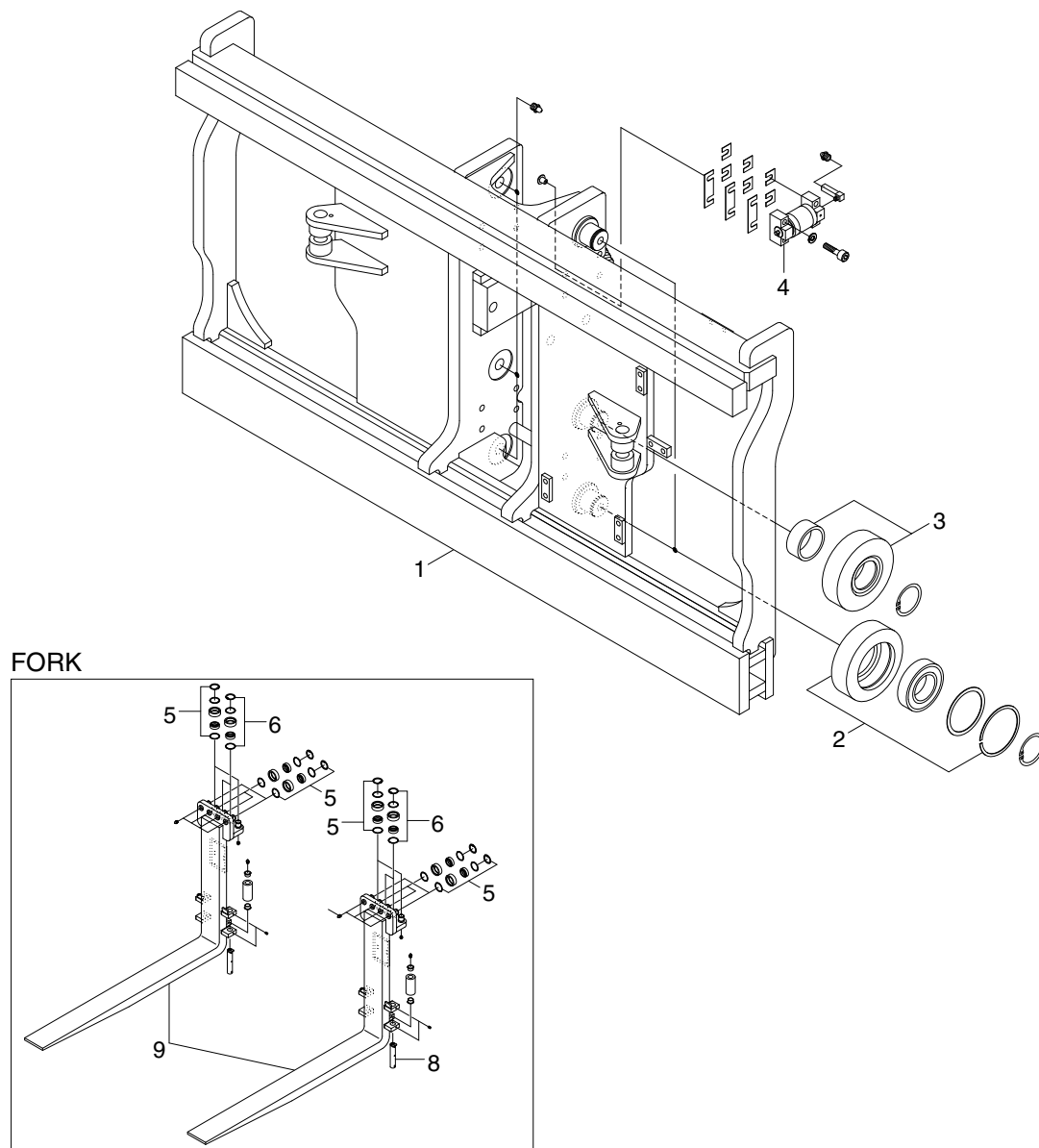
### 1. 3 STAGE MAST (TF MAST)



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- |   |                    |    |                   |    |                      |
|---|--------------------|----|-------------------|----|----------------------|
| 1 | Outer mast         | 6  | Mast mounting pin | 11 | Roller bearing       |
| 2 | Middle mast        | 7  | Tilt cylinder pin | 12 | Chain sheave bearing |
| 3 | Inner mast         | 8  | Anchor bolt       | 13 | Side roller bearing  |
| 4 | Lift chain         | 9  | Anchor bolt       |    |                      |
| 5 | Free lift cylinder | 10 | Roller bearing    |    |                      |

## 2. CARRIAGE AND FORK



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- |   |                     |   |        |
|---|---------------------|---|--------|
| 1 | Carriage            | 6 | Roller |
| 2 | Load roller bearing | 7 | Roller |
| 3 | Load roller bearing | 8 | Pin    |
| 4 | Side roller         | 9 | Fork   |
| 5 | Roller              |   |        |

## GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

### 1. OPERATIONAL CHECKS

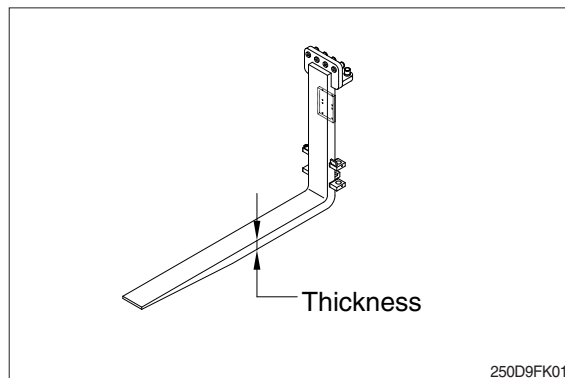
#### 1) FORKS

- (1) Measure thickness of root of forks and check that it is more than specified value.

EX :  $l = 2450$  mm (96 in)

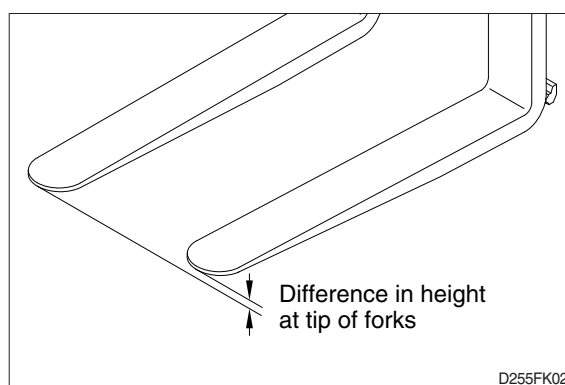
mm (in)

STD Fork assy	Standard	Wear limit
65HV-71200	110 (4.3)	100 (3.9)



- 2) Set forks in middle and measure out of parallel and difference in height at the top of forks.

Fork length (mm)	Height difference (mm)
below 1500	3
equal or above 1500	6



- 3) Most force is concentrated at root of fork and at hook, so use crack detection method to check cracks.

### 2. MAST

- 1) Check for cracks at mast stay, tilt cylinder bracket, guide bar, fork carriage and roller shaft weld. Check visually or use crack detection method. Repair any abnormality.
- 2) Set mast vertical, raise forks about 10cm from ground and check front-to-rear clearance and left-to-right clearance between inner mast and fork carriage, and between outer mast and inner mast. Use these figures to judge if there is any play at roller or rail.
  - Front-to-rear clearance : Within 2.0 mm (0.08 in)
  - Left-to-right clearance : Within 2.5 mm (0.10 in)
- 3) Check that there is an oil groove in bushing at mast support.
- 4) Set mast vertical, raise forks about 10cm from ground, and push center of lift chain with finger to check for difference in tension.
 

If there is any difference in tension, adjust chain stopper bolt.
- 5) Check visually for abnormalities at thread of chain anchor bolt, and at contact surface between chain wheel and chain.
 

Rotate chain wheel by hand and check for any play of bearing.

## 2. TROUBLESHOOTING

### 1) MAST

Problem	Cause	Remedy
Forks fail to lower.	<ul style="list-style-type: none"> <li>Deformed mast or carriage.</li> </ul>	<ul style="list-style-type: none"> <li>Disassemble, repair or replace.</li> </ul>
Fork fails to elevate.	<ul style="list-style-type: none"> <li>Faulty hydraulic equipment.</li> <li>Deformed mast assembly.</li> </ul>	<ul style="list-style-type: none"> <li>See troubleshooting hydraulic pump and cylinders in section 6, hydraulic system.</li> <li>Disassemble mast and replace damaged parts or replace complete mast assembly.</li> </ul>
Slow lifting speed and insufficient handling capacity.	<ul style="list-style-type: none"> <li>Faulty hydraulic equipment.</li> <li>Deformed mast assembly.</li> </ul>	<ul style="list-style-type: none"> <li>See troubleshooting hydraulic pump and Cylinders in section 6, hydraulic system.</li> <li>Disassemble mast and replace damaged parts or replace complete mast assembly.</li> </ul>
Mast fails to lift smoothly.	<ul style="list-style-type: none"> <li>Deformed masts or carriage.</li> <li>Faulty hydraulic equipment.</li> <li>Damaged load and side rollers.</li> <li>Unequal chain tension between LH &amp; RH sides.</li> <li>LH &amp; RH mast inclination angles are unequal. (Mast assembly is twisted when tilted)</li> </ul>	<ul style="list-style-type: none"> <li>Disassembly, repair or replace.</li> <li>See Troubleshooting Hydraulic Cylinders pump and control valve in section 6, hydraulic system.</li> <li>Replace.</li> <li>Adjust chains.</li> <li>Adjust tilt cylinder rods.</li> </ul>
Abnormal noise is produced when mast is lifted and lowered.	<ul style="list-style-type: none"> <li>Broken load roller bearings.</li> <li>Broken side roller bearings.</li> <li>Deformed masts.</li> <li>Bent lift cylinder rod.</li> <li>Deformed carriage.</li> <li>Broken sheave bearing.</li> </ul>	<ul style="list-style-type: none"> <li>Replace.</li> <li>Replace.</li> <li>Disassemble, repair or replace.</li> <li>Replace.</li> <li>Replace.</li> <li>Replace.</li> </ul>
Abnormal noise is produced during tilting operation.	<ul style="list-style-type: none"> <li>Insufficient lubrication of anchor pin, or worn bushing and pin.</li> <li>Bent tilt cylinder rod.</li> </ul>	<ul style="list-style-type: none"> <li>Lubricate or replace.</li> <li>Replace.</li> </ul>

## 2) FORKS

Problem	Cause	Remedy
Abrasion	Long-time operations causes the fork to wear and reduces the thickness of the fork. Inspection for thickness is needed. <ul style="list-style-type: none"><li>· Wear limit : Must be 90% of fork thickness</li></ul>	If the measured value is below the wear limit, replace fork.
Distortion	Forks are bent out of shape by a number of reasons such as overloading, glancing blows against walls and objects, and picking up load unevenly. <ul style="list-style-type: none"><li>· Difference in fork tip height : 15 mm</li><li>· Difference in fork tip width : 35 mm</li></ul>	If the measured value exceeds the allowance, replace fork.
Fatigue	Fatigue failure may result from the fatigue crack even though the stress to fork is below the static strength of the fork. Therefore, a daily inspection should be done. <ul style="list-style-type: none"><li>· Crack on the fork heel.</li><li>· Crack on the fork weldments.</li></ul>	Repair fork by expert. In case of excessive distortion, replace fork.

## GROUP 3 ADJUSTMENT

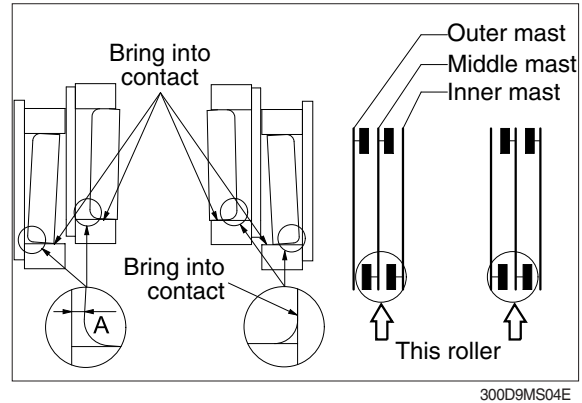
### 1. MAST LOAD ROLLER (TF MAST)

#### 1) INNER/OUTER MAST ROLLER CLEARANCE ADJUSTMENT

(1) Measure the clearance with the mast overlap at near 480 mm (19 in).

(2) Shift the inner mast to one side to bring the roller into contact with the outer mast and middle mast and adjust the clearance between the roller side face and mast at the closest position on the opposite side to the following value by inserting the inner and middle mast roller shim, respectively.

- Standard clearance A = 0~0.6 mm
- Shim thickness : 0.5, 1.0 mm



(3) Distribute the roller clearance equally to the left and right roller.

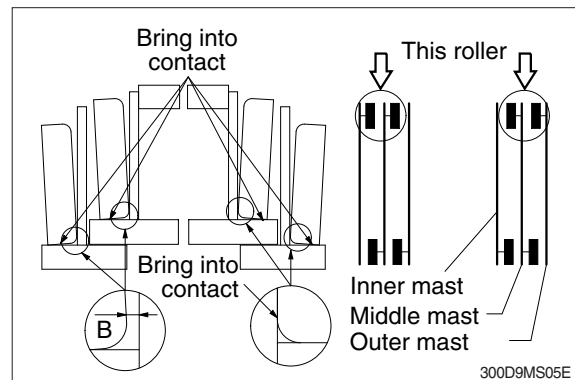
(4) After the adjustment, check that the inner mast moves smoothly in the middle mast and the middle mast moves smoothly in the outer mast.

#### 2) MIDDLE/OUTER MAST ROLLER CLEARANCE ADJUSTMENT

(1) Measure the clearance with the mast overlap at near 480 mm.

(2) Shift the inner mast to one side to bring the roller into contact with the outer mast and the middle mast, and adjust the clearance between the roller side face and mast at the closest position on the opposite side to the following value by inserting the middle and outer mast roller shim, respectively.

- Standard clearance B = 0~0.6 mm
- Shim thickness 0.5, 1.0 mm



(3) Distribute the shim thickness equally to the left and right roller.

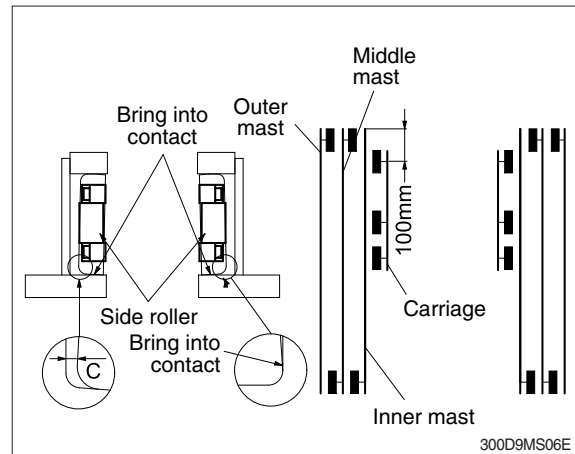
(4) After the adjustment, check that the inner mast moves smoothly in the middle mast, and the middle mast moves smoothly in the outer mast.

※ When assembling the load roller bearings, it must be sure to observe the followings.

- 1) The outer race of the load roller bearings should be assembled to inward for 2.5 mm radius round part and outward for 7 mm radius round part.
- 2) When assembling and disassembling the load roller bearings, the jig fixture should be used so that it can be pressed to inner race of the roller bearings.
- 3) If it is not, the inner race of the load roller bearing could be separated.  
Remove the foreign materials in the grease oil passage of the roller brackets before assembling.

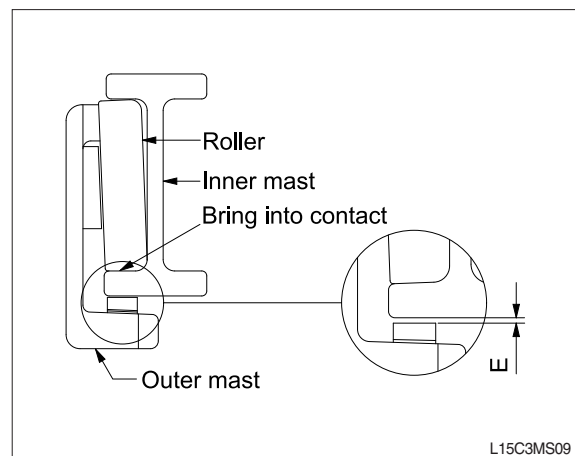
### 3) CARRIAGE LOAD ROLLER

- (1) Measure the clearance when the center of the carriage upper roller is 100 mm from the top of the inner mast.
- (2) Measure the clearance at upper, middle and lower rollers after loosen the adjust screws from the side rollers. Shift the carriage to one side to bring the roller into contact with the inner mast, and measure the clearance between the roller side face and mast at the closest position on the opposite side to the following value by adjust screw.
  - Standard clearance  $C = 0 \sim 0.6 \text{ mm}$
- (3) Distribute the roller clearance equally to the left and right roller.
- (4) After the adjustment, the carriage should move smoothly along the overall mast length.



### 4) MAST BACK UP LINER

- (1) Measure the clearance with the middle mast at the bottom position.
- (2) With the middle mast in contact with the outer mast roller, adjust the clearance between the mast back up liner and middle mast to the following value by inserting the back up liner shim.
  - Standard clearance  $E = 0.2 \sim 0.6 \text{ mm}$
  - Shim thickness : 0.5, 1.0 mm
- (3) After the adjustment, the mast should move smoothly.



※ When assembling the load roller bearings, it must be sure to observe the followings.

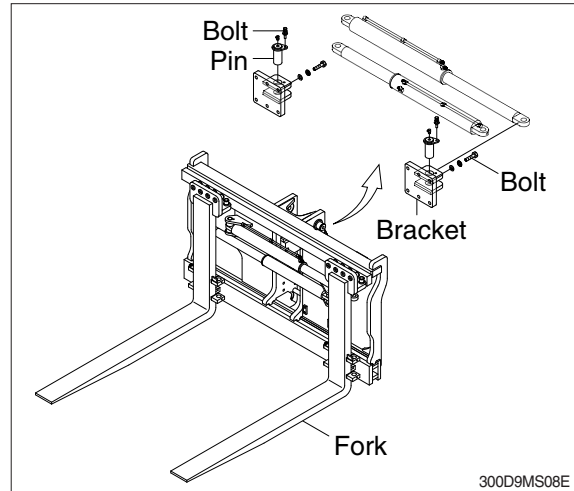
- 1) The outer race of the load roller bearings should be assembled to inward for 2.5 mm radius round part and outward for 7 mm radius round part.
- 2) When assembling and disassembling the load roller bearings, the jig fixture should be used so that it can be pressed to inner race of the roller bearings.  
If it is not, the inner race of the load roller bearing could be separated.
- 3) Remove the foreign materials in the grease oil passage of the roller brackets before assembling.



## GROUP 4 REMOVAL AND INSTALLATION

### 1. FORKS

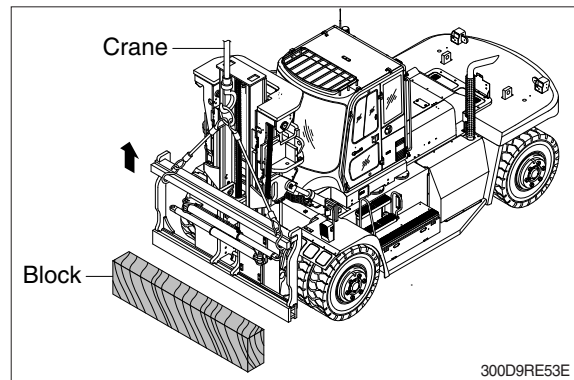
- (1) Lower the fork carriage until the forks are approximately 25 mm (1 in) from the floor.
- (2) Release fork anchor pins and slide one fork at a time toward the center of the carriage where a notch has been cut in the bottom plate for easy fork removal.
- (3) Remove only one fork at a time.
  - ※ On larger forks it may be necessary to use a block of wood.
- (4) Reverse the above procedure to install load forks.



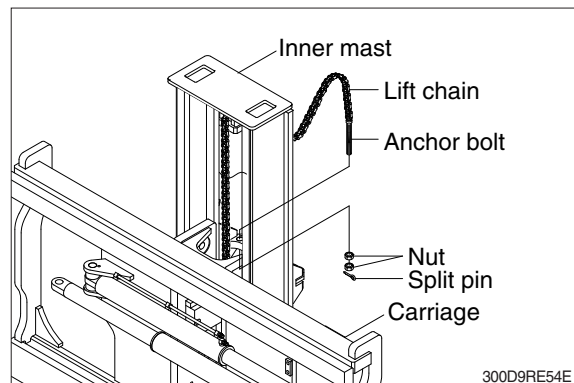
### 2. CARRIAGE ASSEMBLY

#### 1) CARRIAGE

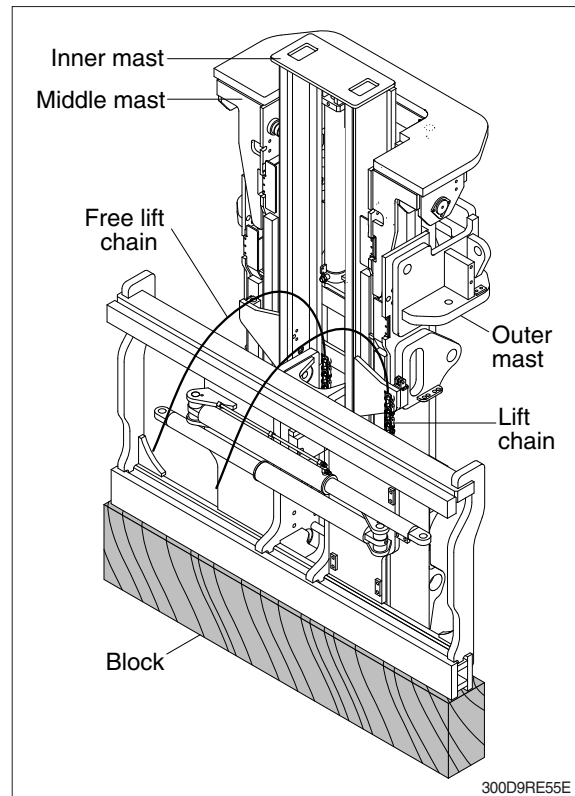
- (1) With the mast vertical, raise the carriage high enough to place blocks under the load forks. This is done to create slack in the load chains when the carriage is lowered. Lower the carriage all the way down to the floor. Make sure the carriage is level, this will prevent any binding when the mast is raised.



- (2) While supporting lift chains, remove the split pin and slide out chain anchor pins from the chain anchors of stationary upright.



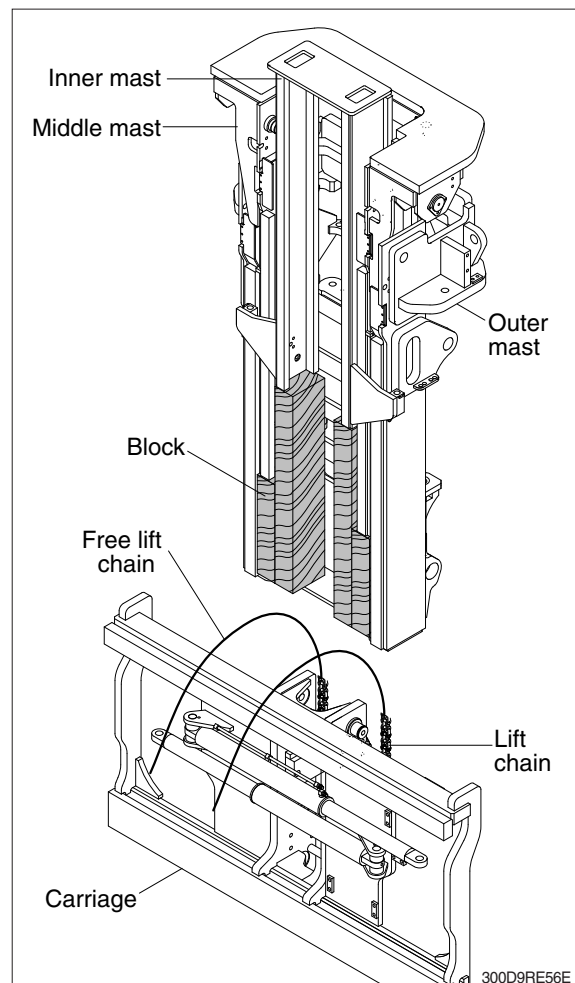
- (3) Pull the chains out of the sheaves and drape them over the front of the carriage.
- (4) Disconnect connector from the work lamp assy.



- (5) Slowly raise inner mast upright until mast clears top of fork carriage. Move carriage to work area and lower mast.

**▲ Make sure that carriage remains on floor and does not bind while mast is being raised.**

- ※ Inspect all parts for wear or damage. Replace all worn or damaged parts.
- ※ Reverse the above steps to reinstall.

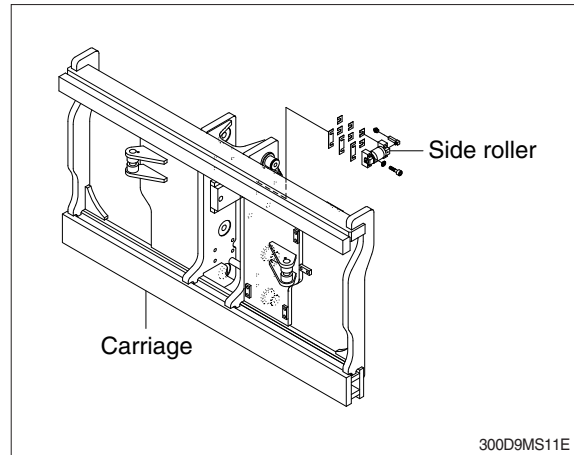


## 2) SIDE ROLLER

- (1) Remove carriage as outlined in the carriage removal paragraph.
- (2) Loosen and remove nuts, adjust screws and side rollers from carriage side plate.
- (3) Thoroughly clean, inspect and replace all worn or damaged parts.
- (4) Reverse the above procedure to assembly.

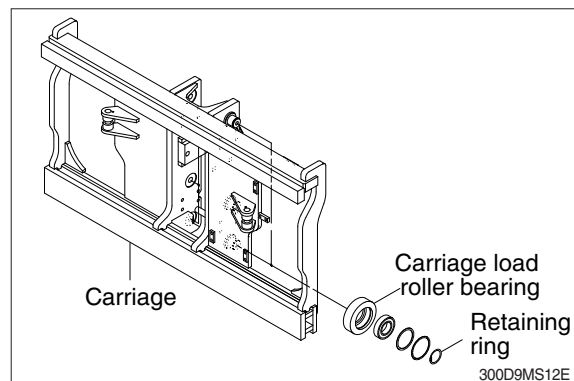
### ※ Adjustment

- Once carriage is properly installed, loosen nuts and adjust screws, (if not already done) allowing carriage to be centered in the inner mast.
- Adjust side roller by tightening screw until side roller just makes contact with mast. Back off approximately 1/10 turn on screw and tighten nut to lock screw in place.
- Run carriage up and down along the inner mast to be sure the carriage has free movement and does not stick. Also, make sure chains are properly adjusted. Refer to chain adjustment paragraph. Make adjustment when necessary and recheck operation of carriage.



## 3) CARRIAGE LOAD ROLLER BEARING

- (1) Remove carriage as outlined in the carriage removal paragraph.
- (2) Using the plier, remove retaining rings from load roller bearing bracket.
- (3) Using a plier, remove load roller bearings from load roller bearing bracket.
- (4) Reverse the above procedure to assembly. Refer to MAST ROLLER ADJUSTMENT paragraph.



## 4. MAST LOAD ROLLER

### 1) 3 STAGE MAST (TF MAST)

- (1) Remove the carriage assembly and move them to one side.
- (2) Loosen and remove hexagon nuts and screws securing lift cylinders to inner mast.
- (3) Loosen and remove hexagon bolts and nuts securing lift cylinders to outer mast.
- (4) Attach chains or sling to the inner mast section at top crossmember. Using an overhead hoist, slowly raise the inner mast high enough to clear lift cylinder.
- (5) After lowering the lift cylinder rods, and disconnecting lift cylinder hose, tilt the lift cylinders (LH and RH) with ropes to the outer mast.
- (6) Using the overhead hoist, lower inner mast until top and bottom rollers are exposed.
- (7) Using a plier, remove load rollers from load roller bracket. Remove side rollers.
- (8) Thoroughly clean, inspect and replace all worn or damaged parts.
- (9) Reverse the above procedure to assemble.

Refer to MAST ROLLER ADJUSTMENT

#### (10) paragraph.

After completing all necessary steps for load rollers removal, use an overhead hoist to remove sling or chain around upper crossmember of the inner mast section.

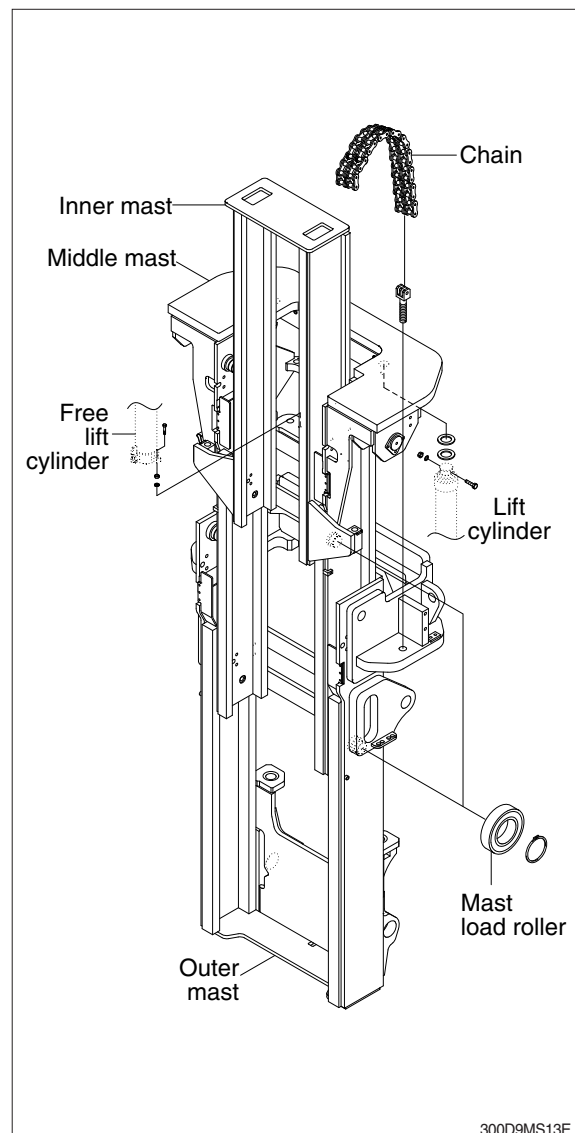
Lift inner mast upright straight up and out

#### (11) of outer mast section.

Replace and reverse above procedure to

#### (12) install.

Make all necessary measurements and adjustments.

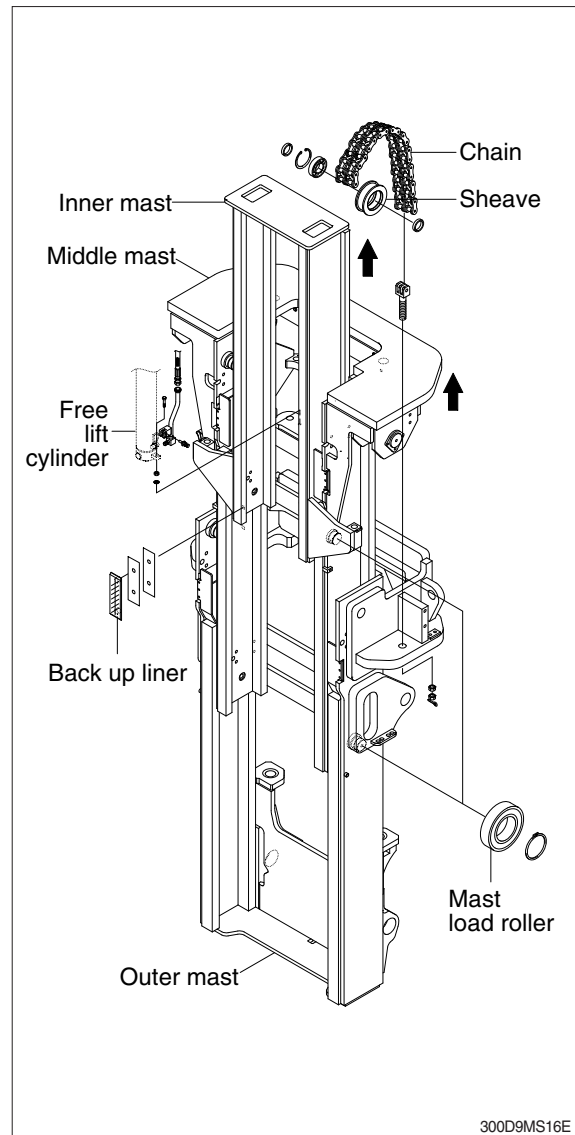


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## 2) ELEVATING THE INNER AND MIDDLE MAST

### (1) Inner and middle mast (TF mast)

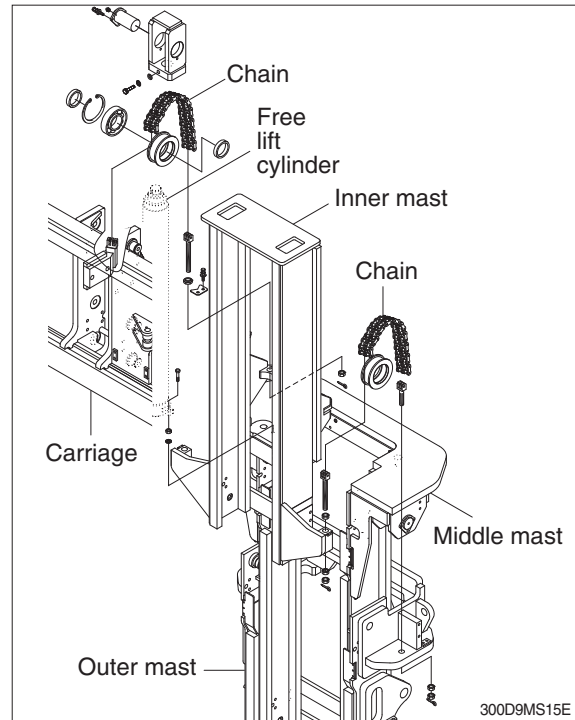
- ① After completing all necessary steps for load rollers and back up liner removal. Remove rear chains and sheave support if not already done.
- ② Disconnect free lift cylinder hose. Drain hose into a suitable pan or container and cap hose.
- ③ While supporting free lift cylinder assembly, remove bolts and washers securing cylinder to mast crossmember.
- ④ Place a sling around free lift cylinder and attach to an overhead hoist. Slowly raise and move cylinder to one side.
- ⑤ Attach chains or sling to the inner mast section at top crossmember. Using an overhead hoist slowly raise the upright straight up and out of middle mast section.
- ⑥ Attach chains or sling to the middle mast section at top crossmember. Using an overhead hoist slowly raise the upright straight up and out of outer mast section.
- ⑦ Replace upright and reverse above procedure to install. Make all necessary measurements and adjustments.



## 5. CHAIN

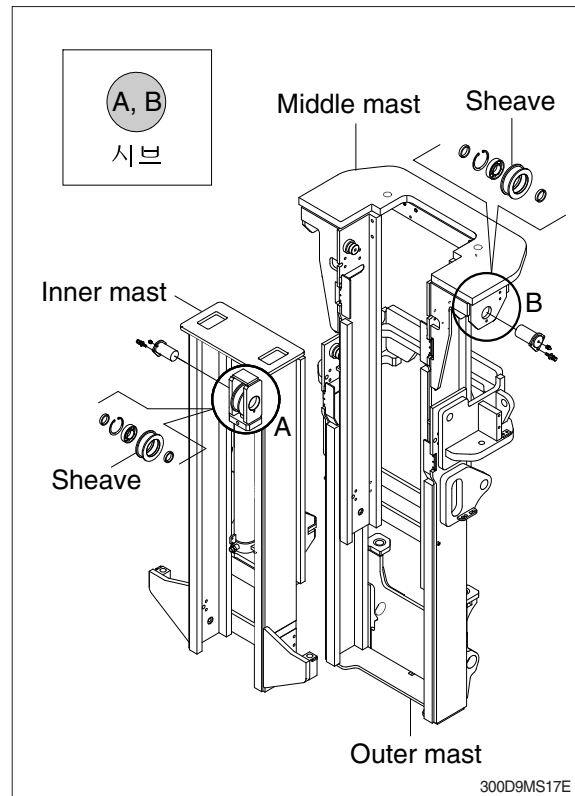
### 1) CHAIN SHEAVE (TF MAST)

- (1) Place a sling around carriage and attach to an overhead hoist. Lift carriage high enough so that the tension on the chain over sheaves is relieved after the carriage is blocked. Position wooden blocks under the carriage and lower it.
- (2) Remove the split pin securing the chain anchor pins and discard. While supporting the chains, remove the chain anchor pins and drape the chain over the carriage.
- (3) Remove retaining ring securing sheaves to sheave support. Remove sheaves with bearings.
- (4) Remove bearing retaining ring from sheave and press bearings from sheaves.
- (5) Thoroughly clean, inspect and replace all worn or damaged parts.
- (6) Reverse the above to assemble and install. Use new split pins in chain anchor pins.



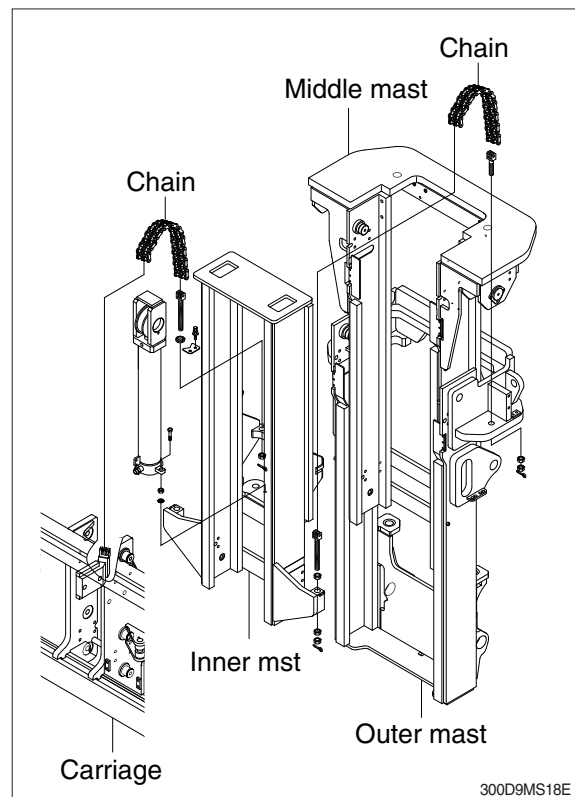
## 2) CHAIN WHEEL BEARING SUPPORT (TF MAST)

- (1) Remove the carriage assembly and move to one side.
- (2) After removing bolt to securing chain wheel bearing support assembly to free lift cylinder.  
After a sling to the chain wheel bearing support assembly. Using an overhead hoist, lift support assembly straight up and off of free lift cylinder. Move assembly to work area.
- (3) Remove retaining ring securing chain wheel bearing to chain wheel bearing support.
- (4) Remove bearing retaining ring from chain wheel bearing and press bearings from chain wheel bearings.
- (5) Thoroughly clean, inspect and replace all worn or damaged parts.
- (6) Reverse the above procedure to install.



## 3) REAR CHAIN (TF MAST)

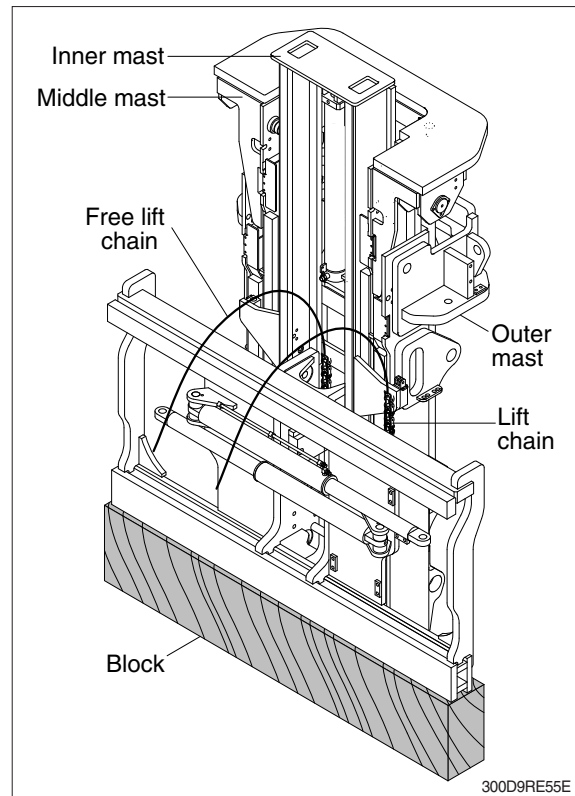
- (1) Remove the carriage assembly and move to one side. Refer to carriage removal and installation.
- (2) Raise and securely block truck approximately 150 mm (6") from the floor.
- (3) Using a sling or chain around inner mast section attached to an overhead hoist, slowly raise inner mast until there is enough slack in the chains to remove them. Block inner mast section.
- (4) Remove split pins and chain anchor pins securing chains to chain anchor (part of inner mast).
- (5) While supporting the chains, remove split and chain anchor pins securing chains to chain anchors attached to outer mast section.
- (6) Remove chains.
- (7) Reverse the above to assemble and install. Use new split pins in chain anchor pins. Refer to this section for Load chain lubrication and adjustment.





#### 4) CARRIAGE CHAIN

- (1) Place a sling around carriage front plate and attach to an overhead hoist. Lift and secure carriage high enough so that split pins and chain anchor pins on carriage can be easily be removed. Remove chain anchor pins from carriage and drape chains out over carriage.
- (2) Place a wooden block under the carriage and lower the carriage on the block.
- (3) While supporting the chains, remove split pins and chain anchor pins from chain anchors.
- (4) Remove chains and wash them with solvent. Refer to this section for Load chain inspection and maintenance.
- (5) Reverse the above procedure to assemble and install. Use new split pins in chain anchor pins.  
Refer to this section for Load chain lubrication and adjustment.



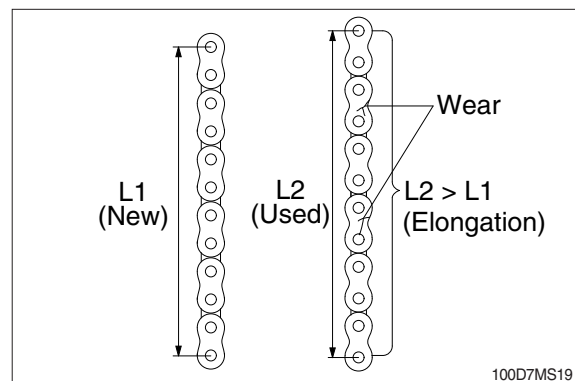
#### 5) LOAD CHAIN INSPECTION AND MAINTENANCE

After every 200 hours of truck operation, lift chains should be inspected and lubricated inspect for the following chain conditions :

##### (1) Wear

As the chain flexes on and off the sheaves, the joints very gradually wear. The stretch a chain develops in service is due to material being worn off pin outer diameter and pitch hole inner diameter on the inside plate.

Chain wear can be measured using a wear scale or steel tape. When chains have elongated 3%, they should be discarded. When checking chain wear, be sure to measure a segment of chain that operates over a sheave. Do not repair chains by cutting out the worn section and splicing in a new piece. If part of the chain is worn, replace all the chains on the truck.





## **(2) Rust and corrosion**

Chains used on lift trucks are highly stressed precision components. It is very important that the "as-manufactured ultimate strength and fatigue strength be maintained throughout the chain service life. Corrosion will cause a major reduction in the load-carrying capacity of lift chain or roller chain because corrosion causes side plate cracking.

## **(3) Cracked plate**

The most common cause of plate cracking is fatigue failure. Fatigue is a phenomenon that affects most metals and many plastics. After many repeated heavy loads, the plates may crack and the chains will eventually break. Fatigue cracks are almost always found through the pitch holes perpendicular to the pitch line. Contrast this failure mode to the random failures caused by stress-corrosion cracking. If cracks are present, replace all the chain on the truck. Noise in the chain indicates that the plate is on the verge of cracking and will be failed before long.

## **(4) Tight joints**

All joints in lift chain should flex freely. Tight joints resist flexure, increase internal friction, thus increasing chain tension required to lift a given load. Increased tension accelerates wear and fatigue problems.

Tight joints in lift chains can be caused by :

- Bent pins or plates.
- Rusty joints.
- Peened plate edges.

Oil rusty chains and replace chains with bent or peened components.

## **(5) Protruding or turned pins**

Heavily loaded chains operating with lube generate tremendous friction between pins and plates. In extreme cases, the frictional torque in the joint can actually turn pins in the press-fit outside plates. If chain is allowed to operate in this condition, the pins slowly work out of the chain causing chain failure. Turned pins can be quickly spotted because the flats on the V heads are no longer in line. Chains with turned or protruding pins should be replaced immediately. Do not attempt to repair the chain by driving pins back into the chain.

## **(6) Chain side wear**

A wear pattern on pin heads and outside plates indicates misalignment. This condition damages chain and sheaves as well as increasing internal friction in the chain system.

## **(7) Chain anchors and sheaves**

An inspection of the chain system includes a close examination of chain anchors and sheaves. Check chain anchors for wear, breakage and misalignment. Anchors with worn or broken fingers should be replaced. Anchors should be adjusted to eliminate twisting or other misalignment in the chain. When chain is misaligned, load is not distributed uniformly between the plates. Prolonged operation will result in premature fatigue failure. Sheaves with badly worn flanges and outside diameter should be replaced. Heavy flange wear indicates chain misalignment.

## **(8) Chain wear scale**

The chain can be checked for wear or stretching with the use of a chain wear scale. Stretching of a chain is due to the elongation of the pitch holes and wearing of the pin O.D. The greatest amount of stretching occurs at the areas of the chain that flex over the sheaves most frequently. Check the chain at this point with a scale. The wear scale has instructions printed on the sides for use in determining chain stretch and are as follows :

- Determine pitch length of chain using 6 inch scale on one side of wear scale.
- If pitch is 1/2 (12.7 mm), 3/4 (19.05 mm), 1 (25.4 mm), 1-1/2 (38.1 mm), 2 (50.8 mm), use side A of scale.
- If pitch is 5/8 (15.875 mm), 1-1/4 (31.75 mm) or 2 (50.8 mm), use side B.
- Align point A or B to center of a pin and note position of the opposite A or B point.
- If other point also lines up with a pin, the chain is worn and should be replaced.

If any of the above conditions exists (cracked plates, turned pins, stretching etc), the chains should be replaced in pairs as a complete assembly. Order chains by part number to insure the correct chain length, pitch and material specifications.

## **6) LOAD CHAIN LUBRICATION AND ADJUSTMENT**

### **(1) Lubrication**

The most important consideration in field maintenance of lift chains is lubrication. Hard working, heavily loaded chains cannot be expected to give satisfactory wear life without scheduled periodic re-lubrication. Like all bearing surfaces, the precision manufactured, hardened steel, joint-wearing surfaces require a film of oil between mating parts to prevent rapid wear. Oil must penetrate the chain joint to prevent wear. Applying oil to external surfaces will prevent rust, but oil must flow into the live bearing surfaces for maximum wear life. Frequency of re-lube will vary with operating conditions and environment, the best estimate of lube period is 200 hours. Trucks parked outdoors or trucks in extremely severe service, may require more frequent re-lube to maintain an oil film on all chain surface.

- Wipe off the old oil with a clean cloth and blow out the remaining dirt with compressed air.

#### **▲ Wear eye protection.**

- With a clean brush, apply EP-140 extreme pressure lubricant or heavy motor oil (40W).

### **(2) Replacement**

Replace chains as a pair. It will be virtually impossible to maintain uniform loading between the strands if a new chain is put into service opposite an old chain. The joints in the old chain will be greater than that on the new chain, greatly complicating the problem of maintaining equal chain tension. The new chain will wear more slowly causing it to bear the major portion of the load resulting in premature wear and fatigue failure. Don't steam clean or decrease new chains.

The manufacturer's grease is effective in reducing wear and corrosion. If the original factory lube is dried out or wiped off, soak the new chain in heavy engine oil for at 1/2 hour prior to installing on truck. After the old chains have been stripped from the mast, very carefully inspect chain anchors and sheaves. Broken, cracked or worn anchor must be replaced using the new anchor pin and split pin. Do not paint newly replaced chain after it has been installed.

### **(3) Adjustment**

Chain adjustments are important for the following reasons :

- Equal loading of chain.
- Proper sequencing of mast.
- Prevent over-stretching of chains.
- Prevent chains from jumping off sheaves if they are too loose.

### **(4) Adjustment procedure**

- With mast in its fully collapsed and vertical position, lower the fork to the floor.
- Adjust the chain length by loosening or tightening nut on the chain anchor.
- After making adjustment on the mast, be sure to tighten the nut.