

SERVICE MANUAL

40/45HR MS/MT
Standard and Triple Stage
Pantograph Mast and Pantograph

FOR PARTS AND SERVICE:
TELEPHONE: (888) 946-3330

Manual Number 246552 R2



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1.1 Introduction

This manual provides the installation Instructions, periodic maintenance requirements, troubleshooting and service procedures for the Lift Tek Series masts.

These masts provide excellent visibility for the lift truck driver. The mast carriage and upright channels are all roller-mounted which provides smooth operation and long service life.

In any communication about the mast, refer to the mast serial number stamped in the nameplate. If the nameplate is missing, these numbers are also stamped on the left-hand lower outer rail. See Figure 1.

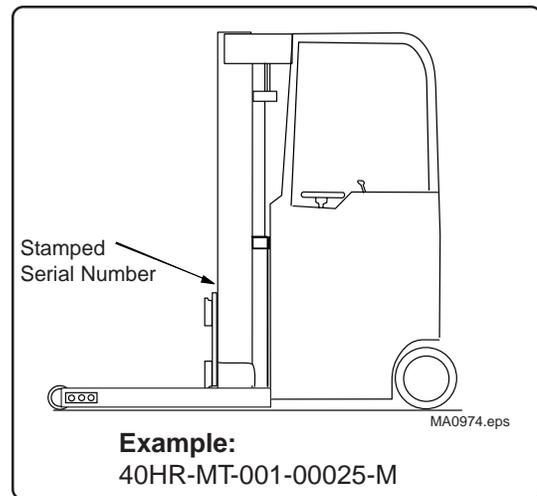


Figure 4A. Serial Mast Number Location

1.2 Special Definitions

⚠ WARNING

A statement preceded by **⚠ WARNING** is information that should be acted upon to prevent **bodily injury**. A **WARNING** is always inside a ruled box.

CAUTION

A statement preceded by **CAUTION** is information that should be acted upon to prevent **machine damage**.

IMPORTANT

A statement preceded by **IMPORTANT** that possesses special significance.

NOTE

A statement preceded by **NOTE** is information that is handy

2.1 Truck System Requirements



WARNING: For proper truck stability or to prevent interference, tilt restriction may be required. Contact the truck manufacturer.

IMPORTANT: Lift Tek Masts are compatible with SAE 10W petroleum base oil per Mil. Spec. MIL-0-5606 or MIL-0-2104 B only. Use of synthetic or aqueous base hydraulic oil is not recommended. If fire resistant hydraulic oil must be used, contact Lift Tek.

2.2 Mounting Bracket Installation

If it is necessary to install mounting brackets and crossmembers to fit your lift truck, consult with the nearest Lift Tek Service Department listed on the back cover. You must supply dimensions **A** through **F** shown in Figure 5A. Failure to install the correct brackets and crossmembers can result in mast structural failure, bodily injury and loss of warranty.



WARNING: Failure to install the correct brackets and crossmembers can result in mast structural failure, bodily injury and loss of warranty.

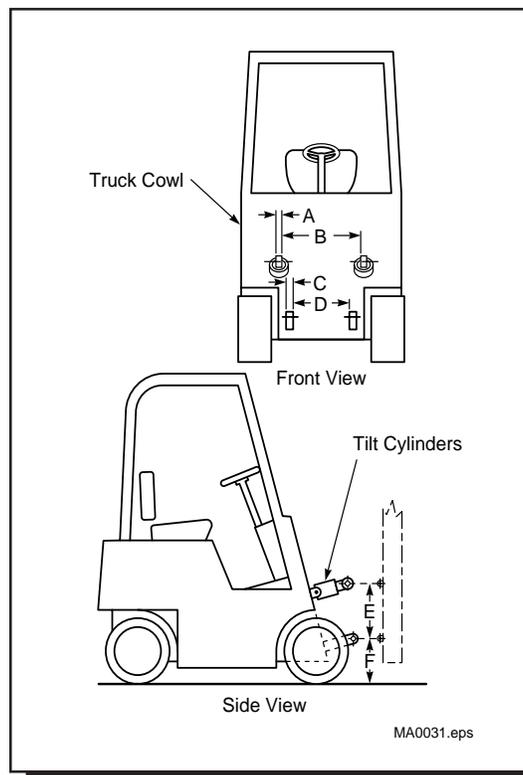


Figure 5A. Determining Mounting Bracket Location.

2.3 Mast Installation

1. Raise and block the front end of the truck 1ft. (30 cm) per ANSI B56.1 or drive the truck over a service pit.
2. Disconnect the truck power supply.
3. Lift the mast using an overhead hoist with a sling looped under the upper upright crossmembers. Position the mast on the truck. Install the mounting blocks and capscrews. Tighten the capscrews to the truck manufacturer's torque specifications.
4. Connect the lift truck hydraulic supply hose to the mast valve.

NOTE: Use as few fittings as possible and always use 45° fittings instead of 90° fittings. Keep the hose lengths to a minimum. Avoid sharp bends or pinch points when routing the hose.

5. Connect the truck power supply.
6. Check the hydraulic fluid level in the truck hydraulic tank when the Mast is fully lower. Fill if required.

Contact Lift Tek if additional fittings are required. See back cover.

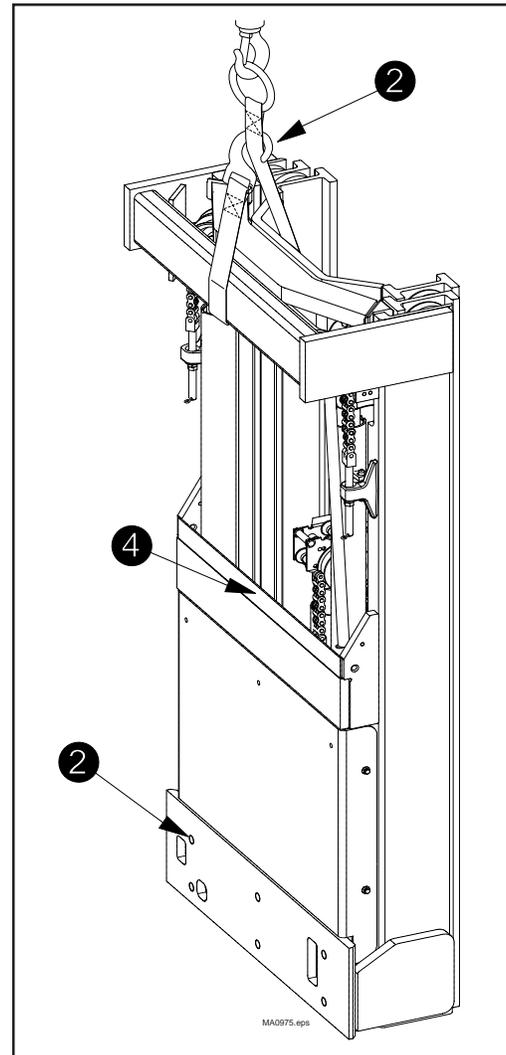


Figure 6A. Mast Installation.

2.4 Mast Inspection

Check each of the following before using the Mast for the first time.

CAUTION: The factory-set adjustments may not be correct for your truck.

1. Inspect all chains for lubrication.
2. Inspect all chains for any visible damage.
3. Inspect the main lift chain adjustment for proper tension and upright position.
4. Inspect the free lift chain adjustment for proper tension and carriage position.
5. Inspect for lubrication in the Mast upright channels.
6. Check for Mast skewing.

2.4-1 Chain Lubrication

The main and free lift chains have been factory lubricated using heat and pressure to force the lubrication thoroughly into the chain links. Avoid removal or contamination of this factory-applied lubrication. **Do not wash, sand blast, etch, steam clean, or paint the chains for initial Mast installation.** If chains need lubrication, refer to Section 5.3-4. **Chain Service**

2.4-2 Upright and Carriage Position, Chain Tension

The main lift chains should be adjusted so that when the unloaded Mast is fully lowered, the uprights are flush at the bottom. The free lift chains should be adjusted so that when the unloaded Mast is fully lowered, the carriage is properly positioned depending on the truck type.

CONTINUED ON PAGE 8

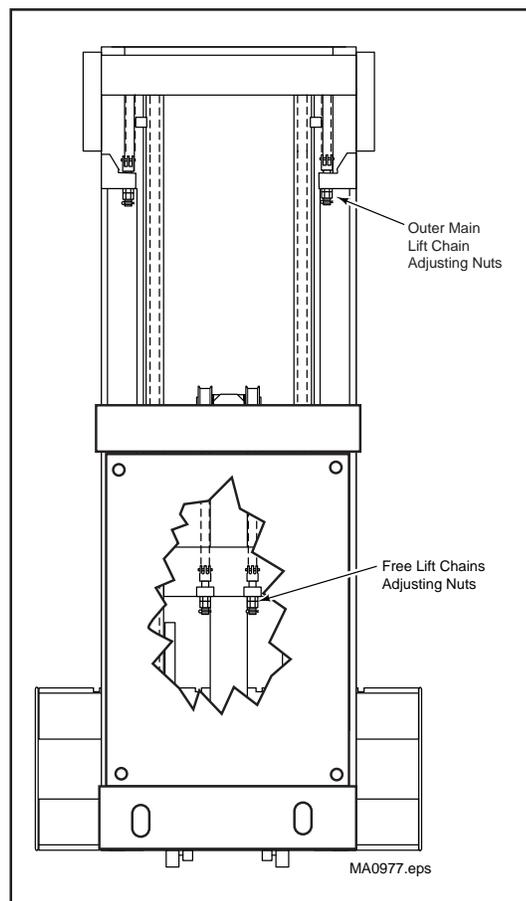


Figure 7A. Adjusting Chain Anchor Location (driver's view).

2.4-2 Upright and Carriage Position, Chain Tension

(Continued)

All chains should also be adjusted for equal tension of the pairs to ensure proper load distribution and mast operation. Chains are adjusted at the chain anchors (see Figure 8A). To determine equal tension, extend the unloaded mast to put the chains under tension. Then press the center of the strand with your thumb. Then press at the same place on the other chain of the pair. Each chain in a pair should have equal “give”.

If the uprights or carriage are not in correct adjustment, or if the chain pairs do not have equal tension, perform the **Main Lift and Free Lift Chain Adjustments** as described on page 25.

2.4-3 Channel Lubrication

Inspect the upright channels for lubrication. If necessary, lubricate the full length of each upright channel with chassis lube or Kendall SR-12X (see Figure 8B).

2.4-4 Mast Skewing

To adjust the Mast to eliminate skewing, perform the **Mast Skewing Adjustment** as described below.

Extend the mast to full lift height and inspect for mast skewing (see Figure 8C).

* If the mast bends to the right at full extension, a shim(s) needs to be removed from the left main lift cylinder rod.

* If the mast bends to the left at full extension, a shim(s) needs to be installed on the left main lift cylinder rod.

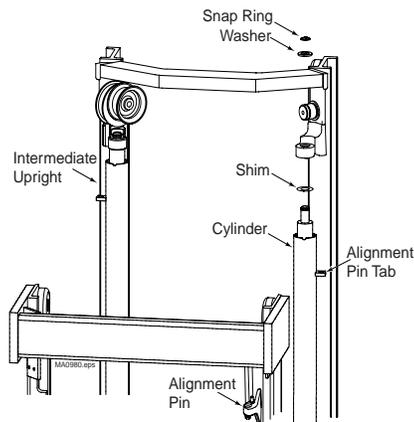


Figure 8A. Shimming ML cylinders.

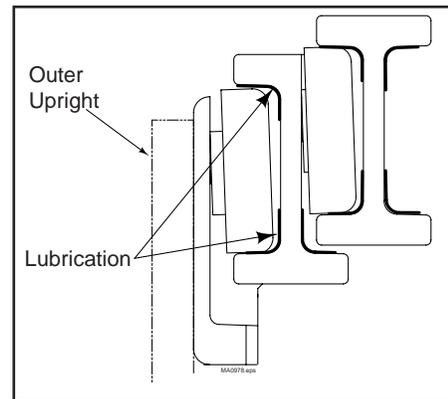


Figure 8B. Lubricating upright channels.

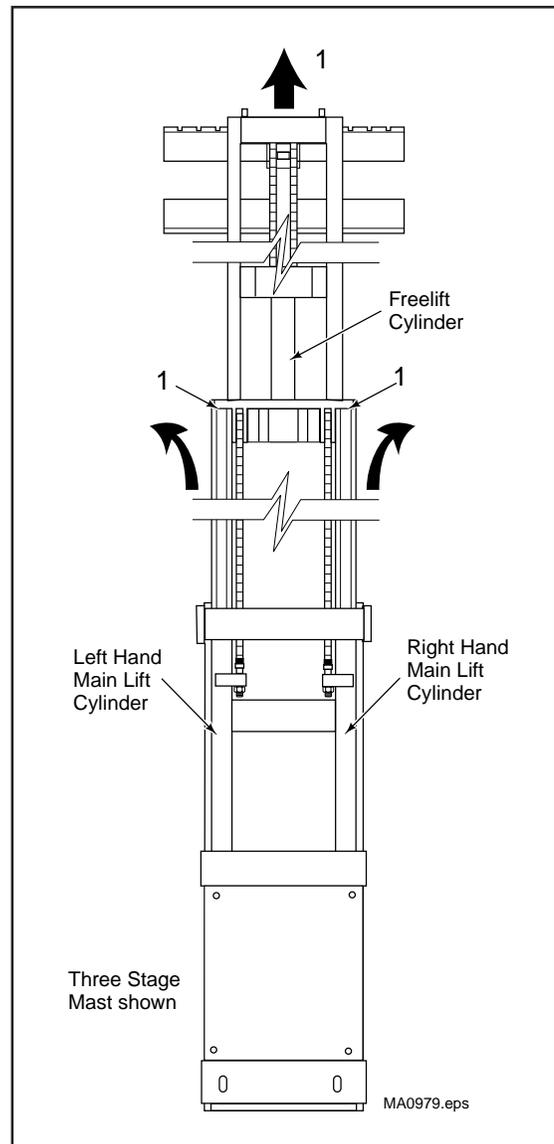


Figure 8C. Extending Mast to check for skewing (driver's view).

3.1 Periodic Maintenance

For proper operation and an extended service life, the Mast should be inspected and serviced regularly as part of your normal lift truck maintenance schedule according to the following outlines and ANSI B56.1 procedures.

The recommended intervals are for Masts operating under normal conditions. If operation is in severe conditions or corrosive atmospheres, inspect the Mast more frequently,



WARNING: Never work on a raised mast with a load without supports, or while anyone is near the lift truck control handles per ANSI B56.1.

3.1-1 Daily Inspection

Perform the following at the beginning of each work shift:

1. Check cylinder rods and glands for obvious damage, nicks, marring, scratches that might damage the cylinder packings. Check the condition of hydraulic plumbing and connections. Tighten connections if loose.
2. Check lift chains for damage.
3. Check the chain anchor pins. Be sure the cotter pins (6) are in place and not damaged.
4. Examine the hydraulic plumbing and connections. Tighten loose connections.
5. Check harness hold-down clamps, brackets, and connectors for security of mounting and damage.

3.1-2 100 - Hour Inspection

After each 100 hours of lift truck operation, and in addition to the Daily inspection:

1. Inspect and lubricate the full length of the chains with SAE 40 wt. oil or Bowman Heavy Load Red Grease.

CAUTION: The chains must be coated with a film of lubricant at all times.

3.1-3 200 - Hour Inspection

1. Clean and lubricate pantograph assembly.
2. Inspect and lubricate the full length of the chains with SAE 40 wt. oil or Bowman Heavy Load Red Grease.

CAUTION: The chains must be coated with a film of lubricant at all times.

3. Lubricate the full length of each mast upright rail.

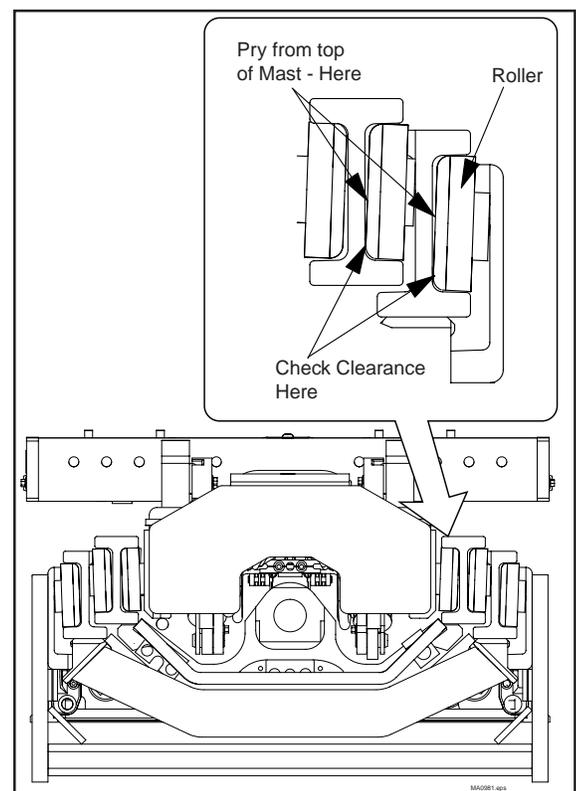


Figure 9A. Measuring Load Roller and Thrust Plug Clearances.

3.1-4 **500 - Hour Inspection**

After each 500 hours of lift truck operation, and in addition to the Daily and 100 - Hour Inspections:

1. Measure load roller clearances in the carriage/pantograph and Mast uprights. Pry between the upright and load roller so that the opposite load roller is tight against the upright (see Figure 9). Total side-to-side clearance should be 0.020 in. (.5 mm) max. across the tightest point throughout the travel of the upright. If shimming is required.
2. Check chains for wear and stretch.
3. Check the backrest capscrews for tightness. Tighten capscrews to 145 ft.-lbs. (195 Nm).

4.1 Troubleshooting Chart

The Following Table lists problems that may be encountered on your Mast, the probable causes, and the recommended corrective action that should be taken to restore the Mast to normal operating condition.

| PROBLEM | PROBABLE CAUSE | SOLUTION |
|--------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Cylinders don't lift load or won't move Empty | a) Plugged inlet hose | a) Unplug hose or replace. |
| | b) Insufficient oil. | b) Check the truck hydraulic system for correct oil level in tank, defective pump or pump drive, leaks in the lines or disconnect control valve linkage. Repair or replace as necessary. |
| | c) Bent or jammed plunger. | c) Repair or replace as necessary. |
| Loaded | ⚠ WARNING: Extreme care should be used when working on a unit when the carriage (with or without a load) is in the raised position. | |
| | a) Plugged piston check valve. | a) Unplug check valve or replace. |
| | b) Truck relief valve setting low. | b) Raise truck relief setting to specified level |
| | c) Over capacity. | c) Reduce load to specified capacity. |
| | d) Mechanical bind due to bent plunger or bad rollers. | d) Remove mechanical bind by replacing/freeing plunger and rollers. |
| ⚠ WARNING: Extreme care should be used when working on a unit when the carriage (with or without a load) is in the raised position. | | |
| Cylinders drift- | a) External leak in pressure line. | a) Tighten or replace as necessary. |
| | b) Truck valve defective-cycle to full lift height to verify. | b) Repair or replace truck valve. |
| | c) External leaks at retainer. | c) Replace all cylinder seals. |
| | d) Piston check valve leaking. | d) Replace check valve. |
| Spongy or jerky action- | a) Sticky or defective truck relief valve. | a) remove and check the truck relief valve. If contaminated oil caused the malfunction, drain and flush the system, change the filter and refill with fresh oil. |
| | ⚠ WARNING: Extreme care should be used when working on a unit when the carriage (with or without a load) is in the raised position. | |
| | b) Bent or damaged cylinder plunger. | b) Disassemble, check and repair cylinder assembly. |
| | ⚠ WARNING: Extreme care should be used when working on a unit when the carriage (with or without a load) is in the raised position. | |
| | c) Load rollers not properly adjusted or defective. | c) Adjust or repair as necessary. |
| | ⚠ WARNING: Extreme care should be used when working on a unit when the carriage (with or without a load) is in the raised position. | |
| | d) Mast channels improperly lubricated. | d) Lubricate mast. |
| | ⚠ WARNING: Extreme care should be used when working on a unit when the carriage (with or without a load) is in the raised position. | |
| | e) Low Battery charge. | e) Charge battery. |
| | f) Low pump volume. | f) Install accumulator. |
| g) Low oil level. | g) Fill oil reservoir. | |
| h) Insufficient hydraulic tank capacity or baffles. | h) Install larger tank baffles | |
| Other. | Contact Lift Technologies | |

5.1 Mast Removal

See Section 5.4

It is recommended that the pantograph carriage assembly be removed before attempting to remove the uprights.

5.2 **Cylinders**

5.2-1 **Main Lift Cylinder Description**

The main lift cylinders (see Figure 10) are single stage displacement type cylinders consisting of a shell and a telescoping plunger/piston assembly. During extension hydraulic pressure is acting against the plunger outer diameter due to the internal porting through the piston. The piston seals do not affect cylinder extension. The truck hoist control valve holds the cylinders in place once extension has stopped.

The shell is internally threaded at the top end to hold the retainer. The retainer seals provide a high-pressure hydraulic seal against the plunger. The retainer also limits the upward stroke of the plunger.

A piston is attached to the bottom end of the plunger. The piston seal provides a high-pressure hydraulic seal against the shell that engages the cushion valve when the cylinder is fully lowered.

A hydraulic fuse/cushion valve is located in the left hand cylinder's inlet port. In case of a hose failure between the lowering control valve and the cylinders, the fuse limits the lowering speed of the cylinder. The valve also cushions the piston when the cylinder nears the fully lowered position.

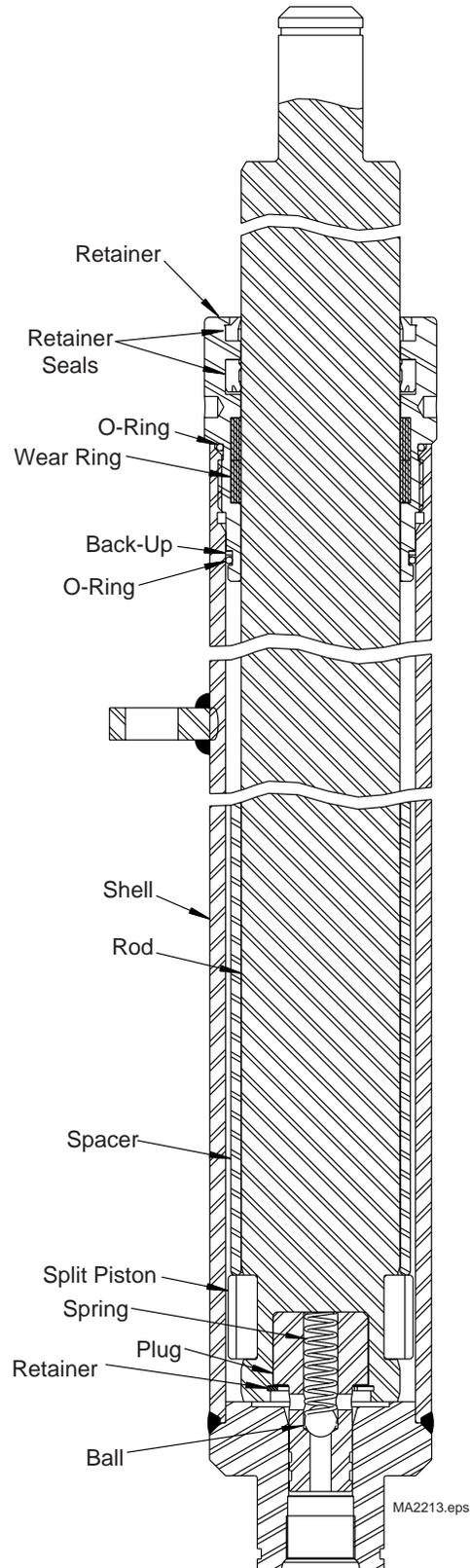
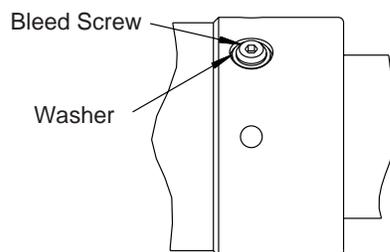


Figure 13A. Main Lift Cylinders.

5.2-2 Free Lift Cylinder Description

The free lift cylinder (see Figure 14A) is a single stage piston type cylinder consisting of a shell and plunger/piston assembly. During extension hydraulic pressure is acting against the fill piston area. The truck hoist control valve holds the cylinder in place once extension has stopped.

The shell is internally threaded at the top end to hold the retainer. The retainer seals provide a high-pressure hydraulic seal against the plunger. The retainer also limits the upward stroke of the plunger.

A piston is attached to the bottom end of the plunger. The piston seal provides a high-pressure seal against the shell. A check valve located in the bottom of the piston allows residual oil between the shell and plunger to escape when the cylinder is extending.

A hydraulic fuse/cushion valve is located in the cylinder inlet port. In case of hose failure between the lowering control valve and the cylinder, the fuse limits the lowering speed of the cylinder.

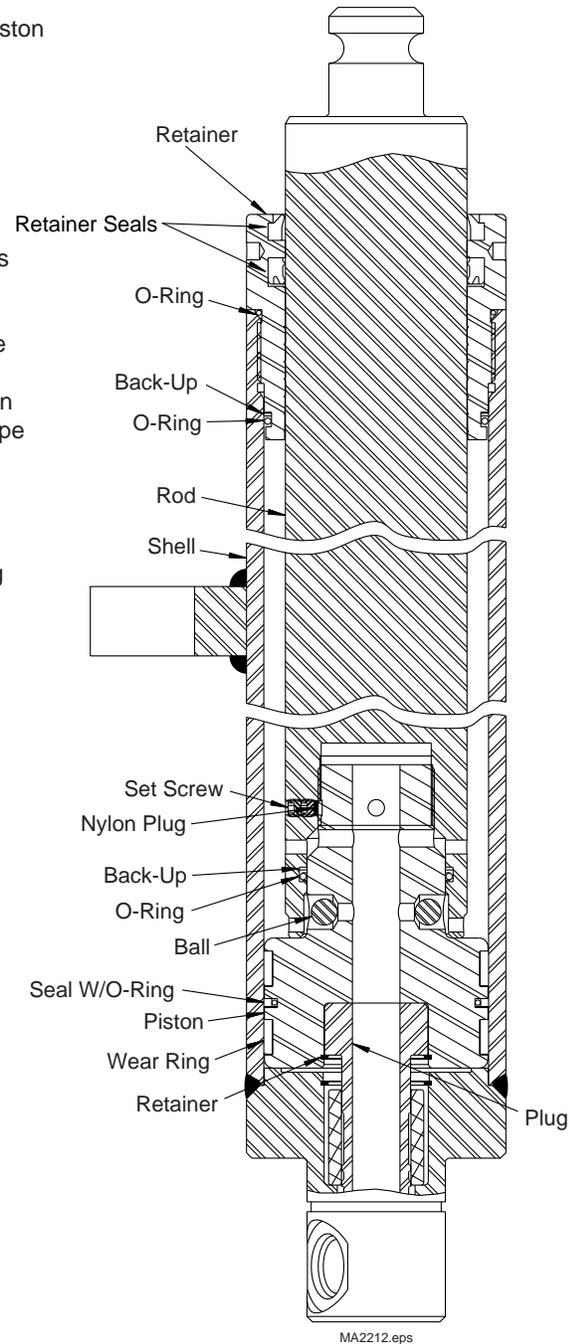


Figure 14A. Free Lift Cylinder.

5.2-3 Cylinder Operation

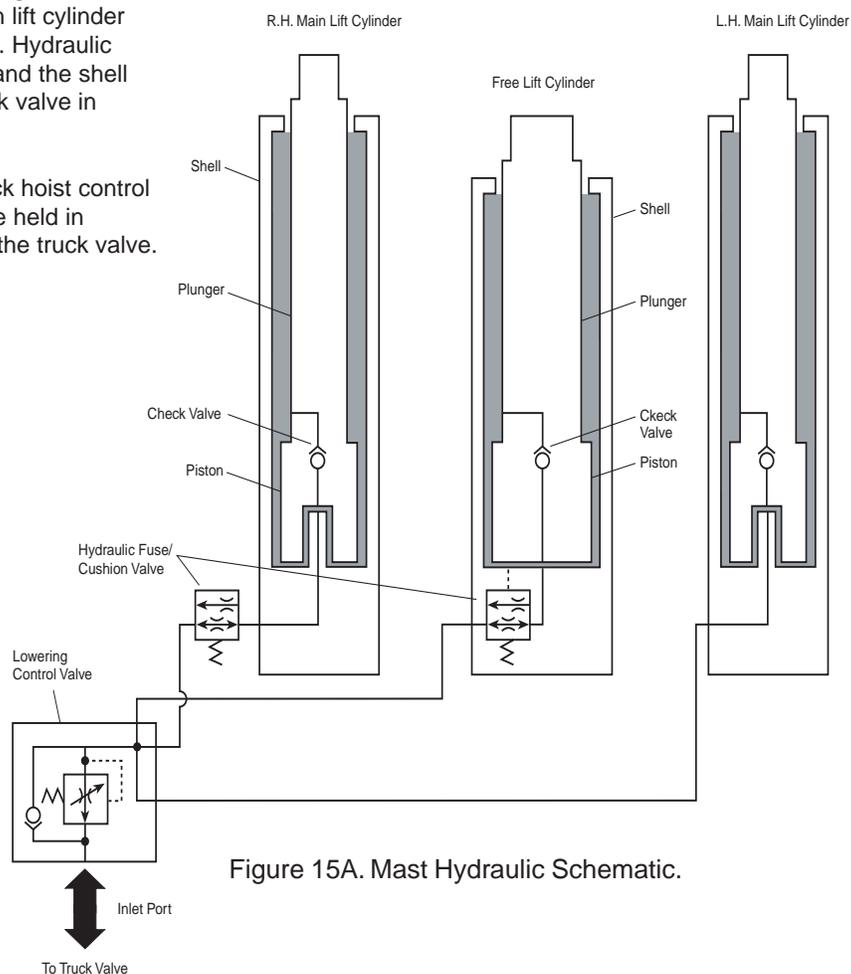
Cylinder Raising

1. Actuating the truck hoist control valve to raise causes hydraulic fluid to enter the lowering control valve through the inlet port where it flows unrestricted through the lowering control cartridge.
2. Hydraulic fluid flows to the cylinder inlet ports. Due to the larger bore diameter of the free lift cylinder compared to both main lift cylinders, the free lift cylinders raise first.
3. Hydraulic fluid flows through the free lift cylinder hydraulic fuse/cushion valve to the bottom of the piston. Lifting force is created against the bottom of the piston causing the plunger to raise. Hydraulic fluid in the areas between the plunger and the shell is allowed to escape through the Check valve in the piston as the plunger raises to the end of its stroke.
4. Hydraulic fluid flows through the hydraulic fuse/ cushion valve to the bottom of the pistons as the free lift cylinder has fully extended, lifting force is created against the bottom of the main lift cylinder pistons causing their plungers to raise. Hydraulic fluid in the area between the plunger and the shell is allowed to escape through the check valve in the piston as the plunger raises.
5. When hydraulic fluid flow from the truck hoist control valve is discontinued, the cylinders are held in position by the closed center spool of the truck valve.

Cylinder Lowering

1. Actuating the truck hoist control valve to lower the mast causes the main lift cylinder plungers then free lift cylinder plunger to lower, forcing hydraulic fluid out through the hydraulic fuse/cushion valves.
- Note:** The restriction setting of each hydraulic fuse is lower (allows more flow) than the setting of the lowering control valve. The hydraulic fuses restrict flow only during failure of a lowering control valve or hose.
2. Hydraulic fluid flows to the lowering control valve where it is restricted at a controlled speed determined by the load being handled.
 3. As the main lift cylinder pistons lower over the spear in the bottom of the shell, a high pressure area is developed between the piston and the shell which engages the cushion valve to restrict flow. This allows the plunger/piston just prior to bottoming, providing a smooth transition to free lift cylinder lowering.

Triple Mast (MT) Hydraulic Schematic



5.2-4 Main Lift Cylinder Service

Main Lift Cylinder Disassembly

1. Wash the exterior surface of the cylinder thoroughly before disassembling.
 - *A soft fiber brush should be used to remove debris and foreign objects from grooves and threaded areas, etc.
 - *A Stoddard type cleaning solvent should be used to wash the cylinder.
2. Place retainer end of cylinder in a vise equipped with soft jaws. Do not over tighten.
3. Using a spanner wrench or a bronze (brass) drift, remove the retainer assembly from the cylinder barrel.
 - *Remove back-up ring and O-Ring from cylinder retainer.
 - *Remove rod wiper and seal from cylinder retainer.
4. Pull piston rod from barrel assembly.
 - *Remove spacer and split piston from piston rod.
5. Remove snap ring, retaining washer, plunger, ball and spring from base end of piston rod.

Cleaning and Inspection

1. Discard old seals, O-Rings, back-up rings, wiper and lock washer.
2. Wash remaining parts in a stoddard type cleaning solvent and dry with a clean shop rag.
3. Inspection threaded parts for damage.
4. Examine the piston rod, inner surfaces of the retainer assembly and cylinder barrel for scoring, nicks or scratches. A crocus cloth may be used to clean up light scratches, etc.. *Be careful no to remove the chrome plating when polishing surfaces.*

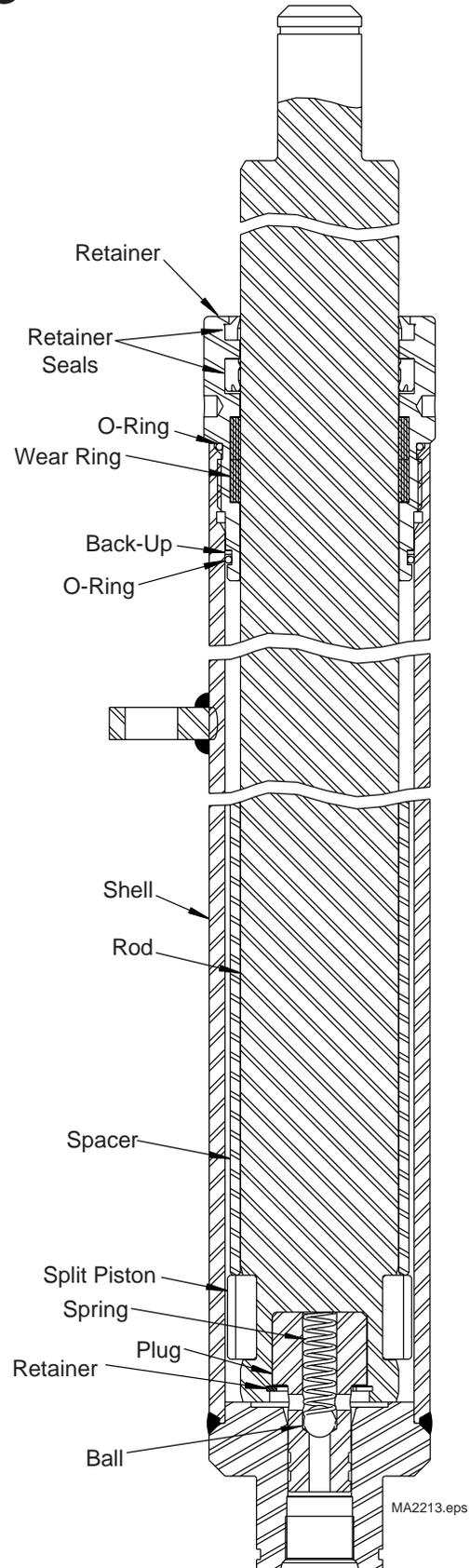


Figure 16A

Main Lift Cylinder Reassembly

Piston Rod and Piston

1. Lubricate all parts with clean hydraulic fluid.
2. Lubricate and install the spring, plunger, washer, snap ring and ball into base end of the piston rod.
Refer to Figure 16A.
3. Lubricate and install spacer onto the piston rod.
Refer to Figure 16A.
4. Now, lubricate and place split piston onto the piston rod. Start piston rod into cylinder barrel and gently push rod inward until it bottoms out.
Be careful no to nick or scratch the chrome surfaces.

Retainer / Retainer Assembly

1. Lubricate new seals, wiper ring and retainer assembly with clean hydraulic fluid.
2. Install the inner seal into the retainer groove. Be certain the **sealing lip** faces inward. Use a seal installation tool for best results. *Be careful not to nick or scratch the chrome surfaces.*
3. Install a new wiper ring into the retainer.
4. Lubricate and install a new O-Ring and back-up ring into the outer groove on the retainer. Install lock washer on outside of retainer.

NOTE

Placing a plastic parts bag over the retainer threads when installing the O-Ring and back-up ring will help protect parts against damage, cutting, etc.

5. Carefully start the retainer assembly over the piston rod and screw it into the barrel finger tight.
Do not cut or nick sealing lips upon installation.
6. Using a spanner, tighten the retainer against the shell assembly.

5.2-5 Free Lift Cylinder Service

Free Lift Cylinder Disassembly

1. Wash the exterior surface of the cylinder thoroughly before disassembly

*A soft fiber brush should be used to remove debris and foreign objects from grooves and threaded areas, etc.

*A stoddard type cleaning solvent should be used to wash the cylinder.

2. Place retainer end of cylinder in a vise equipped with soft jaws. Do not over tighten vise.

3. Using a spanner wrench or a bronze (brass) drift, remove retainer assembly from cylinder barrel.

4. Remove and discard lock washer, back-up ring and O-Ring located inside cylinder retainer.

5. Remove and discard both O-Rings and back-up ring located on the outside of the cylinder retainer.

6. Pull piston rod from barrel assembly.

7. Remove wear ring (ring bearing) from piston rod.

Cleaning and Inspection

1. Discard old seals, O-Rings, back-up rings, wiper and lock washer

2. Wash remaining parts in a Stoddard type cleaning solvent and dry with a clean shop rag.

3. Inspect threaded parts for damage.

4. Examine the piston rod, inner surfaces of the retainer assembly and cylinder barrel for scoring, nicks or scratches. A crocus cloth may be used to clean up light scratches, etc.. *Be careful that you do not remove the chrome plating when polishing surfaces.*

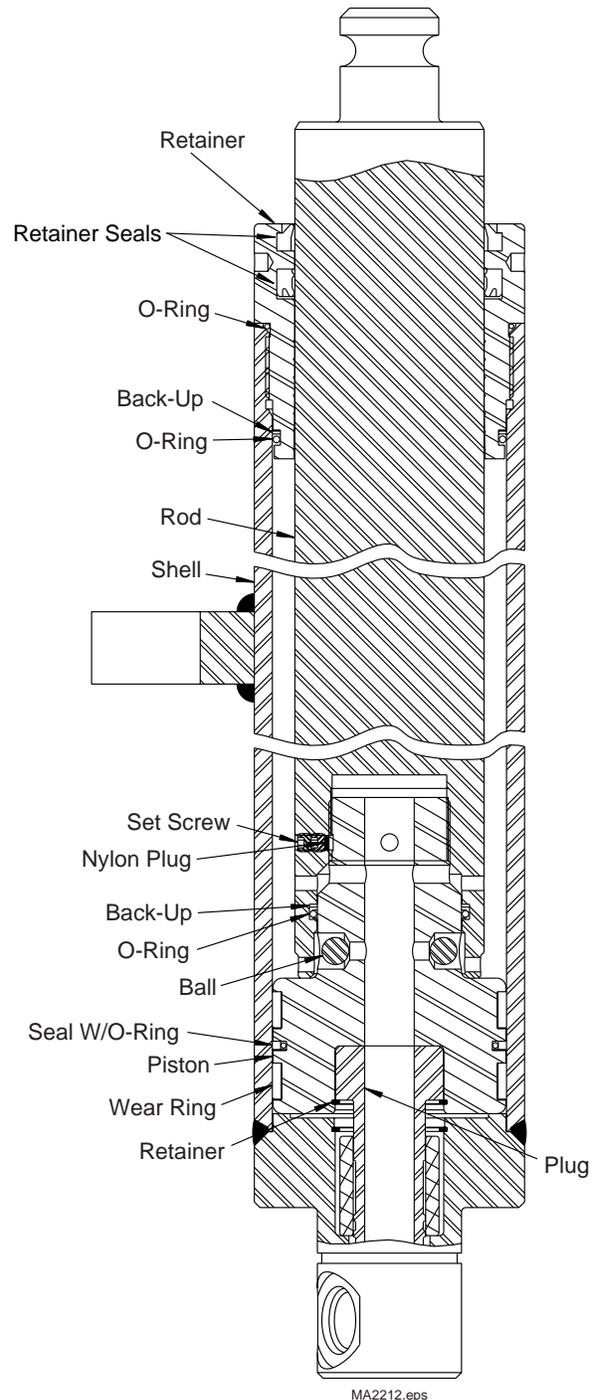


Figure 18A

5.2-5 Reassembly**Piston Rod and Piston**

1. Lubricate all parts with clean hydraulic fluid.
2. Lubricate and install wear ring onto the piston rod. Refer to figure 18A.
3. Now, start piston rod into cylinder barrel and gently push rod inward until it bottoms out. *Be careful that you do not nick or scratch chrome surface.*

Retainer Assembly

1. Lubricate new seals, O-rings, back-up rings, wiper ring and retainer assembly with clean hydraulic fluid.
2. Install back-up ring and the inner seal into the retainer groove. Be certain the **sealing lip** faces inward. Use a seal installation tool. *Be careful that you do not cut or nick the sealing lip upon installation.*
3. Lubricate and install (large) O-Ring into the outer groove nearest to end of retainer.

NOTE

Placing a plastic parts bag over the retainer threads when installing the O-Rings and back-up rings will help protect parts against damage, cutting, etc..

4. Next, lubricate and install a new back-up ring and O-Ring into the outer groove at the base end of the retainer.
5. Install a new wiper into the retainer.
6. Now, carefully place the retainer assembly over the piston rod and after applying lube to threads, screw it into the barrel finger tight. *Do not cut or nick sealing lip(s) upon installation.*
7. Using a spanner wrench, tighten retainer against barrel assembly.
8. Next, using drift as shown in opposite illustration, deform lock washer into groves provided in both the retainer and barrel to securely lock them together.

5.3 Mast Uprights

5.3-1 Upright Description

Outer Upright Assembly

The outer upright assembly is mounted to the truck. A pair of shim adjustable load rollers are attached to stub shafts located near the top of the upright. A pair of adjustable hoist chain anchors are located in the top crossmember. The secondary cylinders rest on an integral lower crossmember.

Intermediate Upright Assembly

The intermediate upright assembly telescopes within the outer upright assembly. A pair of shim adjustable load rollers are attached to stub shafts located at the top and bottom of the upright. A pair of chain sheaves are located near the top of the upright to provide a rolling surface for the main lift chains.

Inner Upright Assembly

The inner upright assembly telescopes within the intermediate upright assembly. A pair of shim adjustable load rollers are attached to stub shafts located at the bottom of the upright. The free lift chain anchors are attached to the center crossmember. The free lift cylinder rests on a cradle which is integral with the lower crossmember.

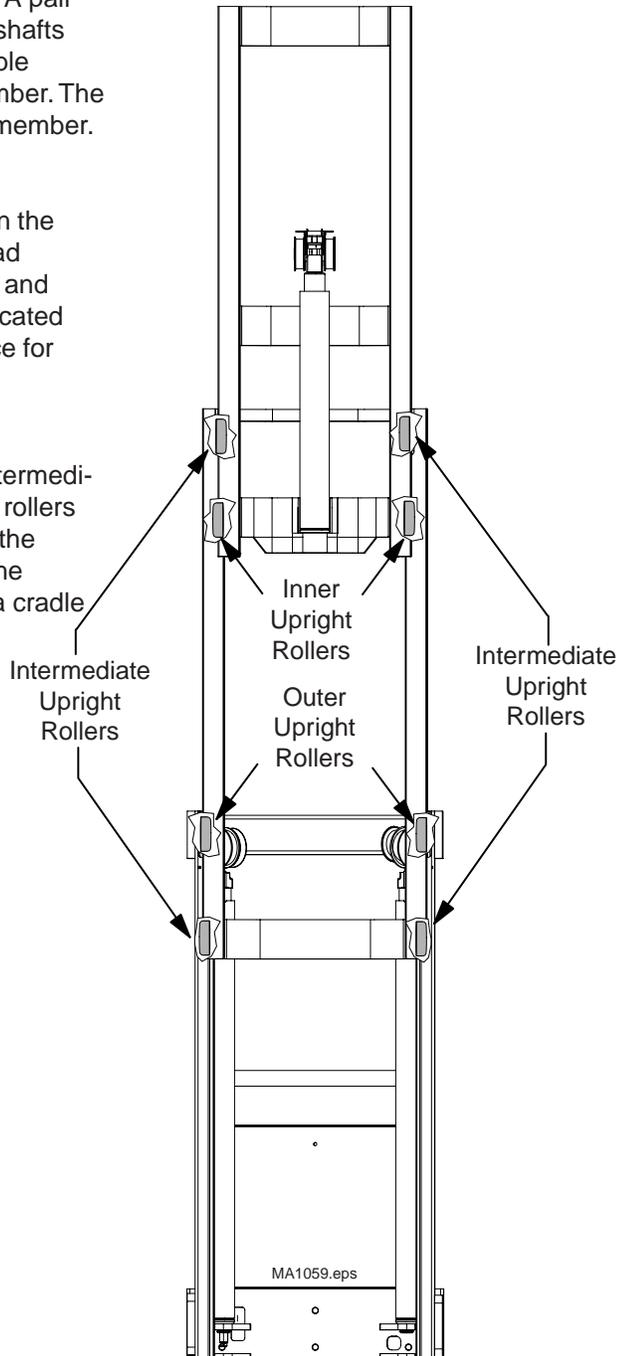
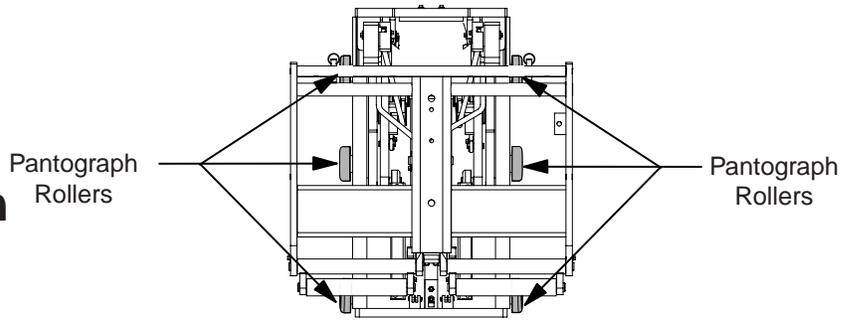


Figure 20A

5.3-2 Upright Chain Inspection

Each 50-250 hours of operation (more frequently in severe or extreme environments), chains should be inspected and lubricated. Inspection should involve the following:

Elongation

When a length of 12.00 inches (305 mm) of a new chain has elongated to a length of 12.360 inches (315 mm), it should be discarded and replaced. It is important to measure the chain in the section that moves over the sheaves because it receives the most frequent articulation. Measuring the chain near its clevis terminals could give an erroneous reading as it would not have flexed as frequently, if indeed at all, as nearer the middle of the assembly. See figure 23.

Chains should be replaced when wear exceeds 3% of the pitch or when 12 inches (305 mm) of chain is stretched 3.8 inch (10 mm).

Edge Wear

Check the chain for wear on the link plate edges caused by running back and forth over the sheave. The maximum reduction of the material should not exceed 5%. This can be compared to a normal link plate height by measuring a portion of chain that does not run over the sheave. Distorted or battered plates on the leaf chain can cause tight joints and prevent flexing. See figure 21A.

Worn contours and worn surfaces on the outside links or pin heads should not exceed 5% of new height.

Turning or Protruding Pins

Highly loaded chain operated with inadequate lubrication can generate abnormal friction forces between pin and link plates. In extreme instances, the torque could surpass the press fit force between the pins and the outside plates, resulting in pin rotation. When chain is allowed to operate in this condition, a pin, or series of pins, can begin to twist out of the chain resulting in failure. The pin head rivets should be examined to determine if the "VEE" flats are still in correct alignment. Chains with rotated/displaced heads or abnormal protrusion should be replaced immediately. Do not attempt to repair the chain by welding or driving the pin(s) back into the chain. Once the press fit integrity between outside plates and pins has been altered, it cannot be restored. Any wear pattern on the pin heads or the sides of the link plates indicates misalignment in the system. This condition damages the chain and increases frictional loading, and should be corrected. See Figure 23.

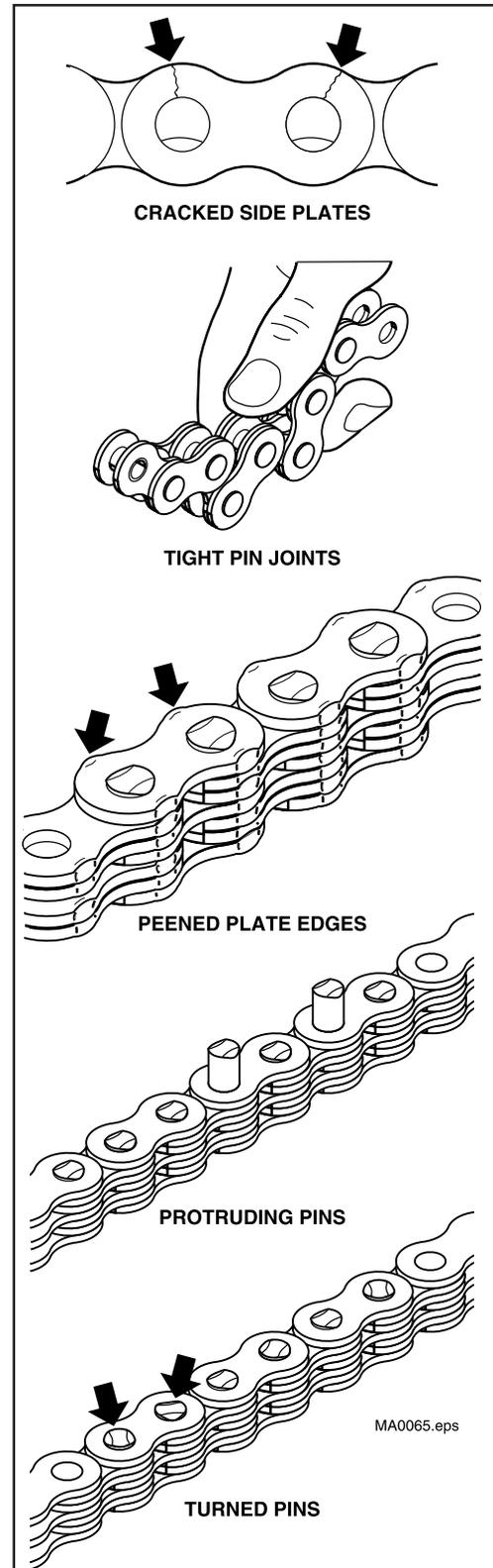


Figure 21A

5.3-2 Upright Chain Inspection (Continued)

Cracked Plates

The chains should be periodically inspected very carefully, front and back as well as side to side, for any evidence of cracked plates. If any one crack is discovered, the chain(s) should be replaced. It is important, however, to determine the causes of the crack before installing new chain so the condition does not repeat itself.

Fatigue Cracking - Fatigue cracks are a result of repeated cyclic loading beyond the chains endurance limit. The magnitude of the load and frequency of its occurrence are factors which determine when fatigue failure will occur. The loading can be continuous or intermittent (impulse load).

Fatigue cracks almost always start at the link plate pin hole (point of highest stress) and are perpendicular to the chain pitch line. They are often microscopic in their early stage. Unlike a pure tensile failure, there is no noticeable yielding (stretch) of the material.

Stress-Corrosion Cracking - The outside link plates which are heavily press fitted to the pins, are particularly susceptible to stress corrosion cracking. Like cracks, these initiate at the point of highest stress (pin hole) but tend to extend in an arch-like pattern between the holes on the plate.

More than one crack can often appear on a link plate. In addition to rusting, this condition can be caused by exposure to an acidic or caustic medium or atmosphere.

Stress corrosion is an environmentally assisted failure. Two conditions must be present: a corrosive agent and static stress. In the chain, static stress is present at the pin hole due to the press fit pin. No cycle motion is required, and the plates can crack during idle periods. The reaction of many chemical agents (such as battery acid fumes) with hardened steel can liberate hydrogen which attacks and weakens the steel grain structure.

For this same reason, never attempt to electroplate a leaf chain or its components. The plating process liberates hydrogen and hydrogen embrittlement cracks will appear. These are similar in appearance to stress corrosion cracks.

If a plated chain is required, consult Lift-Tek. Plated chains are assembled from modified, individually plated components which may reduce the chain rating.

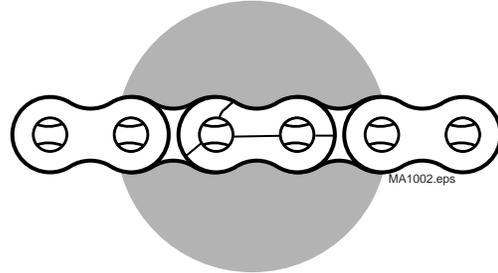


Figure 22A. Arc-Like Cracks in plate are a sign of stress corrosion.

Corrosion Fatigue - Corrosion fatigue cracks are very similar (in many cases identical) to normal fatigue cracks in appearance. They generally begin at the pin hole and move perpendicular (90°) to the chain pitch line.

Corrosion fatigue is not the same as stress corrosion. Corrosion fatigue is the combined action of an aggressive environment and a cyclic stress (not a static stress alone, as in stress corrosion).

Ultimate Strength Failure

This type of failure is caused by overloads far in excess of the design load. See Figure 22B.

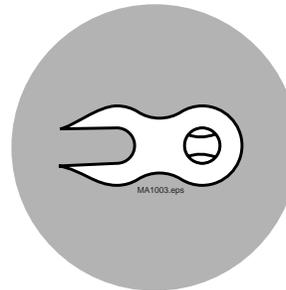


Figure 22B

Tight Joints

All joints in leaf chain should flex freely. Tight joints resist flexure and increase internal friction, thus increasing chain tension required to fit a given load. Increased tension accelerated wear and fatigue problems. See figure 21A.

5.3-3 Chain Length Adjustment

**WARNING:**

An upright or carriage can move unexpectedly:

- * Do not walk or stand under raised forks.
- * Keep clear of load and carriage when making any check or adjustment.
- * Keep your arms and fingers away from moving parts of the upright.
- * Block the carriage or upright when working with the components in a raised position.
- * Do not reach through open areas of the upright.
- * Never attempt to move or align the rails by hand. Use a prybar.

Failure to follow these warning can result in serious injury.

IMPORTANT

- * Threaded chain anchors must be left free to pivot in mounting hole.
- * Anchor pin heads must be to the inside of the upright.
- * Torque jam nuts to adjustment nuts to 100 - 200 Nm (74 - 148 Ft-Lbs).
- * Make sure chain anchors are secured so that no twist is evident in the chains.

IMPORTANT

The carriage stop must not be allowed to contact the upright stop under any circumstances during normal operations.

Triple-Stage Upright (TSU) Chain Length Adjustments

Triple-Stage uprights use two chain set; one set for carriage lift and one set for rail lift. Adjustment anchors for the lift cylinder stage are located at the back of the outer rail. Adjustment anchors for the primary lift stage are behind the primary cylinder. Carriage chain anchors are not intended for adjustment.

For TSU inner rail lift chains, chain length must be adjusted if the difference between the bottom of the inner rail and the outer rail is greater 10 mm (0.40 in.)

For the TSU primary cylinder lift chain, the chain length must be adjusted if:

- * The fork-to-ground clearance is less than 5 mm (0.20 in.) or more than 25 mm (1.0 in.) when the upright is vertical.
- * The center of the bottom carriage roller comes within 20 mm (0.80 in.) of the bottom edge of the inner rail.
- * The carriage safety stop hit the inner rail stop at full extension height.

To adjust the cylinder lift chains on a TSU use the following illustration and procedures:

1. Set the upright in the vertical position.
2. Break the jam nuts loose on the chain anchors.
3. Adjust the chain anchor adjustment nuts until the bottom of the inner rail is within 2.5 mm (0.10 in.) of the bottom of the outer rail.

To adjust the primary cylinder lift chains on a TSU use the following illustration and procedures:

1. Fork-to-ground clearance:
 - a. Set the upright to vertical position.
 - b. Break the jam nuts loose on the chain anchors.
 - c. Turn the chain adjustment nuts until clearance between forks and ground is 10-20 mm (0.40-0.80 in.).

(continued on next page)

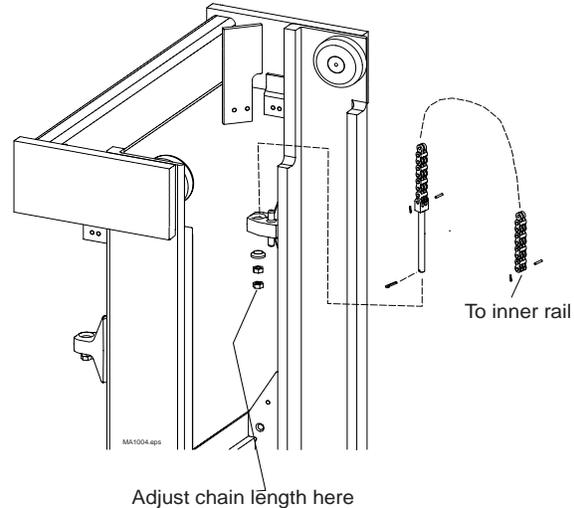


Figure 24A

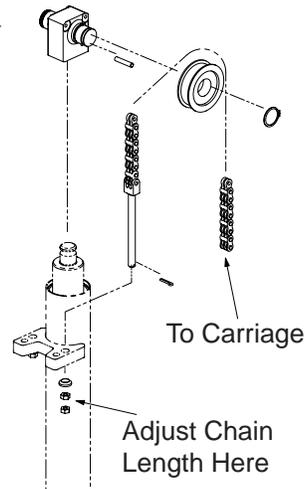


Figure 24B

IMPORTANT

- * Threaded chain anchors must be left free to pivot in mounting hole.
- * Anchor pin heads must be to the inside of the upright.
- * Torque jam nuts to adjustment nuts to 100 - 200 Nm (74 - 148 Ft-Lbs).
- * Make sure chain anchors are secured so that no twist is evident in the chains.

Triple-Stage Upright (TSU) Chain Length Adjustments (Continued)

2. Carriage roller position:

- a. Raise carriage about 1M (3.2 ft.) and smear a bead of grease on the bottom 75 mm (3 in.) of the inner rail in the area of the roller pattern.
- b. Tilt upright fully back and completely lower.
- c. Measure the distance from where the center of the bottom carriage roller stopped to the bottom edge of the inner rail. Distance should not be less than 20 mm (0.80 in.) or chain length adjustment is required.

3. Carriage Stop-to-Upright:

- a. Lift upright to its full height and check for clearance on the carriage safety stop.
- b. If carriage stop hits the upright stop, adjust the chain anchor adjustment nuts out until there is at least 3 mm (0.12 in.) clearance between the stops.

If all three chain length requirements listed previously cannot be met, the tire diameter may be out of the design range allowance. Also, excessive tire wear will decrease carriage stop clearance.

IMPORTANT

The carriage stop must not be allowed to contact the upright stop under any circumstances during normal operations.

5.3-4 Chain Lubrication

Like all bearing surfaces, the precision manufactured, harden-steel, joint-wearing surfaces of a leaf chain require a film of oil between all mating parts to prevent accelerated wear.

Maintaining a lubrication film on all chains surfaces will:

- * Minimize joint wear.
- * Improve corrosion resistance.
- * Reduce the possibility of pin turning.
- * Minimize tight joints.
- * Lower chain tension by reducing internal friction in the chain system.

Laboratory wear test indicate that #40 oil has the ability to prevent wear better than #10 oil. Generally, the heaviest (highest viscosity) oil that will penetrate the joint is best.

Whatever method is used, the 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.

To prepare the chain for oil. The leaf chain plates should be brushed with a stiff brush or wire brush to clear the space between the plates so that oil may penetrate the live bearing areas.

Oil may be applied with a narrow paint brush or directly poured on. Chain should be well flooded to be sure the oil penetrates the joint.

In locations difficult to reach, it may be necessary to use a good quality oil under pressure such as an aerosol can or pump pressure spray.

General Guidelines

- * **Chain Movement** - Make sure that the chain operating path is clear and that the chain articulates freely through its full range of operation.
- * **Lubrication** - Assure that the chain is well lubricated with the heaviest oil that will penetrate the void between the link plate apertures and the pins.
- * **Paint** - Make sure the chain does not get painted over at any time.
- * **Protection** - Where necessary, as a protection from atmosphere or sliding wear, the chain may be covered with a layer of grease. It should be noted, however, that the grease will have to be removed at a later date for chain inspection and relubrication.
- * **Chain Mountings** - Double check to be sure all chain fastening devices are secured and all adjustments have been made to assure uniform loading of multiple chain applications. Check chain anchors and pins for wear, breakage and misalignment. Damaged anchors and pins should be replaced.
- * **Sheaves** - Sheaves with badly worn flanges and outside diameter should be replaced. This wear may be due to chain misalignment or frozen bearings.

5.3-5 Chain Removal and Re- placement



WARNING:

The procedures for removing and replacing chain set involve hoisting and blocking components.

- * Do not walk or stand under raised forks.
- * Keep your arms and fingers away from moving parts of the upright.
- * Do not reach through open areas of the upright.

Failure to follow these warnings can result in serious injury.

Lift Chains (Standard & TSU)

To remove and replace the lift cylinder and/or carriage chain set on standard and triple-stage uprights (TSU):

1. Attach a hoist strap on the carriage of the standard upright or inner of the TSU.
2. Lift the carriage or inner rail slightly to create slack in the chains. Block the carriage or inner rail up for safety.
3. Remove the chain anchor pins on the outer rail and pull the chains off of the sheaves on the inner or intermediate rails.
4. Remove the chain anchor pins from the carriage on the standard upright or the inner rail on the TSU. On the TSU, the inner rails must be lowered to the floor to access the chain anchor pins.

NOTE

If a hose adapter is used, the chain sheaves must be loosened and removed to prevent the hoses from stretching when the inner rails of the TSU are lowered to access the chain anchor pins.

5. Use the steps in reverse order to replace the lift chain set.

Primary Cylinder/Carriage Chains (TSUs)

1. Tilt the upright forward, lower it and completely collapse the primary cylinder to create slack in the chains. The carriage may also be lifted and blocked in position and the primary cylinder completely collapsed to create slack in the chains.
2. Remove the chain anchor pins from the back of the primary cylinder. Pull the chains through the chain sheave and lay them over the carriage load backrest.
3. Remove the chain anchor pins from the back of the carriage.
4. Use these steps in reverse order to replace the primary cylinder/carriage chain.

Perform the chain length adjustment and chain tension check before returning the truck to service.

Other Chain Service Notes

- * Use lengths of factory assembled chain. Do not build lengths from individual components.
- * Do not attempt to rework damaged chains by replacing only the components obviously faulty. The entire chain may be compromised and should be discarded.
- * Never electroplate assembled leaf chain of its components. Plating will result in failure from hydrogen embrittlement. Plated chains are assembled from modified, individually plated components.
- * Welding should not be performed on any chain or components. Welding splatter should never be allowed to come in contact with chain or components.
- * Leaf chains are manufactured exclusively from heat treated steels and therefore must be annealed. If heating a chain with a cutting torch is absolutely necessary for remove, the chain should not be used.
- * **Always replace chains in sets, Failure to do so may damage new chain.**

5.4 Upright & Pantograph Removal & Replace Roller Shim Adjustments

It is recommended that the pantograph carriage assembly be removed before attempting to remove the uprights.

5.4-1 Pantograph Removal Preparation

1. Truck should be parked on a level surface.

Extend the pantograph fully.

Lower the pantograph onto hardwood (oak) blocks. Refer to figure 28A.
2. Place a support (2 X 4 or 4 X 4) between the front and rear members of the pantograph to prevent the pantograph from retracting once the hydraulic supply is disconnected. Refer to figure 28.
3. Actuate the lowering control long enough for the primary cylinder to collapse and slacken the chains. Release the control.
4. Turn the key to the "OFF" position and remove the key.
5. Disconnect the battery.

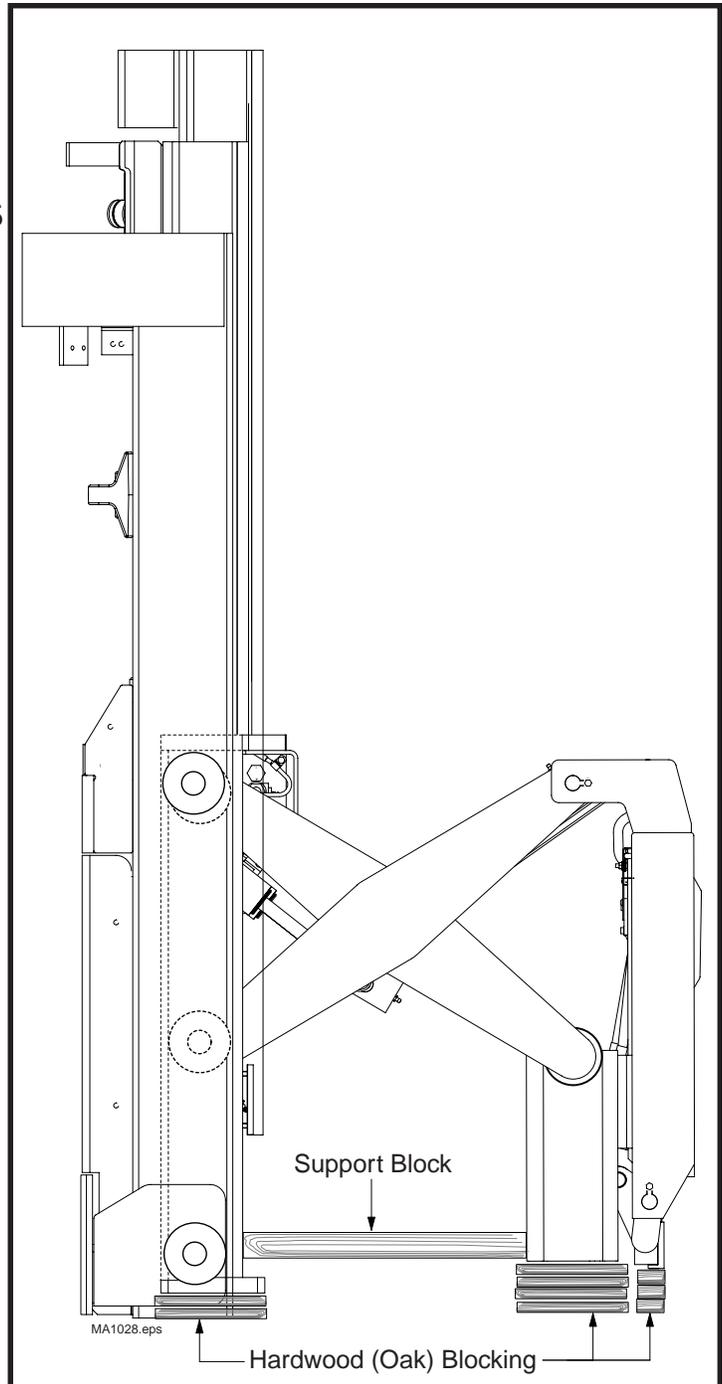


Figure 28A

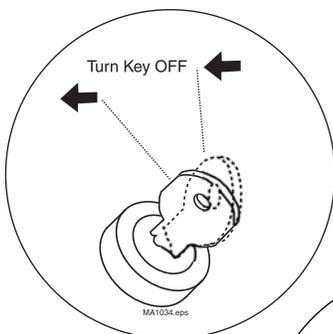


Figure 28B

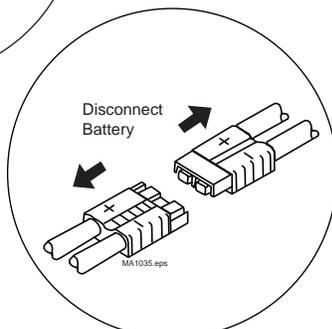


Figure 28C

NOTE

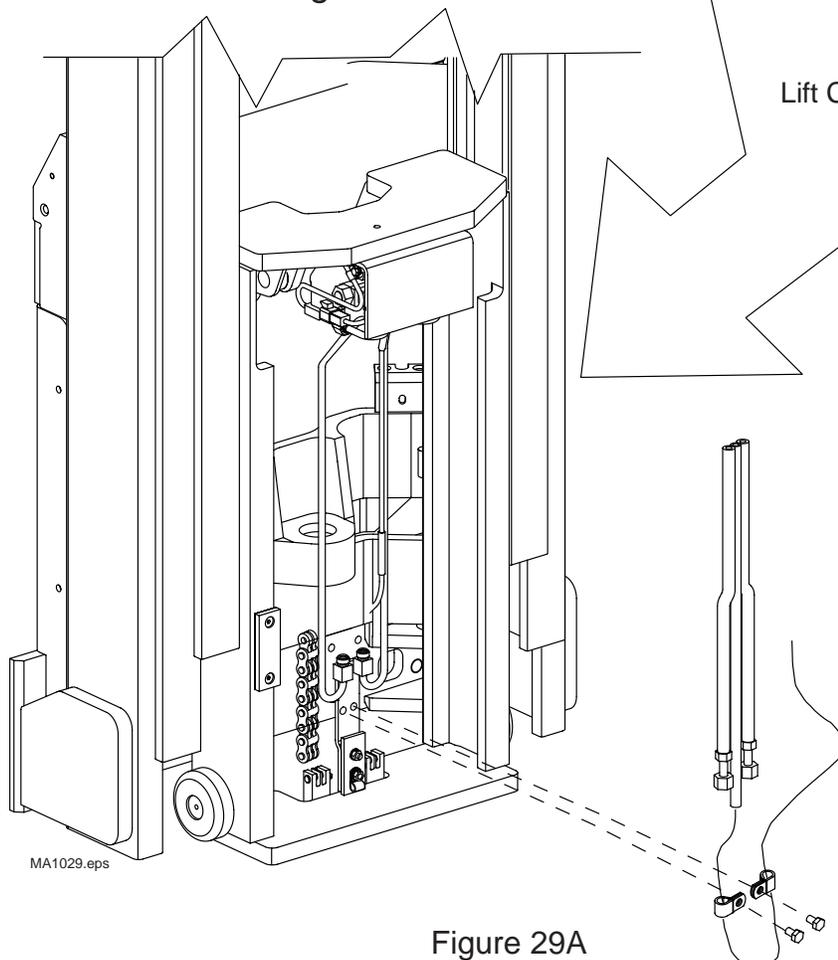
If the upright is to be removed, a 5-ton chain hoist equipped with safety hooks is required.

5.4-1 Pantograph Removal (continued)

6. Remove two bolt (1) from cable retainers (2).
7. Remove front and rear retainers.
8. Disconnect electrical plug (3).
9. Remove both harness clamp bolts (4).
10. Disconnect hydraulic hoses from tube connections (5) using two wrenches. One wrench to hold the tube connection(s) while loosening the hose connection(s). There will be some hydraulic fluid leakage upon disconnecting fittings.
11. Remove cotter pins (6).
12. Remove chain anchor pins (7) securing the lift chains to the carriage chain anchors.

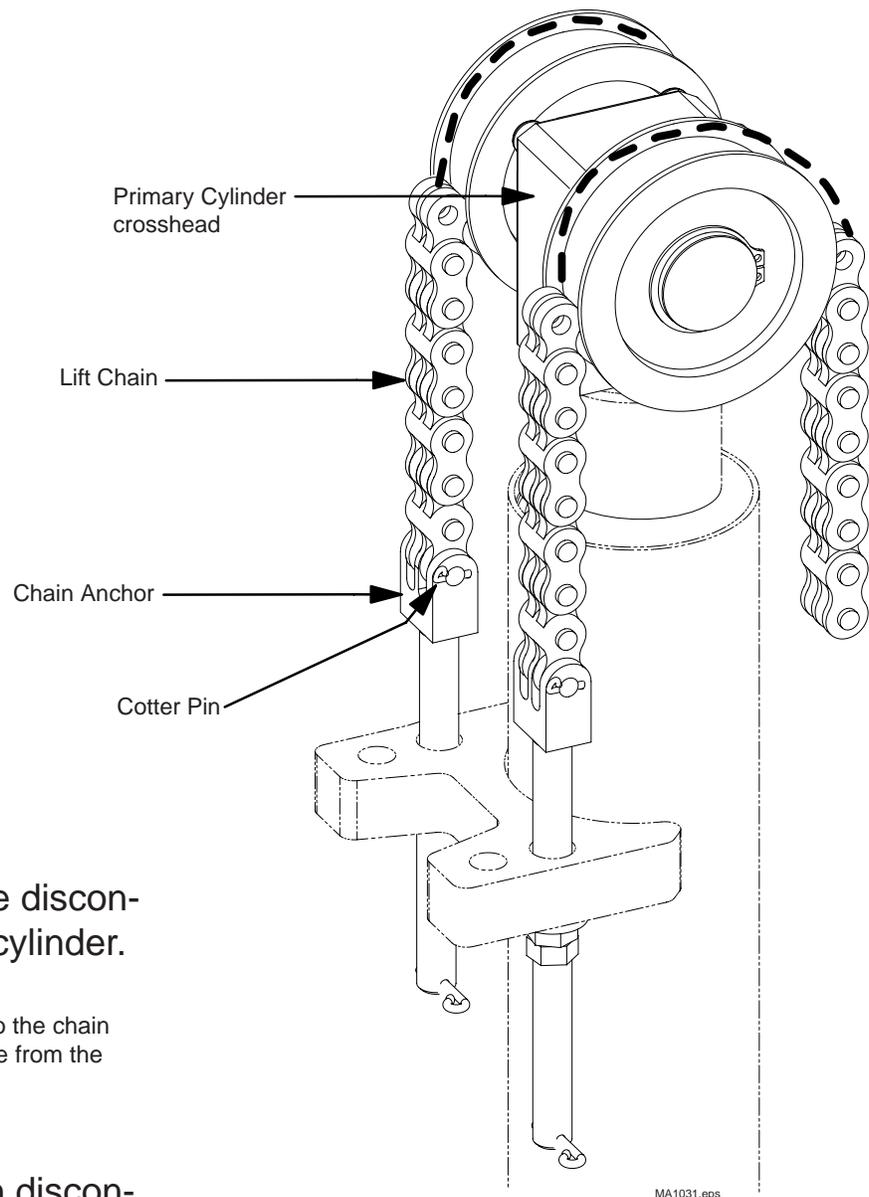
NOTE

Lift chains may be disconnected at the primary lift cylinder cross-head (see next page) or from the carriage as shown.



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Figure 29A

5.4-1 Pantograph Removal (continued)**NOTE**

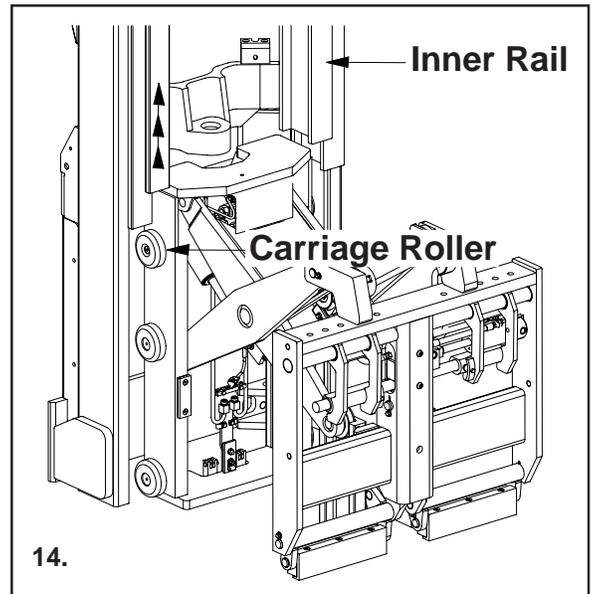
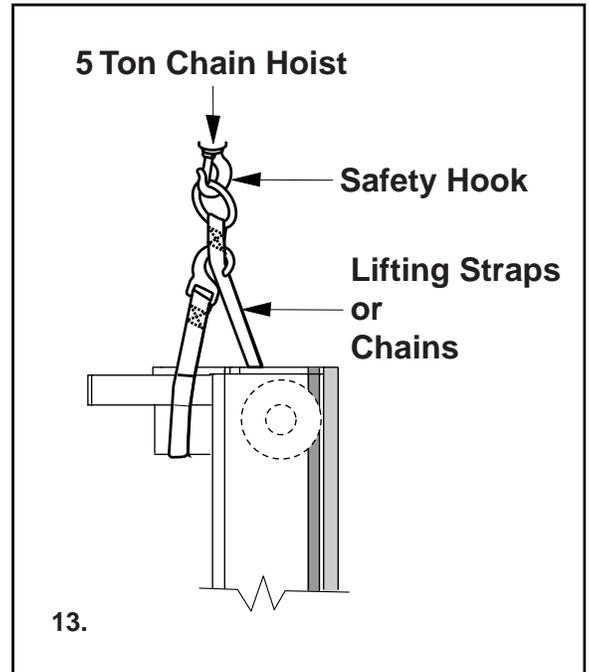
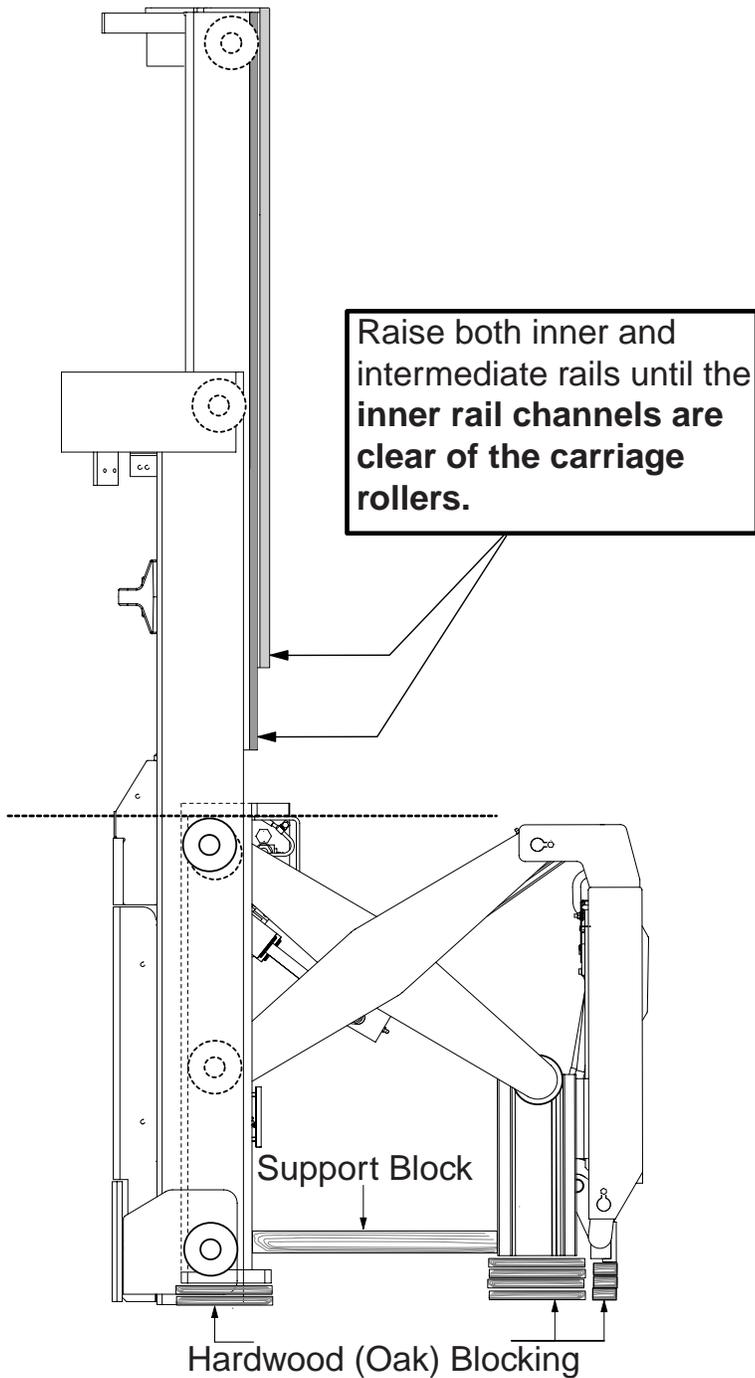
Carriage chains may be disconnected at the primary cylinder.

- * Remove cotter pins securing lift chains to the chain anchors. Remove lift chains one at a time from the chain anchors.

NOTE

Once a lift chain has been disconnected, lay it over the pantograph. Then, using wire, tie the chain end to the load backrest. This will keep the chains out of the way and from falling to the ground.

Figure 30A



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Figure 31A

5.4-1 Pantograph Removal (continued)

13. Using a 5-ton chain hoist, attach hoist to the inner and intermediate rail assemblies, See Figure 31A above. **Be sure hoist is equipped with safety hook(s).**

14. Raise both inner and intermediate rails until the inner rails clear the upper carriage rollers.

5.4-1 Pantograph Removal (continued)

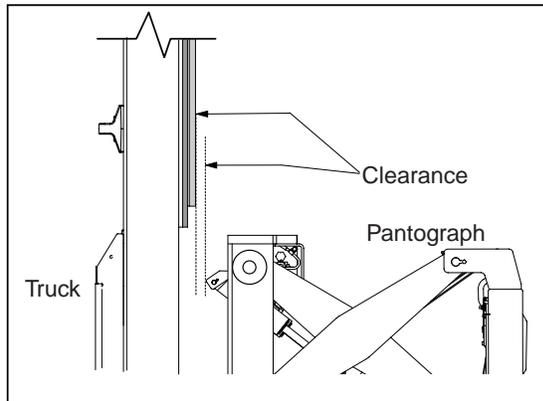
NOTE

15. Move truck away from pantograph just far enough to allow the intermediate and inner rails to clear the pantograph.
16. Completely lower the intermediate and inner rail assemblies.
17. Disconnect hoist and move truck away from pantograph.

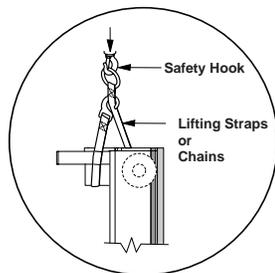
If the upright rail lift cylinders are to be removed, refer to the following pages.

The free lift (center) cylinder may be removed without removing the upright.

- Backup truck just enough to provide clearance Between pantograph and upright rails.



- Fully lower intermediate and inner rails.
- Disconnect hoist safety hook from lifting device.



- Move truck away from pantograph.

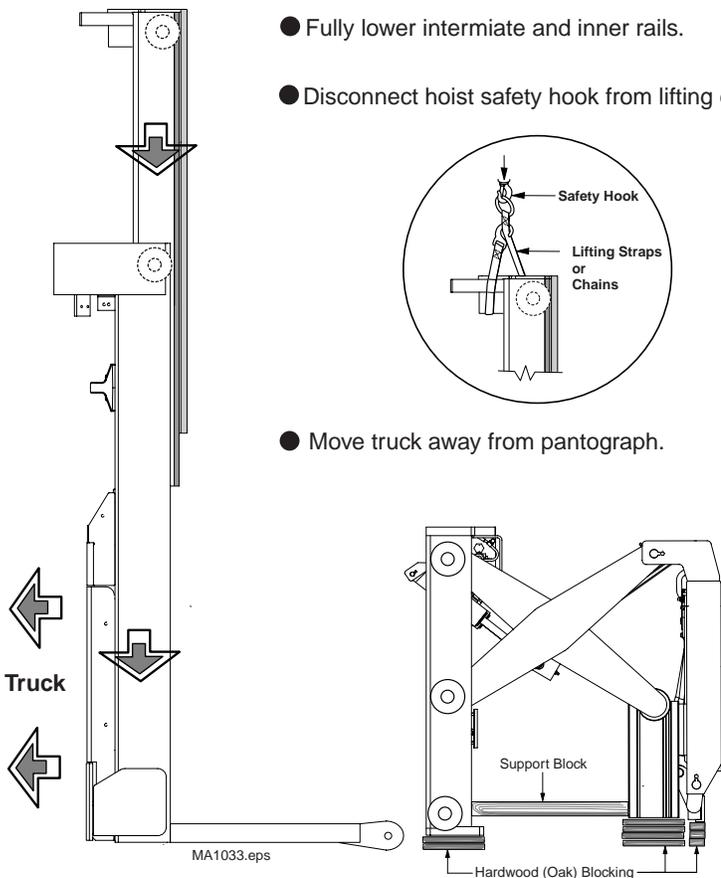


Figure 32A

5.5 Upright Removal

It is recommended that the pantograph carriage assembly be removed before attempting to remove the uprights.

Preparation

1. Turn key switch off.
- * Remove key from switch.
2. Disconnect truck battery at the battery disconnect.
3. Remove battery from truck.

NOTE

The pantograph must be removed before attempting to remove the upright.

4. Remove any overhead guards and/or screen guards.
5. Elevate and support each side of truck with suitable hardwood (Oak) blocking.
6. Disconnect all hydraulic supply lines to the upright. Cap all open lines and fittings.
7. Disconnect all electrical connections to the mast and tie wires out of the way.

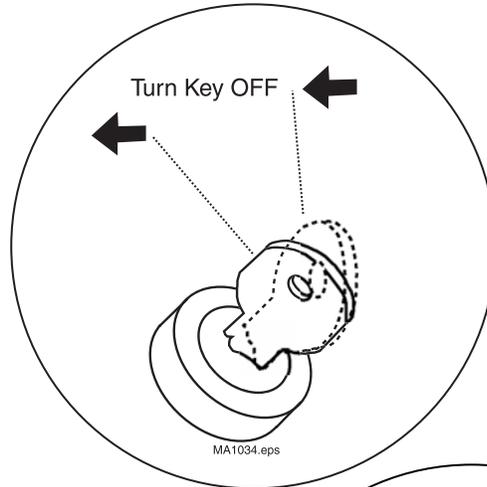


Figure 33A

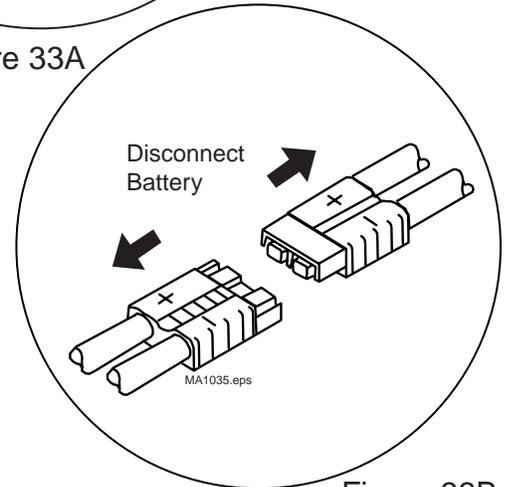
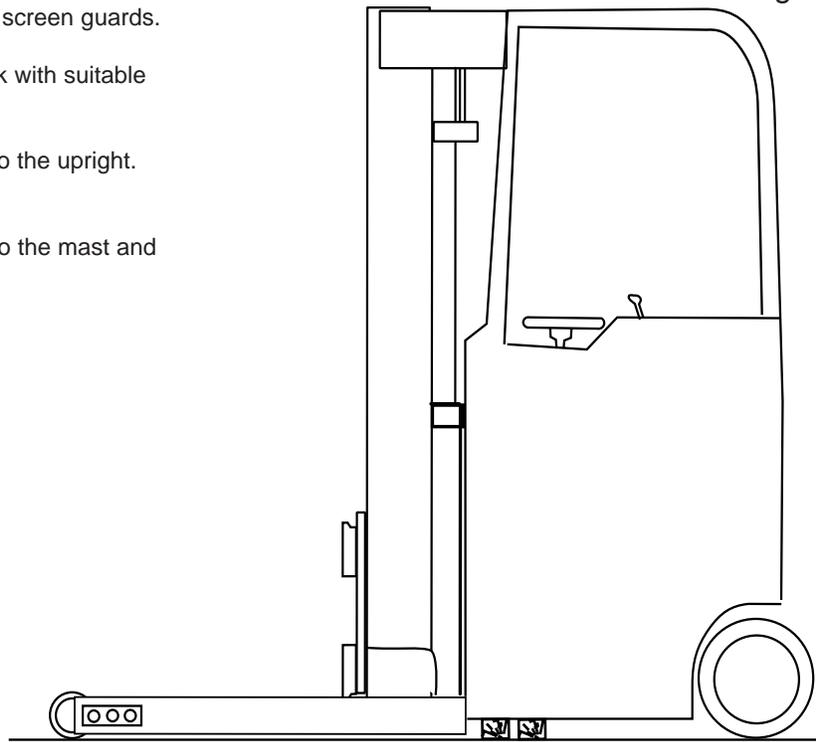


Figure 33B



3" Blocking (Oak) Hardwood

Figure 33C

5.5 Upright Removal (Continued)

8. Place lifting strap beneath the upper tie bars of the outer, intermediate and inner rail assemblies. Connect straps ends to the chain hoist. **Be certain the hoist is equipped with safety hooks.** See Figure 34A.
9. Raise lift to remove slack in the strap. Strap should be taut enough to support the upright after it is disconnected from the truck.
10. Remove all fasteners securing the upright to the truck.
11. Using hardwood (Oak) blocks to support the bottom end of the upright and to keep it level when laid horizontally on the floor.
12. Lower the upright onto the blocks with the truck side down. This will allow the rail assemblies to be pulled out of the outer rail assembly to access rail rollers and secondary cylinders.

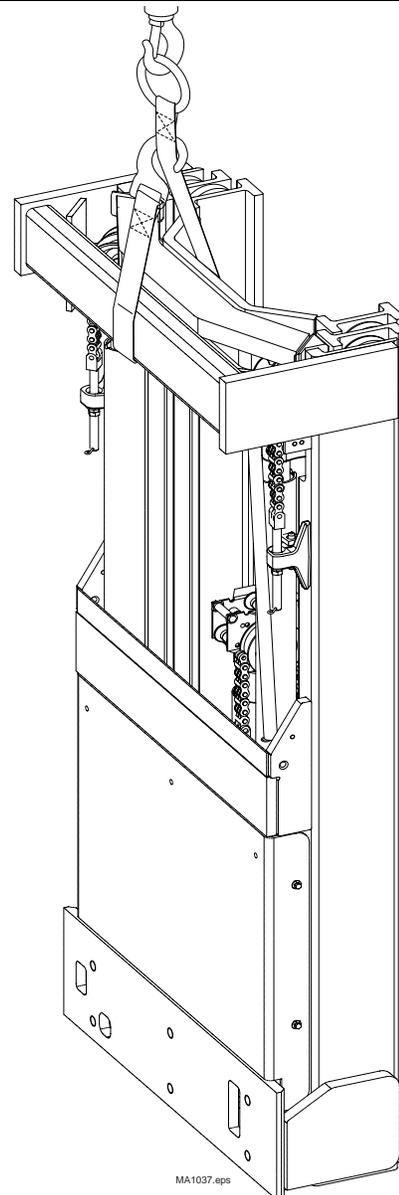


Figure 34A

WARNING: Do not stand on or near the Mast while it is suspended by an overhead hoist.

WARNING: Do not stand the Mast up vertically unless it is chained to a support.

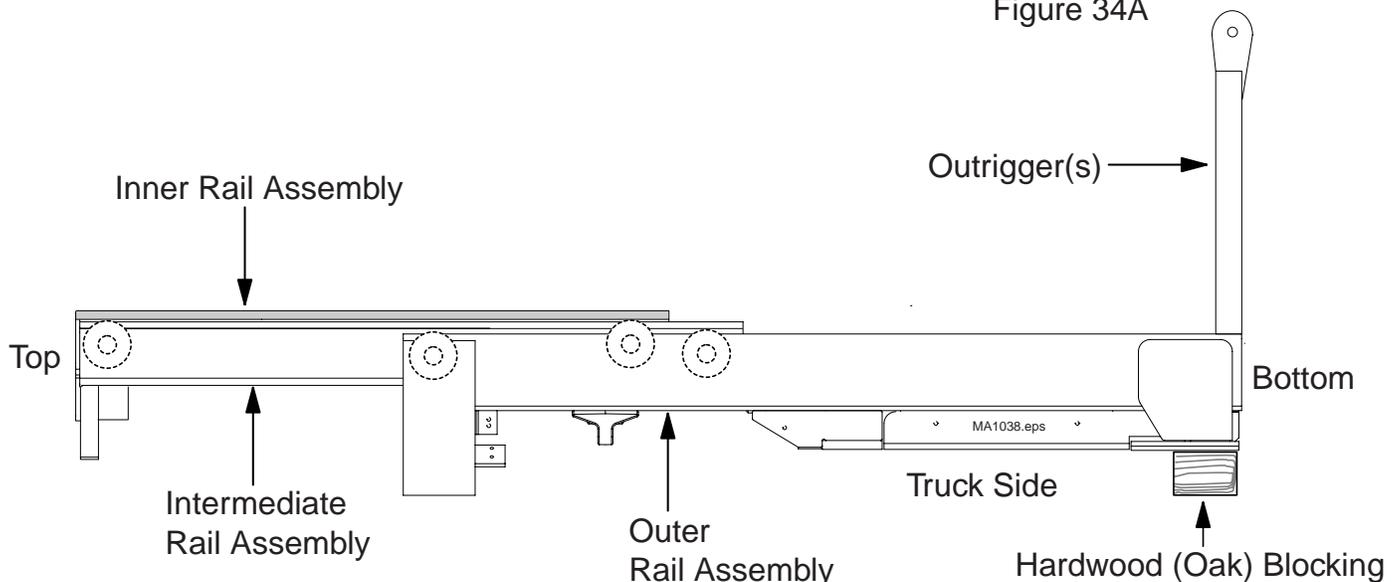


Figure 34B

5.5-1 Upright Disassembly

Rail Cylinders

1. Pull the inner and intermediate rail assemblies part way out of the outer rail assembly to provide access for secondary cylinder removal. The rail cylinders must be removed to adjust or replace the lower rail rollers.
2. Loosen and remove the hydraulic fittings at the base of the left and right secondary cylinders. Discard old O-Rings. Install new O-Ring(s) at time of installation.
3. Remove the snap ring at the base of each cylinder.

Rollers and Shims

Pulling the rail assemblies part way out of the bottom of the outer rail assembly will allow access to remove and/or replace rollers and shims. The rail cylinders must be removed to accomplish this.

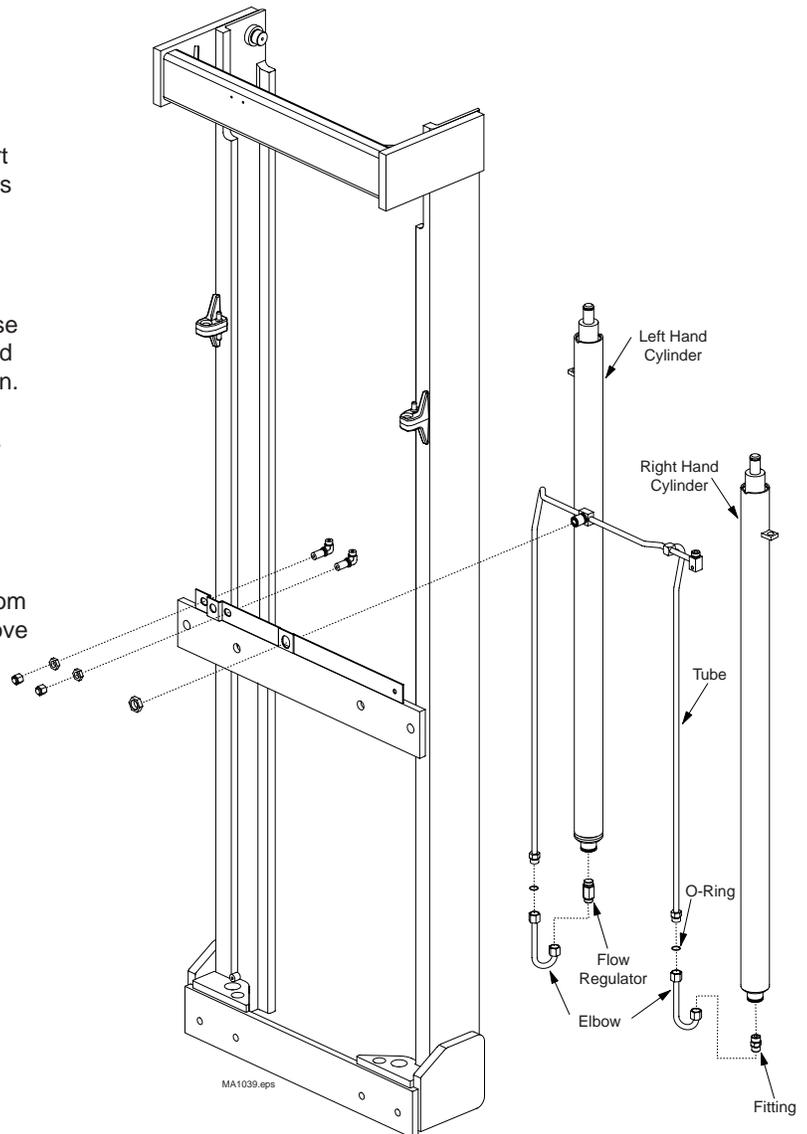


Figure 35A

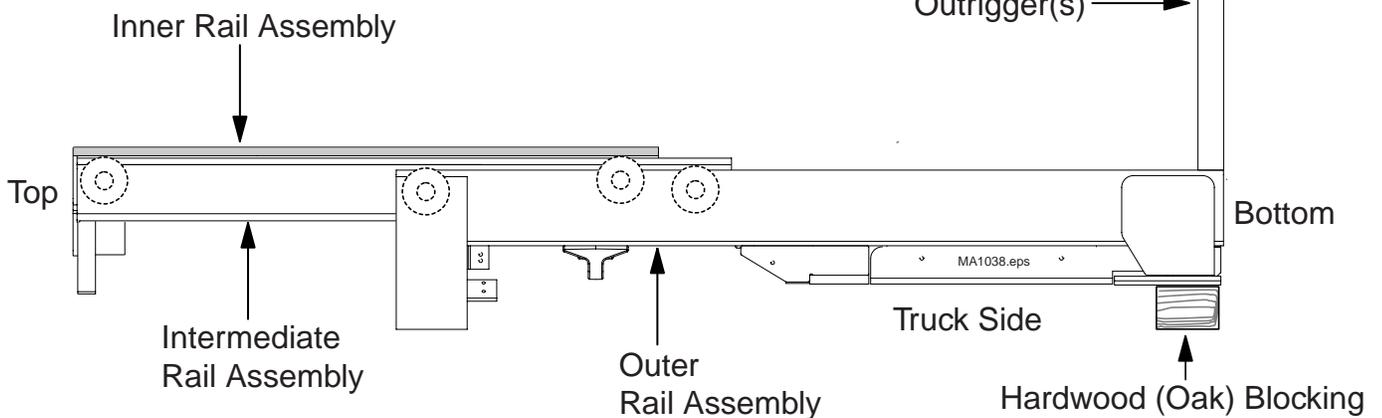
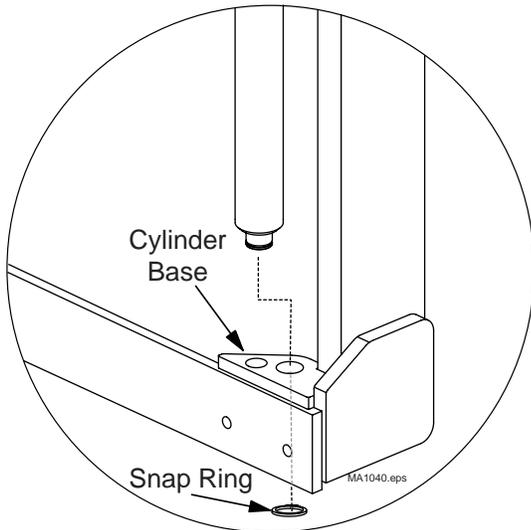


Figure 35B

5.5-1 Upright Disassembly (Continued)

4. Remove the external snap ring from the top of each cylinder piston rod.
5. Remove the washer from each cylinder rod.
6. Support the cylinders, and move the rails outward far enough to allow removal of the cylinders.

NOTE

Each cylinder is equipped with a weldment near the top end of each barrel assembly. This weldment fits over an alignment pin that is part of the chain anchor mount of the outer upright.

NOTE

Record the number of shims removed for each side. The same number of shim should be reinstalled on each side to prevent “racking” of the upright assemblies.

**WARNING**

Rail cylinders are heavy and care must be taken to avoid personal injury.

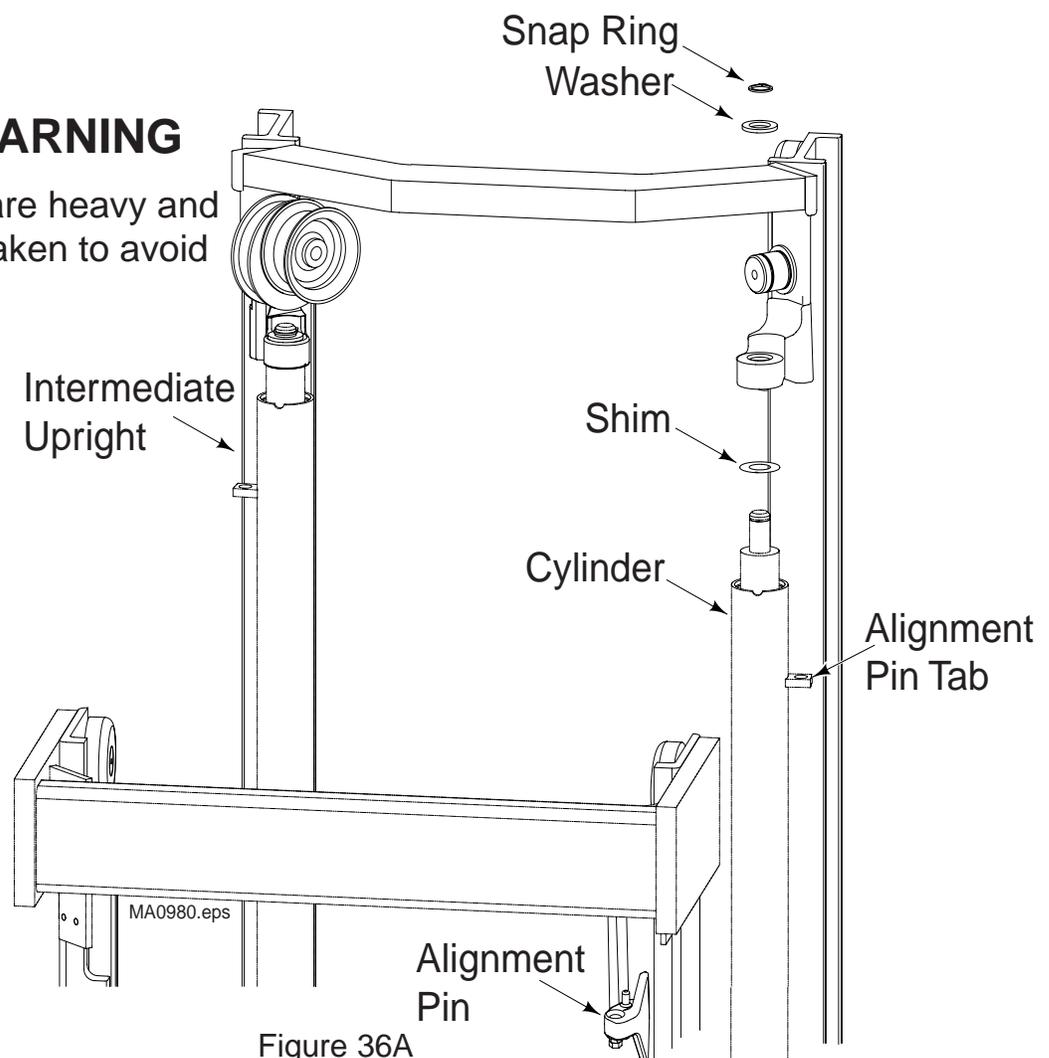


Figure 36A

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Cable, Hose and Chain Sheaves

- * Remove snap rings (6) and sheaves (5).
- * Remove screws (4) securing mounting plates to crosshead (16) and remove assembly from block.
- * Remove pins (15) and crosshead (16) from primary cylinder piston rod.
- * Loosen and remove nuts (1), capscrews (3), and spacers (2).
- * Disassemble assembly. Replace and worn and/or damaged components.

Installation is the reverse of removal.

Free Lift Cylinder

- * Remove cotter pins (7), jam nuts (11), full nuts (10) and ecentrical washer.
- * Remove chain anchors (8) and lift chains (13).
- * Remove snap ring (14). Lift cylinder off alignment pin (12) and out of upright.

Installation is reverse of removal.

NOTE

The free lift cylinder may be removed with upright attached to truck..



WARNING

The free lift cylinder is heavy and care must be taken to avoid personal injury.

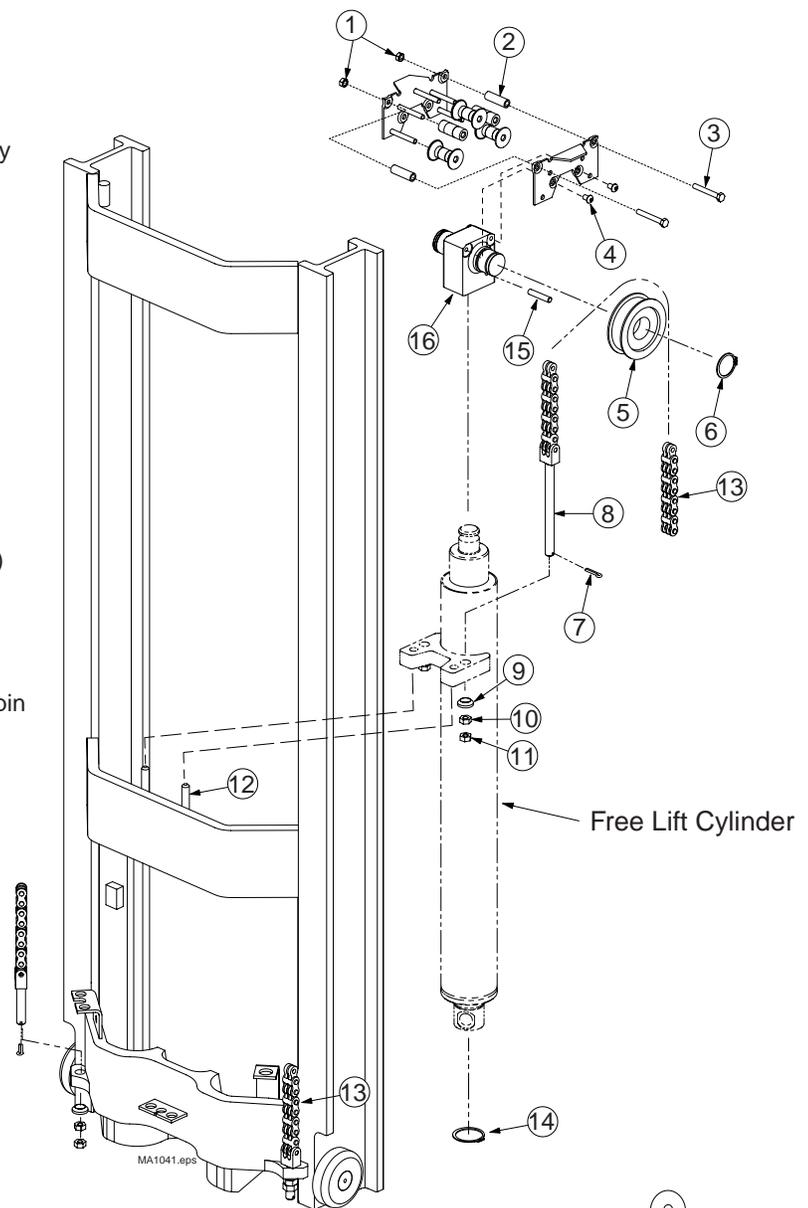


Figure 37A

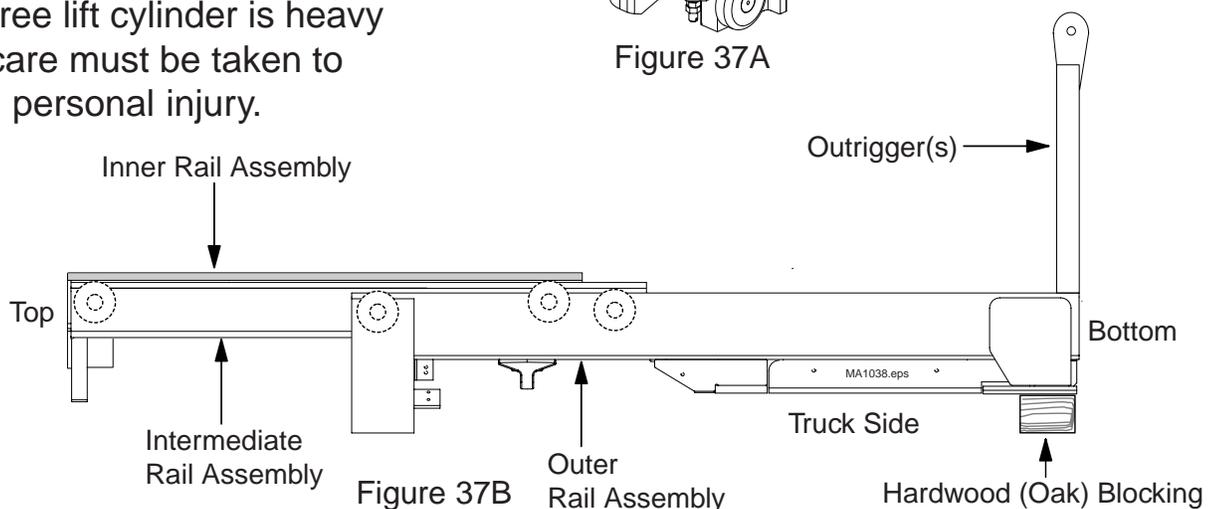


Figure 37B

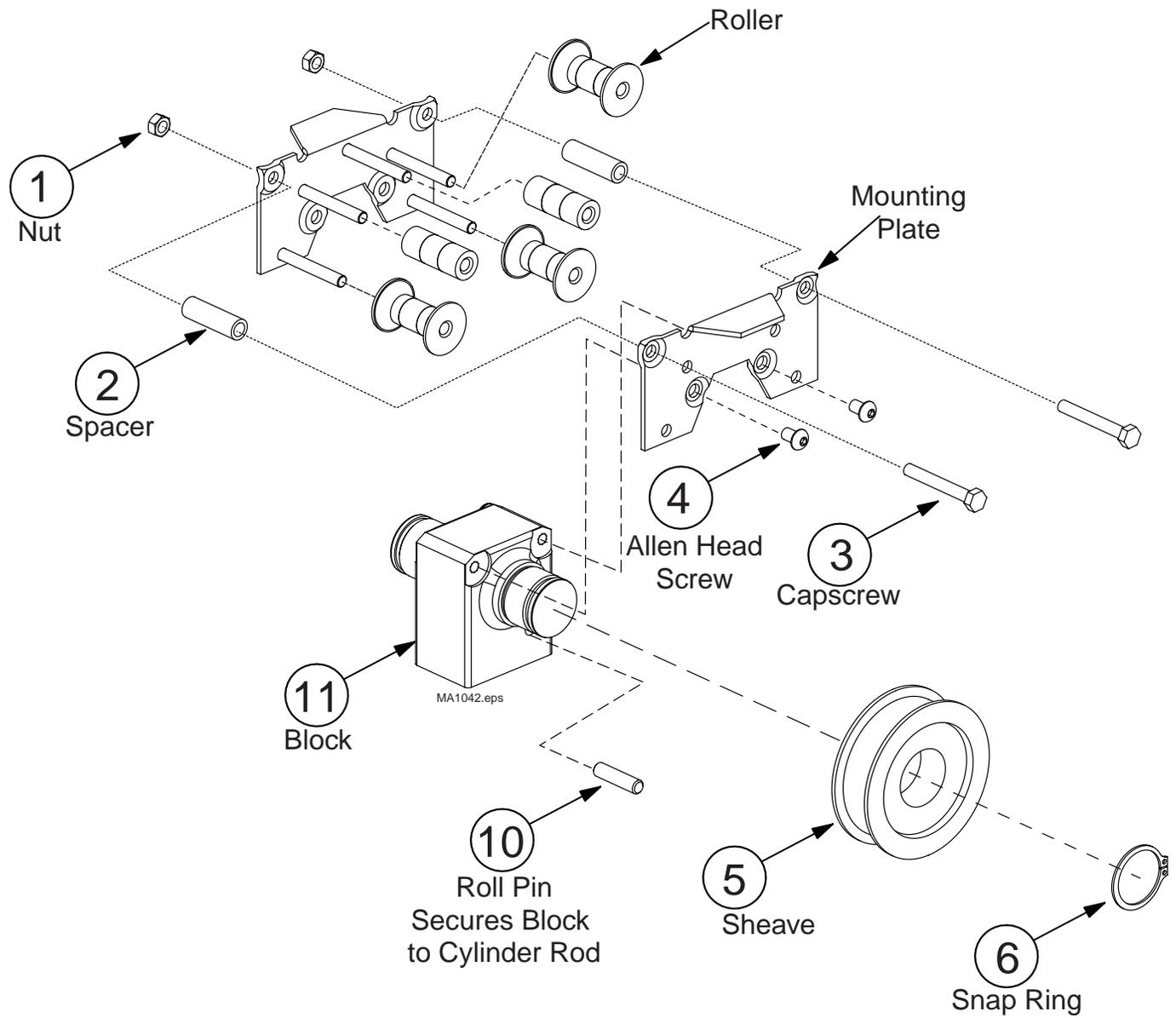


Figure 38A

Cable and Chain Sheaves Removal

- * Loosen and remove retainer bolt from stub shaft.
- * Remove washer, sheaves and spacer.
- * Replace worn and/or damaged components.

Installation is the reverse of removal.

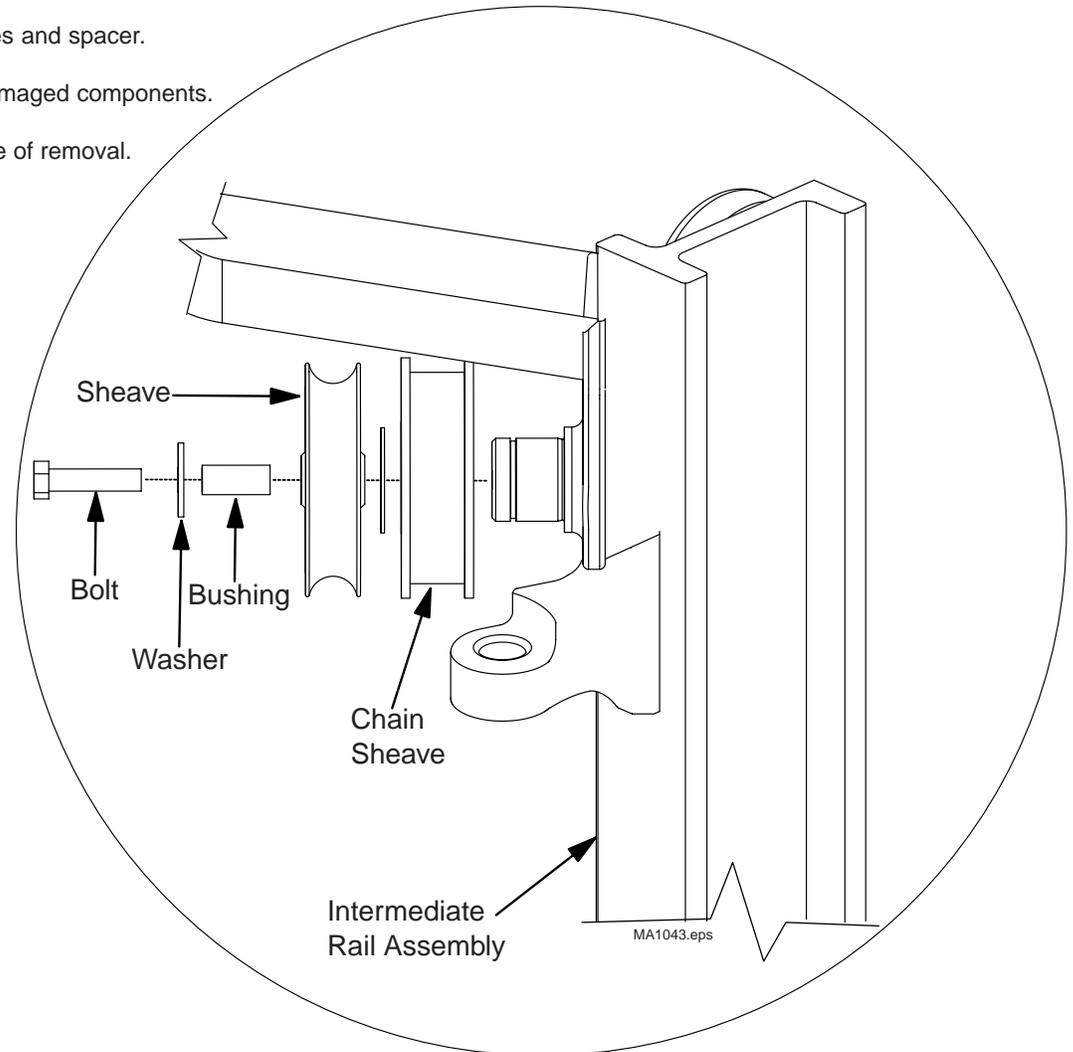


Figure 39A

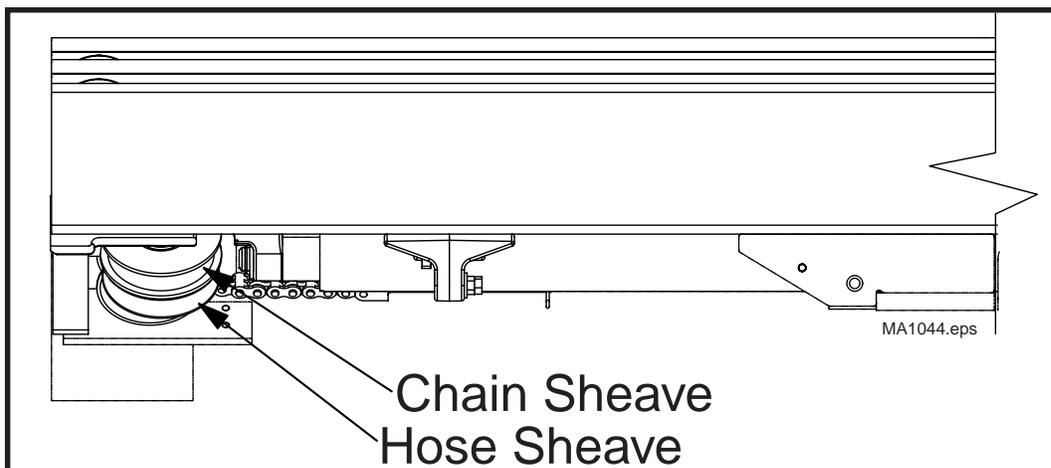
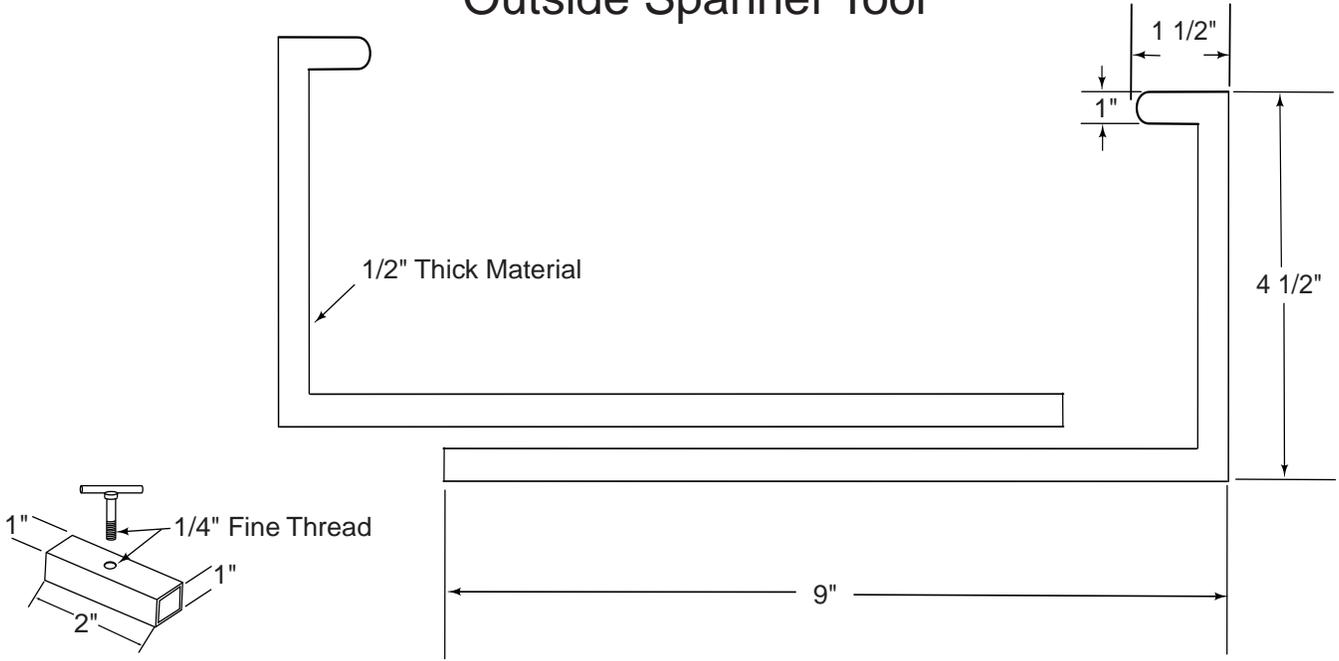
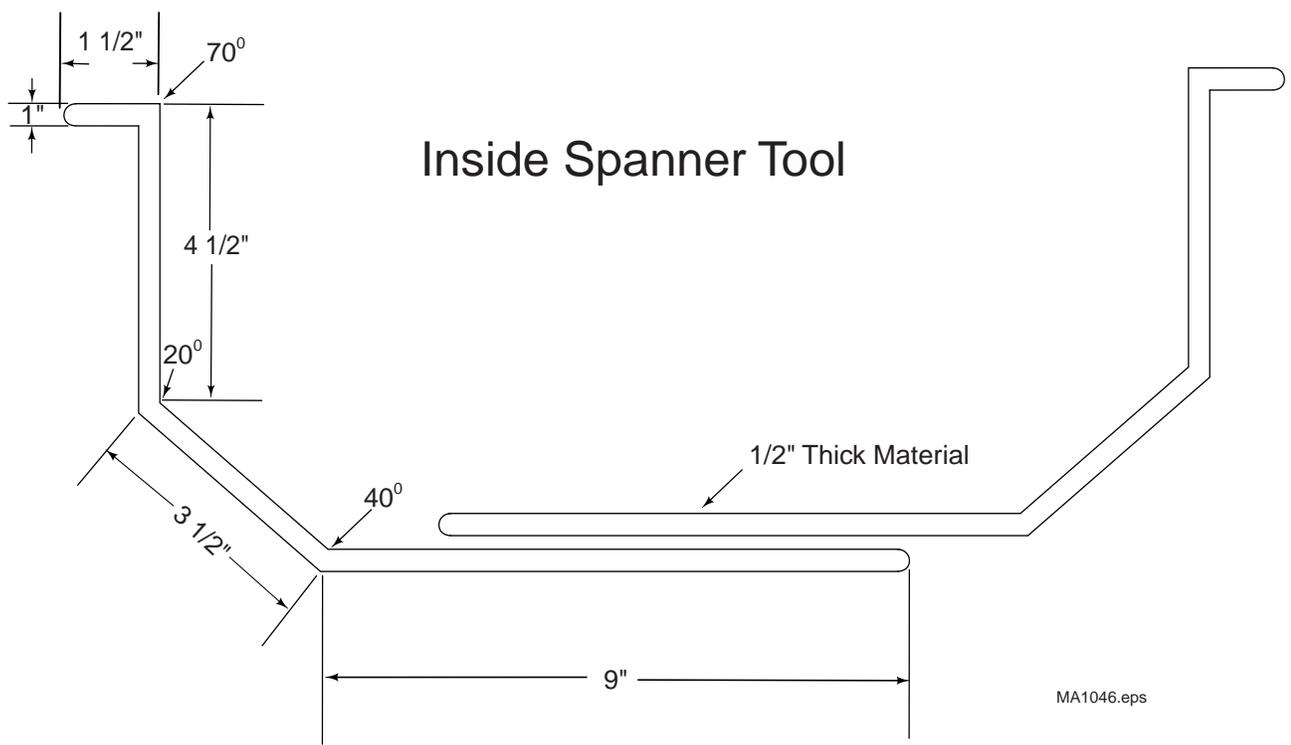


Figure 39B

Outside Spanner Tool



Inside Spanner Tool



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Figure 40A

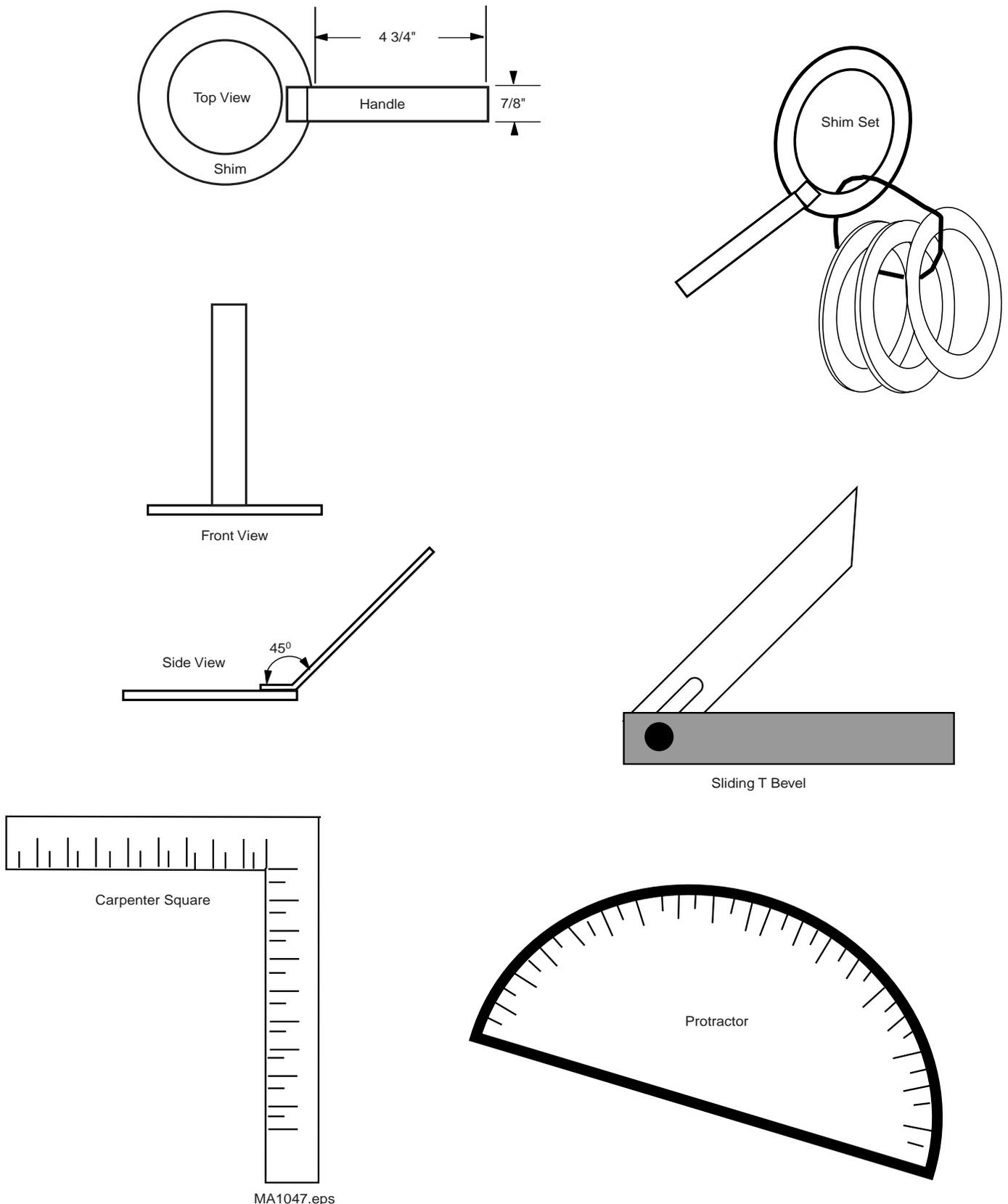


Figure 41A

Pantograph Assembly

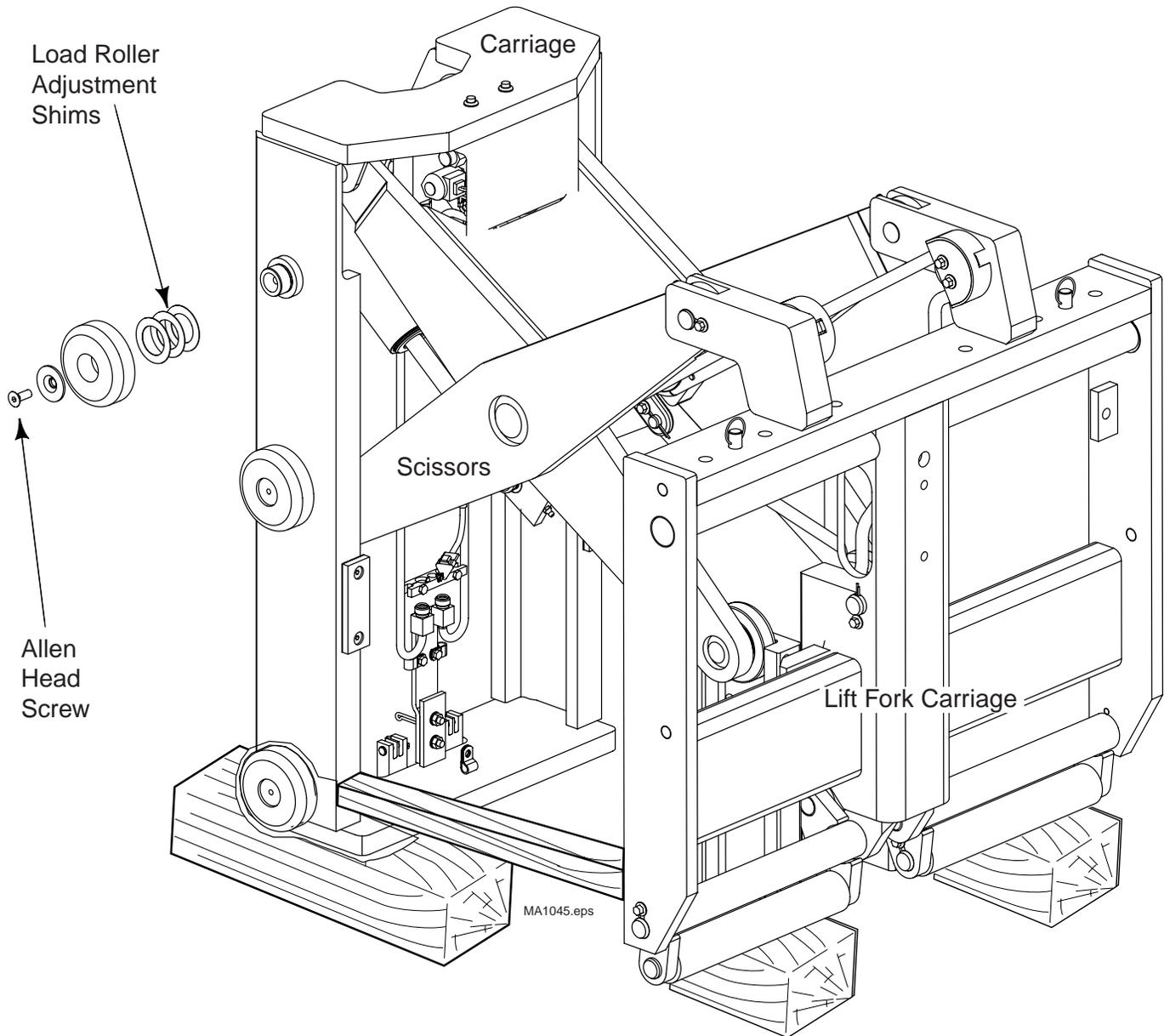


Figure 42A

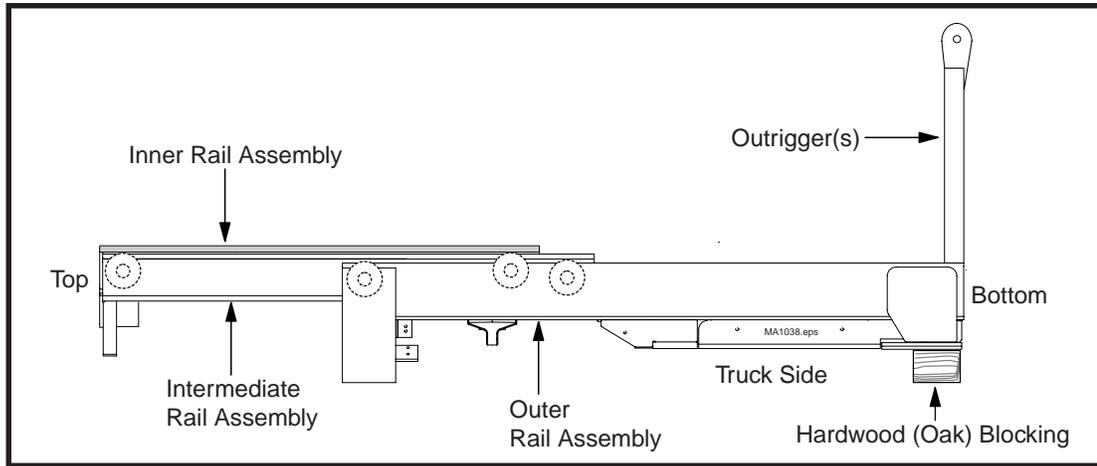


Figure 43A

5.6-1 PANTOGRAPH CARRIAGE ROLLERS

The clearance between the upright inner rails and the pantograph carriage rollers must be checked and adjusted.

Checks and Adjustments

NOTE

Roller clearance and adjustment may be accomplished with the upright mounted to the truck or removed and laying on the floor as shown above.

1. Span inner rail with inside spanner tool.

* Find the smallest distance between rails.

* After finding the smallest distance, place a roller shim between the spanner tool and the inner rail. Lock the tool in position.

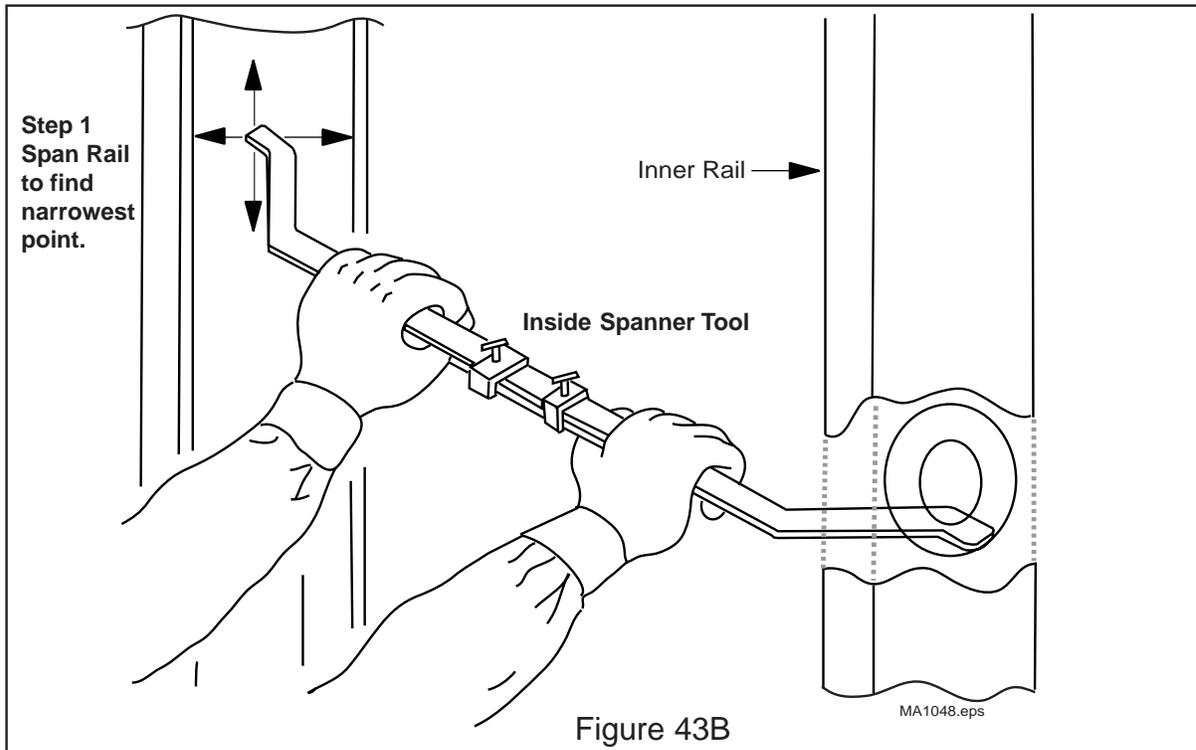


Figure 43B

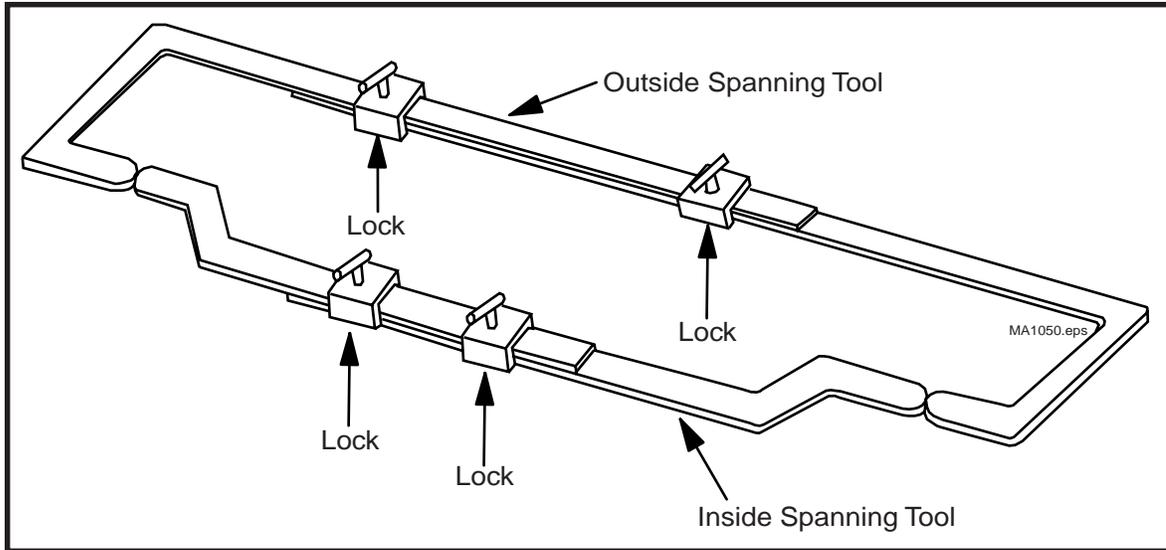


Figure 44A

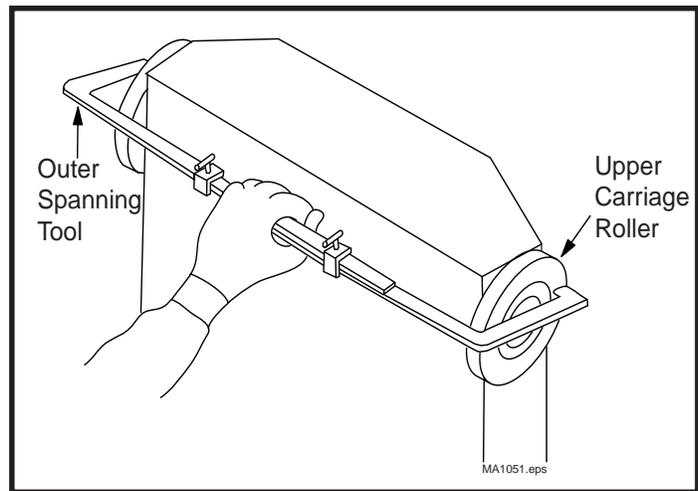


Figure 44B

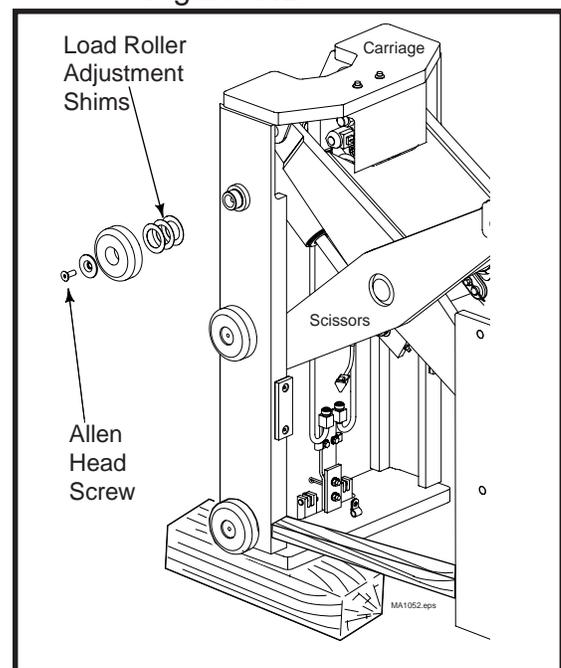


Figure 44C

2. Set outside spanning tool to match the adjusted inside spanning tool.
3. Lock the outside spanning tool in the adjusted position.
4. Span the upper carriage rollers at their outer most camber point. Add or remove shims at the roller shaft to match tool size.
5. Canter carriage rollers by counting the shims and using equal numbers of shims on both sides. If there is an odd number of shims, place the odd shim on the right hand side.

IMPORTANT

When upright is fully extended, the upper carriage rollers extend beyond the inner rail assembly. To allow the rollers to retract smoothly back into the rail, one shim should be removed from each side.

6. Install upper carriage rollers and securely tighten the Allen head retaining capscrews.

7. Span center carriage rollers at their outer most camber point. Add or remove shims to match tool size.
8. Center carriage rollers by using equal amounts of shims on both sides. If an odd number is used, place the odd shim on the right hand side.

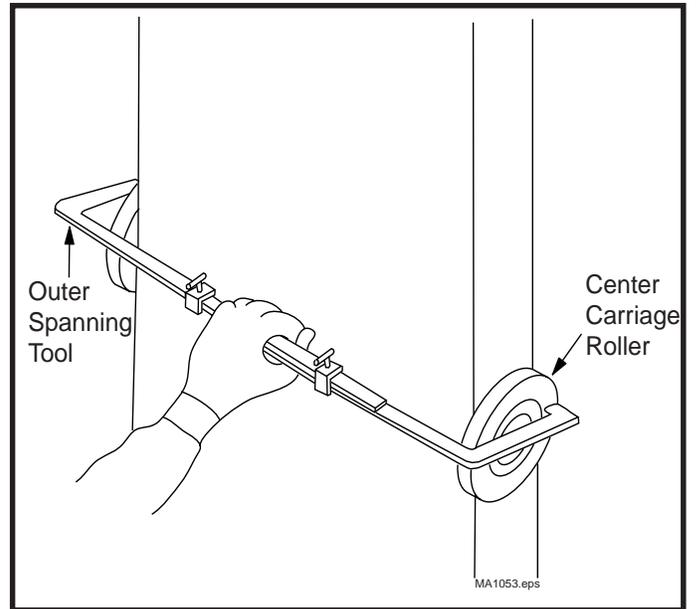


Figure 45A

9. Place a carpenters square at the outer most camber point of the center and lower rollers. Hold the square tight against rollers and take the following measurements.
 - * Measure the distance between the top of the square and the straight edge at point (A).
 - * Take a measurement at point (B). These measurements should be the same. If they are not, add or remove shims from the lower rollers shaft(s) until the distance measured at each point is equal.

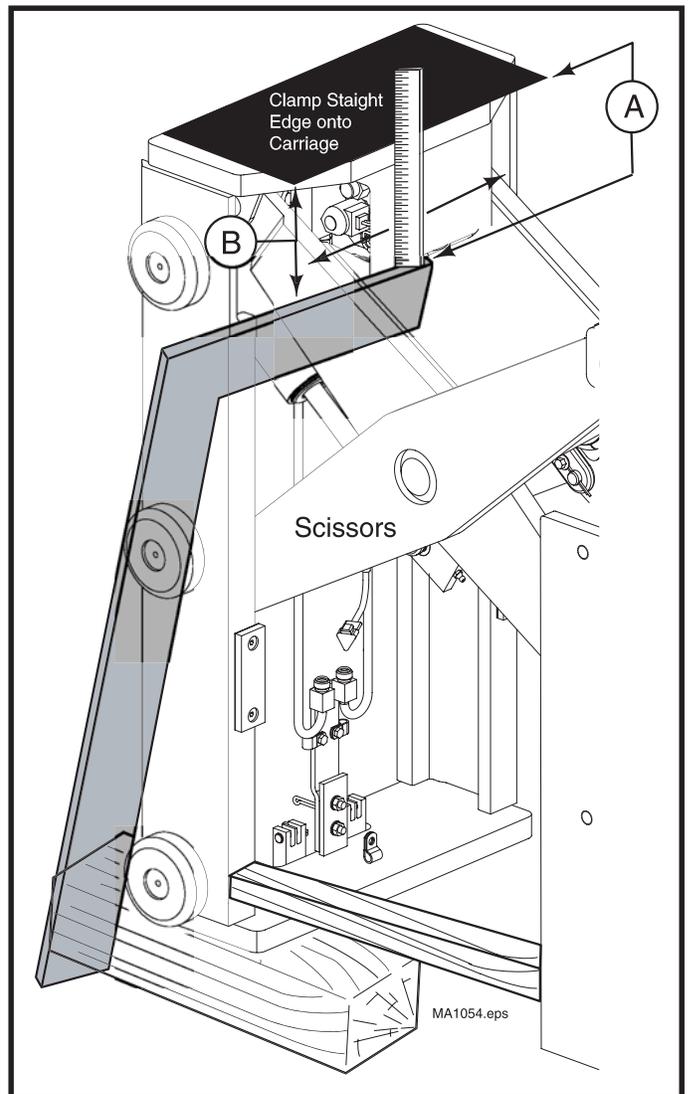


Figure 45B

10. Span lower rollers. Add or remove shims to (*the roller that has not be squared*) match the size of the outside spanning tool.

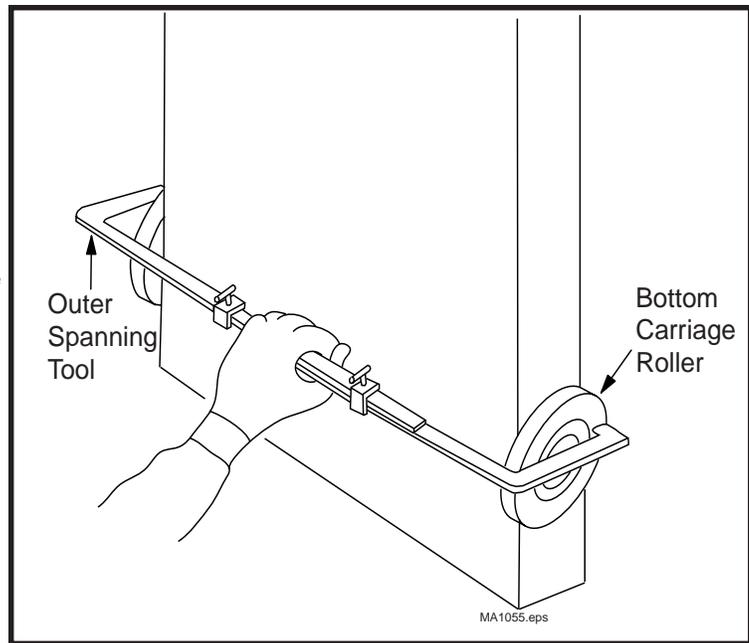


Figure 46A

11. Check and adjust rollers on the opposite side of carriage. Place square at the outer most camber of the center and lower rollers. Take measurements as before. This side will be square within 1/32.; if not , return to step 9 and repeat procedure. *Make sure rollers are center as previously described.*

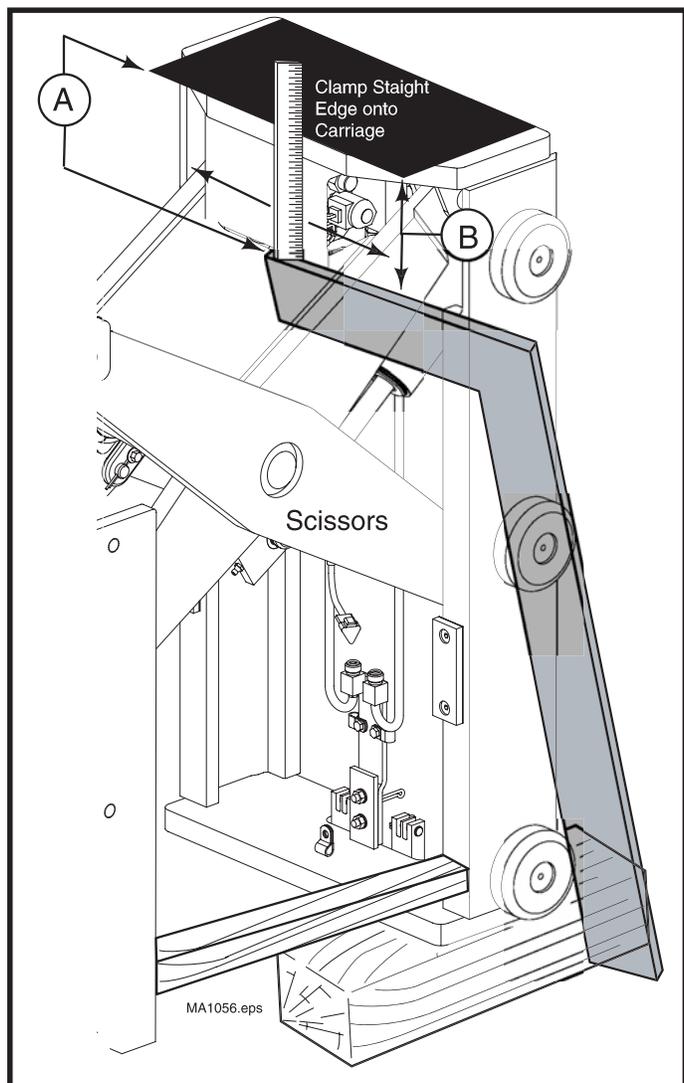


Figure 46B

12. The top rollers are checked last. Remember that the top carriage rollers extend out of the inner rails when the mast uprights are at full extension. To make re-entry of these rollers into the inner rails easier, additional clearance is required for the top rollers. (Refer to steps 4,5 and 6).

- * Place the square directly through the center of the rollers as shown in the illustration to the right.
- * The rollers are shimmed properly when a 1/32" shim can be fit between the outer most camber point of top roller and the square. The clearance should not exceed 1/32".
- * If adjustments are necessary, remove the Allen head capscrew and the roller. Add or remove shims to correct the adjustment.
- * Install Allen head capscrew and check adjustment.

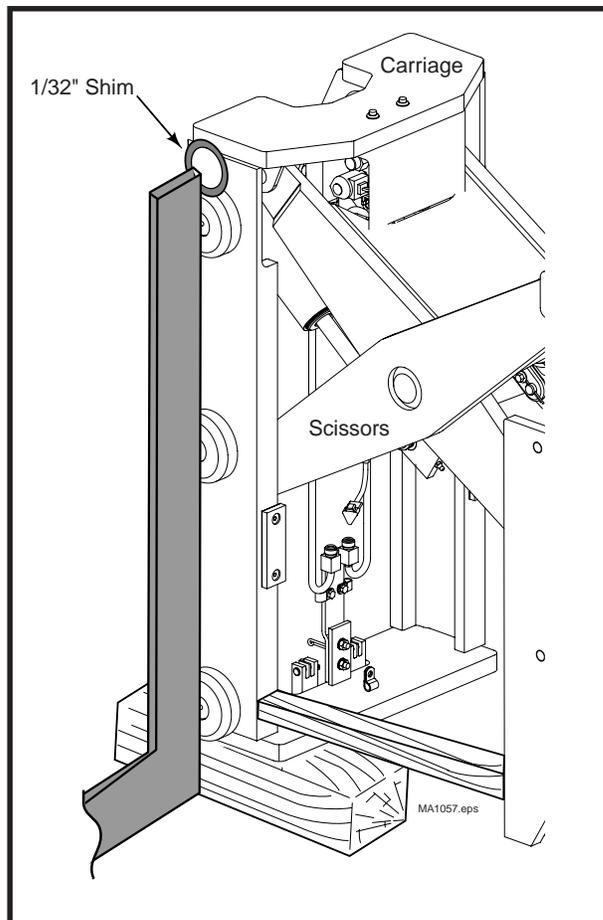


Figure 47A

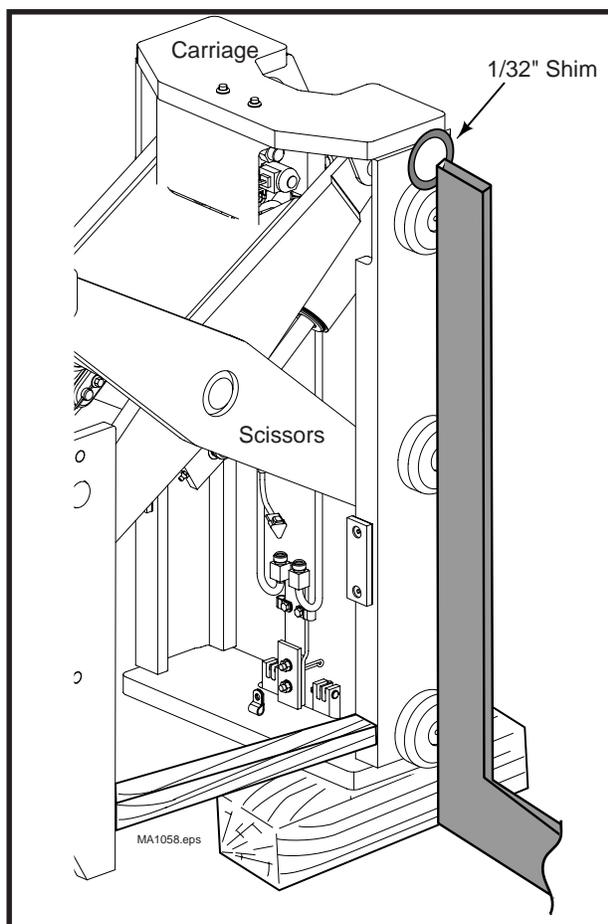


Figure 47B

13. Check opposite roller in use the same procedure, adjusting if necessary.

NOTE

Upper Rollers are retained only with the Allen head capscrews. Center and lower rollers are always captive within the rails.

5.6-2 Upright Rails to Rollers

The following procedure explains how to:

- * 1st - Measure rail-to-roller clearance.
- * 2nd - Adjust rail-to-roller clearance.

IMPORTANT

With age and wear, clearances between the upright rails and the rollers can increase and cause excessive looseness between rails and rollers. Upright rollers become worn, rail surfaces wear, and stress relieving due to handling heavy loads over a period of time may cause slight dimensional changes between upright rails. The illustration shows clearance between rails and rollers.

A roller clearance inspection should be performed if, during normal operational checks of the upright, noticeable looseness or binding between rails sets, or if scoring is evident on the rails.

Proper roller clearance should be maintained because the mast is designed to nest the rails snugly while providing smooth operation.

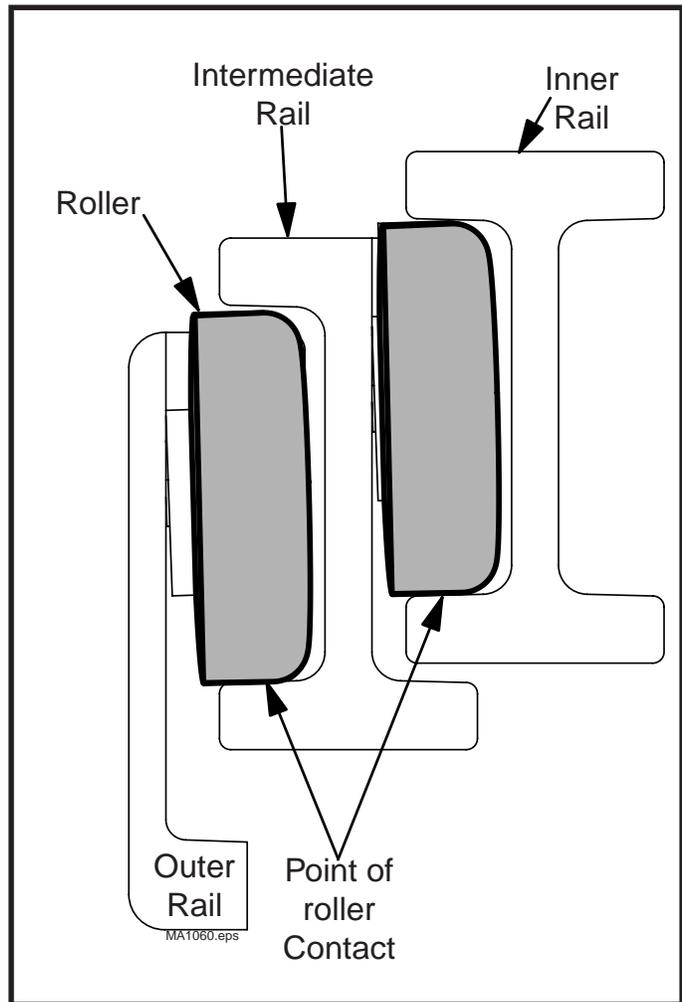


Figure 48A

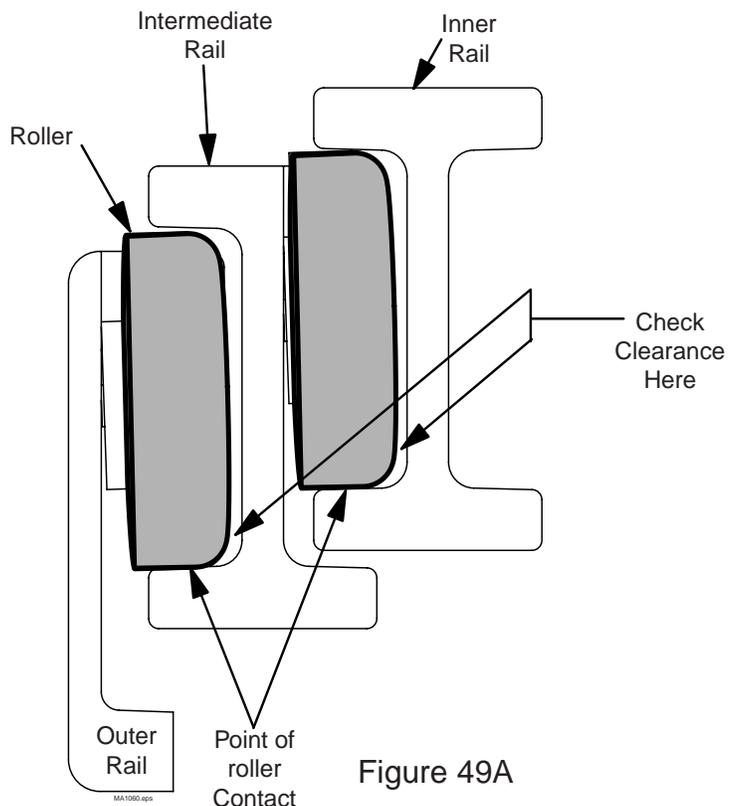
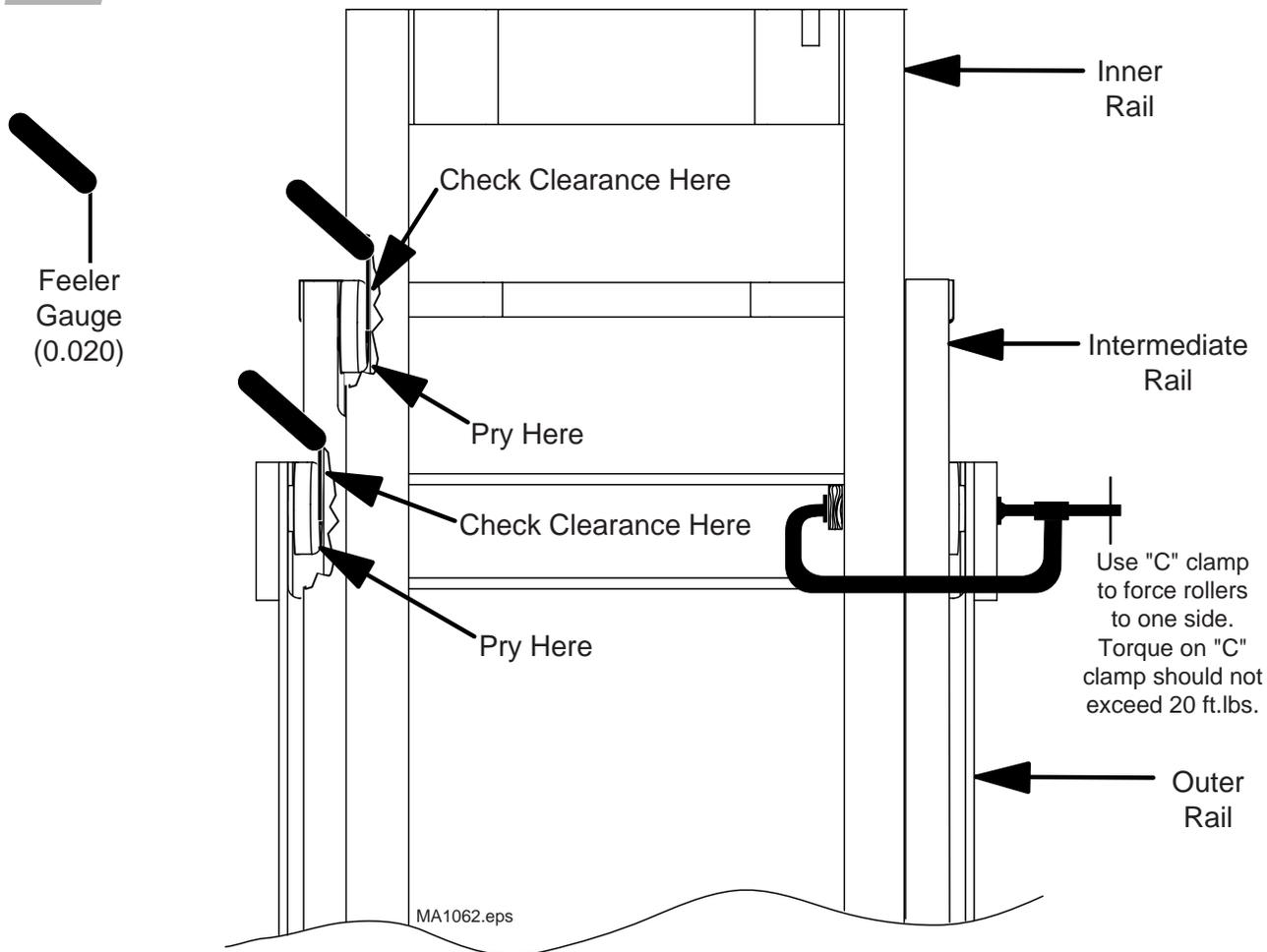


Figure 49A



CAUTION

Watch for overhead clearance when extending upright.



WARNING

Use extreme care when working on the upright to avoid placing hands or fingers into potential pinch points. Unexpected movement of the upright can cause serious injury.

Checking Lower Roller Clearance with upright 6” from fully retracted position

Evaluation of shim requirements generally dictates the a specific roller is acceptable until 0.040” clearance is exceeded, meaning adjustment requires one standard 1/32” shims to reduce rail-to-roller clearance to proper tolerances.

**ROLLERS SHOULD BE INSTALLED
“LINE-TO-LINE”
0.020” MINIMUM CLEARANCE**

Refer to adjustment reference chart when using feeler gauges.

Roller Clearance Inspection

Before checking the roller clearances, place the intermediate rail approximately 6 inches out of the outer rail and the inner approximately 6 inches out of the intermediate rail as illustrated on the previous page. If the upright is mounted and the rails are being elevated hydraulically, the inner rail will automatically assume it’s correct position. Note the procedure for checking the clearance is basically the same whether the upright is mounted or has been removed from the truck.

There ate two methods presented, one using a pry bar to position the rails and rollers and the other using a “C” clamp.

If the upright is mounted to the truck,, the use of an approved safety platform or step ladder is recommended when making inspections and checking clearances at the upper levels.

If the upright has been removed and placed on the flat floor, proper blocking of hardwood (Oak) or steel supports *must be used to keep the upright horizontal with the floor.* This is especially important when fully extending the intermediate and inner rails.

| Step | Feeler Gauge | Gauge will Pass / Not Pass | Shimmed Correctly | Shim QTY |
|------|------------------|----------------------------|-------------------------|----------|
| 1 | 0.020" 0.050" | PASS NOT PASS | Check with a YES | 0 |
| 2 | 0.050" 0.080" | PASS NOT PASS | Check with a No, ADD | 1 |
| 3 | 0.080" 0.120" | PASS NOT PASS | Check with a No, ADD | 2 |

When using a pry bar:

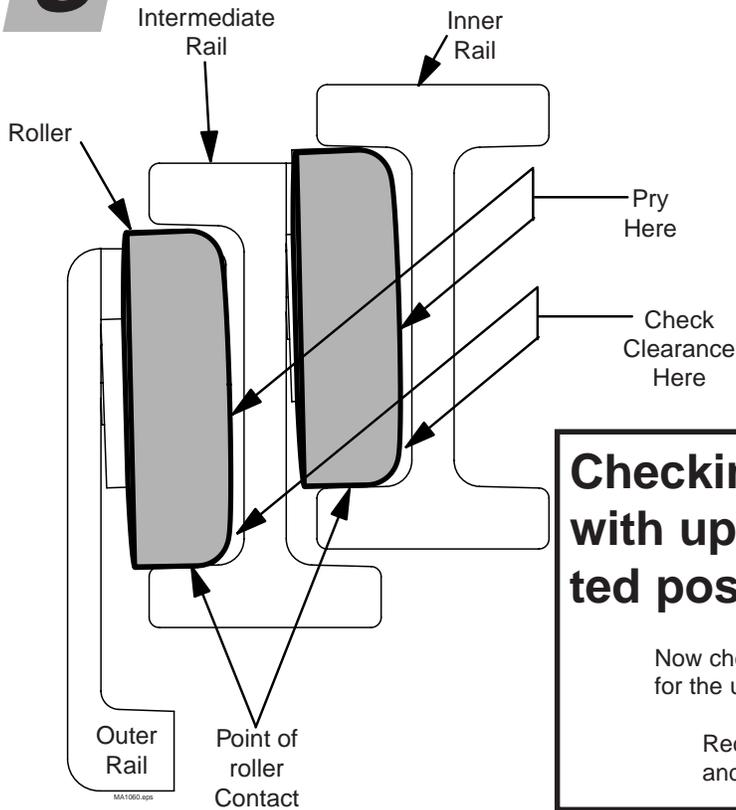
- * Insert the pry bar between the outer and intermediate upright rail on the right side (as shown on page 51). Pry with moderate pressure moving the intermediate and inner rails to the left top end of the upright.
- * Using a 0/020" feeler gauge, see if you can insert a shim between the roller and rail. There needs to be some clearance but it is not to exceeds 0.040". If the clearance between the roller and the rail is two or more shims, record the number of shims that will fit in the space between the roller and rail. Refer to the chart on page 52.
- * Pry the intermediate rail away from the inner rail. Check the clearance between the intermediate rail roller and the inner rail.
- * Record the number of shims needed to fit in the space between the roller and the rail for the outer and intermediate rail.

“C” Clamp Method:

- * Install “C” clamp at the location shown on page 51. It may be necessary to use a block on the inside of the channel as shown.
- * Tighten the “C” clamp to displace the roller clearance on that side of the upright. Now, check roller clearance on the opposite side of the upright.
- * Using a 0.020" feeler gauge, try to insert it between the roller and the rail at the point of contact as shown on page 51.
- * If a 0.020" will pass between the roller and the rail, and 0.040" will not fit between the rail and roller, it does not require adjustment. If clearance exceeds 0.040", refer to the chart on page 52.
- * Record the number of shims needed to fill the space between the roller and the rail.

IMPORTANT

There needs to be at least 0.020" of clearance but no more than 0.050".



Checking Lower Roller Clearance with upright 6" from fully retracted position

Now check the lower rollers in the same manner as for the upper rollers.

Record the number of shim needed for the outer and inner rails opposite the rollers checked.

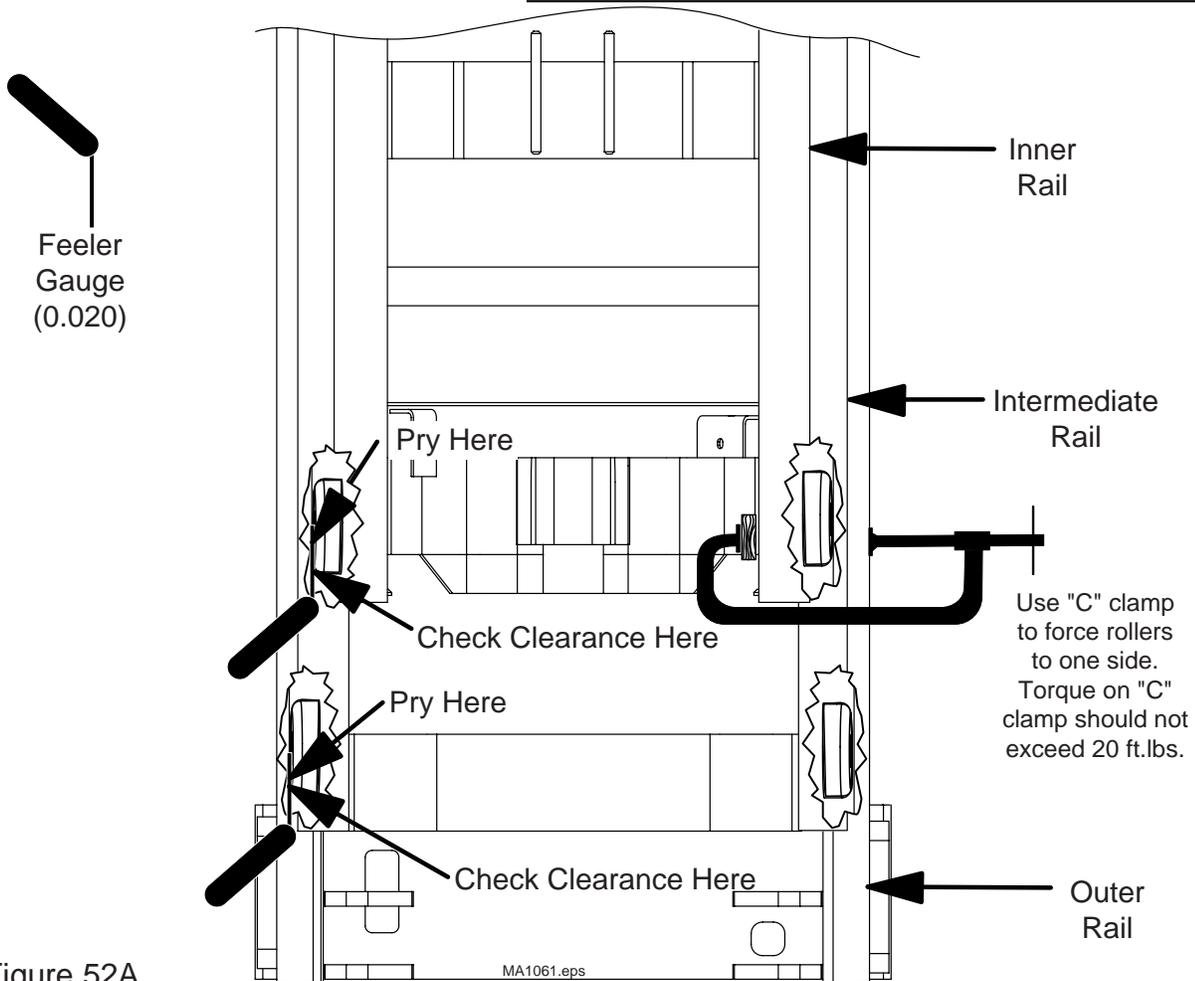
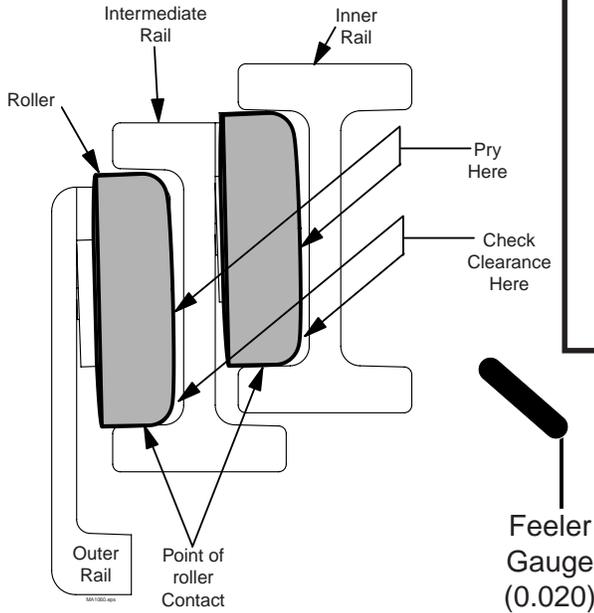


Figure 52A

**Checking Upper Roller Clearance
With upright extended Approximately 1/2 of full extension**

Now check the roller clearance in the same manner as before.

Record the number of shim needed for the outer and inner rails opposite the rollers checked.



**ROLLERS SHOULD BE INSTALLED
"LINE-TO-LINE"
0.020" MINIMUM CLEARANCE**

Refer to adjustment reference chart when using feeler gauges.

| Step | Feeler Gauge | Gauge will Pass / Not Pass | Shimmed Correctly | Shim QTY |
|------|------------------|----------------------------|----------------------|----------|
| 1 | 0.020" 0.050" | PASS NOT PASS | Check with a YES | 0 |
| 2 | 0.050" 0.080" | PASS NOT PASS | Check with a No, ADD | 1 |
| 3 | 0.080" 0.120" | PASS NOT PASS | Check with a No, ADD | 2 |

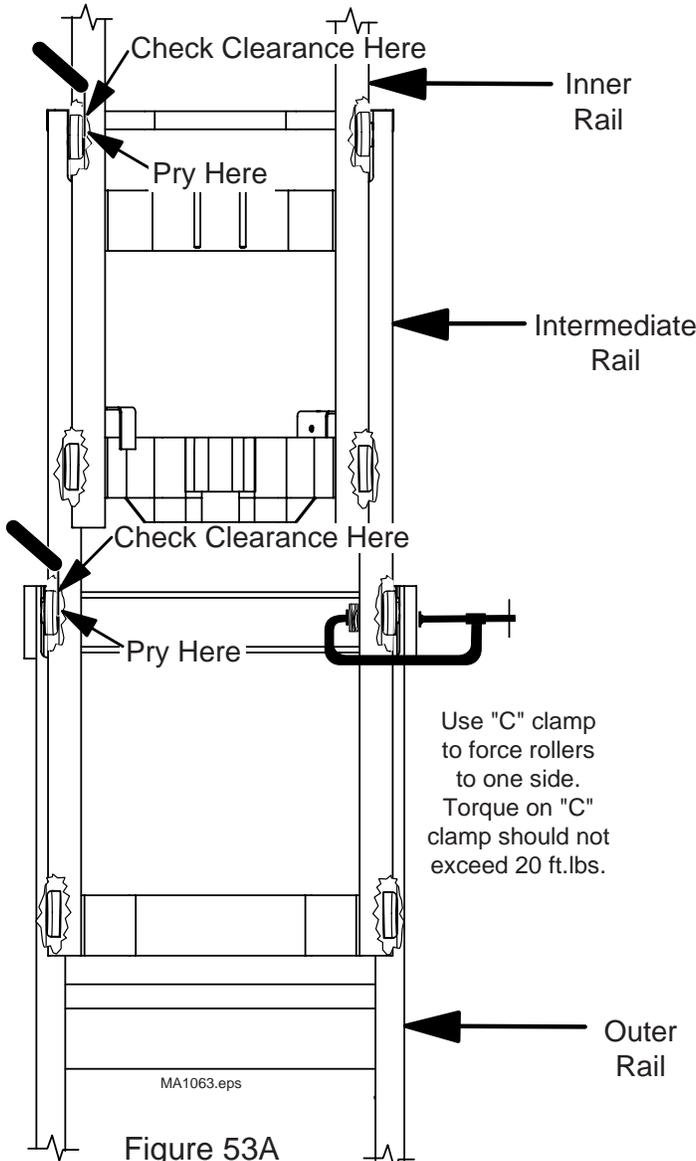


Figure 53A

**Checking Lower Roller Clearance
With upright extended
Approximately 1/2 of full extension**

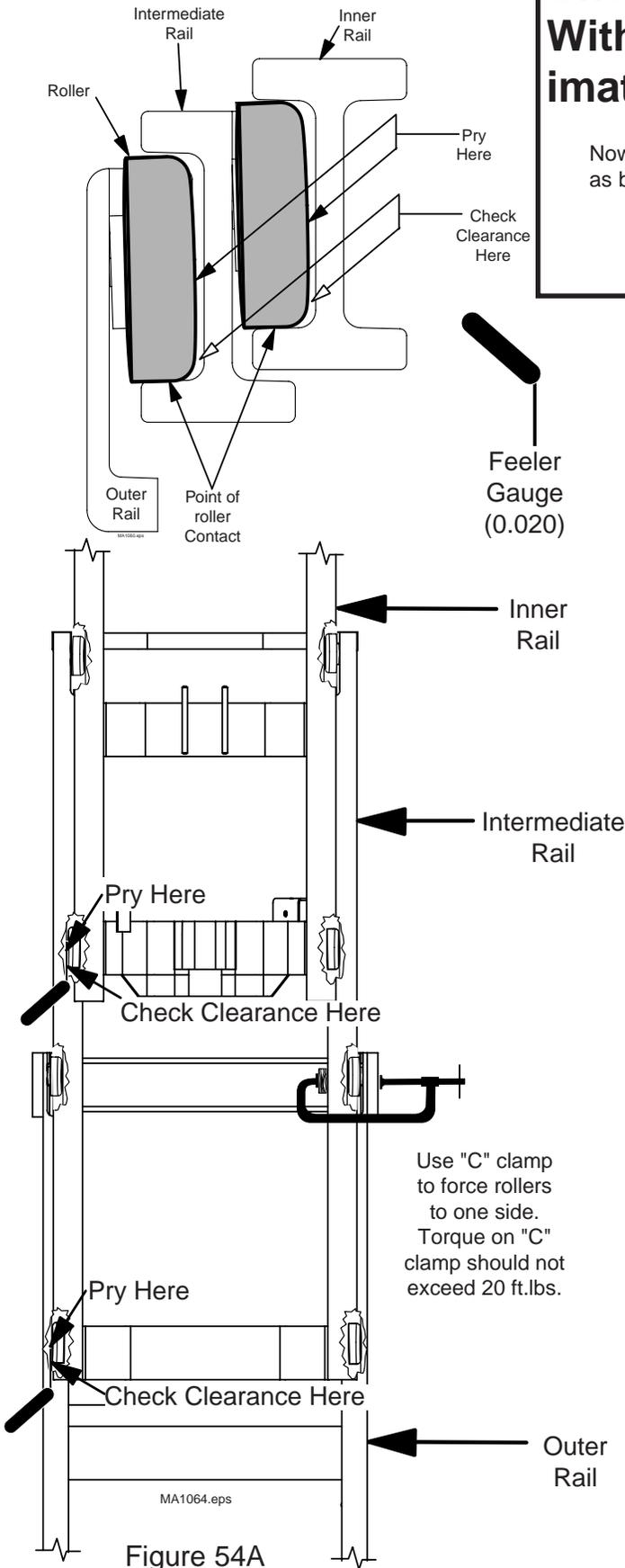
Now check the roller clearance in the same manner as before.

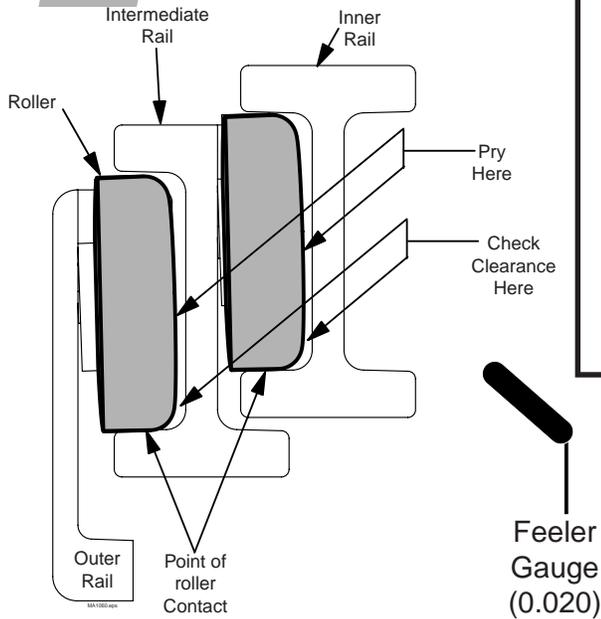
Record the number of shim needed for the outer and inner rails opposite the rollers checked.

**ROLLERS SHOULD BE INSTALLED
"LINE-TO-LINE"
0.020" MINIMUM CLEARANCE**

Refer to adjustment reference chart when using feeler gauges.

| Step | Feeler Gauge | Gauge will Pass / Not Pass | Shimmed Correctly | Shim QTY |
|------|------------------|----------------------------|----------------------|----------|
| 1 | 0.020" 0.050" | PASS NOT PASS | Check with a YES | 0 |
| 2 | 0.050" 0.080" | PASS NOT PASS | Check with a No, ADD | 1 |
| 3 | 0.080" 0.120" | PASS NOT PASS | Check with a No, ADD | 2 |





Checking Upper Roller Clearance With upright extended Approximately to full extension

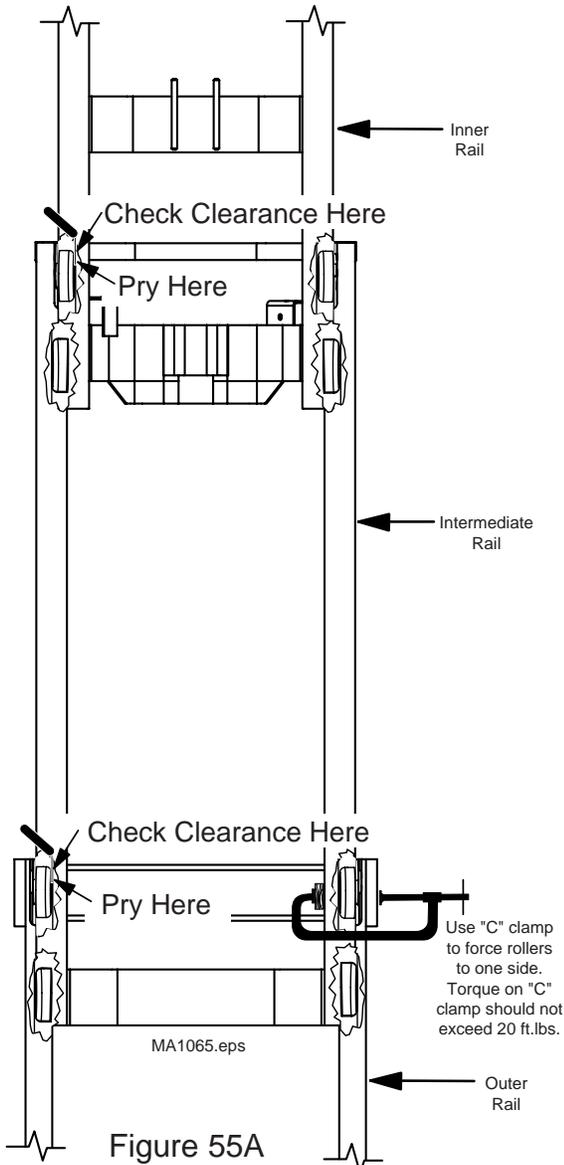
Now check the roller clearance in the same manner as before.

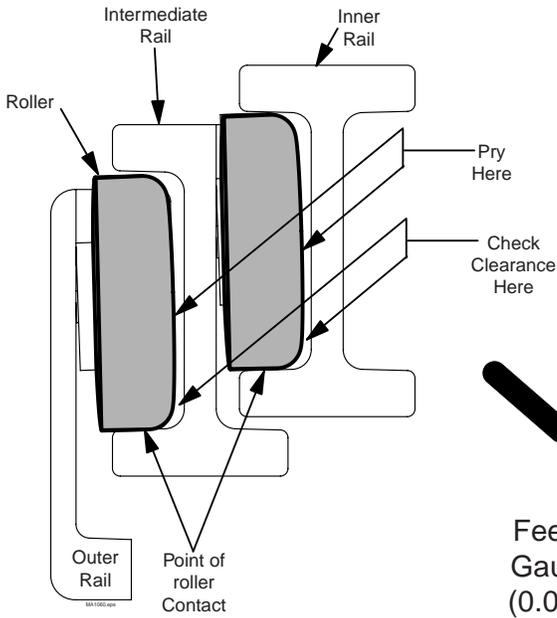
Record the number of shim needed for the outer and inner rails opposite the rollers checked.

**ROLLERS SHOULD BE INSTALLED
"LINE-TO-LINE"
0.020" MINIMUM CLEARANCE**

Refer to adjustment reference chart when using feeler gauges.

| Step | Feeler Gauge | Gauge will Pass / Not Pass | Shimmed Correctly | Shim QTY |
|------|------------------|----------------------------|----------------------|----------|
| 1 | 0.020" 0.050" | PASS NOT PASS | Check with a YES | 0 |
| 2 | 0.050" 0.080" | PASS NOT PASS | Check with a No, ADD | 1 |
| 3 | 0.080" 0.120" | PASS NOT PASS | Check with a No, ADD | 2 |





Checking Lower Roller Clearance With upright extended Approximately within 6" of full extension

Now check the roller clearance in the same manner as before.

Record the number of shim needed for the outer and inner rails opposite the rollers checked.

**ROLLERS SHOULD BE INSTALLED
"LINE-TO-LINE"
0.020" MINIMUM CLEARANCE**

Refer to adjustment reference chart when using feeler gauges.

| Step | Feeler Gauge | Gauge will Pass / Not Pass | Shimmed Correctly | Shim QTY |
|------|------------------|----------------------------|----------------------|----------|
| 1 | 0.020" 0.050" | PASS NOT PASS | Check with a YES | 0 |
| 2 | 0.050" 0.080" | PASS NOT PASS | Check with a No, ADD | 1 |
| 3 | 0.080" 0.120" | PASS NOT PASS | Check with a No, ADD | 2 |

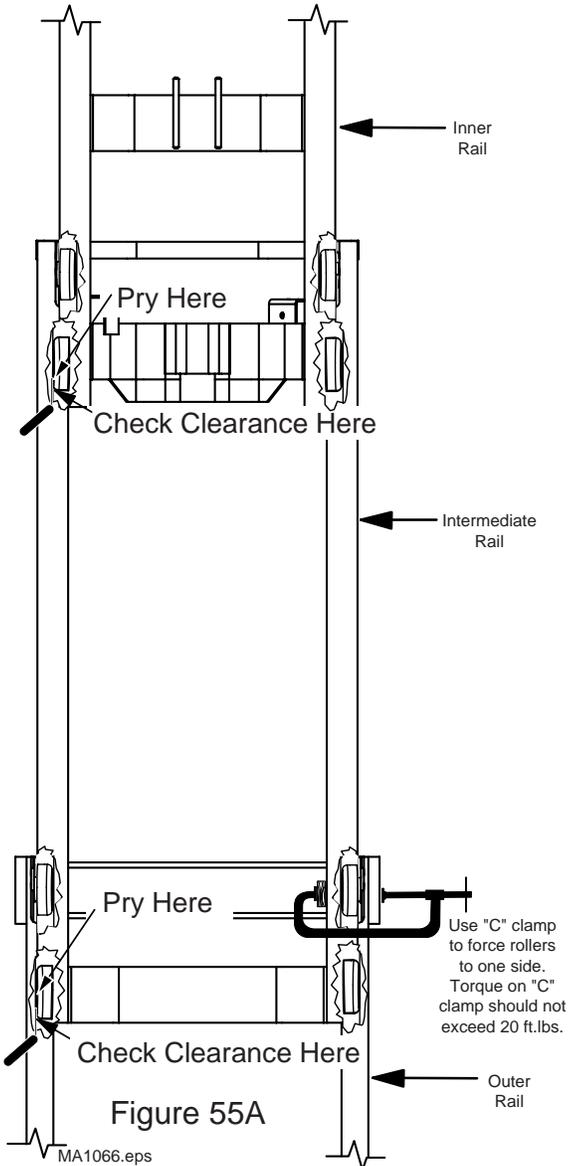


Figure 55A

MA1066.eps

Determining the Number of Shims needed to make roller adjustments

* Refer to step 3. Look at the three numbers that were recorded at each roller on the rails. The smallest of these is the total number of shims that need to be added. "0" means DO NOT add shims.

* If any of the rollers require adjustment, refer to adjustment procedures on next page.

* If the upright roller clearance was checked with the upright mounted to the truck, and roller adjustment is required, remove the upright from the truck as described at the beginning of this section.

* Do not attempt to adjust roller with the upright mounted to the truck.

| # of Shims | Dimension per Shim (in) | Dimension (decimal - in) |
|------------|-------------------------|--------------------------|
| one | 1/32" | 0.031 |
| two | | 0.062 |
| three | | 0.093 |

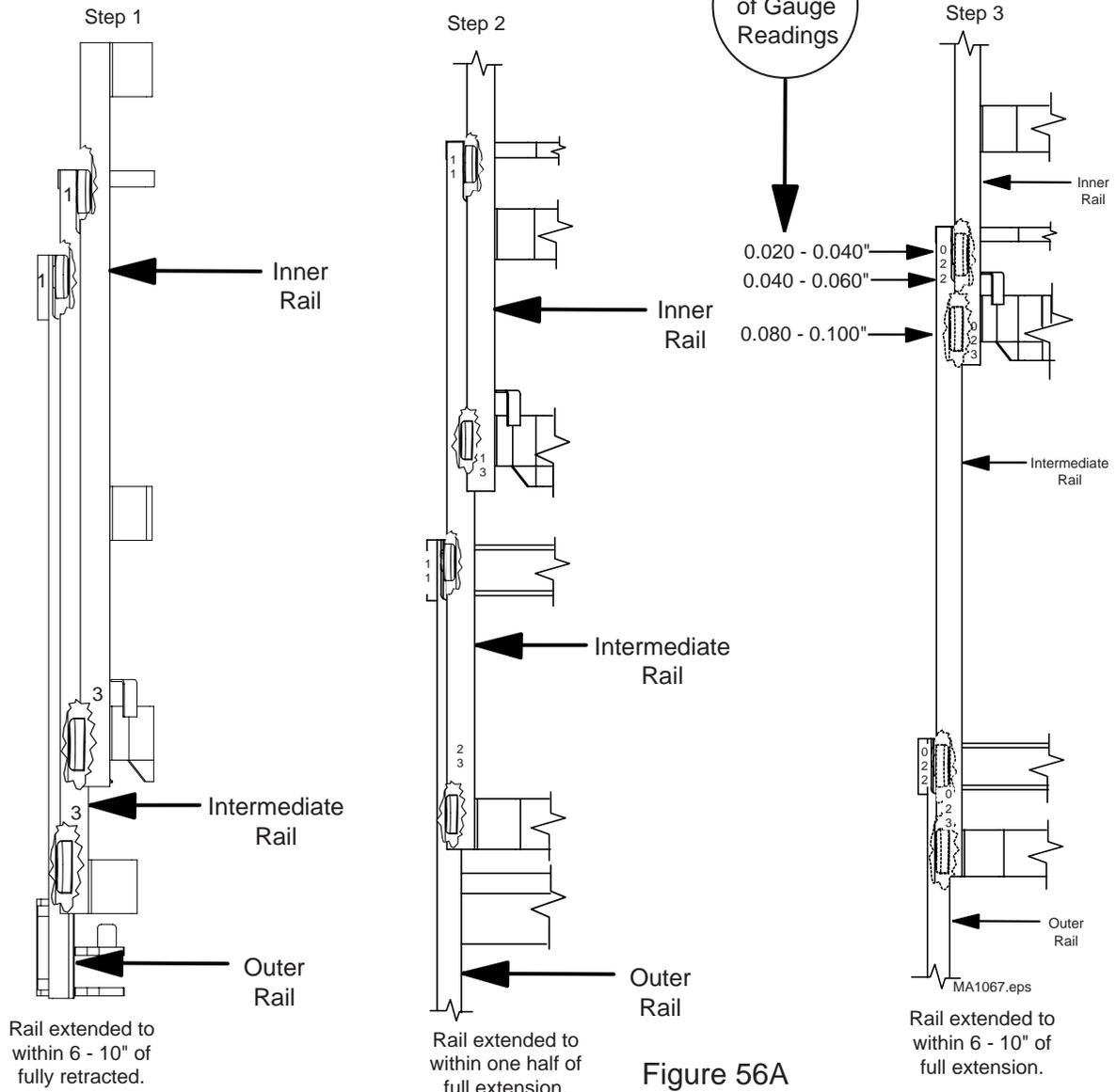
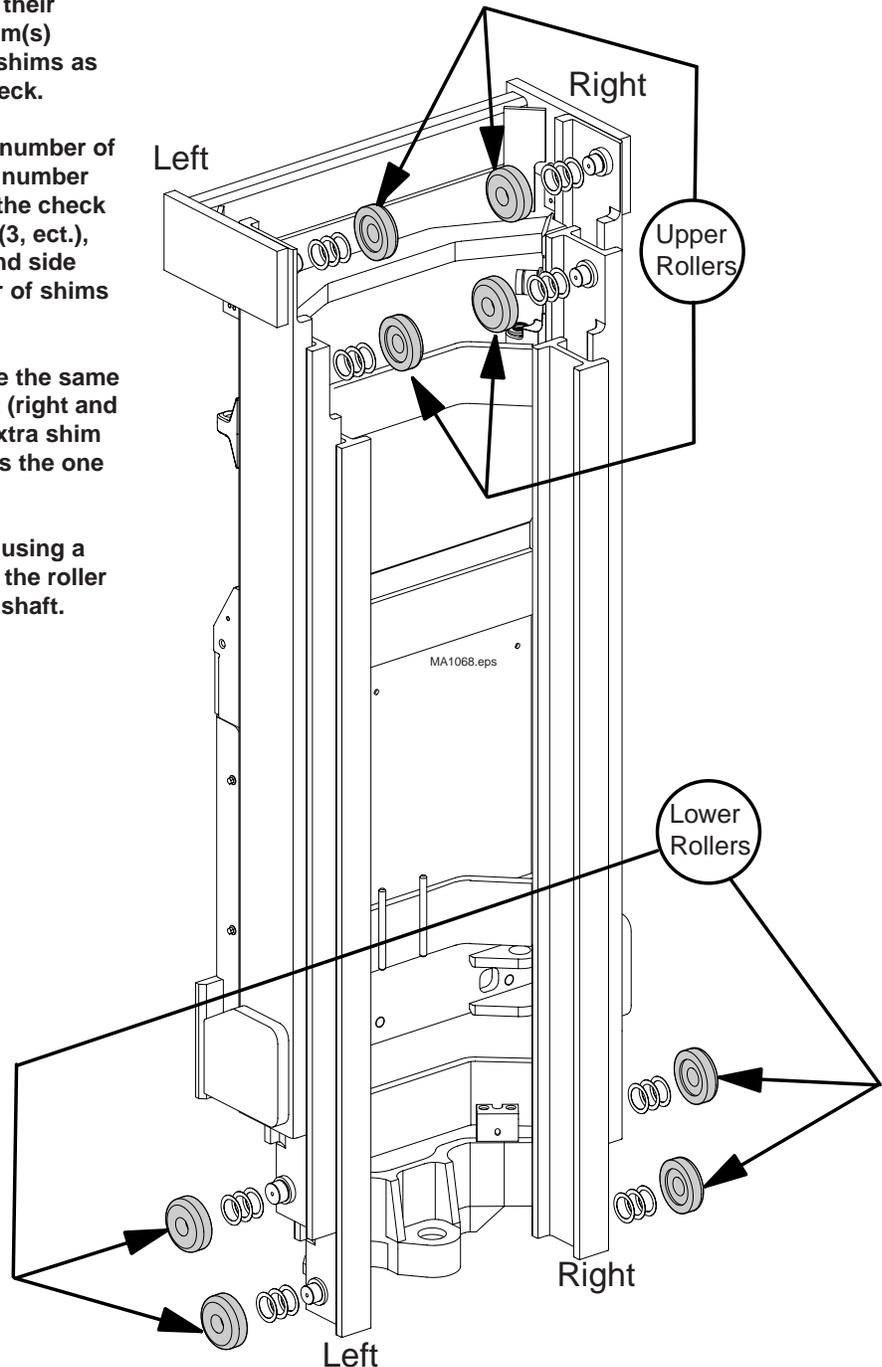


Figure 56A

5.6-3 Shim Adjustment

With the upright laying horizontal on blocking.

- * Expose the rollers by pulling the rails part way out of the bottom as shown.
- * Pull rollers (one set at a time) from their stubshaft. Count the number of shim(s) currently used on each shaft. Add shims as indicated in the roller clearance check.
- * If the check indicates that an even number of shims are needed (2 ect.), split the number between the right and left sides. If the check indicates an odd number of shims (3, ect.), place the odd shim on the right hand side shaft. Always keep the odd number of shims on to one side.
- * The target for adjustment is to have the same number of shims on each roller set (right and left per rail assembly). An odd or extra shim must be placed on the same side as the one before.
- * Reposition each roller on it's shaft using a rubber or plastic mallet. Gently tap the roller to seat it evenly and snugly on the shaft.



Pull Rails part way out the bottom exposing rollers at both ends.

Figure 58A

5.7 Pantograph & Fork Carriage Assembly

The Pantograph Assembly may be serviced while installed in the upright with two exceptions: the carriage rollers and the inner and outer arm bushings must be serviced with the pantograph removed from the upright.

Preparation

- * Move truck to service area.
- * Park truck on a flat level surface.
- * Extend and lower pantograph.
- * Turn key switch **OFF**.

1. Remove Load Back Rest Extension.

Remove bolts from LBR Extension and lift the extension free of the fork carriage.

2. Elevate and Block Pantograph.

- * Turn key switch **ON** and elevate pantograph approximately 3 to 4 feet.
- * Place an oak block (hardwood) between pantograph carriage and ground. Lower pantograph until carriage rests on 4X4 blocking as shown.
- * Tilt forks forward.
- * Turn key **OFF** and remove key.
- * Disconnect truck battery.

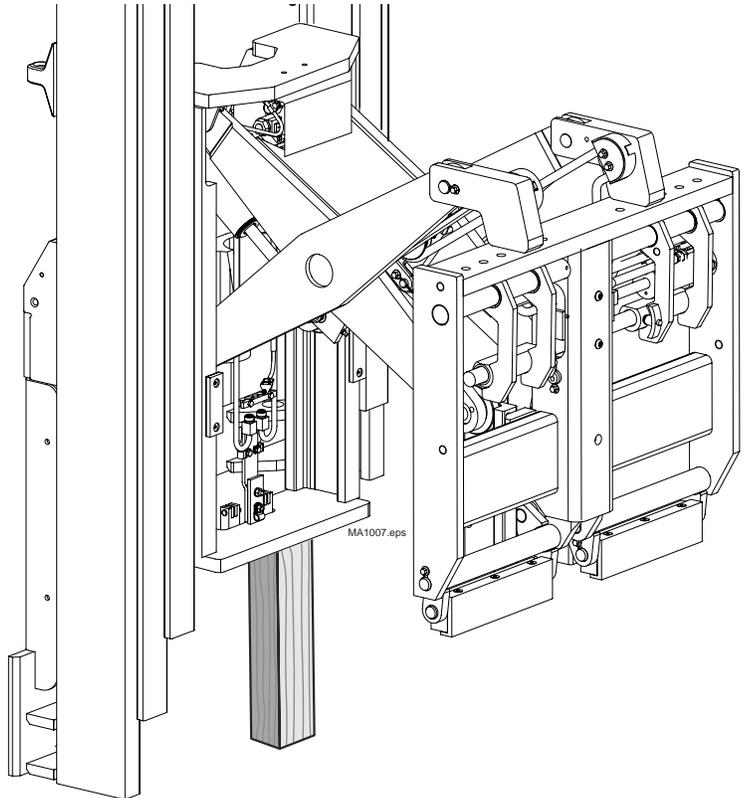


Figure 59A

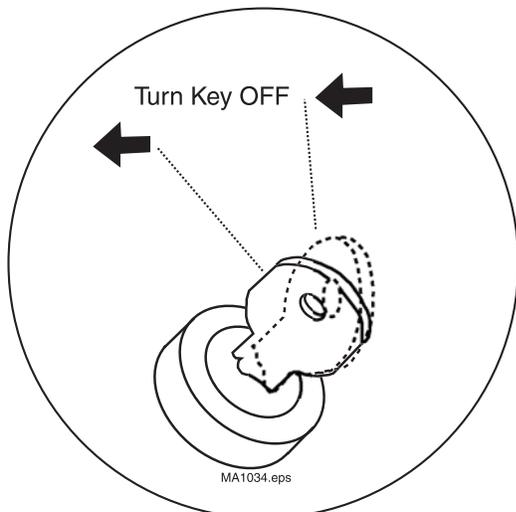


Figure 59B

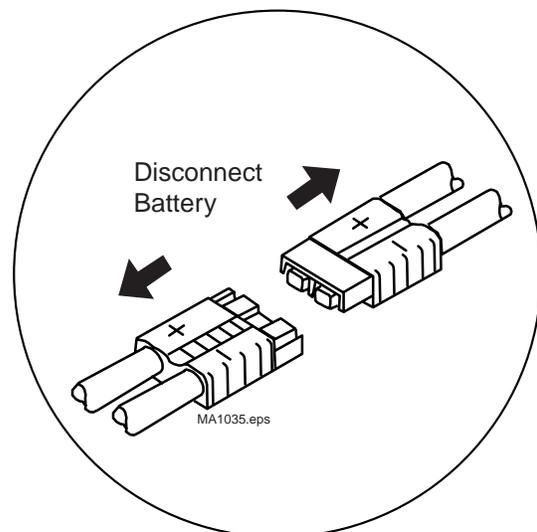


Figure 59C

Standard Models Only

Remove forks.

Refer to illustrations 60A and 61A.

- * Remove fork lock pins and snap ring from the for bar.
- * Remove fork bar from carriage and forks. Using a hammer and brass drift, drive the fork bar in direction of arrows until free of carriage and forks.
- * Remove forks.



WARNING:

Support forks as forkbar is removed so they cannot fall.

Side Shift Models Only

Remove forks.

Refer to illustrations 60B and 61B.

- * Remove fork lock pins and snap ring from the fork bar.
- * Remove snap ring from fork bar (B).
- * Remove fork lock pins from fork guides.
- * Drive fork bar (B) in direction of arrows (with a brass drift).
- * When bar (B) is free of carriage, remove forks.
- * Examine bushings in fork guides (C) for damage. If bushings are unfit for further service, install new bushings.
- * Check fork bar (B) for burrs or excessive wear.



WARNING:

Support forks as forkbar is removed so they cannot fall.

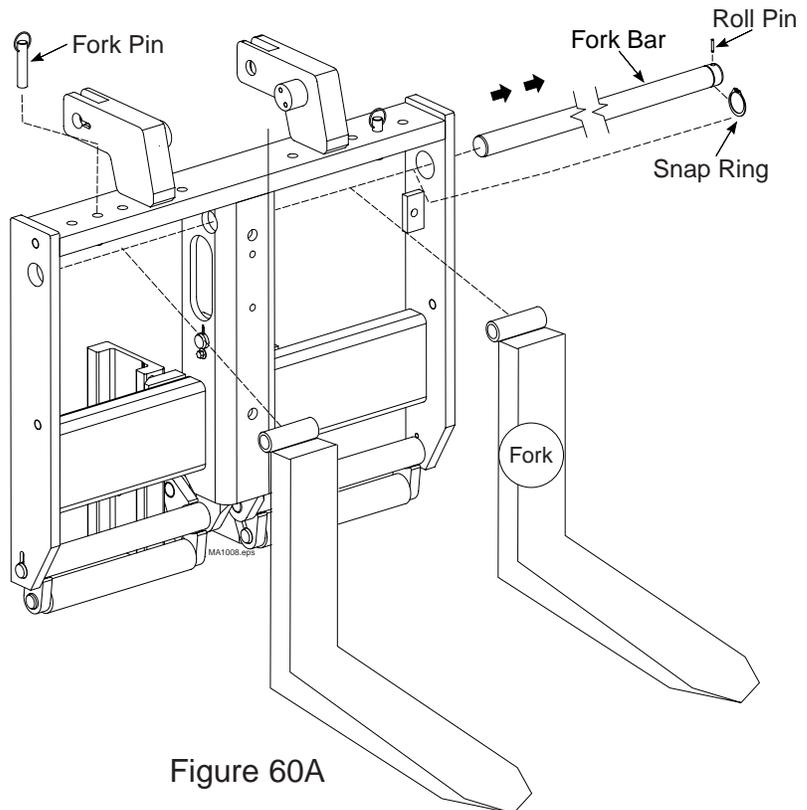


Figure 60A

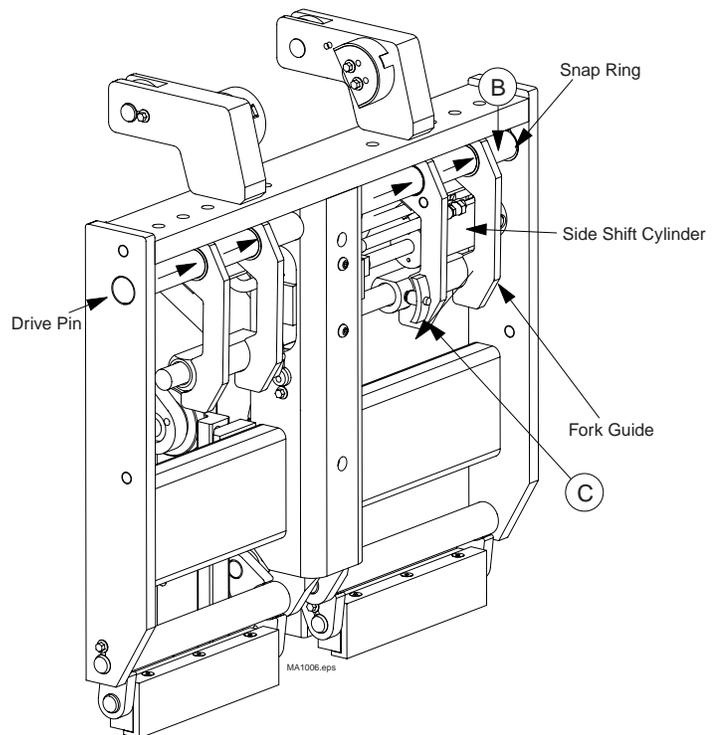


Figure 60B

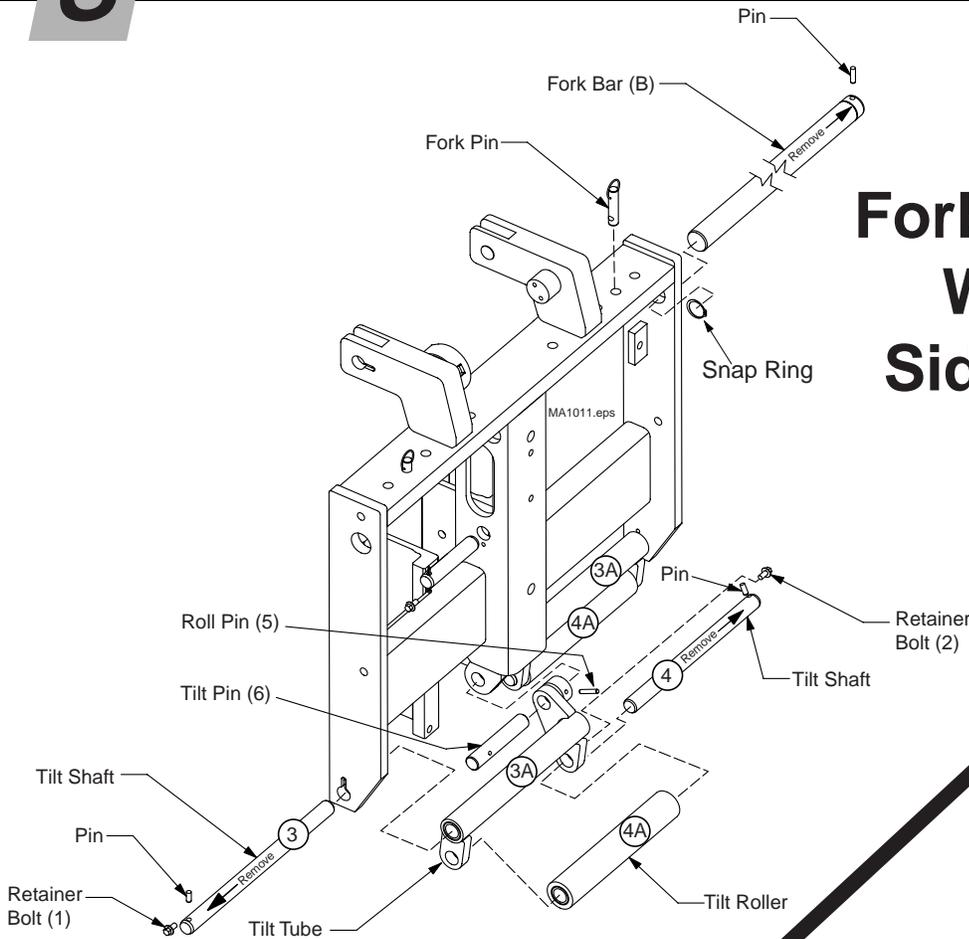


Figure 61A

Fork Carriage Without Side Shifter

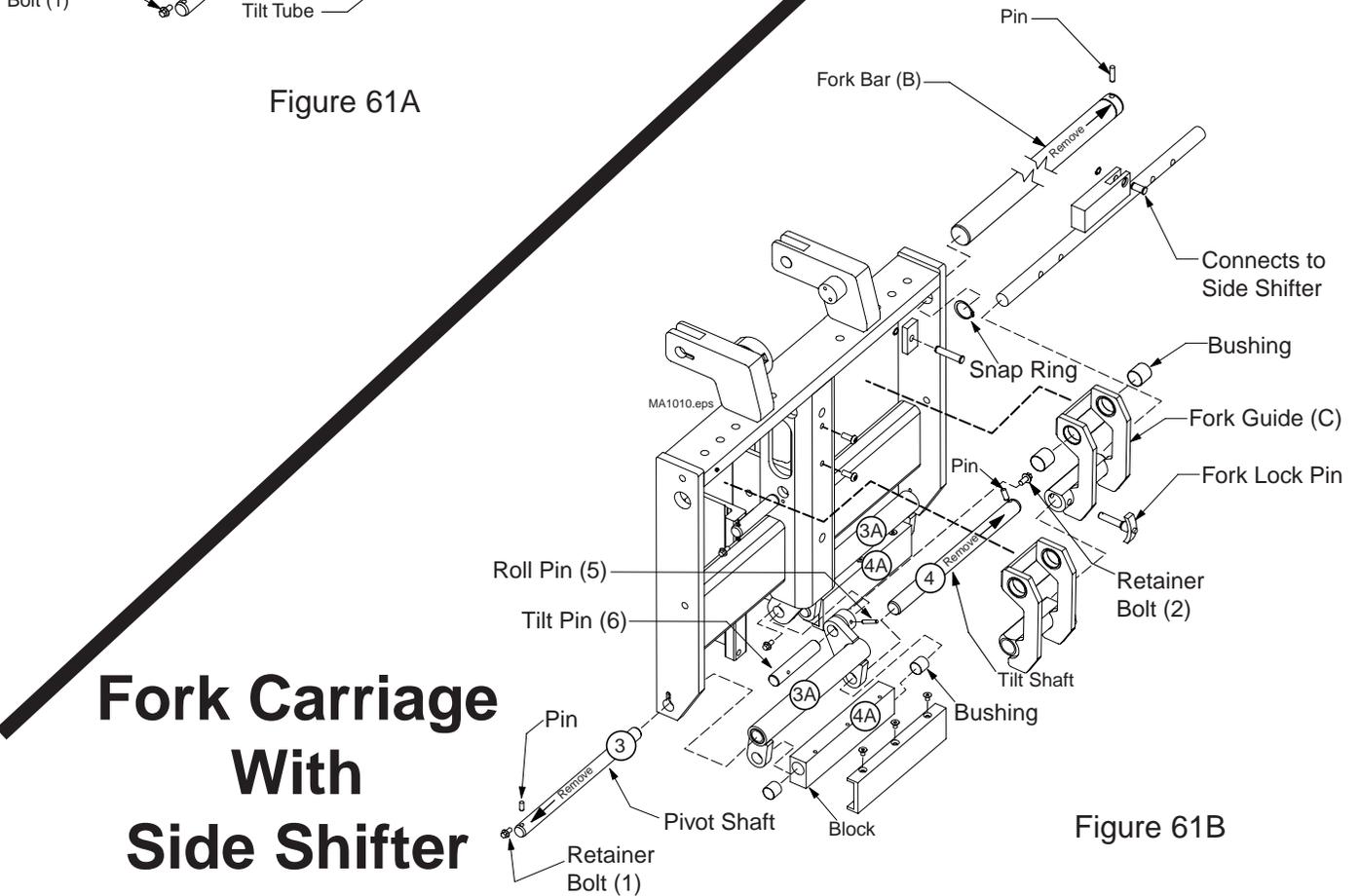


Figure 61B

Fork Carriage With Side Shifter

Servicing Fork Carriage

1. Remove retainer bolt (1 and 2) securing pivot shafts (3 and 4) in position. See figure 62A.
2. Remove roll pin (5) from Tilt Cylinder Rod End Mounting Shaft. See figure 62A.
3. Using a brass drift, drive shaft (6) out of each bell crank (3A) freeing cylinder rod end from both bell cranks. See figure 62A.
4. Using a brass drift, drive shaft (4) out of roller (4A) and bell crank.
5. Now, drive shaft (3) outward free of bell crank (3A). Remove shaft and bell crank. See Figure 62A.
6. Remove old bushings and press in new ones.

NOTE

The bell crank and tilt roll (or block) may be removed as a subassembly. Removing shaft (3) will allow both bell crank (3A) and roller (4A) to be removed as a subassembly.

7. Installation is the reverse of removal.

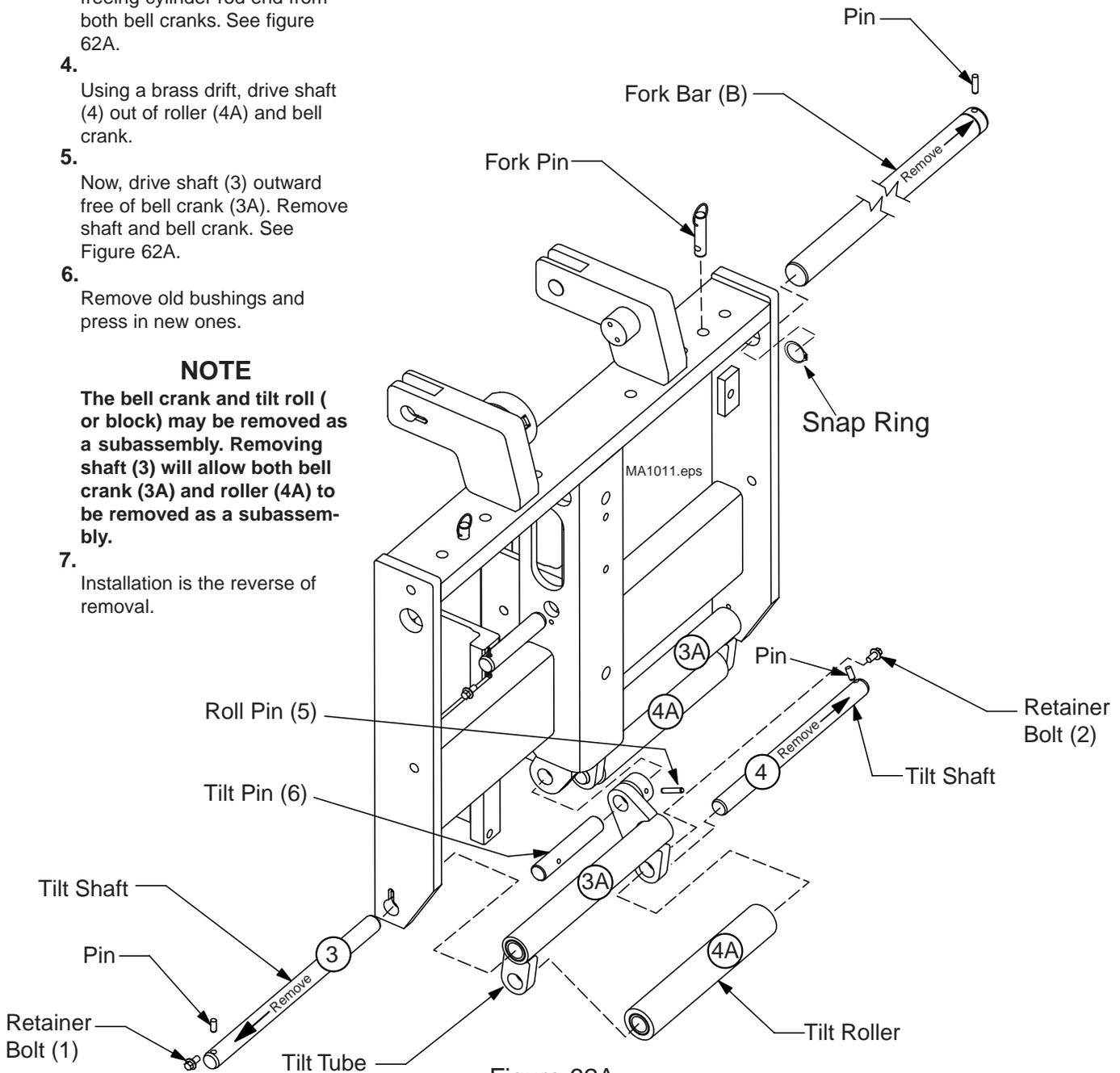


Figure 62A

Fork Carriage Removal

Side Shift Models Only

1. Remove cover bolts and cover (1).
2. Remove harness clamp (3).
3. Remove both cable and hose covers (4).

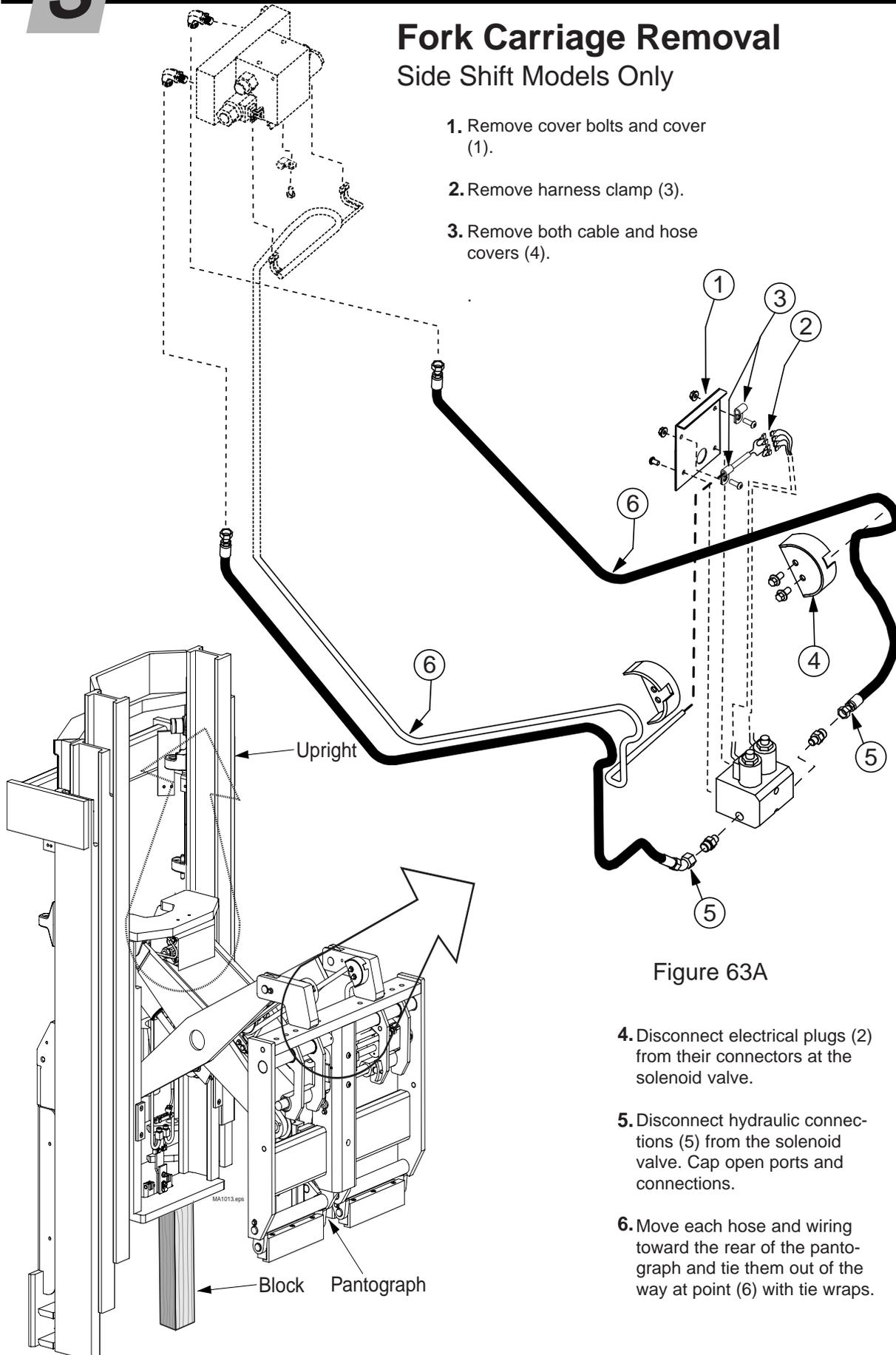


Figure 63A

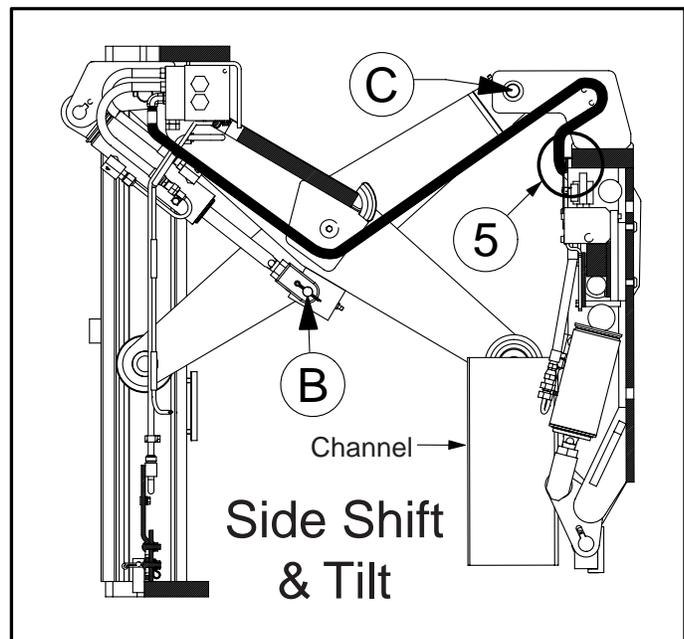
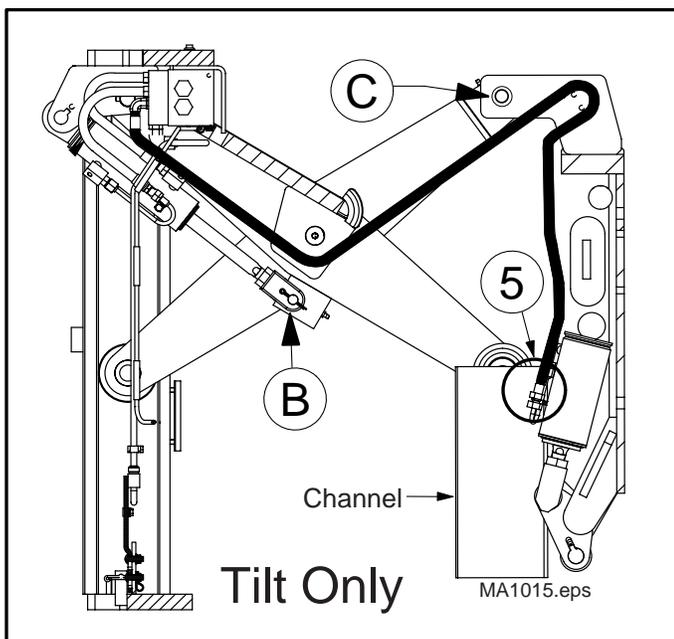
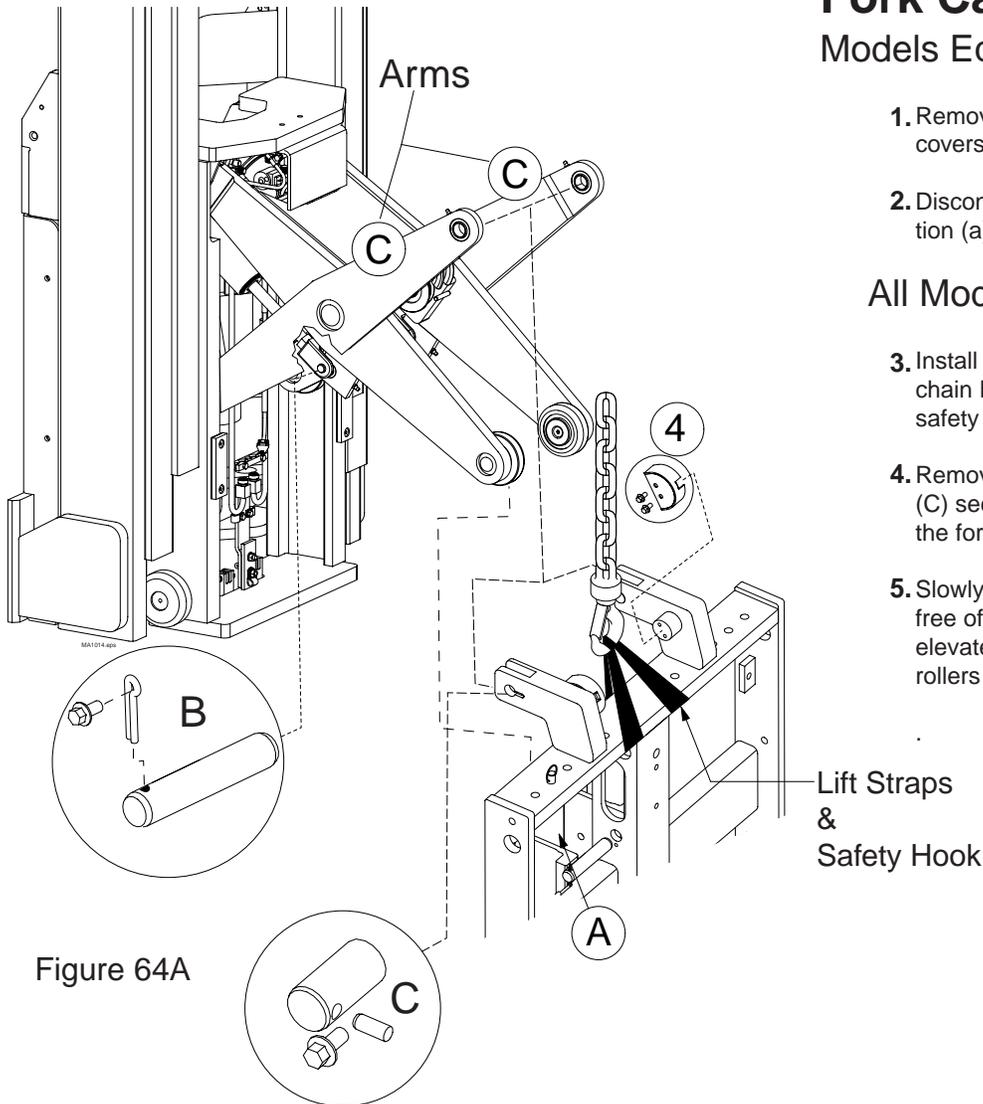
4. Disconnect electrical plugs (2) from their connectors at the solenoid valve.
5. Disconnect hydraulic connections (5) from the solenoid valve. Cap open ports and connections.
6. Move each hose and wiring toward the rear of the pantograph and tie them out of the way at point (6) with tie wraps.

Fork Carriage Removal Models Equipped with Tilt Only

1. Remove both cable and hose covers (4), See below.
2. Disconnect hydraulic connection (a) from tilt cylinders.

All Models

3. Install lifting straps as shown to chain hoist equipped with safety hook.
4. Remove retainer bolts and pins (C) securing scissor arms to the fork carriage.
5. Slowly elevate carriage until free of arms. Continue to elevate until lower scissor rollers are free to one side.



Servicing Pantograph Arm Rollers

Thrust Pads (Scissor Arm Roller "B" & "C")

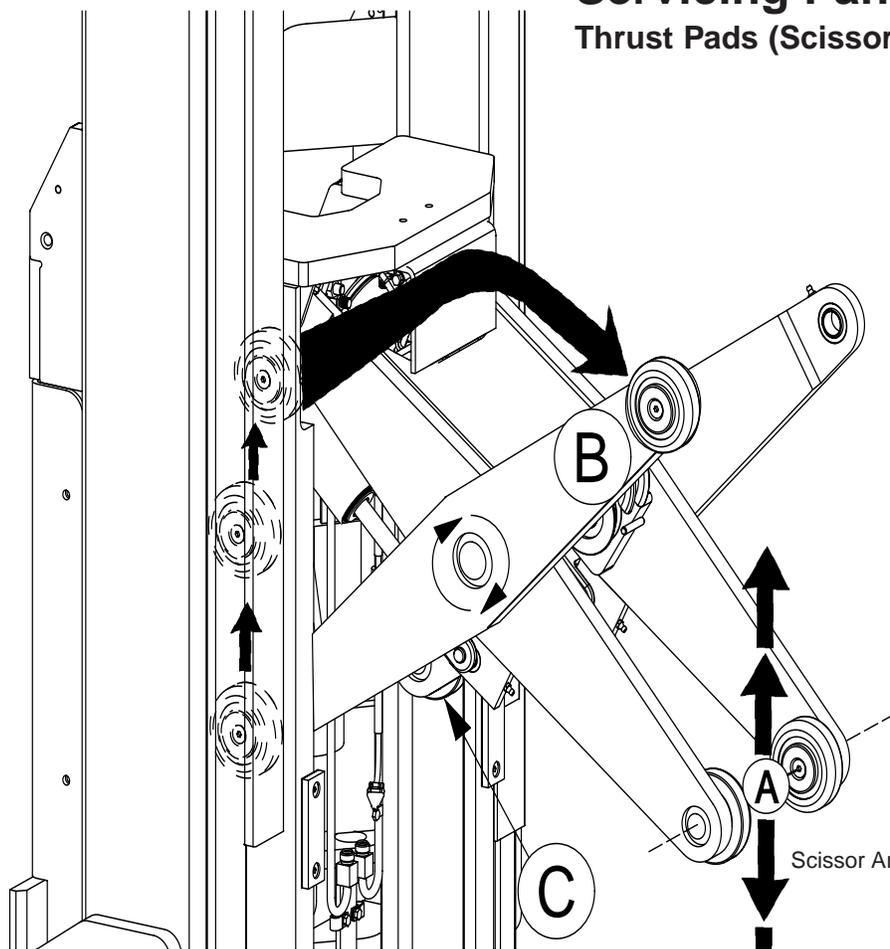
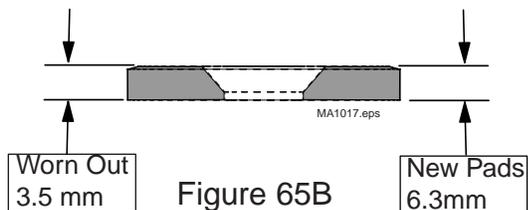
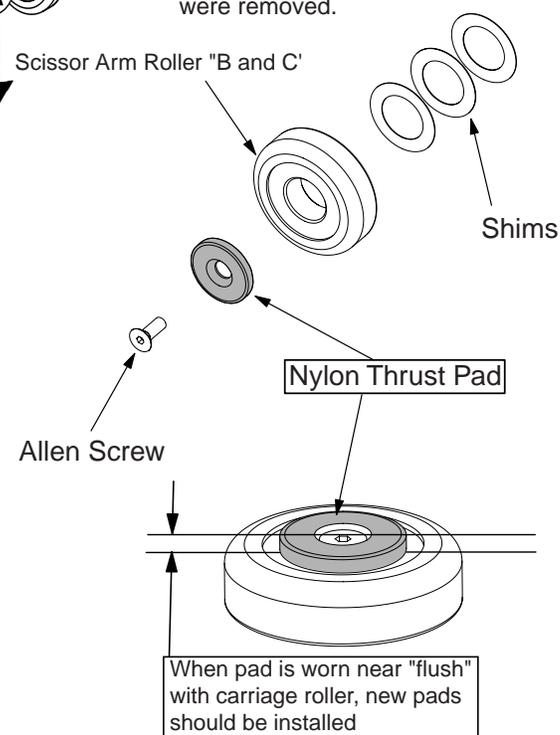


Figure 65A

1. Disconnect reach arm cylinders. See figure 65A. Remove retainer bolts and pins (item "B") securing reach cylinder to pantograph arms.
2. Lift reach arms (A) upward while pivoting arm (B) in direction shown in figure 65A. This allows access to arm roller and thrust pad without removing scissor assembly from carriage.
3. Inspect the thrust pads for further service as shown in figure 65B. Pads that are damaged or worn to their wear limit should be removed and new pads installed.
4. Remove Allen screw and pad. Install new pad. Be certain same number of shims are installed on the shaft if they were removed.



To Remove Arm Roller "B" (or "C"):

Slowly move Arm "A" (up as required) while rotating Arm "B" (as shown) to move arm roller upward and out of the carriage channel.

Be extremely careful that you do not "pinch" your hands or fingers.

Figure 65B

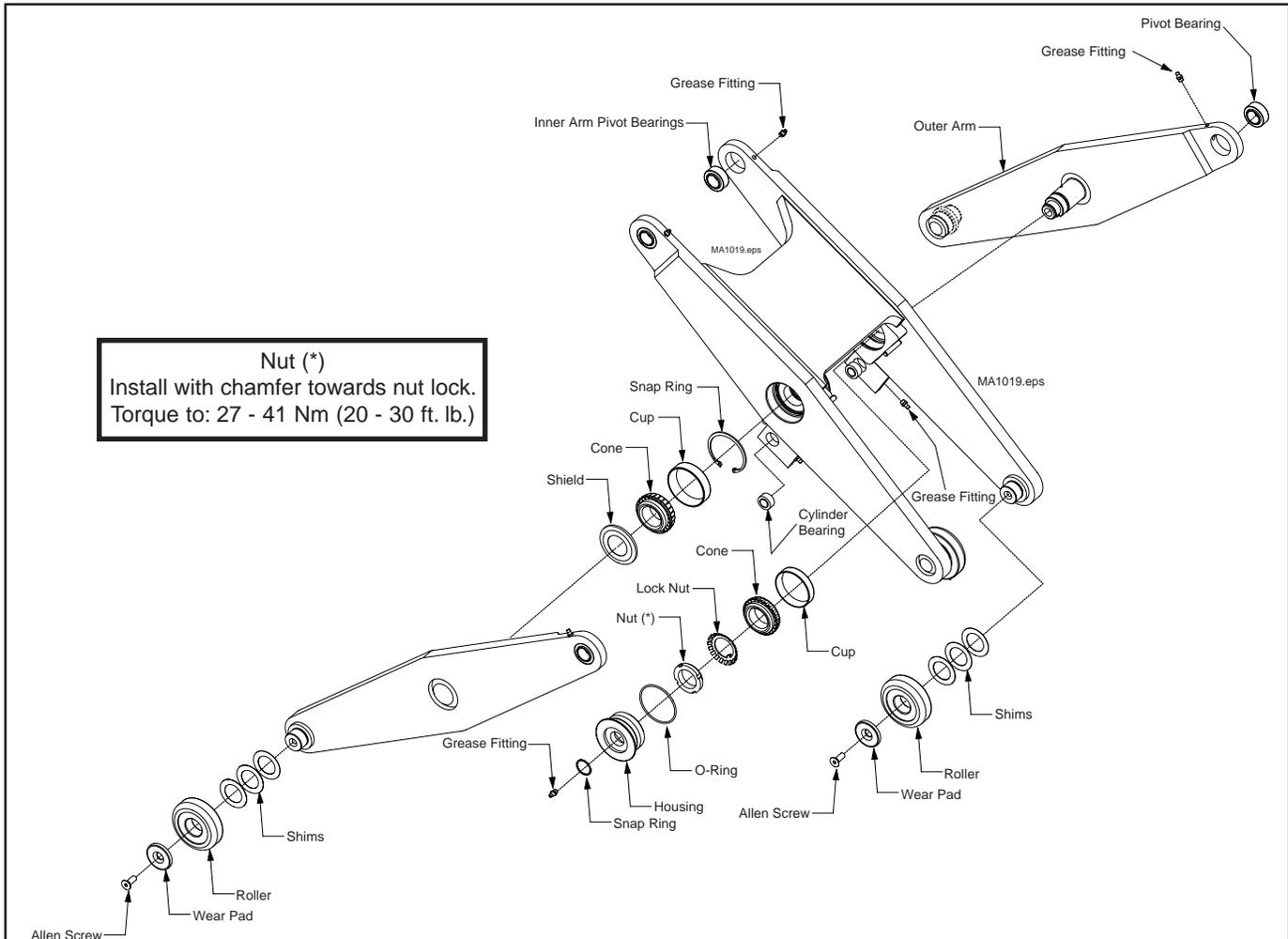


Figure 66A

5. Disassemble the outer arm assembly.
6. Replace seals with new ones.
7. Wash bearings (cups and Cones) in a Stoddard type solvent. Inspect parts for further serviceability. Replace any part that is nicked or having rough spots in the cones or cups. Cones and cups must be replaced together. Do not install a new cone in an old cup.
8. Check grease fitting for damage and to make certain none are missing.

NOTE

If the Inner Arm Pivot Bearings need to be replaced, the pantograph carriage must be removed from the upright.

9. Reassemble to the reverse of disassembly.

Lubricate parts with clean chassis grease prior to assembly.

Important

Prepack bearing cup and cone assemblies prior to installation

5.7-1 Tilt Cylinder Overhaul Cylinder Removal

Extend Pantograph as described in section 5.4.

Fork removal

Refer to figure 67A.

1. Remove fork lock pins and snap ring from the fork bar.
2. Remove snap ring from fork bar (B).
3. Remove fork lock pins from fork guides.
4. Drive fork bar (B) in direction of arrows (with a brass drift). When bar (B) is free of carriage, remove forks.
5. Remove old bushings and press in new bushings.
6. Check fork bar (B) for burrs or excessive wear.



WARNING:

Support forks as forkbar is removed so they cannot fall.

Cylinder removal:

Remove the fork carriage as described on page 65.

Refer to figure 67A.

1. Extend the tilt cylinder completely.
2. Remove retainer bolt (1 and 2) securing pivot shafts (3 and 4) in position. See figure 80.
3. Remove roll pin (5) from Tilt Cylinder Rod End Mounting Shaft. See figure 80.
4. Using a brass drift, drive shaft (6) out of each bell crank (3A) freeing cylinder rod end from both bell cranks. See figure 80.
5. Using a brass drift, drive shaft (4) out of roller (4A) and bell crank.

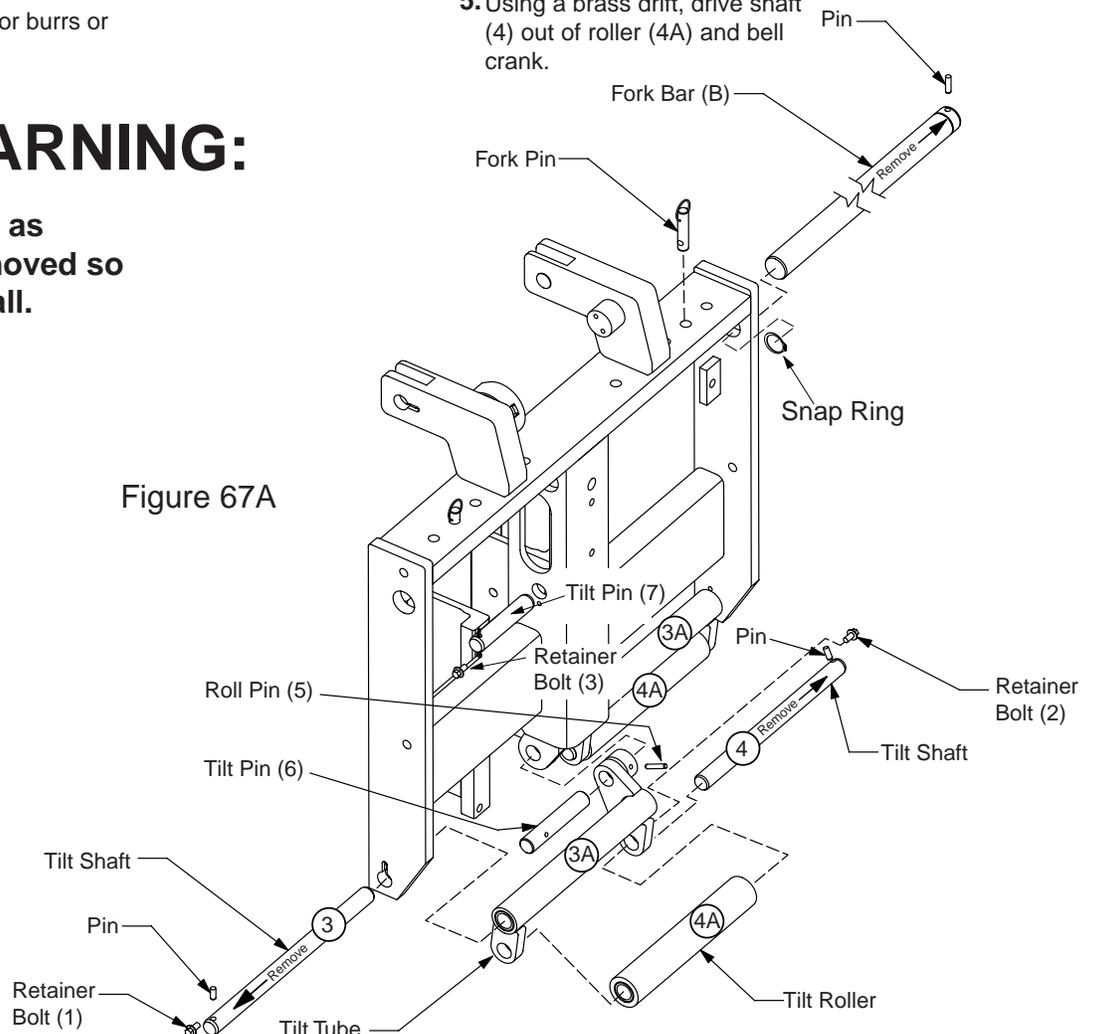


Figure 67A

Cylinder Removal (Continued)

Cylinder removal:

Remove the fork carriage as described on page 65.

Refer to Figure 67A.

6. Now, drive shaft (3) outward free of bell crank (3A). Remove shaft and bell crank. See Figure 80.
7. Remove old bushings and press in new ones.
8. Remove roll pin (5) from tilt cylinder rod end mounting shaft.
9. Remove the Retainer bolts and tilt pins (3) & (7) from each end of the side shifter cylinder.
10. Rotate the cylinder slightly to access the hose connectors.
11. Loosen the hose connectors and remove. Plug all open ends.
12. Remove the cylinder and place on a clean workbench.

Preparation Cleaning and Inspection

1. The exterior surface of a cylinder should be thoroughly washed before disassembly.
2. A soft fiber brush should be used to remove debris and foreign objects from grooves and threaded areas, etc.
3. A Stoddard type cleaning solvent should be used to wash the cylinder.
4. Threaded area of piston rod should be examined for damage, stripping or marring after removal of rod end and jam nut. The bushing in rod end should be inspected for further serviceability.

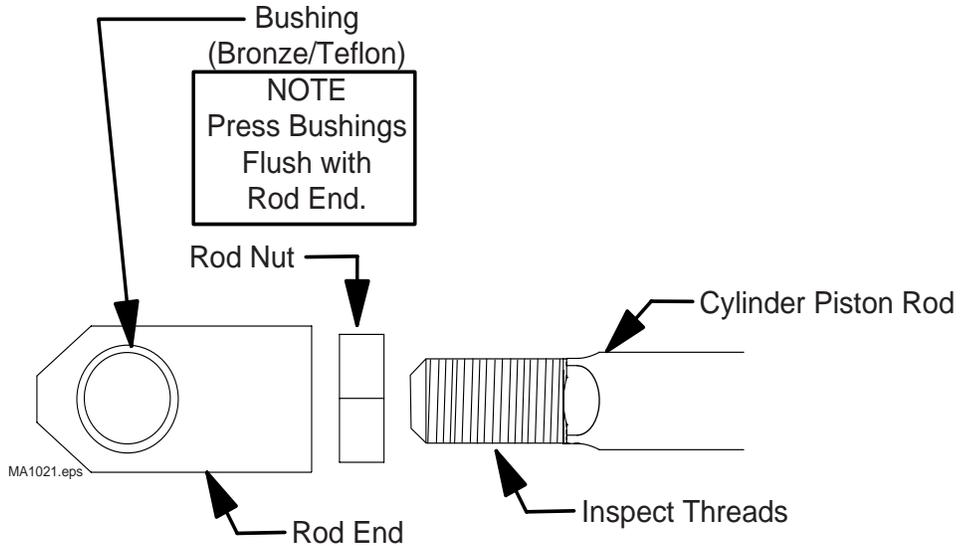


Figure 69A

5. All foreign objects should be removed from between threads on the piston rod, in the nut and rod end.
6. Any part unfit for further service should be replaced with new part.

**IMPORTANT
HOSE MUST BE ROUTED
AS SHOWN**

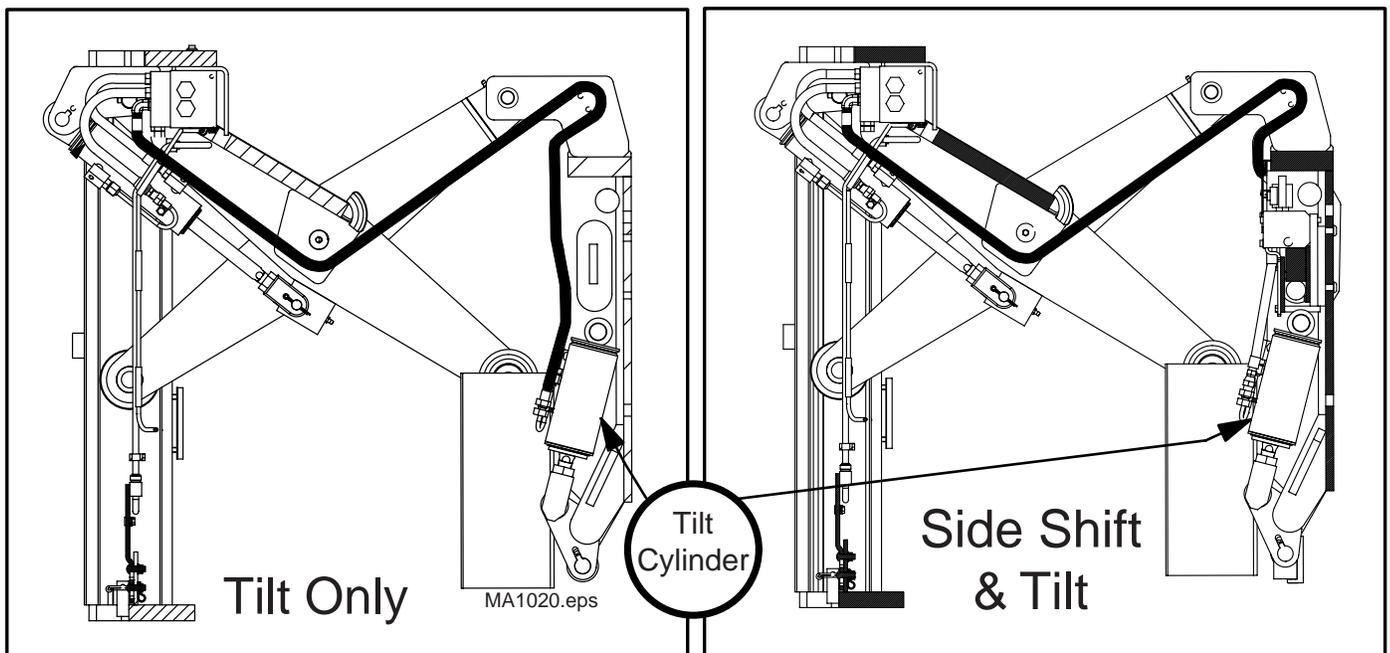


Figure 69B

Disassembly (Refer to Illustration Below)

Wash exterior of the tilt cylinder in a Stoddard type cleaning solvent before disassembly. Use a brush to remove grease and grime from the cylinder tube, anchor and rod ends. Remove rod end and jam nut.

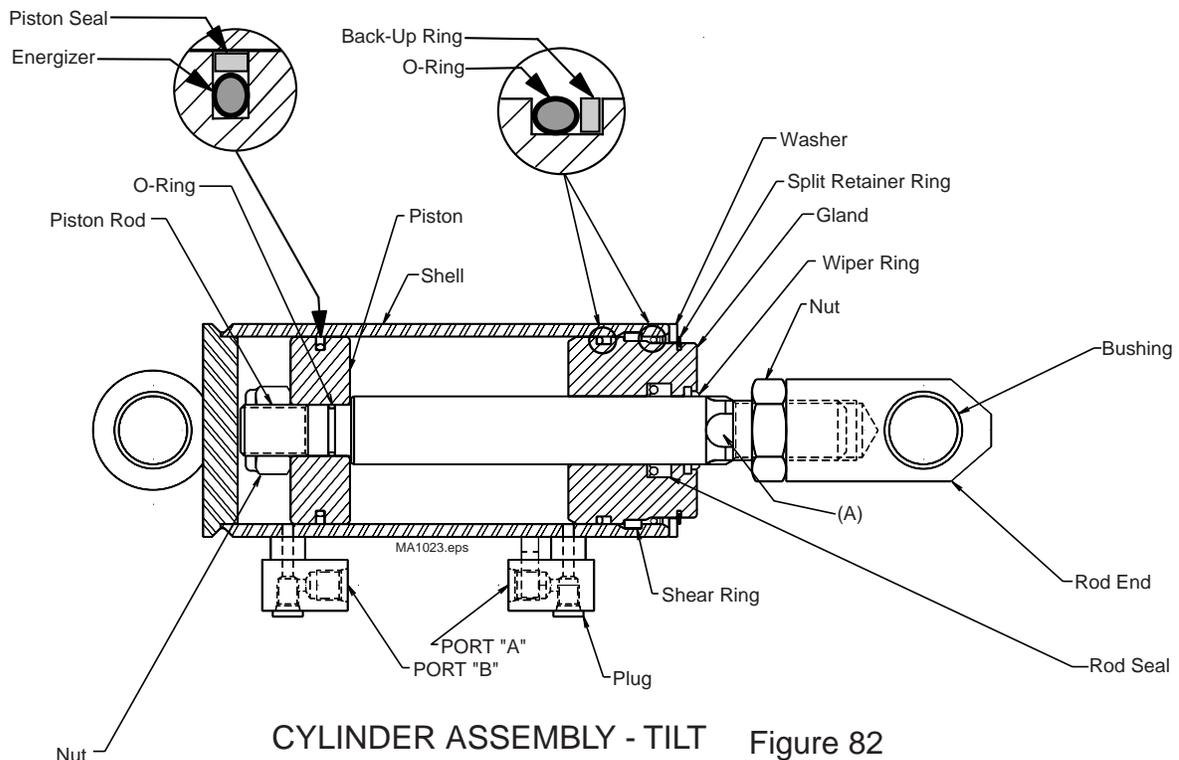
1. Place cylinder in a vise equipped with soft jaws. Do not overtighten - distort barrel.
2. Push piston rod all the way into cylinder.
3. Using a narrow blade screwdriver, remove the split type retainer ring.
4. Remove washer.
5. Remove white backup ring.
6. Remove O-Ring.
7. Using a bronze drift, gently tap gland assembly into cylinder housing clear of the shear ring.
8. Using a screwdriver, carefully lift end of shear ring from it's groove. *Be careful not to nick or scratch the piston rod.*
9. With a pair of pliers, carefully pull shear ring from cylinder tube. *Again, be careful not to nick or scratch the piston rod.*
10. Pull outward on piston rod until rod and gland are free of cylinder housing. Remove gland.

Gland Assembly

1. Remove wiper ring.
2. Remove rod seal from inner groove. *Be careful that you do not nick or scratch surface of gland assembly.*
3. Remove outer O-Ring and backup ring from the gland assembly.
4. Discard seals, wiper and backup rings.

Piston Rod and Piston

1. Using a 3/4" open end wrench, hold the rod using the "flats" provided just below threaded area of piston rod, see arrow (A) below. Now install a 1-1/8 in. socket onto the piston rod nut.
2. Remove nut from piston rod while holding retainer rod.
3. Pull piston free of piston rod.
4. Remove O-Ring from piston rod and discard.
5. Remove sealing ring and the energizer from piston. Use care not to nick or scratch piston surfaces.
6. Discard O-Ring, sealing ring and energizer. Always install new seals.



CYLINDER ASSEMBLY - TILT Figure 82

Cleaning and Inspection

1. Discard old seals, wiper and shear ring.
2. Wash all parts in a Stoddard type cleaning solvent and dry with a clean lint free shop rag.
3. Inspect cylinder mounting bushings for damage. Both the rod end and anchor ends have two bushings each end. If the bushings show signs of wear and/or damage, they may be pressed out and new bushing installed. New bushings should be pressed flush with outer surface of the anchor and rod ends. Refer to figure 71A.
4. Inspect threaded parts for damage. Examine cylinder barrel for scoring, nicks or scratches. The cylinder barrel may be sanded with crocus cloth to remove minor scratches, etc.. *Be careful not to remove the chrome plating when polishing the surface.* Replace all damaged or unserviceable parts.
5. Inspect surfaces of the piston and piston rod to be sure they are clean, smooth and free of damage.

Reassembly

1. Using only new seals and O-Rings, lubricate all parts with clean hydraulic fluid.
2. Lubricate and install the energizer ring into the groove in the piston. Refer to figure 70A.
3. Lubricate and install the piston seal over the energizer. *Be careful not to nick or cut the seals.*
4. Place a plastic parts bag over the threaded area of the piston rod (to protect seal). Slide a new O-Ring over the bag and into the groove in the piston rod.
5. Remove bag and install piston onto rod. Carefully slide the piston over the O-Ring and up against the rod shoulder.
6. Install nut onto piston rod finger tight against the piston.
7. Install the 3/4" wrench back into the "flats" provided in the piston rod.
8. Using a torque wrench and 1-1/8 in. socket, torque nut to 201 - 230 ft. lbs. (273 - 312 Nm).
9. Now, lubricate the piston and piston rod with clean hydraulic fluid.
10. Start piston into cylinder tube while gently pushing and rotating piston rod until piston and seal have passed the shear ring groove in the cylinder tube. *Be careful not to damage seal.*

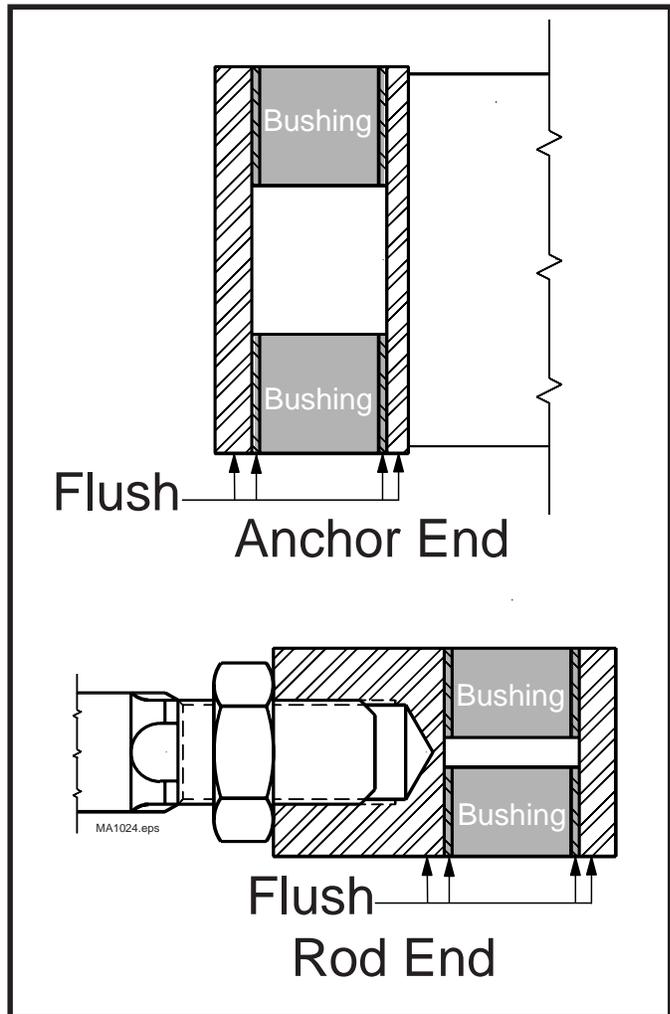


Figure 71A

11. Shove the piston rod all the way into the cylinder tube until it bottoms.

Gland Assembly

1. Lubricate new seals, wiper ring and gland assembly with clean hydraulic fluid.
2. Install the inner seal, with the **sealing lip** facing inward, into the gland groove. *Be careful not to nick the sealing lip upon installation.*
3. Install a new wiper into gland.
4. Lubricate and install a new backup ring into the outer groove on the gland.

Gland Assembly (Continued)

5. Lubricate and install a new O-Ring in the groove next to the backup ring. Note the position of the backup and O-Ring per above diagram.
6. Place a plastic parts bag over the threaded end of the rod (to protect seals) and carefully slide the gland over the rod and into the cylinder housing.
7. Push gland as far as it will go into the housing.
8. Insert the open end of a new shear ring into the cylinder housing while pushing on the ring with your fingers. Push ring inward as far as you can.
9. Using a bronze punch, gently tap ring the rest of the way into the tube and groove. Be sure the shear ring is fully seated in it's groove.
10. Pull the piston rod out as far as it will come. This will position the gland so that the retainer ring groove is located above the cylinder housing.
11. Lubricate a new O-Ring and place it over the gland and into the housing on top of the gland.
12. Lubricate a new backup ring and place it over the O-Ring just installed.
13. Install the washer over the gland and next to the backup ring previously installed.
14. Install a new split retainer into it's groove in the gland assembly. Be sure it is completely seated in it's groove.
15. Install jam nut and rod end to the same location it was when removed from the piston rod.
16. Cap cylinder ports until the cylinder is installed on the truck.
17. Check fluid level of truck once cylinder have been installed.
18. Purge air from hydraulic system by cycling cylinders several times to force air from the lines into the sump tank.

5.7-2 **Reach Cylinder Overhaul****Cylinder Removal**

Extend Pantograph as described in section 5.4.

Fork removal

Refer to figure 73A.

1. Remove fork lock pins and snap ring from the fork bar.
2. Remove snap ring from fork bar (B).
3. Remove fork lock pins from fork guides.
4. Drive fork bar (B) in direction of arrows (with a brass drift). When bar (B) is free of carriage, remove forks.
5. Remove old bushings and press in new bushings.
6. Check fork bar (B) for burrs or excessive wear.

**WARNING:**

**Support forks as
forkbar is removed so
they cannot fall.**

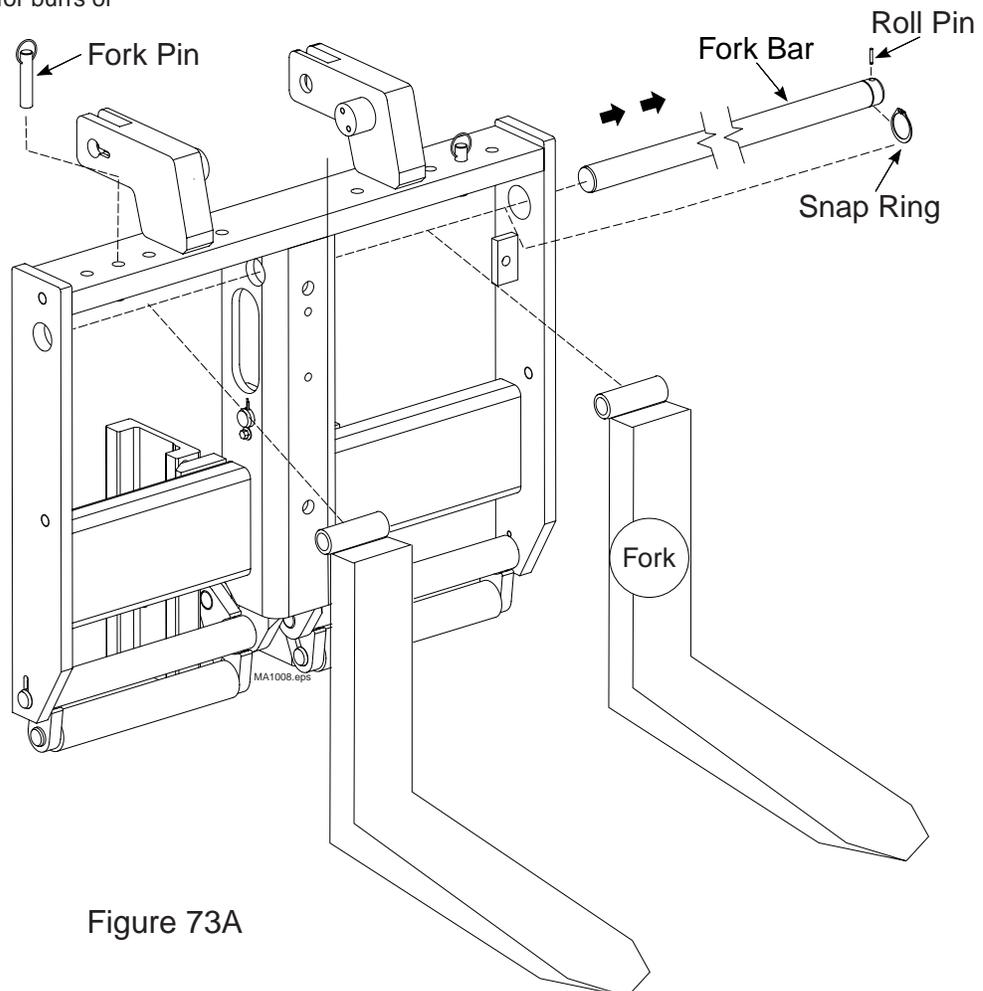


Figure 73A

Cylinder removal:

Remove the fork carriage as described on page 65.

Refer to figure 74A.

1. Extend the reach cylinder completely.
2. Using an overhead crane, secure the scissor arms (C) to keep the scissor arms from falling once the reach cylinder has been disconnected. See figure 74A.
3. Disconnect the hydraulic connectors and plug all open lines.
4. Remove retainer bolt and pin (B) securing cylinder shaft ends in position. See figure 74A. It may be necessary to use a brass drift to gently tap the pins loose.
5. Remove the reach cylinder and place on a clean work bench.

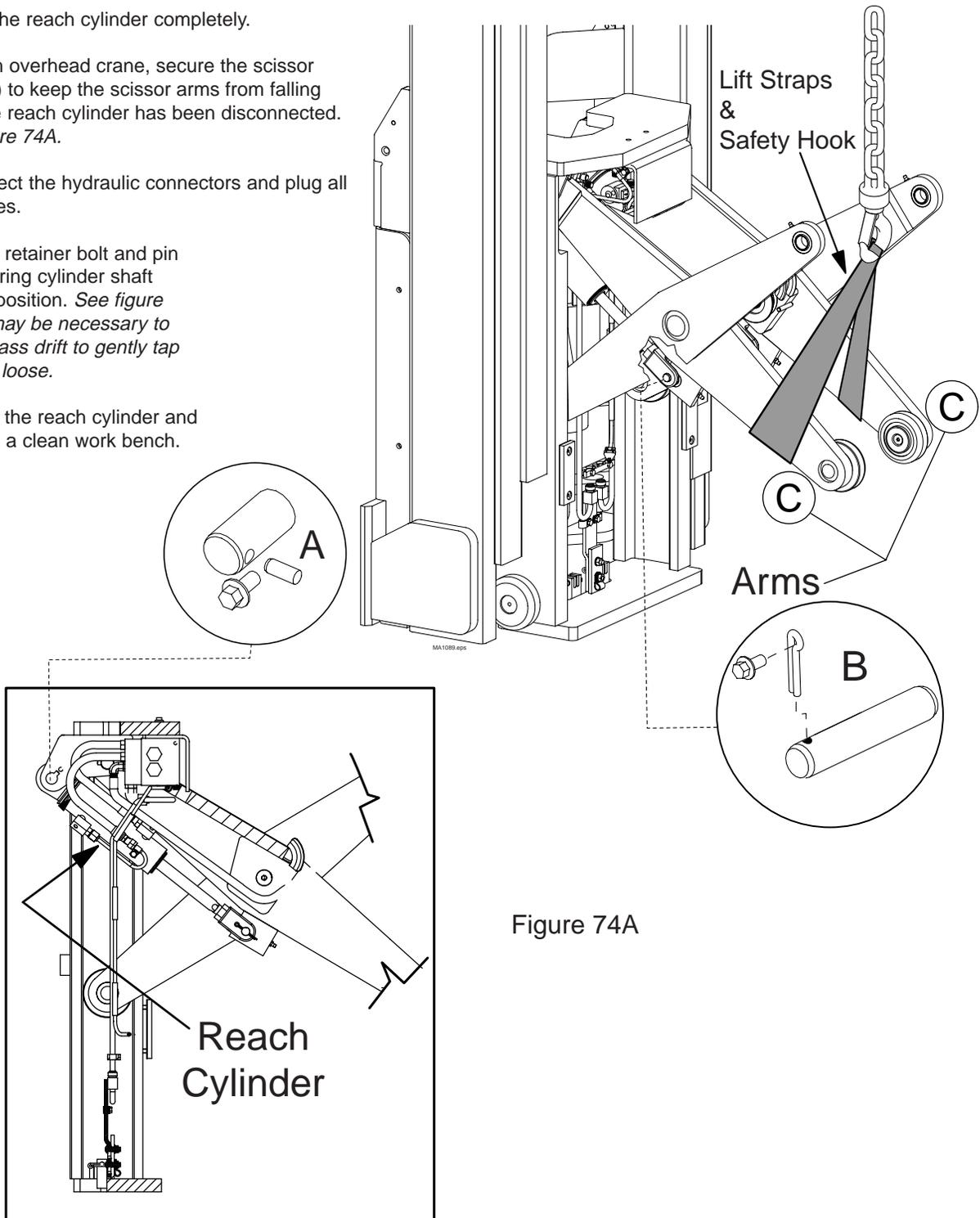
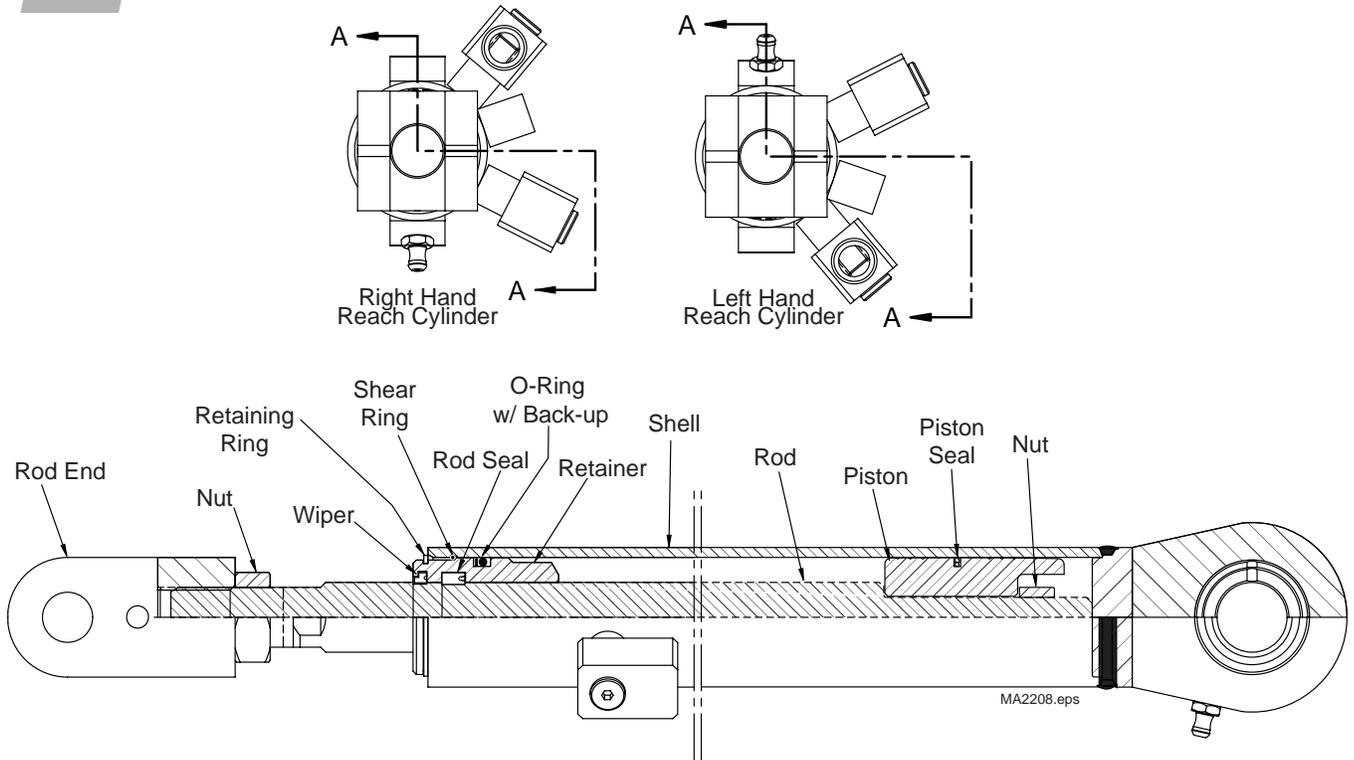


Figure 74A



Typical Illustration Figure 75A

Disassembly (Refer to Illustration Above)

Wash exterior of the reach cylinder in a Stoddard type cleaning solvent before disassembly. Use a brush to remove grease and grime from the cylinder tube, anchor and rod ends. Remove rod end and jam nut.

1. Place cylinder in a vise equipped with soft jaws. Do not overtighten - distort shell.
2. Push piston rod all the way into cylinder.
3. Using snap ring pliers, remove the snap ring from the cylinder retainer.
4. Remove O-Ring.
5. Using a bronze drift, gently tap retainer assembly into cylinder housing clear of the shear ring.
6. Using a screwdriver, carefully lift end of shear ring from it's groove. *Be careful not to nick or scratch the piston rod.*
7. With a pair of pliers, carefully pull shear ring from cylinder tube. *Again, be careful not to nick or scratch the piston rod.*
8. Pull outward on piston rod until rod and retainer are free of cylinder housing. Remove retainer.

Retainer Assembly

1. Remove wiper.
2. Remove seal from inner groove. *Be careful that you do not nick or scratch surface of retainer assembly.*
3. Remove outer O-Ring and backup ring from the retainer assembly.
4. Discard seals, wiper and backup rings.

Piston Rod and Piston

1. Using a 3/4" wrench, hold the rod using the "flats" provided just below threaded area of piston rod. Now install a 2-2/8 in. socket onto the piston rod nut.
2. Remove nut from piston rod while holding the piston rod.
3. Pull piston free of piston rod.
4. Remove sealing ring and the energizer from piston. Use care not to nick or scratch piston surfaces.
5. Discard O-Ring, sealing ring and energizer. Always install new seals.

5.7-3 Cleaning and Inspection

1. Discard old seals, wiper and shear ring.
2. Wash all parts in a Stoddard type cleaning solvent and dry with a clean lint free shop rag.
3. Inspect cylinder mounting bushing for damage. If the bushings show signs of wear and/or damage, they may be pressed out and new bushing installed. A Sleeve to fit over spherical inner bushing will be needed. Do not press out by prying on the inner bushing. Refer to figure 76A.
4. Inspect threaded parts for damage. Examine cylinder barrel for scoring, nicks or scratches. A The cylinder barrel may be sanded with crocus cloth to remove minor scratches, etc.. *Be careful not to remove the chrome plating when polishing the surface.* Replace all damaged or unserviceable parts.
5. Inspect surfaces of the piston and piston rod to be sure they are clean, smooth and free of damage.

Reassembly

1. Lubricate all parts with clean hydraulic fluid.
2. Lubricate and install the energizer ring into the groove in the piston. Refer to figure 77A.
3. Lubricate and install the piston seal over the energizer. *Be careful not to nick or cut the seals.*
4. Place a plastic parts bag over the threaded area of the piston rod (to protect seal). Slide a new O-Ring over the bag and into the groove in the piston rod.
5. Remove bag and install piston onto rod. Carefully slide the piston over and up against the rod shoulder.
6. Install nut onto piston rod finger tight against the piston.
7. Install the 3/4" wrench back into the "Flats" provided in the piston rod.
8. Using a torque wrench and 1-1/8 in. socket, torque nut to 115 - 132 ft. lbs. (156 - 179 Nm).
9. Now, lubricate the piston and piston rod with clean hydraulic fluid.
10. Start piston into cylinder tube while gently pushing and rotating piston rod until piston and seal have passed the shear ring groove in the cylinder tube. *Be careful not to damage seal.*

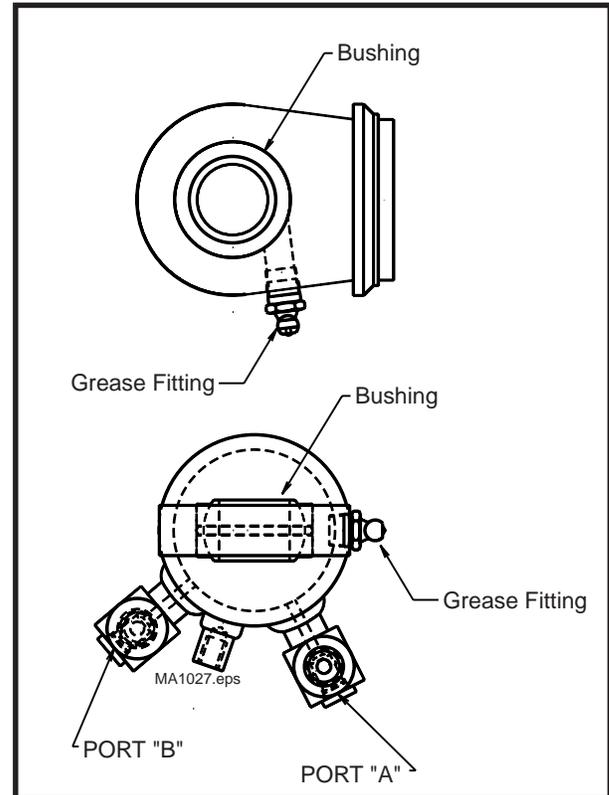


Figure 76A

11. Push the piston rod all the way into the cylinder tube until it bottoms.

Retainer Assembly

1. Lubricate new seals, wiper ring and retainer assembly with clean hydraulic fluid.
2. Install the inner seal, with the **sealing lip** facing inward, into the retainer groove. *Be careful not to nick the sealing lip upon installation.*
3. Install a new wiper into retainer.
4. Lubricate and install a new backup ring into the outer groove on the retainer.
5. Lubricate and install a new O-Ring in the groove next to the backup ring. Note the position of the backup and O-Ring per above diagram.
6. Place a plastic parts bag over the threaded end of the rod (to protect seals) and carefully slide the retainer over the rod and into the cylinder housing.
7. Push retainer as far as it will go into the housing.
8. Insert the open end of a new shear ring into the cylinder housing while pushing on the ring with your fingers. Push ring inward as far as you can.

Retainer Assembly (Continued)

1. Using a bronze punch, gently tap ring the rest of the way into the tube and groove. Be sure the shear ring is fully seated in it's groove.
2. Pull the piston rod out as far as it will come. This will position the retainer so that the retainer ring groove and into the housing on top of the retainer.
3. Lubricate a new backup ring and place it over the O-Ring just installed.
4. Install the washer over the retainer and next to the backup ring previously installed.
5. Install a new split retainer into it's groove in the retainer assembly. Be sure it is completely seated in it's groove.
6. Install jam nut and rod end to the same location it was when removed from the piston rod.
7. Cap cylinder ports until the cylinder is installed on the truck.
8. Check fluid level of truck once cylinder have been installed.
9. Purger air from hydraulic system by cycling cylinders several times to force air from the lines into the sump tank.

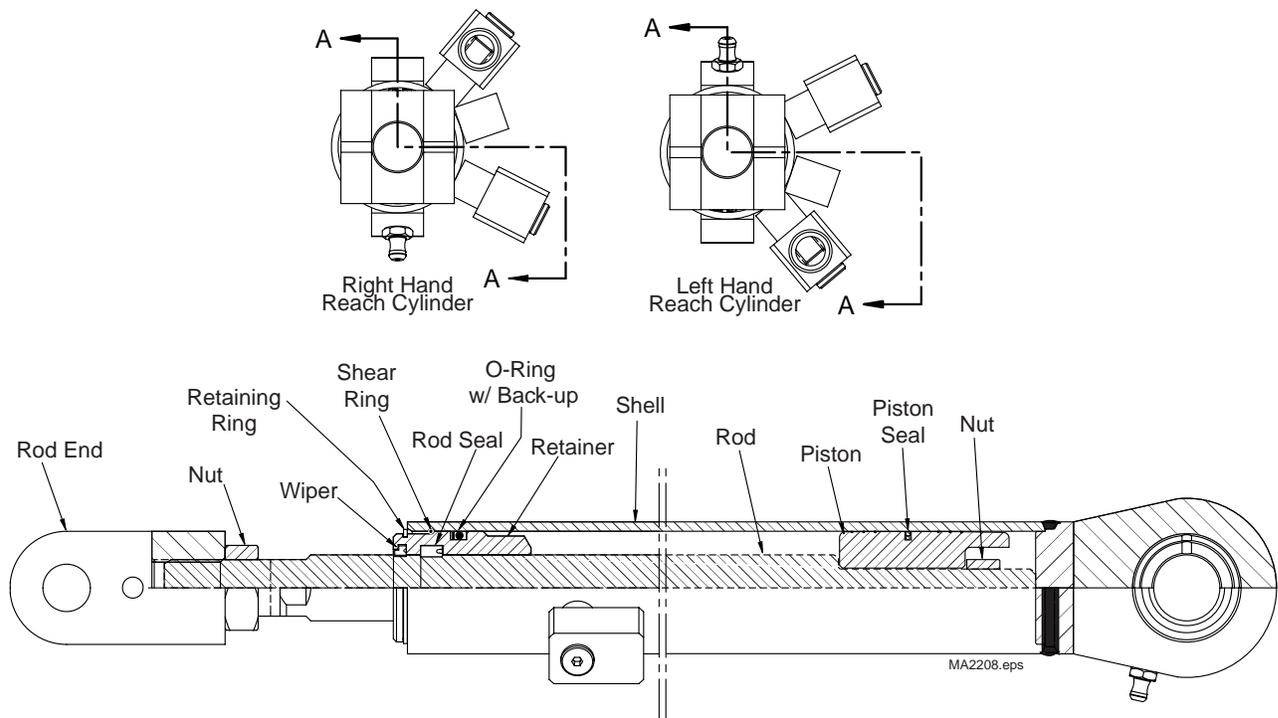


Figure 77A Typical Illustration

5.7-3 Side Shift Cylinder Overhaul Cylinder Removal

Extend Pantograph as described on page 29.

Fork removal

Refer to Figure 78A.

- * Remove fork lock pins and snap ring from the fork bar.
- * Remove snap ring from fork bar (B).
- * Remove fork lock pins from fork guides.
- * Drive fork bar (B) in direction of arrows (with a brass drift).
- * When bar (B) is free of carriage, remove forks.
- * Examine bushings in fork guides (C) for damage. If bushings are unfit for further service, install new bushings.
- * Check fork bar (B) for burrs or excessive wear.

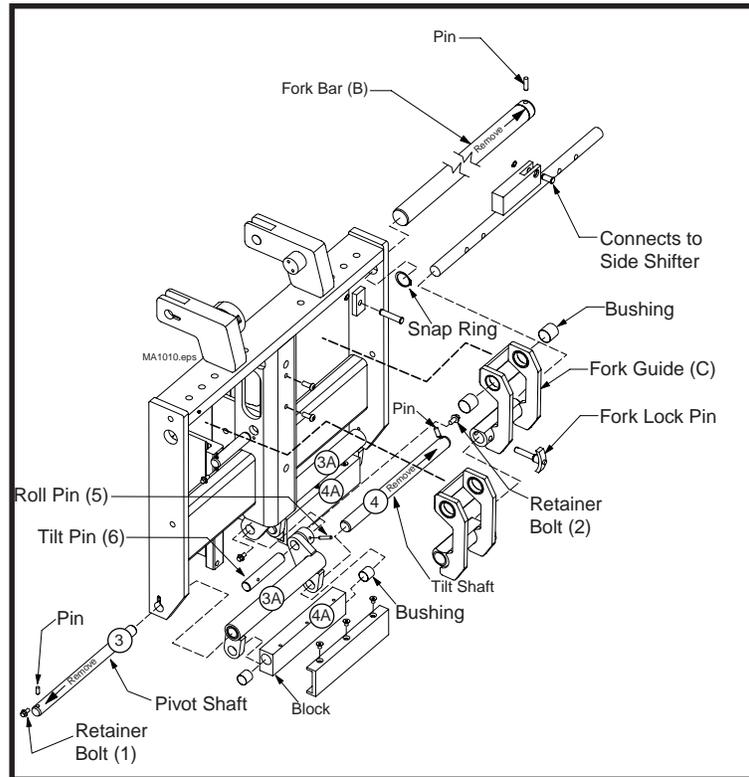


Figure 78A

Support forks as forkbar is removed so they cannot fall.

Figure 90

 **WARNING:****Cylinder removal:**

Refer to Figure 79A.

- * Retract the side shift cylinder completely.
- * Remove the snap rings and retaining pins (A) & (B) from each end of the side shifter cylinder.
- * Rotate the cylinder slightly to access the hose connectors.
- * Loosen the hose connectors and remove. Plug all open ends.
- * Remove the cylinder and place on a clean workbench.

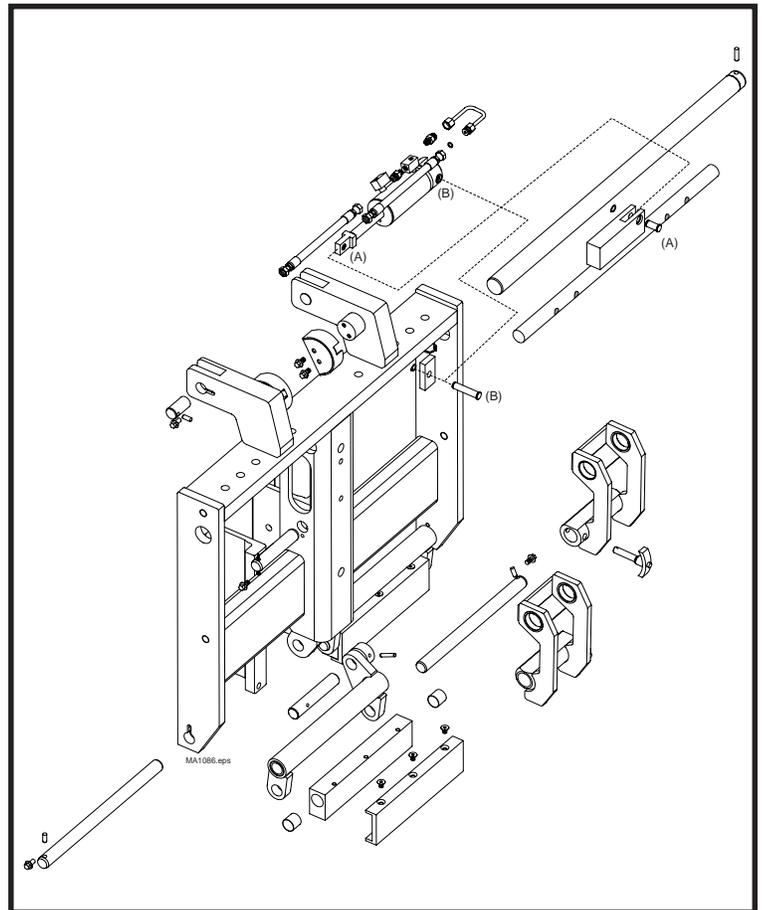


Figure 79A

Preparation Cleaning and Inspection

1. The exterior surface of a cylinder should be thoroughly washed before disassembly.
2. A soft fiber brush should be used to remove debris and foreign objects from grooves and threaded areas, etc.
3. A Stoddard type cleaning solvent should be used to wash the cylinder.
4. Threaded area of piston rod should be examined for damage, stripping or marring after removal of rod end and jam nut. The bushing in rod end should be inspected for further serviceability.
5. All foreign objects should be removed from between threads on the piston rod, in the nut and rod end.
6. Any part unfit for further service should be replaced with new part.

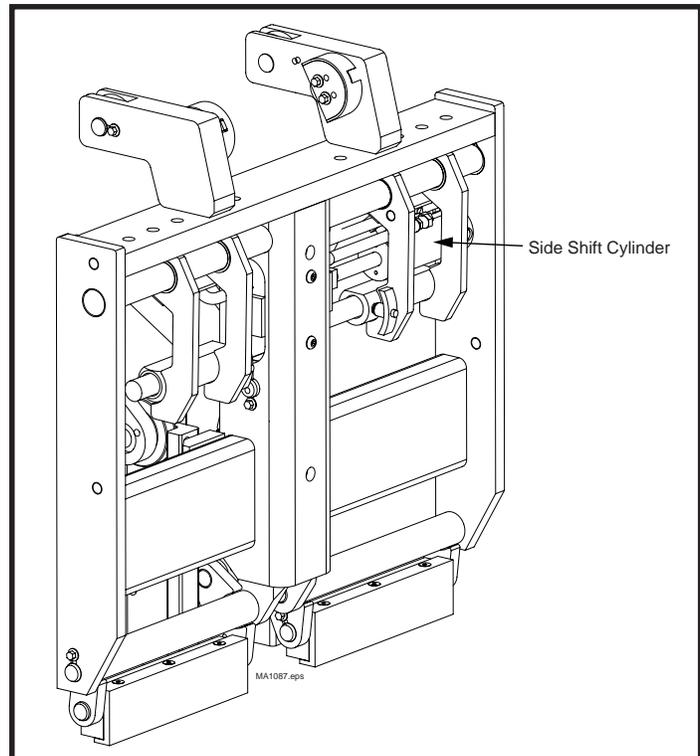


Figure 80A

Disassembly (Refer to Illustration Below)

Wash exterior of the side shift cylinder in a Stoddard type cleaning solvent before disassembly. Use a brush to remove grease and grime from the cylinder tube, anchor and rod ends.

1. Place cylinder in a vise equipped with soft jaws. Do not overtighten - distort barrel.
2. Push piston rod all the way into cylinder.
3. Using a spanner wrench in the holes located in the top of the gland, rotate the gland assembly counter clockwise to loosen the gland.
4. Pull outward on piston rod until rod and gland are free of cylinder housing. Remove gland from the piston rod.

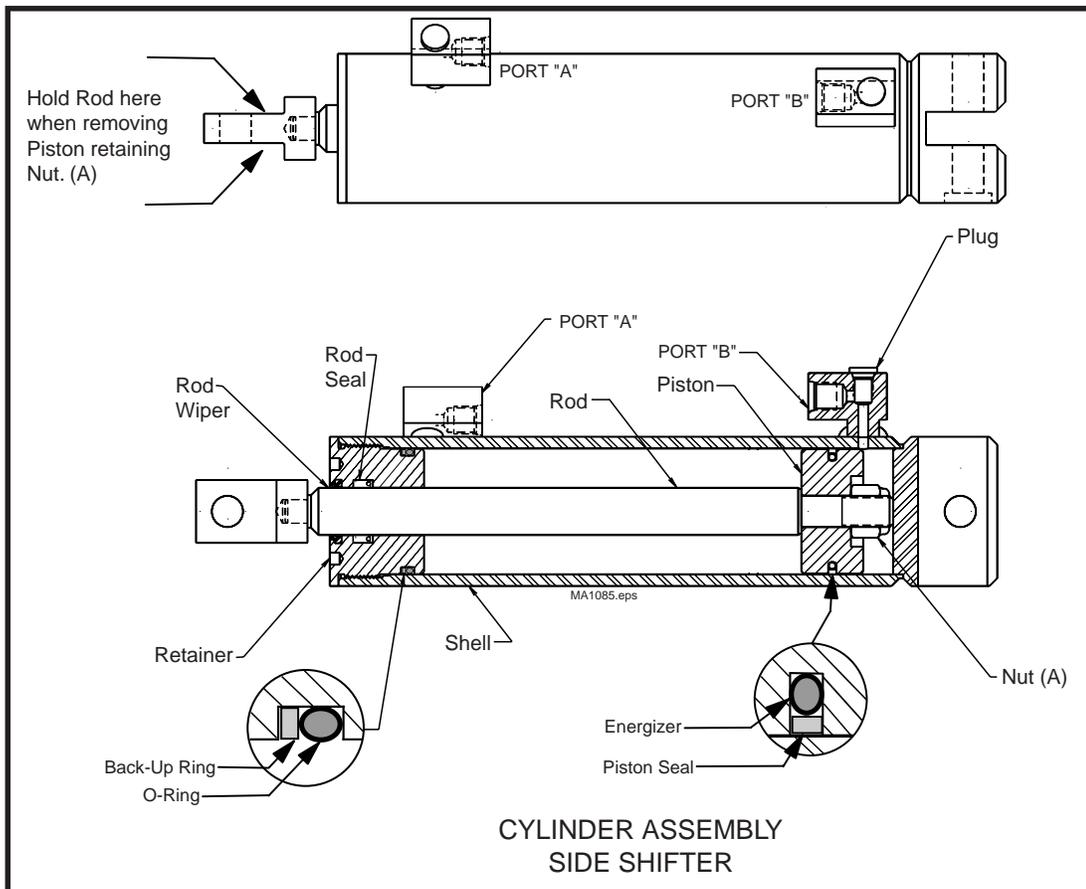
Gland Assembly

1. Remove the piston rod seal and wiper. *Be careful that you do not nick or scratch surface of gland assembly.*
2. Remove outer O-Ring and backup ring from the gland assembly.
3. Discard seals, wiper and backup rings.

Piston Rod and Piston

1. Using a 1/2" wrench, hold the rod using the "flats" provided on the rod end area of piston rod, see arrow (A) below. Now install a 3/4 in. socket onto the piston rod nut.
2. Remove nut from piston rod while holding rod end. *The old nut must be replaced. When reassembling the cylinder, install a new nut.*
3. Pull piston free of piston rod.
4. Remove sealing ring and the energizer from piston. Use care not to nick or scratch piston surfaces.
5. Discard the sealing ring and energizer. Always install new seals.

Figure 81A



Cleaning and Inspection

1. Discard old seals and wiper.
2. Wash all parts in a Stoddard type cleaning solvent and dry with a clean lint free shop rag.
3. Inspect cylinder mounting for damage.
4. Inspect threaded parts for damage. Examine cylinder barrel for scoring, nicks or scratches. A The cylinder barrel may be sanded with crocus cloth to remove minor scratches, etc.. *Be careful not to remove the chrome plating when polishing the surface.* Replace all damaged or unserviceable parts.
5. Inspect surfaces of the piston and piston rod to be sure they are clean, smooth and free of damage.

5.8-4 Reassembly

1. Lubricate all parts with clean hydraulic fluid.
2. Lubricate and install the energizer ring into the groove in the piston. Refer to figure 81A.
3. Lubricate and install the piston seal over the energizer. *Be careful not to nick or cut the seals.*
4. Install nut onto piston rod finger tight against the piston.
5. Install the 1/2" wrench back into the "Flats" provided in the piston rod end.
6. Using a torque wrench and 3/4 in. socket, torque nut to 87 - 79 ft. lbs. (117 - 132 Nm).
7. Now, lubricate the piston and piston rod with clean hydraulic fluid.
8. Start piston into cylinder tube while gently pushing and rotating piston rod until piston and seal have passed the shear ring groove in the cylinder tube. *Be careful not to damage seal.*
9. Push the piston rod all the way into the cylinder shell until it bottoms out.

Gland Assembly

1. Lubricate new seals, wiper ring and gland assembly with clean hydraulic fluid.
2. Install the inner seal, with the **sealing lip** facing inward, into the gland groove. *Be careful not to nick the sealing lip upon installation.*
3. Install a new wiper into gland.
4. Lubricate and install a new backup ring into the outer groove on the gland.
5. Lubricate and install a new O-Ring in the groove next to the backup ring. Note the position of the backup and O-Ring per above diagram.
6. Place a plastic parts bag over the threaded end of the rod (to protect seals) and carefully slide the gland over the rod and into the cylinder housing.
7. Push gland as far as it will go into the housing.
8. Using a spanner wrench, tighten the gland.
9. Cap cylinder ports until the cylinder is installed on the truck.
10. Check fluid level of truck once cylinder have been installed.
11. Purger air from hydraulic system by cycling cylinders several times to force air from the lines into the sump tank.

5.7-4 Reach and Tilt Selector Valve**Preparation****1.** Move the truck to a service area.

- * Move truck to a flat level surface.
- * Extend pantograph.
- * Fully lower pantograph.
- * Tilt (if so equipped) forks forward until the fork tips touch the ground.

2. Turn key switch off.

- * Remove key.
- * Disconnect truck battery.

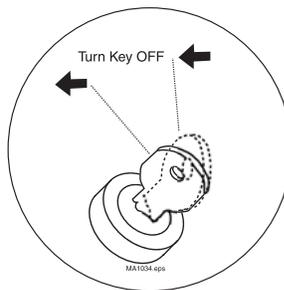
3. If equipped, control circuit capacitors must be discharged to avoid possibly being shocked when working on the solenoid valve.

Figure 83A

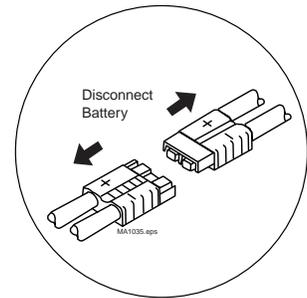


Figure 83B

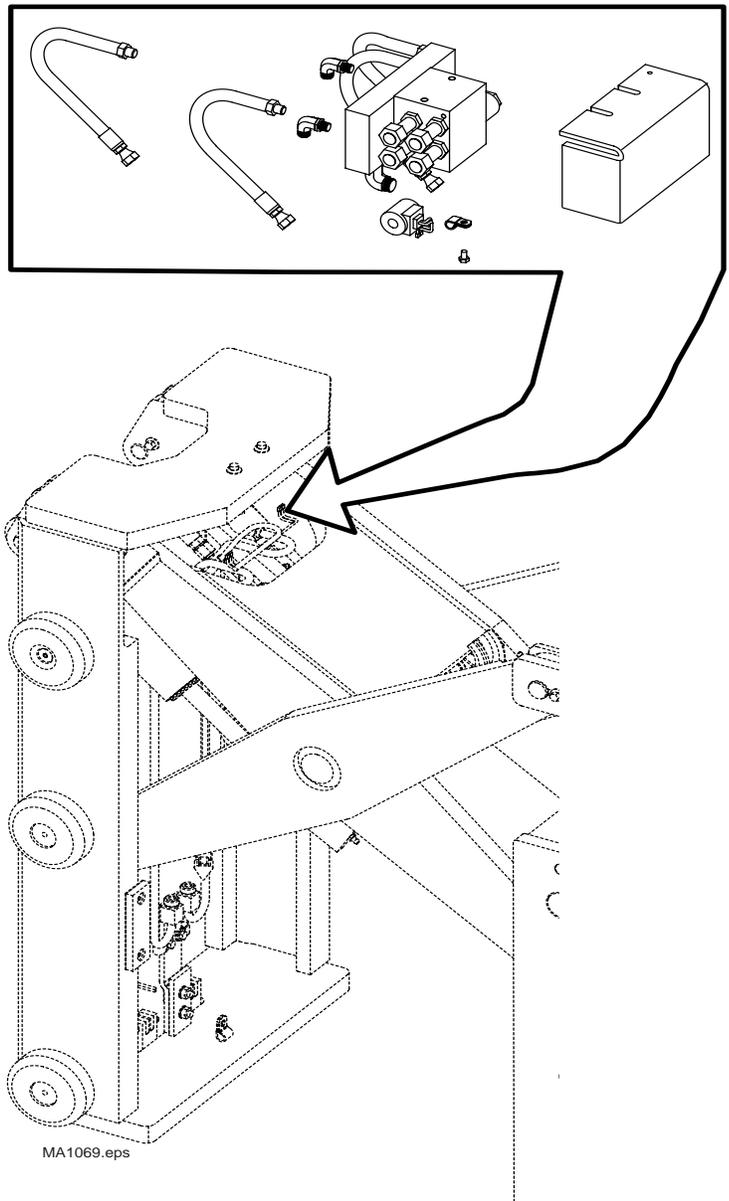
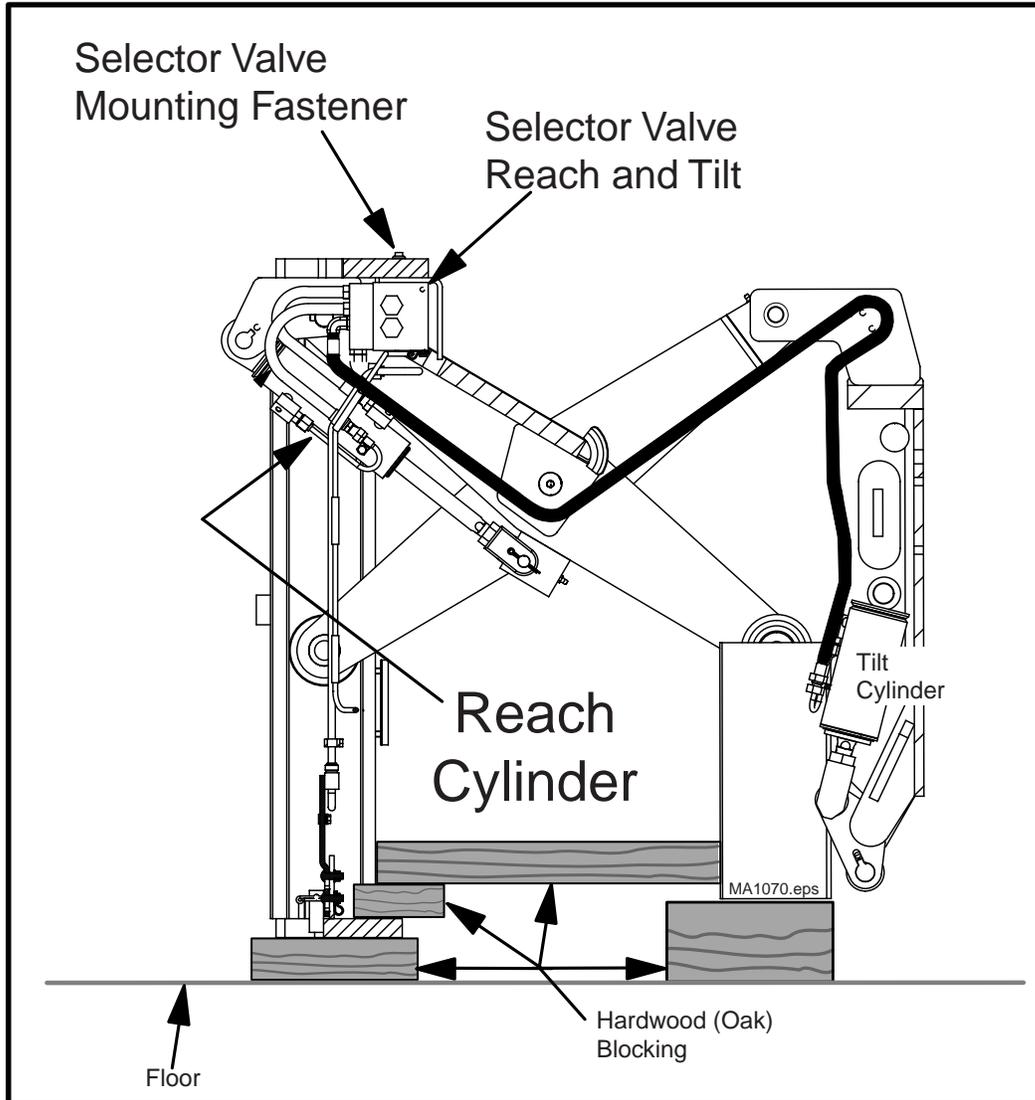


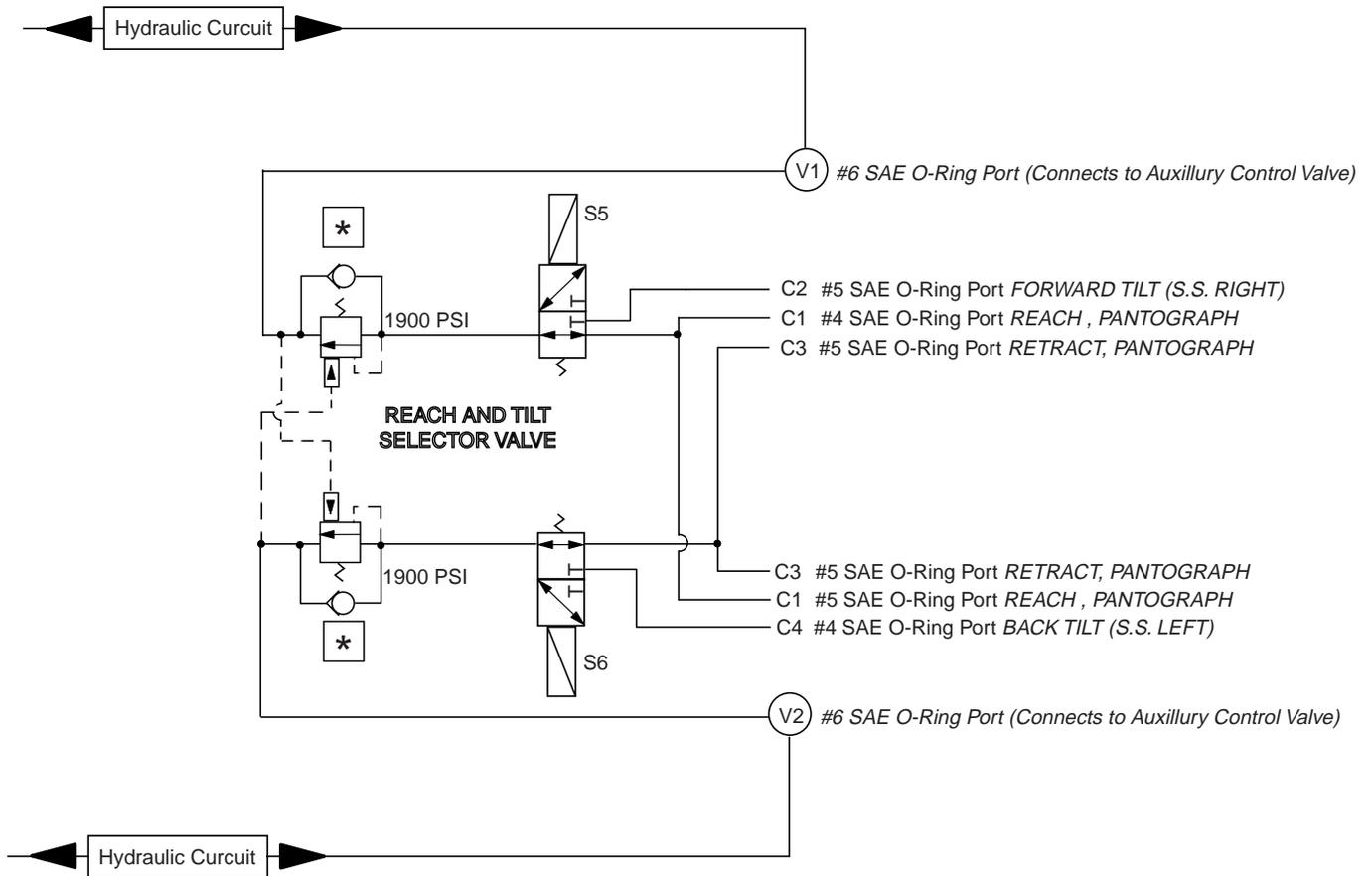
Figure 83C

**IMPORTANT
HOSING MUST BE ROUTED
AS SHOWN**



**Before working on Pantograph
Be Certain it is Blocked as Shown**

Figure 84A



- * = Counterbalance Valves
- S5 = Solenoid Valve
- S6 = Solenoid Valve

- S5 (V1) C2 Port = Back Tilt or Side Shift Right Control Circuit
- S6 (V2) C4 Port = Forward Tilt or Side Shift Left Control Circuit
- S5 (V1) C1 Port = Reach (Pantograph) Control Circuit
- S6 (V2) C3 Port = Retract (Pantograph) Control Circuit

MA1071.eps

Figure 85A

TYPICAL APPLICATION

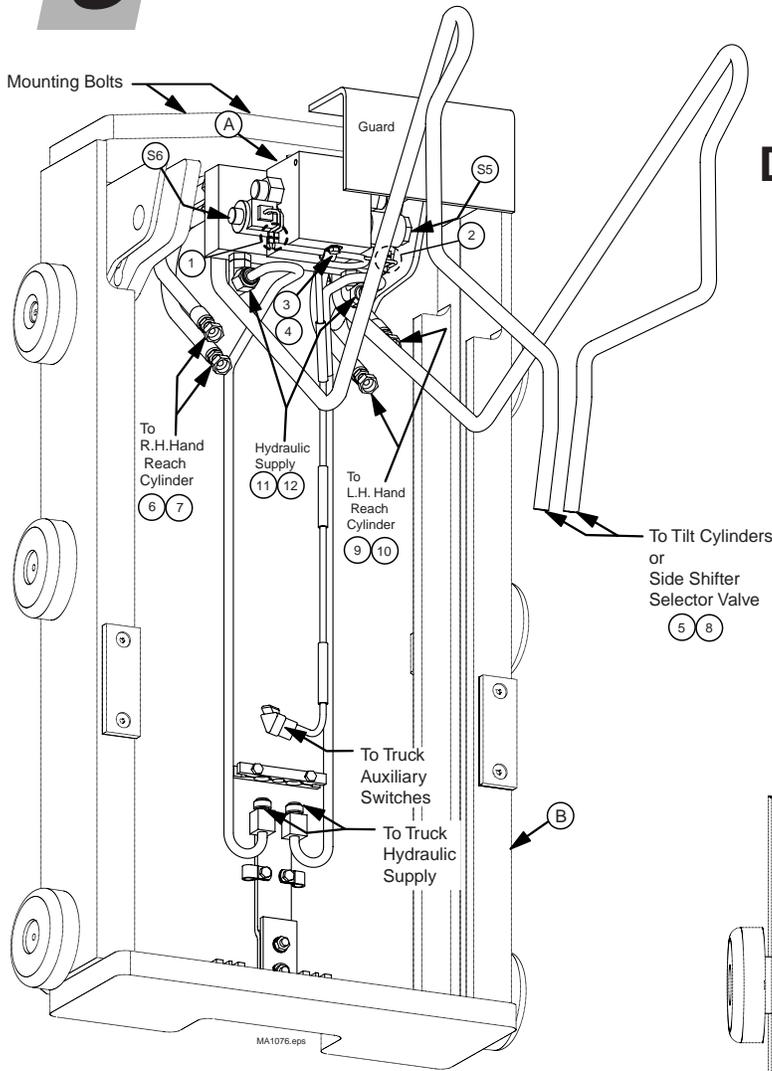


Figure 90A



CAUTION

The solenoid valve stem is very fragile. Be very careful when handling the valve that you do not dent or bend the stem.

Over torquing the coil nut or the valve at installation will cause damage to the valve.

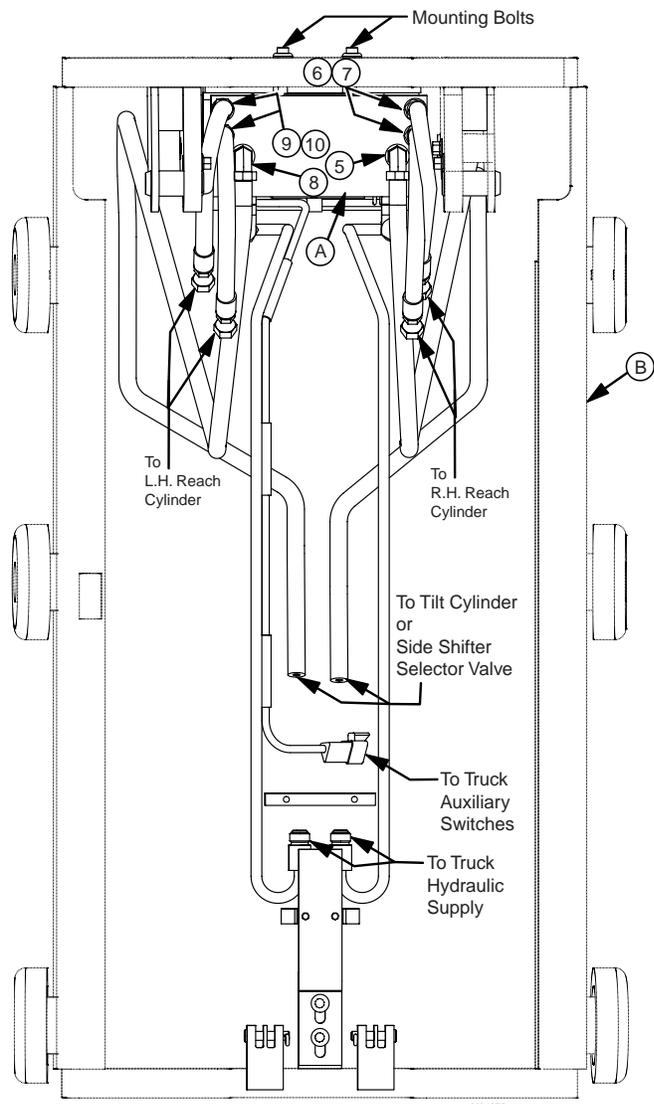
Disassembly

Remove nuts, coils and solenoid valves (S5) and (S6) from the valve body.

NOTE

The valve body and valves are not serviceable. If the unit is not functioning properly, it must be replaced.

Figure 90B



Reach and Tilt Selector Valve



WARNING

Be sure the pantograph is blocked as shown on page 59.

Removal



WARNING

Hydraulic lines may have trapped pressure. “Crack” the fittings to bleed pressure before disconnecting.



WARNING

When trapped pressure is bled, the pantograph may settle. Beware.

1. Loosen guard mounting bolts and remove the guard.
2. Unplug connect (#1) from coil (S6) and unplug connectors (#2) from coil (S5).
3. Remove fasteners (#4) from clamp (#3).
4. Tag hoses and disconnect hydraulic connections (#5) and (#8) from valve (A). Cap both hose ends.



CAUTION

Residual pressure will be present when disconnecting hydraulic lines. Use caution when disconnecting fittings.

5. Tag tubes and disconnect fittings (#11) and (#12) from bottom side of valve (A). Cap both hose ends.
6. Remove both mounting fasteners from pantograph frame (B) and valve (A).
7. Remove valve from pantograph. Place components on a clean work bench.

Mounting Selector Valve

Refer to Figure 90A and 90B

1. Position the valve to the pantograph frame aligning holes in frame with those in the valve. Refer to illustration on previous page.
2. Install mounting fasteners finger tight. *Do not tighten fasteners until after the hydraulic hoses are installed.*

Connecting Hydraulic Plumbing

3. Remove cap, hose tag and install connection (#11) to the valve finger tight.
4. Remove cap, hose tag and install (#12) connection finger tight.
5. Install connections (#5) and (#8). Install connections (#6, 7, 8, 9 and 10) to the reach cylinders finger tight.
6. Securely tighten each hydraulic connection to the valve body and the reach cylinder.

IMPORTANT

Be sure the hoses are routed correctly before attempting to connect them to the valve. Refer to page 94.

Installing clamps, connect wire, tighten nuts and bolts

7. Be sure the valve guard is located properly and securely tighten both solenoid valve mounting bolts.
8. Install wire clamps (#3) and bolts (#4).
9. Connect coil plugs to their respective receptacles.

IMPORTANT

All electrical plugs and their receptacles are matched labeled for easy connection. Check to be sure each plug and receptacle match before attempting to make connections.



CAUTION

The system must be purged of air before putting truck back into service or damage to the hydraulic system may occur.

10. Install and tighten clamp bolts (#4).

5.7-5 Side Shifter Solenoid Control Valve

Preparation

1. Move the truck to a service area.
 - * Move truck to a flat level surface.
 - * Extend pantograph.
 - * Fully lower pantograph.
 - * Tilt (if so equipped) forks forward until the fork tips touch the ground.
2. Turn key switch off.
 - * Remove key.
 - * Disconnect truck battery.

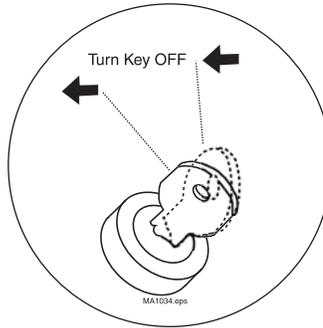


Figure 92A

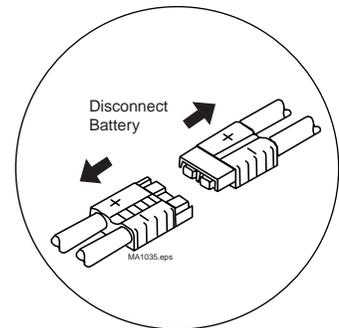


Figure 92B

3. If equipped, control circuit capacitors must be discharged to avoid possibly being shocked when working on the solenoid valve.

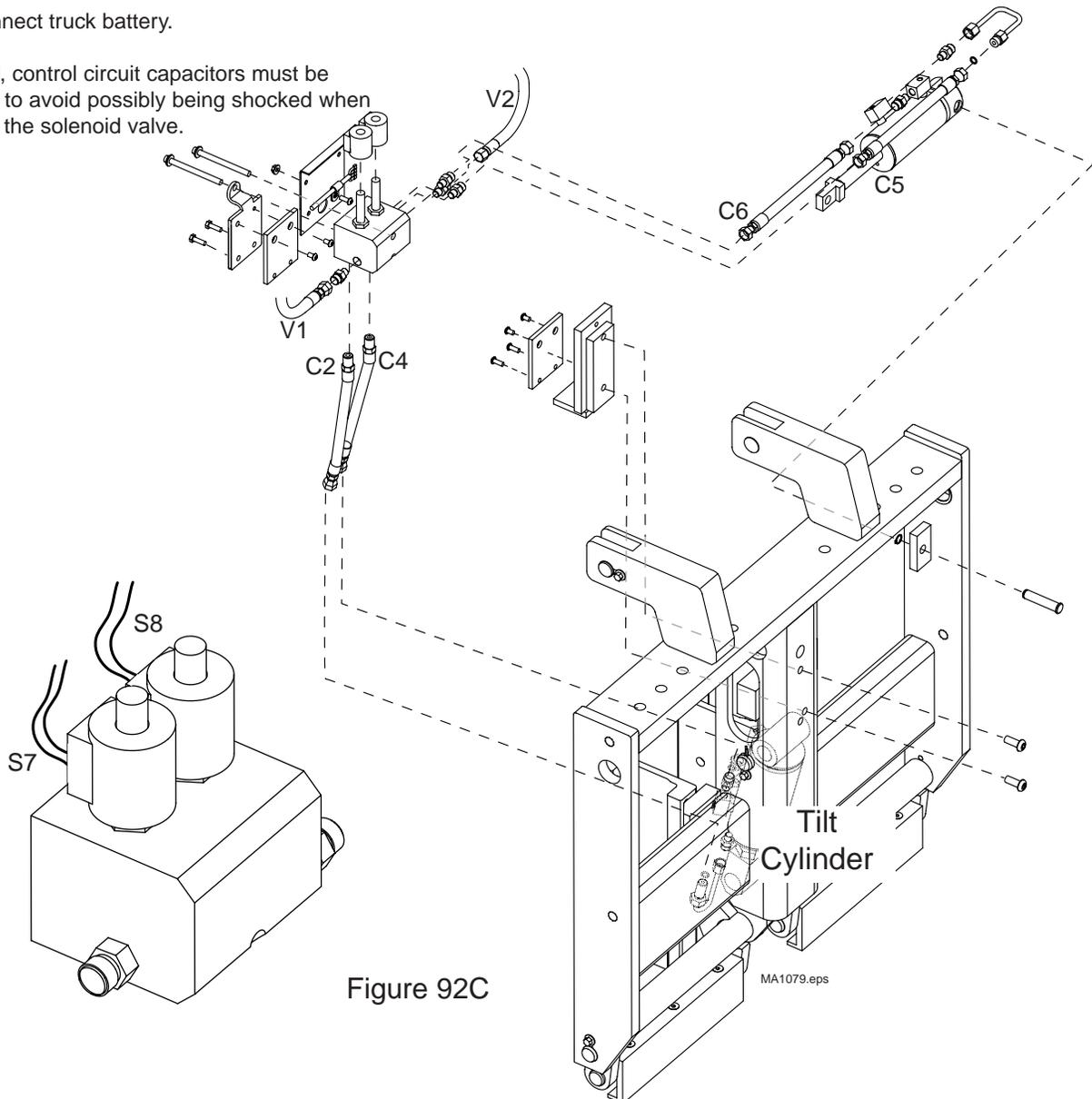


Figure 92C

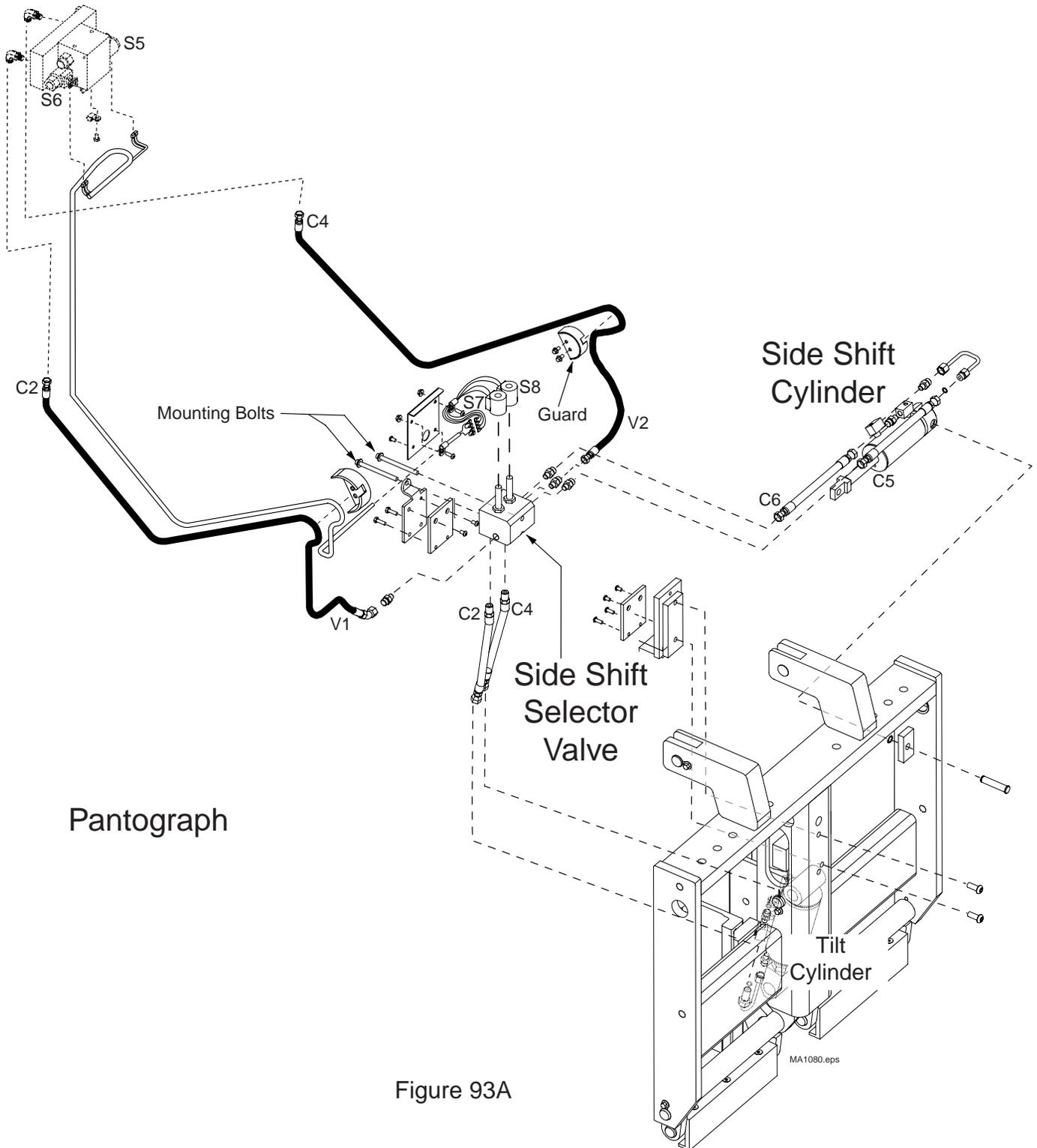


Figure 93A

TYPICAL APPLICATION

Removal

Refer to Figure 106

- * Unplug Connectors from (S7) coil.
- * Unplug connectors from (S8).
- * Label each hose with it's location.
- * Disconnect hydraulic connections (V1, V2, C6, C5, C2, and C4) from the side shifter selector valve.



WARNING

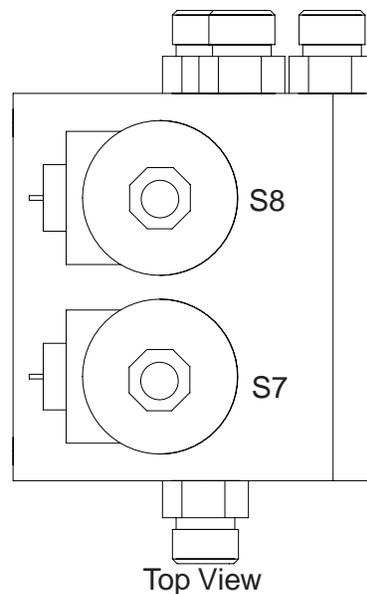
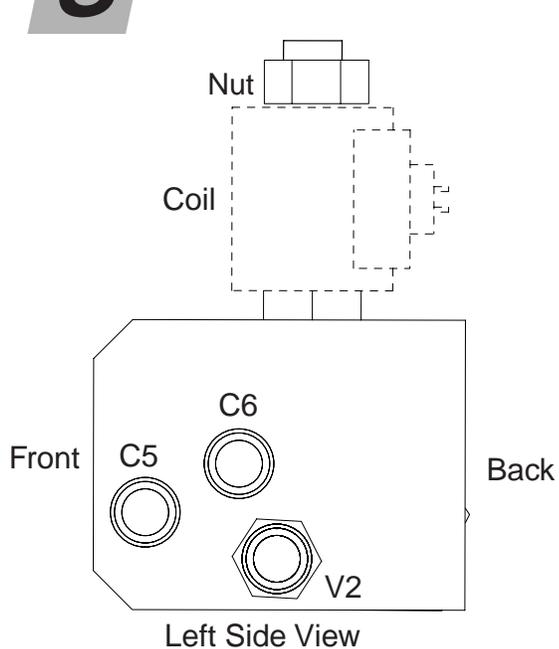
Hydraulic lines may have trapped pressure. “Crack” the fittings to bleed pressure before disconnecting.

- * Cap each hose when disconnected.

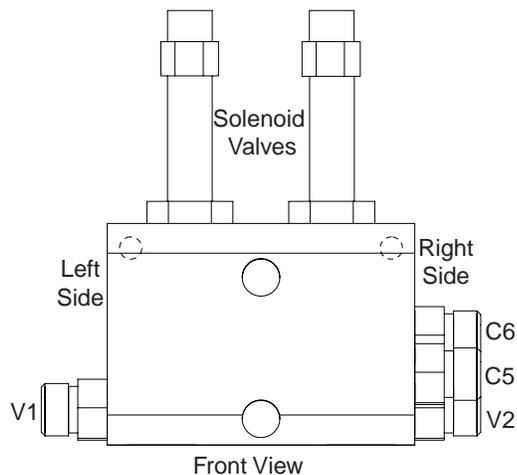
Note

There will be some fluid leakage when hydraulic fittings are disconnected. Place a rag beneath the fitting to be removed.

- * Remove mounting bolts securing the selector valve to the pantograph.
- * Remove valve and place on a clean work bench.
- * Replace all O-Rings with new ones.
- * Inspect hoses and connectors for further serviceability.
- * Replace defective parts.



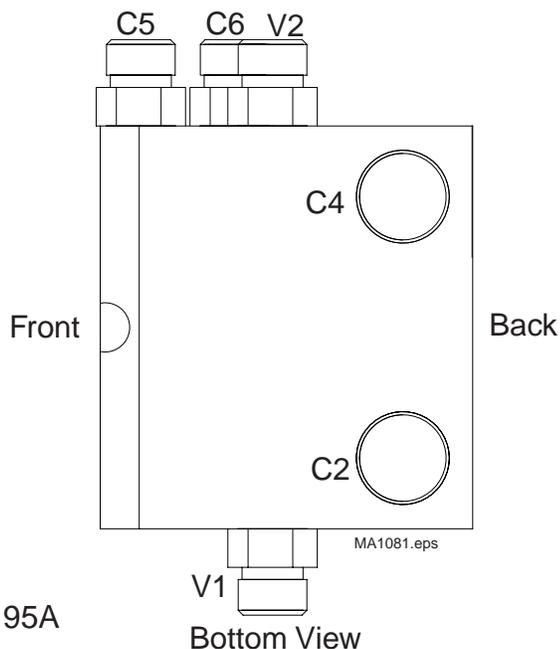
- C2 #5 SAE O-Ring Port
- C4 #5 SAE O-Ring Port
- C5 #4 SAE O-Ring Port
- C6 #4 SAE O-Ring Port
- V1 #4 SAE O-Ring Port
- V2 #4 SAE O-Ring Port



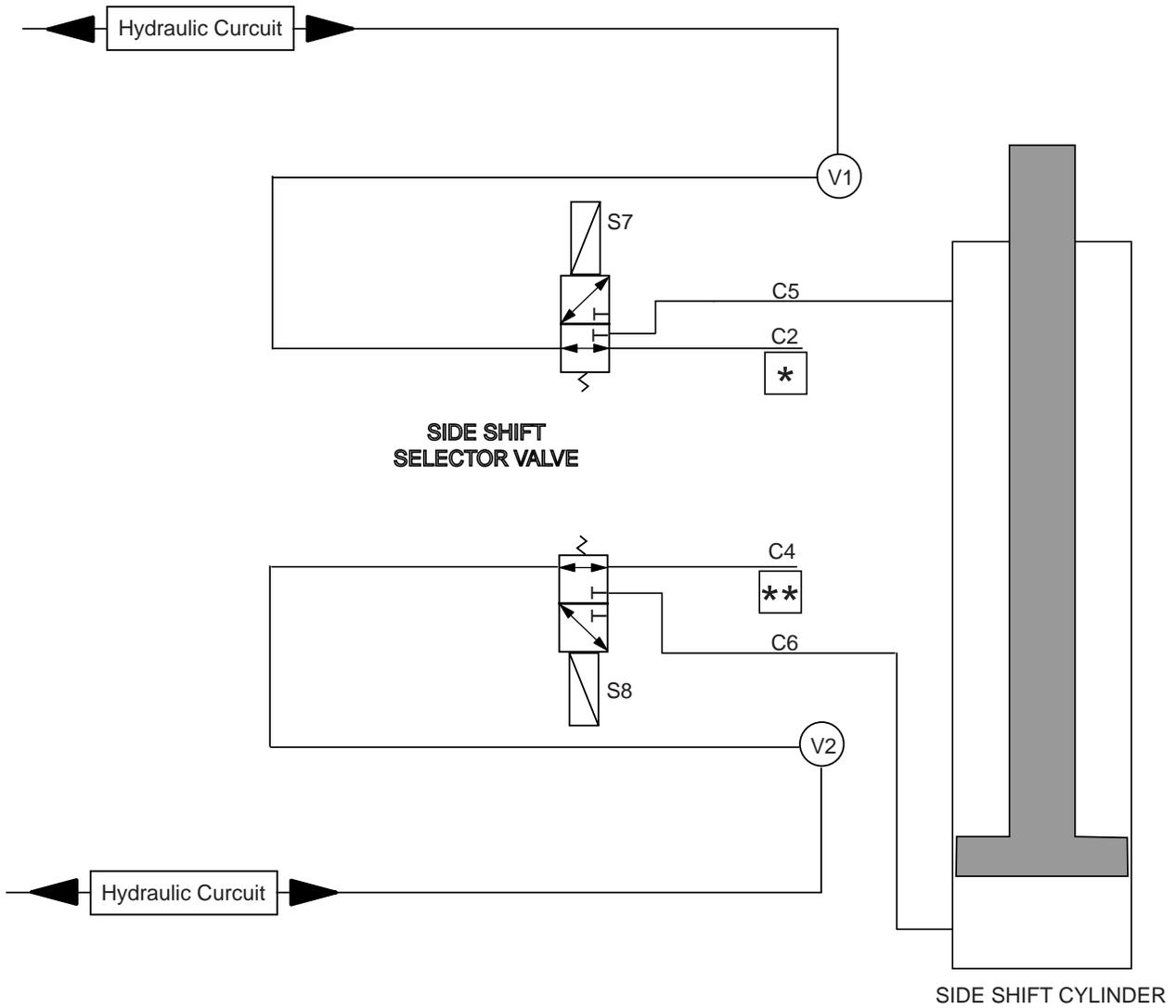
TYPICAL APPLICATION

Note
Refer to hydraulic schematic on the next page.

Figure 95A



HYDRAULIC SCHEMATIC



- * = RETURN TO V1/C2/S5 CIRCUIT
- ** = RETURN TO V2/C4/S6 CIRCUIT

MA1082.eps

TYPICAL APPLICATION

Figure 96A

5.10-6 Installation**Mount Selector Valve**

* Line up mounting holes in selector valve with those in the mounting bracket. Install mounting bolts finger tight. See Figure 98A.

Install Hoses

* Wipe hose ends and connectors clean. Remove hose caps just prior to installation. Be certain all connections are tight.

Connect Coils

* Plug connectors to (S7) and (S8) coils. See illustration on page 95.

* Tighten all mounting fasteners.

* Install guard.

NOTE

The valve body and valves are not serviceable. If the unit is not functioning properly, it must be replaced.

**IMPORTANT
HOSING MUST BE ROUTED
AS SHOWN**

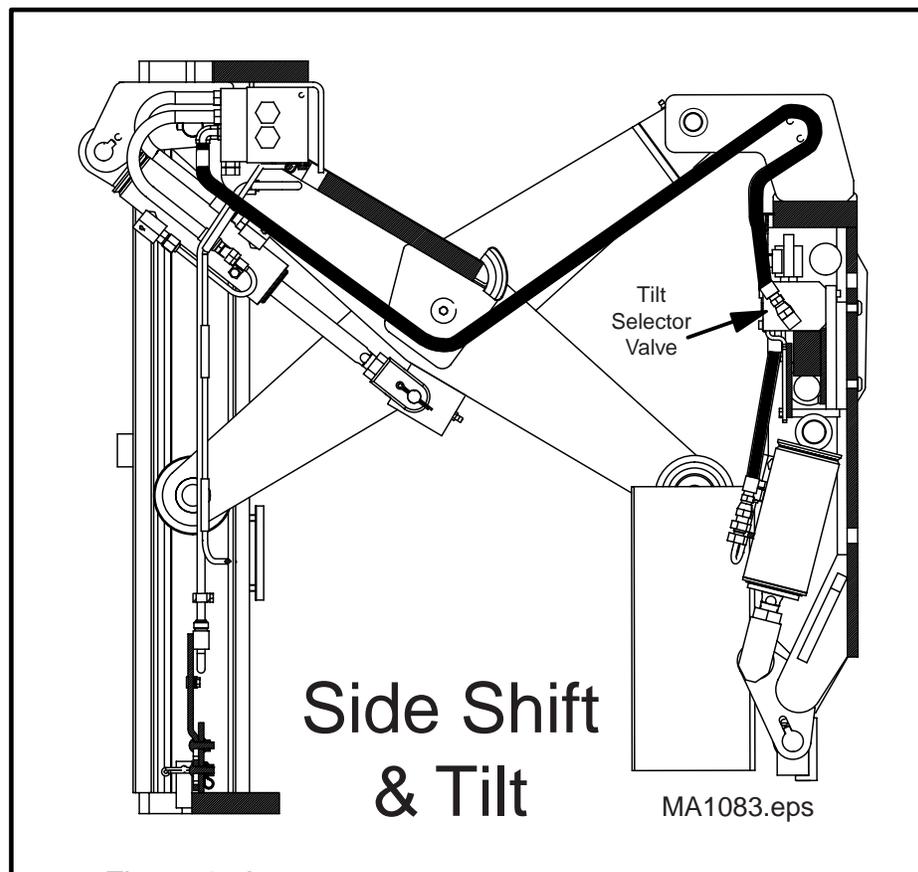


Figure 97A

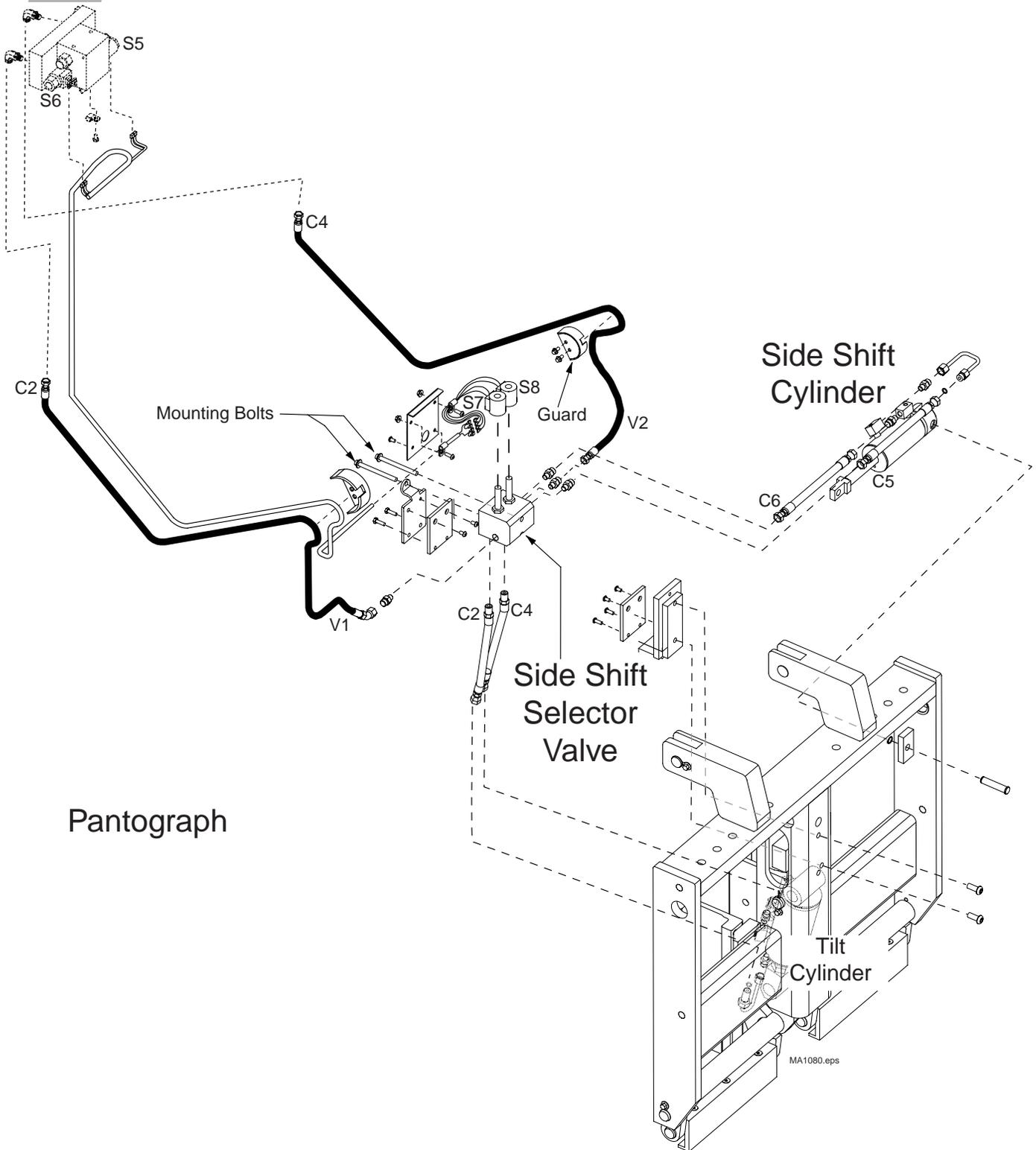


Figure 98A

M anual Change Summary

R1 - Add new ML and FL cylinder illustrations, Add note to schematics, revise panto cylinder instructions. 11/21/03

R2 - Revise illustration (left side view) on Page 91. 04/27/04

Do you have any questions that need to be answered right now?

Lift Technologies, Inc.

7040 South Highway 11

Westminster, SC 29693

USA

Tel: +1(864) 647-1119

Fax: +1(864) 647-5406

**Customer Service
(North America Toll Free)**

1-888-946-3330

Other Lift Technologies Locations

Lift Technologies Inc.

Corporate Head Office

251 Woodlawn Road W., Unit 217

Guelph, ON N1H 8J1 Canada

Tel: +1-519-823-4545

Lift -Tek Elecar Srl

29015 Castel. San. Giovanni (PC)

Via G. Galilei

Italy

