

INTRODUCTION

GENERAL

This section has the description, disassembly, assembly, checks and adjustments for the attachment. Troubleshooting and specification tables are at the end of the section.

DESCRIPTION (See FIGURE 1., FIGURE 2. and FIGURE 3.)

The mast lifts and lowers the attachment.

The N30XMH attachment has an optional side shift carriage. Load rollers on this carriage fit into the channels of the inner mast. A traverse frame mounts on the side shift carriage with rollers. A side shift cylinder connects the side shift carriage and the traverse frame. Actuation of the cylinder rod moves the entire attachment to the right or left of the lift truck. This movement is the optional "side shift" function.

On trucks without side shift, load rollers on the traverse frame fit into the channels of the inner mast.

A boom is fastened to the traverse frame by rollers. The boom is moved left and right by a traverse cylinder and chain arrangement. One end of each chain is connected to the traverse frame. The other end of each chain is connected to the boom. As the shell of the traverse cylinder moves to the left or right, it pulls the boom in the same direction. This movement is the "traverse" function.

A rotary actuator is attached to the end of the boom. A fork carriage is fastened to the rotary actuator. The rotary actuator moves the fork carriage and forks in a 180 degree arc for left and right hand load handling. Movement of the forks in an arc is the "rotate" function.

Movement of all of these parts are controlled by the hydraulic control levers beside the seat. Information on the hydraulic valves for the attachment are in the section for the **HYDRAULIC SYSTEM, 1900 SRM 559.**

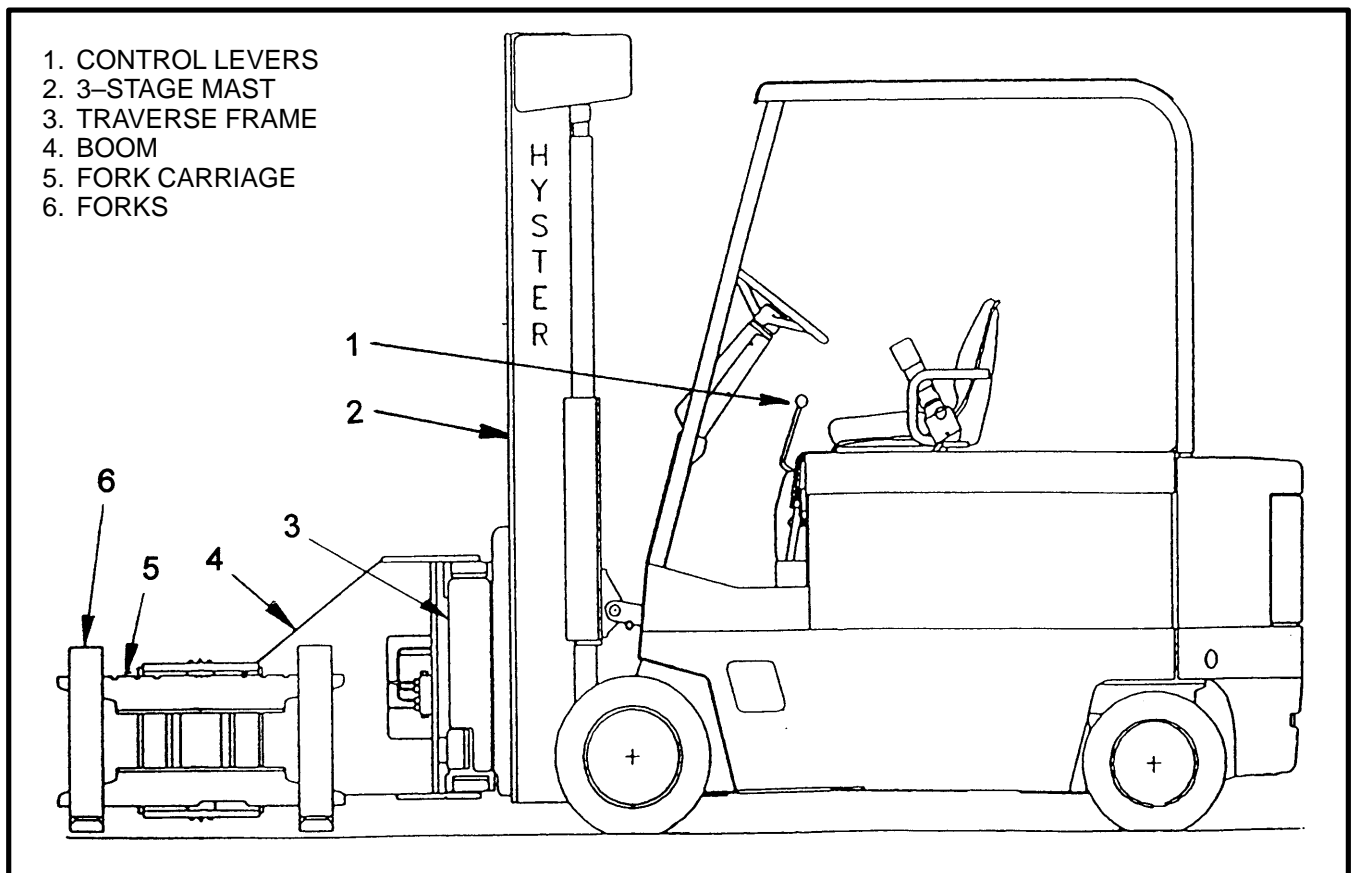


FIGURE 1. N30XMH ATTACHMENT

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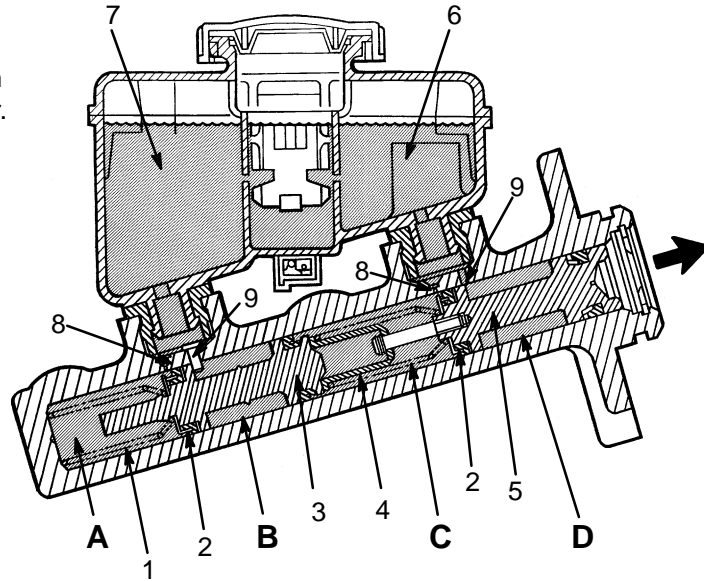
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BRAKE "OFF"

When the brakes are "OFF," the hydraulic fluid can move freely between the dual circuit system and the separate chambers of the fluid reservoir.

BRAKE "RELEASED"

When the brake pedal is released, the return springs cause the pistons to retract faster than the fluid. This action causes a vacuum between the fluid in chambers **A** and **C**. The vacuum causes the seals (2) to change shape. When the seals change shape, they permit the fluid in chambers **B** and **D** to flow through the holes in the pistons and past the seals into chambers **A** and **C**. The supply holes in the cylinder body supplies fluid as the flow moves from the one chamber to the other chamber. The fluid returns to the reservoir through the bypass holes when the pistons are fully retracted.



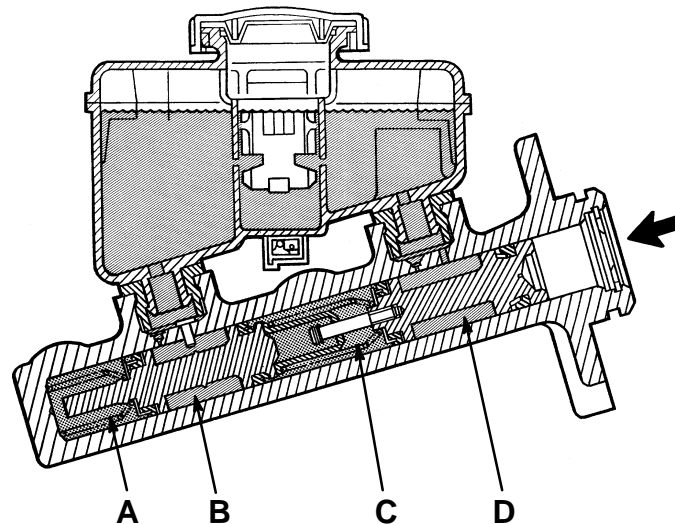
FLUID WITH NO PRESSURE
FLUID UNDER PRESSURE

- 1. SECONDARY SPRING
- 2. SEAL
- 3. SECONDARY PISTON
- 4. PRIMARY SPRING
- 5. PRIMARY PISTON

- 6. PRIMARY FLUID CHAMBER
- 7. SECONDARY FLUID CHAMBER
- 8. BYPASS HOLES
- 9. SUPPLY HOLES

BRAKE "APPLIED"

When the brake pedal is pressed, the primary piston moves in the cylinder bore. This movement creates hydraulic pressure that combines with the force of the primary spring. These combined forces overcome the secondary spring force and move the secondary piston in the bore with the primary piston. The first movement of both pistons pushes the seals (2) past the bypass holes in the chambers **A** and **C**. This action applies pressure to the fluid in those chambers and causes fluid to flow to the chambers of the two separate systems. The fluid in chambers **B** and **D** is not effected by movement of the pistons. This fluid can move freely between the piston chambers and the chambers of the fluid reservoir, before and during brake application.



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FIGURE 2. OPERATION OF MASTER CYLINDER

MASTER CYLINDER

Removal (See FIGURE 11.)

1. Remove the floor plates from the lift truck for access to the master cylinder.
2. Loosen and remove the two brake hydraulic lines from the master cylinder. Disconnect the wire at the switch on the reservoir.
3. Remove the cotter pin, washer, and pin from the push rod end that is attached to the brake linkage lever arm.
4. Remove the capscrews, washers, and nuts that hold the master cylinder to the bracket assembly and remove the master cylinder from the lift truck.

Cleaning And Inspection

CAUTION

DO NOT use an oil solvent to clean the master cylinder, wheel cylinder, or the brake linings. Use a sol-

vent approved for cleaning of brake parts. Do not permit oil or grease in the brake fluid or on the linings.

Inspect the bore of the master cylinder for holes or scratches. Replace the master cylinder assembly if there is damage.

Repair

See the repair procedures for the master cylinder in FIGURE 12.

Installation (See FIGURE 11.)

Use the reverse order of **Removal** to install the master cylinder. Check the adjustment of the brake pedal as described in CHECKS AND ADJUSTMENTS.

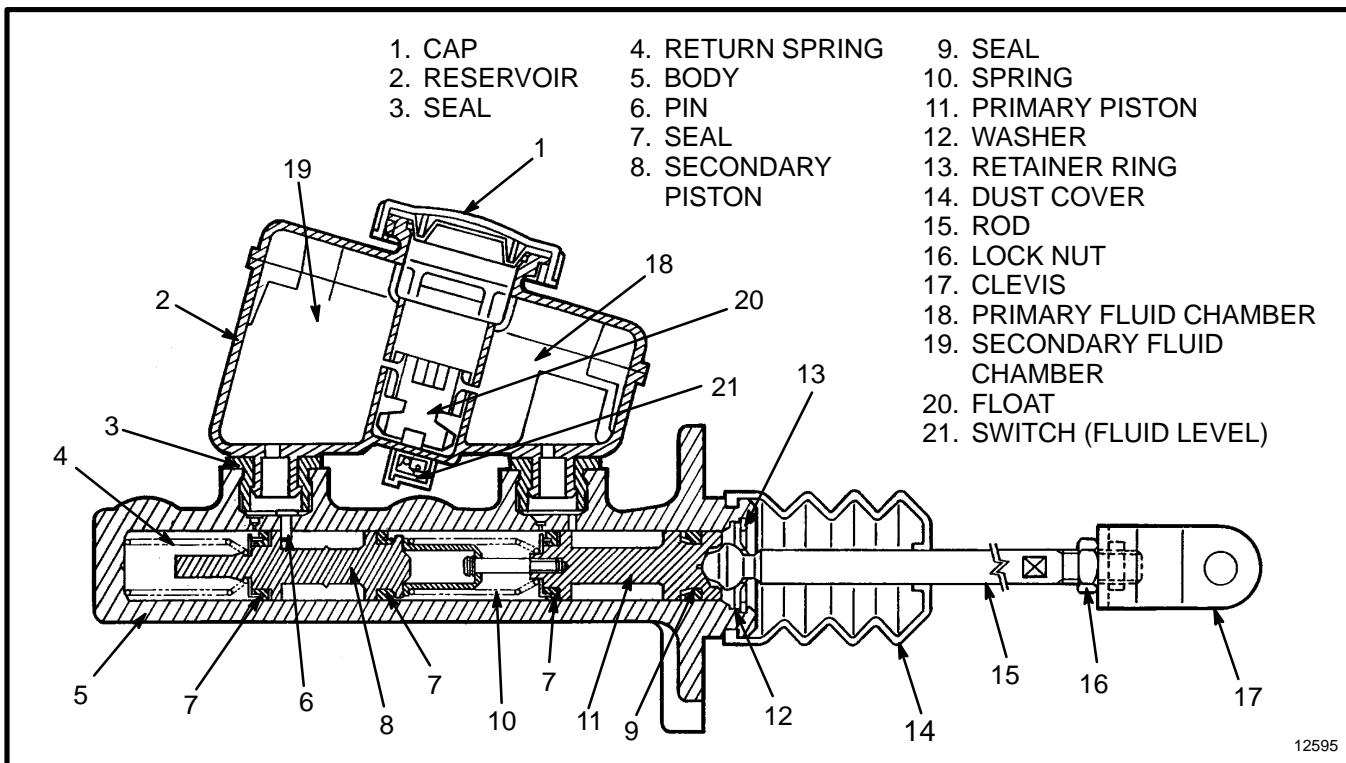


FIGURE 11. MASTER CYLINDER

COUNTERWEIGHTS

MODEL	mm* (in*)	WEIGHT ^{+50kg (110lb)} _{-0 kg (0lb)}
E2.00XM & E2.50XM E2.50XM, (E50XM & E50XM ₂) E3.00XM	700 mm (27.6 in) 847 mm (33.3 in) 1015 mm (40.0 in)	544 kg (1200 lb)
(E45XM & E45XM ₂) (E55XM, E55XM ₂) & E2.50XM, (E65XM, E65XM ₂), E3.00XM E3.20XM & (N30XMH, N30XMH ₂)	700 mm (27.6 in) 847 mm (33.3 in) 1015 mm (40.0 in)	770 kg (1700 lb)
(E50XM, E50XM ₂) & E2.50XM (E60XM, E60XM ₂) & E3.00XM,	700 mm (27.6 in) 847 mm (33.3 in)	976 kg (2150 lb)
J2.00XM & J2.50XM (J40XM, J40XM ₂ & J50XM, J50XM ₂) J2.50XM & J3.00XM (J50XM, J50XM ₂ & J60XM, J60XM ₂)	717 mm (28.2 in) 861 mm (33.9 in)	678 kg (1495 lb)
J3.20XM & (J65XM, J65XM ₂)	861 mm (33.9 in)	749 kg (1650 lb)
* approximate battery compartment lengths (identifies frame size)		

HYDRAULIC SYSTEM

ITEM	SPECIFICATION
RELIEF PRESSURE, LIFT SYSTEM E2.00-3.20XM, (E45-65XM, E45-65XM ₂) And (N30XMH, N30XMH ₂) J2.00-3.20XM, (J40-65XM, J40-65XM ₂)	21.7 ± 0.7MPa (3100 ± 100 psi) 21.0 ± 0.7 MPa (3000 ± 100 psi)
RELIEF PRESSURE, TILT SYSTEM With Auxiliary Relief Valve Without Auxiliary Relief Valve	15.75 ± 0.7 MPa (2250 ± 100 psi) 21.7 ± 0.7MPa (3100 ± 100 psi)
RELIEF PRESSURE, AUXILIARY	15.75 ± 0.7 MPa (2250 ± 100 psi)
RELIEF PRESSURE, STEERING SYSTEM	8620 ± 345KPa (1250 ± 50psi)
* Oil temperature 54 to 66°C (130 to 150°F).	

This section is for the following models:

E2.00XM, E2.50XM(SHORT), E2.50XM, E3.00XM(SHORT), E3.00XM, E3.20XM
E45XM, E45XM(SHORT), E50XM, E50XM(SHORT), E55XM, E60XM, E65XM
E45XM₂, E45XM₂(SHORT), E50XM₂, E50XM₂(SHORT), E55XM₂, E60XM₂, E65XM₂
N30XMH, N30XMH₂
J2.00XM, J2.50XM, J2.50XM(SHORT), J3.00XM, J3.20XM
J40XM, J50XM, J50XM(SHORT), J60XM, J65XM
J40XM₂, J50XM₂, J50XM₂(SHORT), J60XM₂, J65XM₂

E2.00-3.20XM MAST SPEEDS (72 or 80 Volt) Europe

CONTACTOR CONTROLLED STANDARD MOTOR & SMALL LIFT PUMP*						
MODEL	MAST	V	LIFTING		LOWERING	
			RATED LOAD	NO LOAD	RATED LOAD	NO LOAD
			m/sec	m/sec	m/sec	m/sec
E2.00XM	TWO-STAGE Limited Free Lift	72 80	0.290 0.310	0.411 0.462	0.559	0.508
	TWO-STAGE Full Free Lift	72 80	0.300 0.330	0.432 0.478	0.508	0.457
	THREE-STAGE Full Free Lift	72 80	0.295 0.320	0.422 0.472	0.528	0.467
	FOUR-STAGE Full Free Lift	72 80	0.310 0.340	0.406 0.447	0.447	0.411
E2.50XM	TWO-STAGE Limited Free Lift	72 80	0.274 0.295	0.411 0.462	0.574	0.508
	TWO-STAGE Full Free Lift	72 80	0.279 0.305	0.432 0.478	0.538	0.457
	THREE-STAGE Full Free Lift	72 80	0.279 0.300	0.422 0.472	0.549	0.467
	FOUR-STAGE Full Free Lift	72 80	0.295 0.325	0.406 0.477	0.447	0.411
E3.00XM	TWO-STAGE Limited Free Lift	72 80	0.229 0.259	0.371 0.411	0.559	0.457
	TWO-STAGE Full Free Lift	72 80	0.234 0.259	0.381 0.422	0.538	0.366
	THREE-STAGE Full Free Lift	72 80	0.234 0.259	0.366 0.422	0.544	0.396
E3.20XM	TWO-STAGE Limited Free Lift	72 80	0.229 0.254	0.371 0.411	0.559	0.457
	TWO-STAGE Full Free Lift	72 80	0.229 0.254	0.381 0.422	0.523	0.366
	THREE-STAGE Full Free Lift	72 80	0.229 0.254	0.366 0.422	0.533	0.396

* Slow (lift) speed 12 cubic cm displacement pump, 190 mm standard pump motor and 500 mm load center.

Oil temperature 54 to 66°C. Lifting speeds (valve fully open) ± 10% acceptable. No Load lowering speeds are minimum values. Rated Load lowering speeds are maximum values.

J40-65XM, J40-65XM₂, MAST SPEEDS (36 or 48 Volt) (3/99) Americas

190 mm (7.5 in) MOTOR & SMALL LIFT PUMP*										
MODEL	MAST	V	LIFTING				LOWERING			
			RATED LOAD		NO LOAD		RATED LOAD		NO LOAD	
			m/sec	ft/sec	m/sec	ft/sec	m/sec	ft/sec	m/sec	ft/sec
J40XM J40XM ₂	TWO-STAGE Limited Free Lift	36 48	0.136 0.182	44 59	0.209 0.277	68 90	0.339	110	0.308	
	TWO-STAGE Full Free Lift	36 48	0.139 0.188	45 61	0.216 0.286	70 93	0.308	100	0.277	
	THREE-STAGE Full Free Lift	36 48	0.139 0.185	45 60	0.212 0.283	69 92	0.320	104	0.283	
J50XM J50XM ₂	TWO-STAGE Limited Free Lift	36 48	0.129 0.169	42 55	0.209 0.277	68 90	0.348	113	0.308	
	TWO-STAGE Full Free Lift	36 48	0.136 0.179	44 58	0.216 0.286	70 93	0.326	106	0.277	
	THREE-STAGE Full Free Lift	36 48	0.132 0.176	43 57	0.212 0.283	69 92	0.333	108	0.283	
J60XM J60XM ₂	TWO-STAGE Limited Free Lift	36 48	0.111 0.142	36 46	0.185 0.246	60 80	0.345	112	0.277	
	TWO-STAGE Full Free Lift	36 48	0.114 0.151	37 49	0.188 0.252	61 82	0.326	106	0.222	
	THREE-STAGE Full Free Lift	36 48	0.114 0.151	37 49	0.188 0.249	61 81	0.329	107	0.240	
J65XM J65XM ₂	TWO-STAGE Limited Free Lift	36 48	0.108 0.145	35 47	0.185 0.246	60 80	0.339	110	0.277	
	TWO-STAGE Full Free Lift	36 48	0.111 0.148	36 48	0.188 0.252	61 82	0.317	103	0.222	
	THREE-STAGE Full Free Lift	36 48	0.111 0.148	36 48	0.188 0.249	61 81	0.323	105	0.240	

*Slow (lift) speed 12 cubic cm (0.73 cubic in) displacement pump, 190 mm (7.5 in) standard pump motor and 610 mm (24 in) load center.

Oil temperature 54 to 66°C (130 to 150°F). Lifting speeds (valve fully open) ± 10% acceptable. "No Load" lowering speeds are minimum values. "Rated Load" lowering speeds are maximum values. N/A = Not Available

TORQUE SPECIFICATIONS

ITEM	TORQUE
DRIVE AXLE, SPEED REDUCER AND DIFFERENTIAL J2.00-3.20XM (J40-65XM, J40-65XM₂)	
Axle Mounts To Frame	
Torque Wrench On Head Of Bolt	540 N.m (400 lb _f ft)
Torque Wrench On Nut Of Bolt	473 N.m (350 to 525 lb _f ft)
Axle Housing To Differential Housing	38 N.m (28 lb _f ft)
Axle Shaft Capscrews	98 N.m (72 lb _f ft)
Back Plate To Axle Mount Capscrews	
5/8 in Capscrews	245 N.m (180 lb _f ft)
1/2 in Capscrews	125 N.m (92 lb _f ft)
Bearing Cap Capscrews For Differential Bearings	95 to 110 N.m (14 lb _f ft)
Bearing Cap Capscrews For Speed Reducer	19 N.m (14 lb _f ft)
Differential Case Halves	50 N.m (37 lb _f ft)
Drive Gear To Differential Case	111 N.m (82 lb _f ft)
Retainer Capscrews For Adjustment Nuts	19 N.m (14 lb _f ft)
Speed Reducer Housing To Differential Housing	52 N.m (38 lb _f ft)
Traction Motor To Speed Reducer Housing	38 N.m (28 lb _f ft)
Wheel Cylinder Capscrews	
7/16 in Capscrews	78 to 91 N.m (58 to 67 lb _f ft)
1/2 in Capscrews	91 to 102 N.m (67 to 75 lb _f ft)
Wheel Nuts	237 to 305 N.m (175 to 222 lb _f ft)
STEERING AXLE E2.00-3.20XM (E45-65XM, E45-65XM₂ And N30XMH, N30XMH₂)	
Mount Brackets M12 x 1.75 x 45 bolts (4)	88 N.m (65 lb _f ft)
Steering Cylinder to Axle capscrews	
M16 x 2 x 130 (4)	121 N.m (89 lb _f ft)
Tie Rod Nuts 3/4 UNF (2)	163 N.m (120 lb _f ft)
Capscrews, Lower Spindle Cap (6)	
3/8 UNC X 1	44 N.m (32 lb _f ft)
Castle Nut, Wheel Hub (2)	Initial: 68 Nm (50 lb _f ft) while rotating wheel Loosen, then 3 Nm (2 lb _f ft)

To remove the battery, either raise the hood panels or unfasten the floor plate, depending on which motor needs to be accessed.

2. To remove the battery if necessary, see How To Remove The Battery in the **OPERATING MANUAL** or the **PERIODIC MAINTENANCE MANUAL** for your lift truck.

⚠ WARNING

Compressed air can move particles so that they cause injury to the user or to other personnel. Make sure that the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.

3. Remove the access plate or hood panels that cover the motors. Remove the brush covers on the motor. See FIGURE 2. Wear eye protection. Use a vacuum cleaner or compressed air to remove dirt and brush dust from the commutator area.

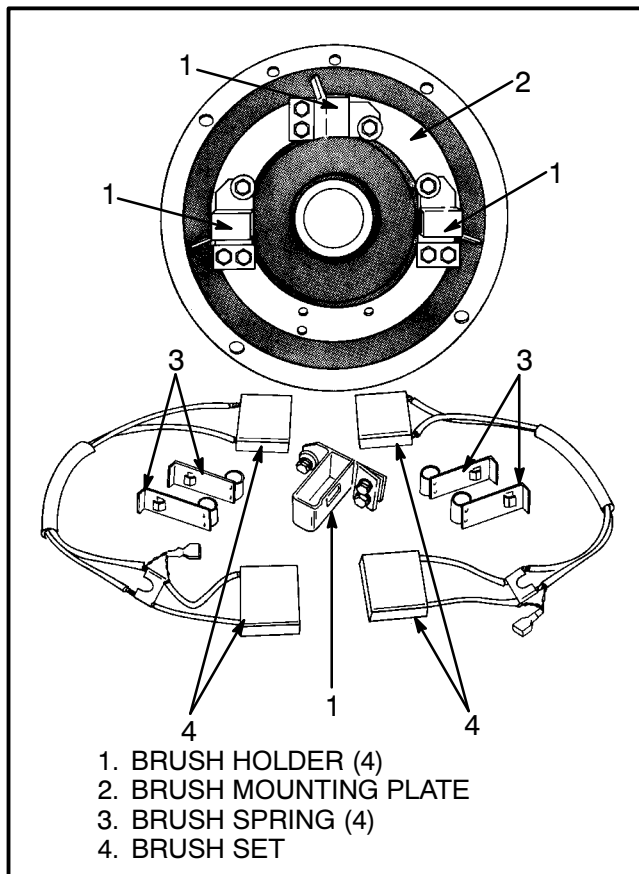


FIGURE 13. TYPICAL BRUSH ASSEMBLY

4. Make a note of the arrangement and connections of the brush assembly. The new brushes must be installed in the same positions from which the worn brushes were removed.

5. Loosen the screw that fastens the brush wire to its terminal. Remove the brush springs and brushes.

6. Inspect the brush holders for burns and damage. Make sure the brush holders are fastened tightly to the brush mounting plate at the end of the motor. Make sure the new brushes will move freely and smoothly in the brush holders. Check that the brush mounting plate is holding the brush holder so that it does not move.

7. Connect the new brush wire to its terminal mount.

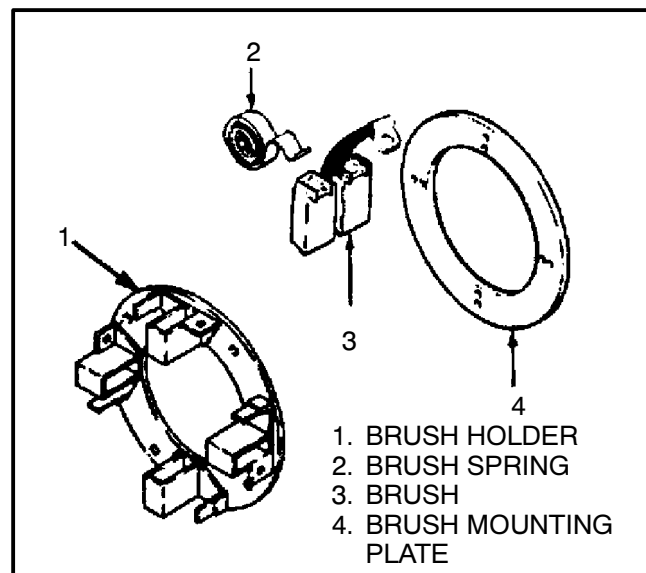


FIGURE 14. TYPICAL BRUSH HOLDER AND MOUNTING PLATE

NOTE: When new brushes must be installed, it is recommended that new brush springs be installed as well. Damage from heat can cause the brush springs to have the wrong spring pressure.

8. Check the brush springs for damage from heat and corrosion. If brush springs are damaged, install new brush springs. Check that the brush springs for approximately equal pressure.

Brush springs normally have a spring pressure of approximately

1.0 to 2.0 Newtons per each cm²
(1.5 to 3.0 lbf per each in²) when measured with a spring scale.

brush holder must be installed in the same position as the old holder so that the timing will be correct.

TESTS FOR A DAMAGED FIELD AND ARMATURE

The tests described in the following paragraphs are to help service personnel check a motor for damage and determine if it must be sent to a repair service for rebuilt motors. The resistance checks will not normally indicate a short-circuit in a motor winding. A resistance greater than 1 to 2 ohms can indicate a damaged winding. The motor must be removed from the lift truck and disassembled as shown in the illustrations before the tests can be done.

Test For An Open Circuit In The Armature (See FIGURE 23.)

The armature windings in large electric motors normally have less than one ohm of resistance. The two commutator bars for a winding are found 180 degrees apart on the commutator. If an ohmmeter (R x 1 scale) is used to check the resistance between the two commutator bars of the winding, a resistance of more than one ohm indicates a problem in that winding. A resistance of infinity (∞) indicates an open (damaged) winding.

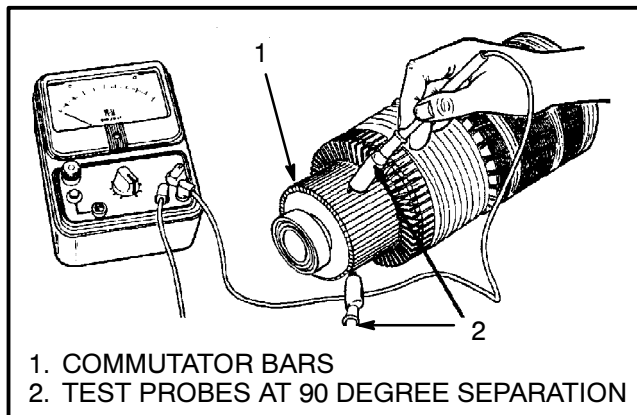


FIGURE 23. TEST FOR AN ARMATURE OPEN-CIRCUIT

If the armature has an open circuit, there will normally be two burned commutator bars on opposite sides of the commutator. These burned areas will cause the brushes to wear rapidly. When the motor operates, large electric sparks and arcs occur as the damaged commutator bars rotate under each brush. See FIGURE 9.

Test For A Short-Circuit In One Armature Winding (See FIGURE 24.)

A short-circuit in a motor winding is difficult to test because of the normal low resistance (less than one ohm) of a good armature. Special equipment is necessary to check for a short-circuit in a motor winding. A motor with a short-circuit in an armature winding will have a different sound when it begins to operate, but a service person must have experience to hear and understand the difference in sound. A winding with a short-circuit will also run hotter than a good winding and can have indications of heat damage. A winding that shows heat damage when the other windings are normal can have a short-circuit.

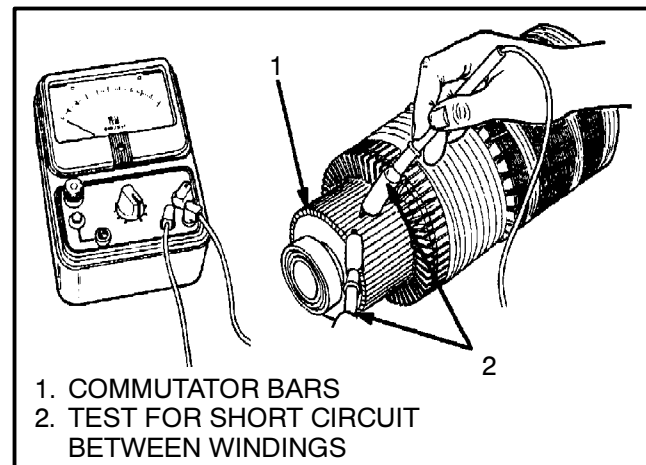
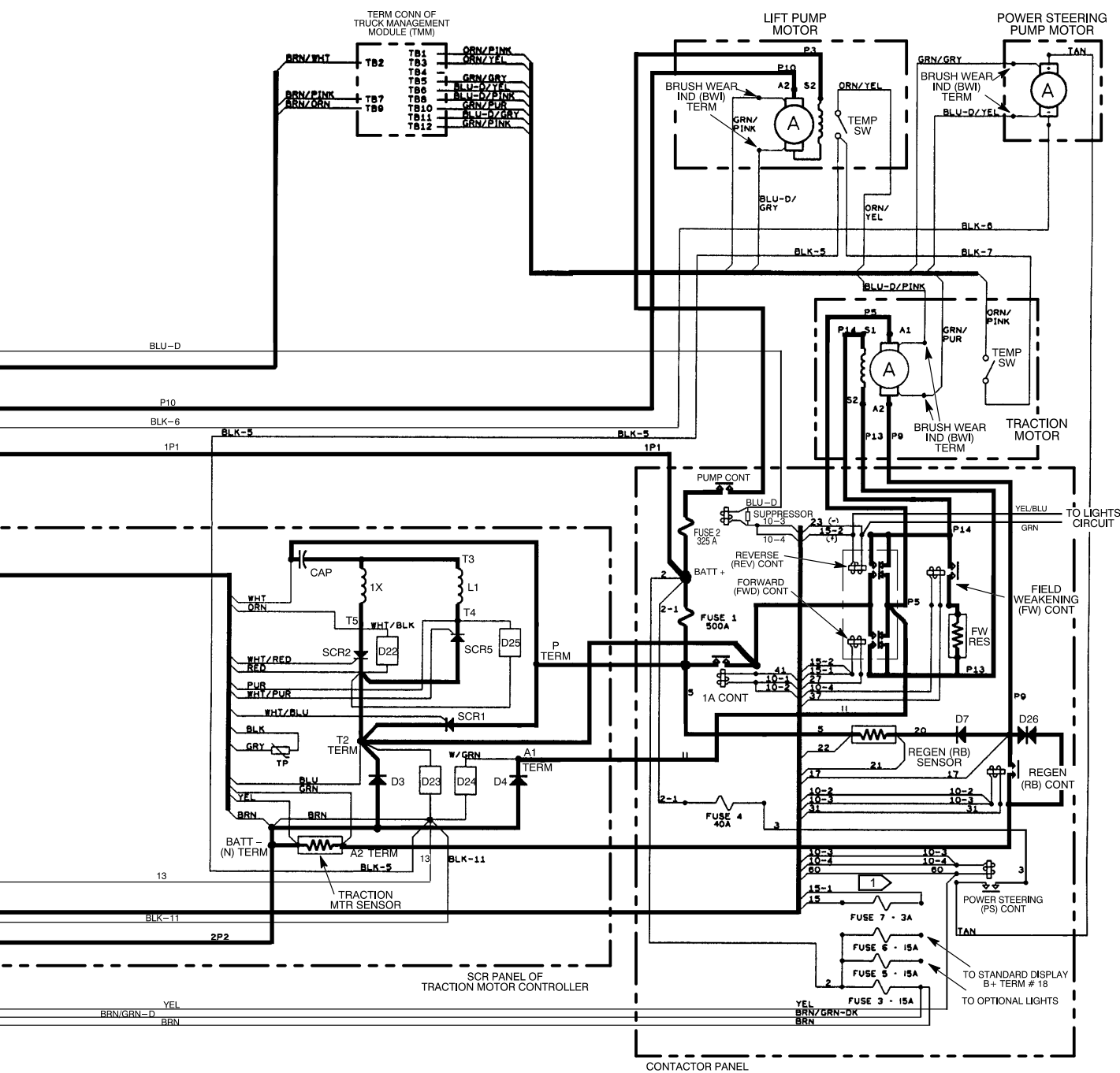


FIGURE 24. TEST ALL ARMATURE WINDINGS

E2.00-3.20XM (E45-65XM) AND N30XMH SCR TRACTION MOTOR CONTROLLER, CONTACTOR CONTROL OF PUMP MOTORS AND ENHANCED DISPLAY

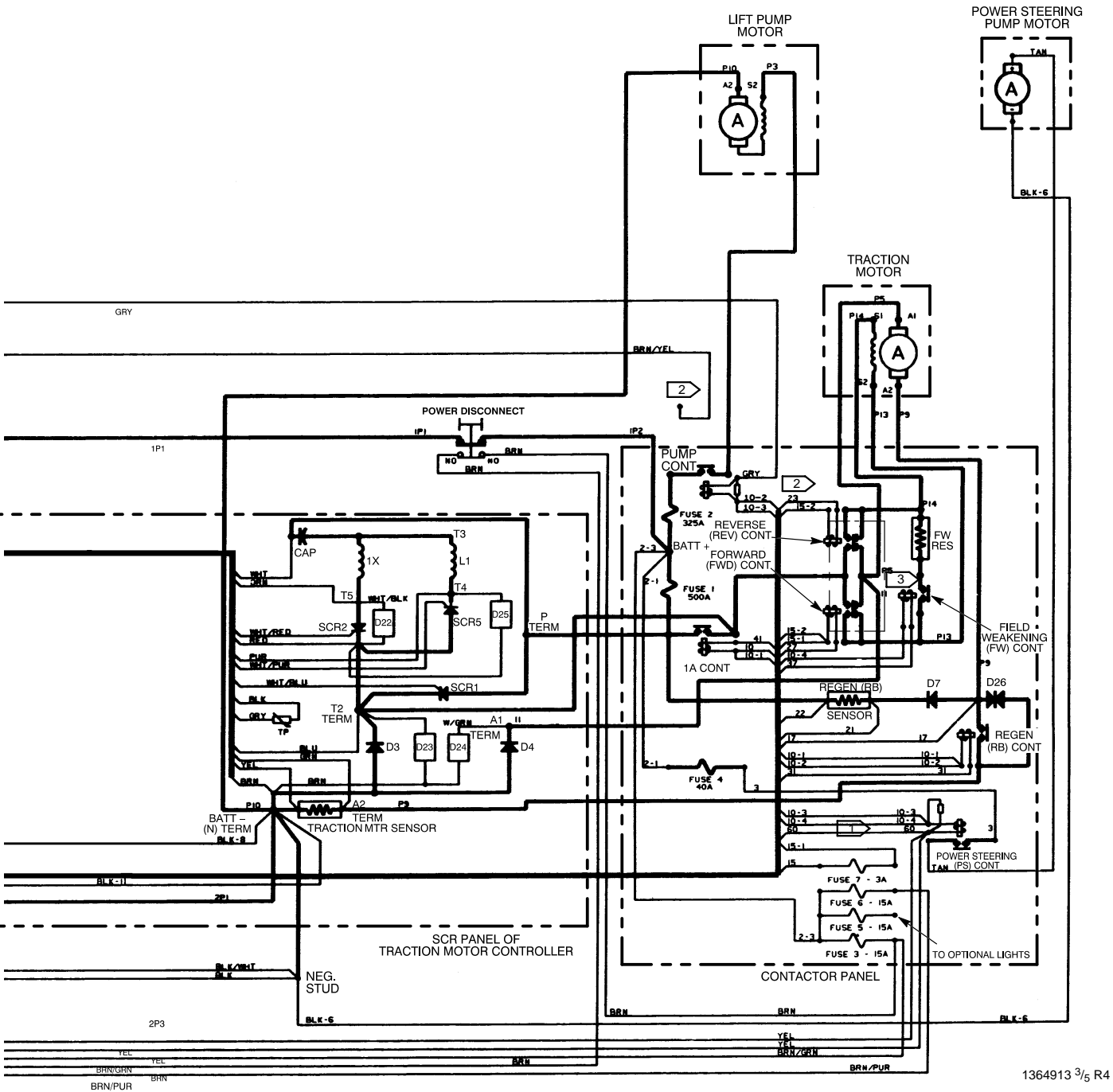


1340790 2/5 R3

1 Wire 60, between Power Steering Contactor and Traction PB3, is not connected when On-Demand Steering is installed.

FIGURE 5. WIRING DIAGRAM, E2.00-3.20XM (E45-65XM) AND N30XMH

J2.00-3.20XM (J40-65XM) SCR TRACTION MOTOR CONTROLLER, CONTACTOR CONTROL OF PUMP MOTORS AND STANDARD DISPLAY



1364913 3/5 R4

- ① Wire 60, between Power Steering Contactor and Traction PB3, is not connected when On-Demand Steering is installed.
- ② With Lift Interrupt, wires 10-2 and 10-3 are connected together and insulated, but not connected to Pump Contactor. The BRN/YEL wire is connected to the + term. (10-2, 10-3 term) of the Pump Contactor.
- ③ Wire terminals of wires 37 and 10-3, for contactor coil, are insulated when Field Weakening is not installed.

FIGURE 11. WIRING DIAGRAM, J2.00-3.20XM (J40-65XM)

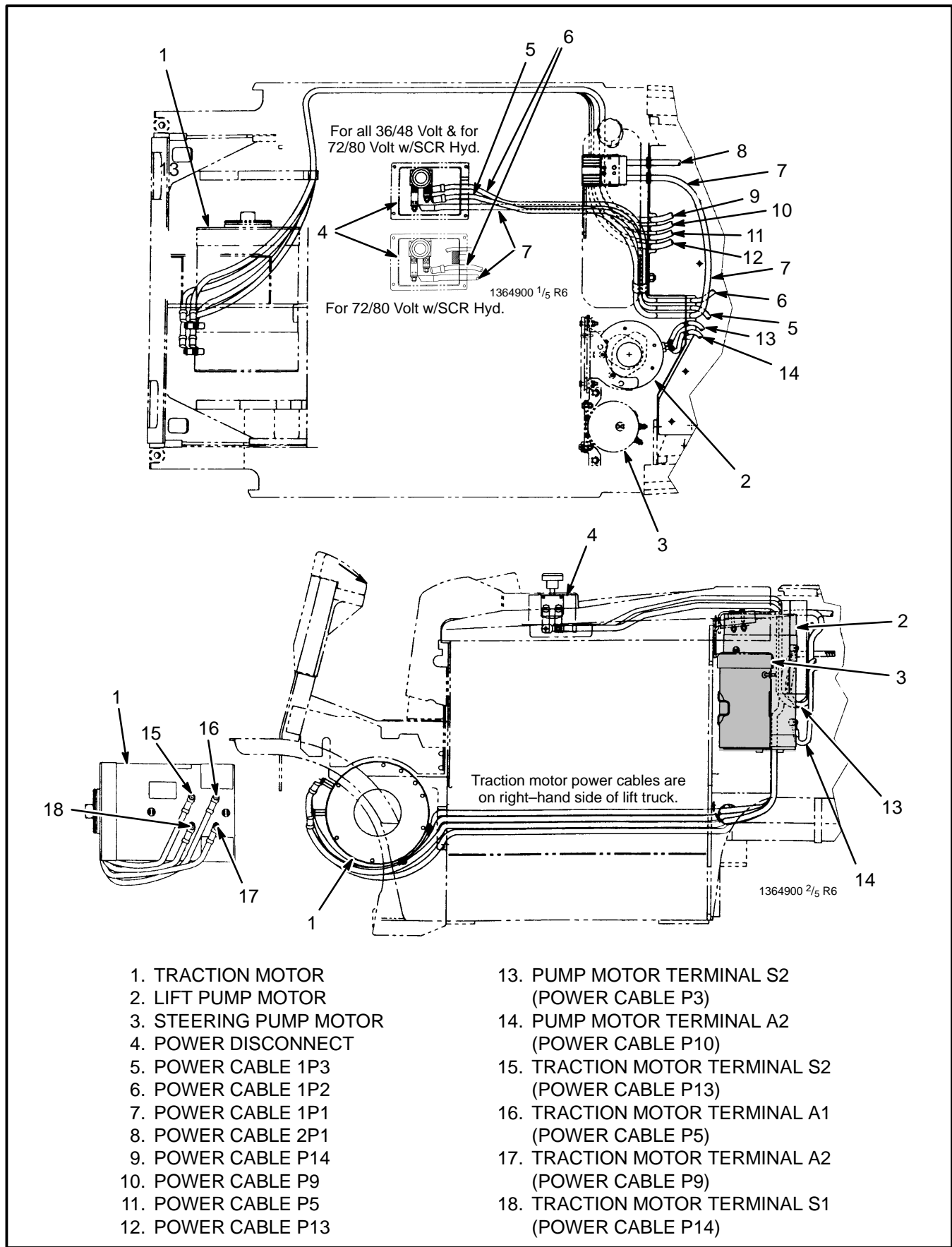


FIGURE 21. TRUCK POWER CABLES, J2.00-3.20XM (J40-65XM)

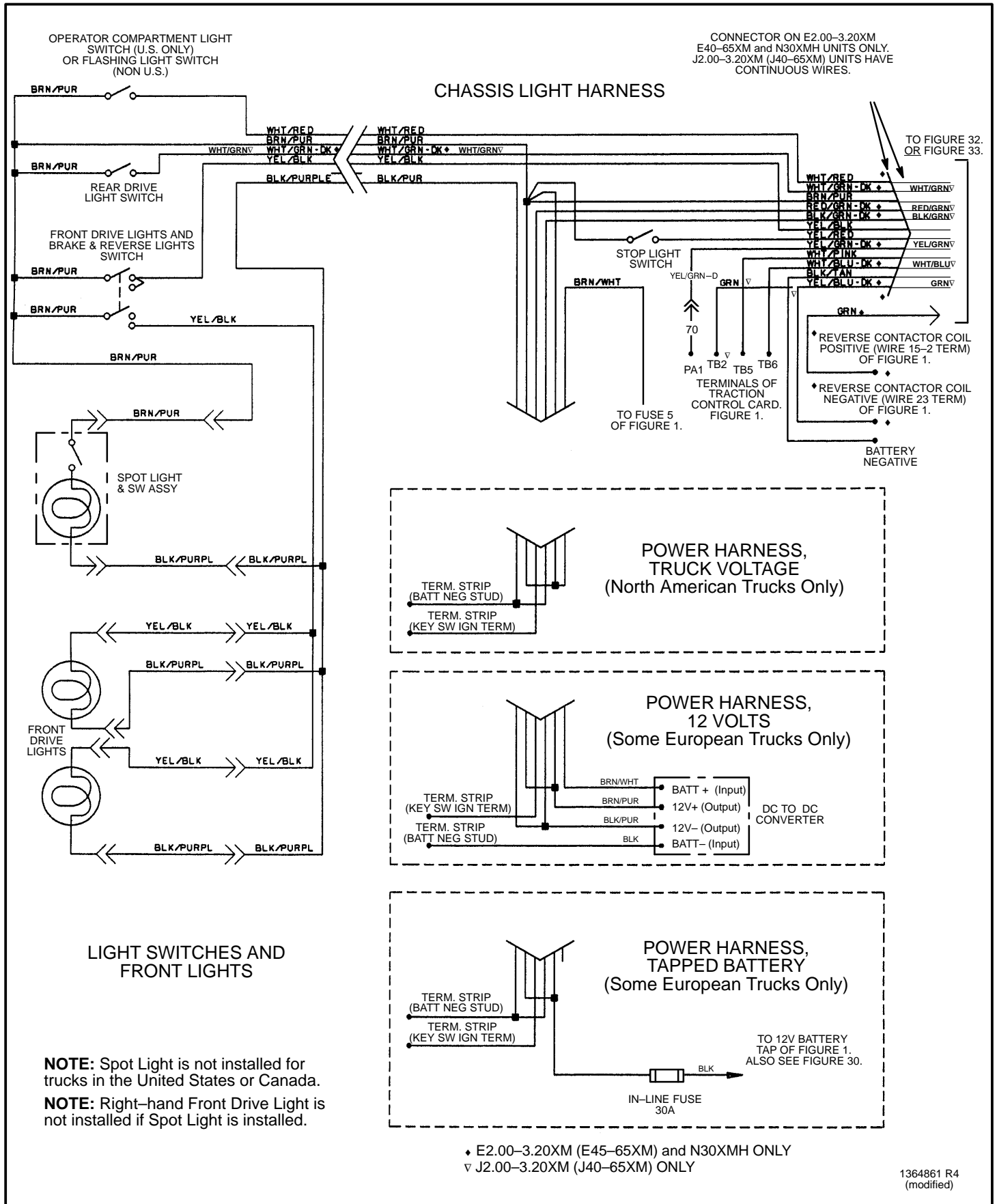


FIGURE 31. LIGHTING SCHEMATIC (CHASSIS)

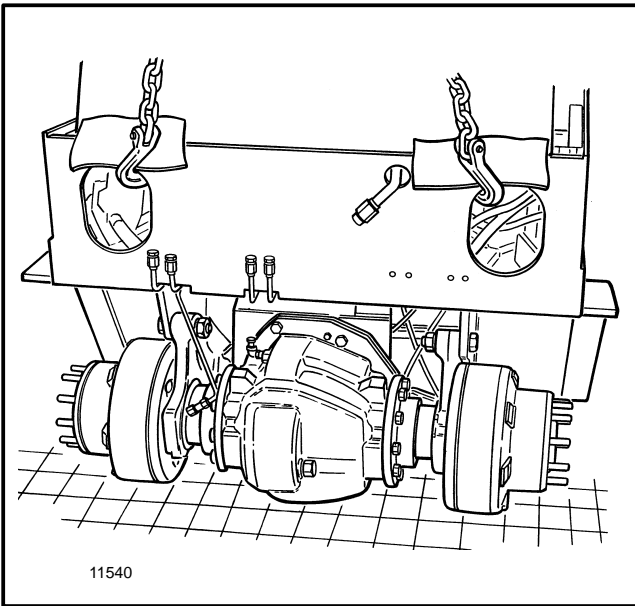


FIGURE 4. LOWER THE DRIVE AXLE TO THE SURFACE

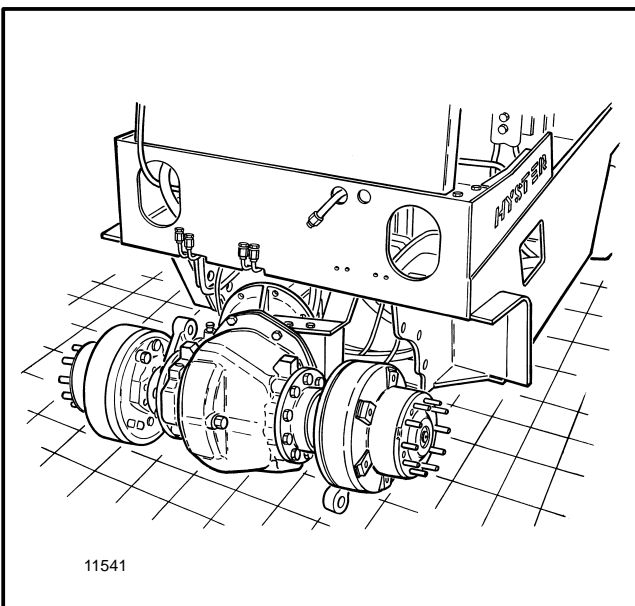


FIGURE 5. REMOVE THE DRIVE AXLE FROM THE LIFT TRUCK

5. Remove the drive wheels and lower the lift truck so that the drive axle and the front of the frame is on the floor. (The steering wheels are on the floor and hold the end of the frame with the counterweight.)

6. Remove the $\frac{7}{8}$ x 14 UNF bolts that hold the axle mounts to the frame. Turn the axle mounts forward so that there is additional clearance for removal of the drive axle.

NOTE: Some early models of the electric XL series of lift trucks have M20 x 2.5 x 80 bolts instead of $\frac{7}{8}$ x 14 UNF bolts.

7. Remove the mounting bolts for the hydraulic filter. With the hoses still attached to the filter, move the filter to improve access to the mounting bolt for the transmission. Remove the mounting bolt that is located on the top of the transmission/differential assembly (see item 12, FIGURE 2.)

8. Slide the drive axle assembly from the lift truck. Use a crane and slings to move the drive axle to a work space.

Disassembly of the Drive Axle

1. Remove the capscrews that hold the axle shaft to the hub. There are two holes with threads in the flange of the axle shaft. Put capscrews (M12 x 1.75) in these holes to loosen the axle shaft from the hub.

2. Bend the lock plate so that the nut can be removed from the axle spindle. Remove the nut, lock plate, washer, and bearing cone. Carefully slide the hub and brake drum assembly from the spindle. Keep the spindle in the center of the hub and brake drum assembly during removal so that the oil seal in the hub is not damaged. Do not permit oil or grease to get on the brake shoes.

3. Remove the inner bearing cone from the spindle. [E/J1.25–1.75XL (E25–35XL) models also have a spacer between the grease seal and the shoulder of the wheel spindle.]

4. If the brakes must be repaired, disassemble the brake assembly as described in the section for THE BRAKES. If disassembly of the brakes is not required, slide the brake assembly and the axle mount bracket from the axle spindle.

5. The axle spindles are not normally removed from the differential housing. If repairs are necessary, remove the 16 M12 x 1.75 x 35 capscrews that hold the axle spindles to the differential housing. Remove the axle spindles.

6. Remove the six M10 x 1.5 x 30 capscrews and washers and the two M10 x 1.5 x 40 capscrews and washers from the bottom of the differential housing. Remove the transmission and differential assembly from the differential housing.

See Figure 3 for the variation in the mounts for the drive wheels and axles. When the capscrews are not used for the drive wheel mounts, install the 10 M14 x 1.75 x 35 capscrews and tighten them to 155 N.m (115 lb_f ft).

E2.00–3.00XL (E40–60XL). Install the eight M12 x 1.75 x 35 capscrews and tighten to 90 N.m (66 lb_f ft).

J2.00–3.00XL (J40–60XL). Install the eight M12 x 1.75 x 35 capscrews and tighten to 98 N.m (72 lb_f ft).

E2.00–3.20XM (E45–65XM) and N30XMH. Install the eight M12 x 1.75 x 35 capscrews and tighten to 90 N.m (66 lb_f ft).

INSTALLATION OF THE DRIVE AXLE ASSEMBLY

1. Use a crane to move the drive axle assembly to the floor in front of the lift truck. Slide the drive axle assembly in position under the lift truck. Turn the axle mounts forward so that there is additional clearance for installation of the drive axle.

2. Align the bolt holes in the axle mounts and the frame. The lower edge of the speed reducer housing must be raised over the frame cross member so that the drive axle assembly can be aligned with the frame. Install the bolts to fasten the mount brackets to the frame. See the following NOTE.

NOTE: Some early models of the electric XL series of SitDrives used M20 x 2.5 x 80 bolts to fasten the mount brackets to the frame. If the lift truck has these metric bolts, use the following torque values:

If the torque wrench is on the head of the bolt, tighten the bolt to 540 N.m (400 lb_f ft). If the torque wrench is on the nut, tighten the nut to 473 N.m (350 lb_f ft).

Later models of the electric XL series SitDrives use special ⁷/₈ x 14 UNF bolts. This special set of hardware has the following Hyster part numbers: 366714 (⁷/₈ x 14 UNF bolt) 366713 (washer) 366715 (hex nut) Other nuts and bolts must not be used to replace these special bolts because of the high torque values.

3. Use a crane or jack to raise the drive axle from the floor so that the drive wheels can be installed. Install the drive wheels.

E1.25–1.75XL (E25–35XL). Tighten the wheel nuts to 155 N.m (115 lb_f ft).

E/J2.00–3.00XL (E/J40–60XL). Tighten the wheel nuts to 237 to 305 N.m (175 to 225 lb_f ft).

E2.00–3.20XM (E45–65XM) and N30XMH. Tighten the wheel nuts to 237 to 305 N.m (175 to 225 lb_f ft).

4. Put the drive wheels of the lift truck on blocks.

E/J1.25–1.75XL (E25–35XL). Install the hand lever assembly for the parking brake. Carefully slide the hand lever assembly and cables past the hydraulic lines and electric wires so that the hand lever assembly can be fastened in position on the cowl. Tighten the retainer that holds the lines and cables near the floor plate. Install the two M8 x 1.25 x 40 capscrews and washers that hold the hand lever assembly to the cowl mount. DO NOT tighten the capscrews more than 12 N.m (9 lb_f ft) or you will bend the hand lever assembly enough to cause it to malfunction.

E/J2.00–3.00XL (E/J40–60XL). Connect the parking brake cables at the brakes.

E2.00–3.20XM (E45–65XM) and N30XMH. Attach the park brake assembly to the frame.

5. Connect the brake lines to the wheel cylinders. Make sure there is brake fluid in the reservoir. Remove the air from the brake lines (See **NOTE** below).

NOTE: Make sure that a small hose is installed from the special fitting to a container for brake fluid when air is removed from the brake lines. If brake fluid is permitted to flow freely over the parts of the drive axle in this area, it can cause problems in the lubrication in the mast pivots and cause early failure of some grease seals.

6. Adjust the clearance of the brake shoes as described in the section for **THE BRAKES**.

7. Install the traction motor. See the **FRAME** section for procedures to install the traction motor.

8. Install and tighten the drain plug. Fill the differential housing with SAE 90 EP gear oil through the fill hole until the oil level is even with the bottom of the fill hole. Install the plug.

9. Install the mast as described in the section for **THE MASTS**. Install the battery as described in the **PERIODIC MAINTENANCE** section. Remove the blocks so that the lift truck is on its wheels.

The hourmeter display shows the operating time of 0000 to 9999 hours. The time for the traction circuit is shown for four seconds after the lift truck has been operating and the key is turned to the **OFF** position. The indicator lights for the traction motor (8) and for the hourmeter (12) will also be illuminated during this time. If there is an SCR control card for the hydraulic pump motor, this time will then be shown on the hourmeter for another four seconds. The indicator lights for the hydraulic motor (9) and for the hourmeter (12) will also be illuminated during this time.

- (3) **Warning Light, Fasten Seat Belt.** The red light is **ON** for eight to ten seconds after the key switch is turned to the **ON** position.
- (4) **Warning Light, Brake Fluid Reservoir Is Low (Early Only).** The red light is **ON** for one second when the key switch is turned to the **START** position and must go **OFF** when the key switch is in the **ON** position. If the warning light is **ON** when the key switch is in the **ON** position, the brake fluid level in the reservoir is too low.
- (5) **Warning Light, Parking Brake Indicator.** The red light is **ON** when the parking brake is applied and the seat switch is closed. and goes **OFF** when the parking brake is released.

A warning buzzer will make a noise if the operator leaves the seat (key switch **ON**) and the parking brake is not applied.

- (6) **Indicator Light, Steering Pump Motor.** This light will illuminate with another warning light if a fault occurs in the steering pump motor. If the brush wear sensor is activated in the motor, the warning light, brush wear (7) will go **ON** and the indicator light for the steering pump motor will show which motor has the problem.
- (7) **Warning Light, Motor Brushes Are Worn.** When the sensor for brush wear closes, this warning light and the indicator light for the motor that has the problem will both illuminate.
- (8) **Indicator Light, Traction Motor.** This light will illuminate with another warning light if a fault occurs in the traction motor. Example: If the brush wear sensor is activated in the motor, the warning light, brush wear (7) will go **ON** and the

indicator light for the traction motor will show which motor has the problem.

- (9) **Indicator Light, Hydraulic Motor.** This light will illuminate with another warning light if a fault occurs in the hydraulic pump motor. Example: If the temperature over limit switch closes in the motor, the warning light, motor temperature over limit (10) will go **ON** and the indicator light for the hydraulic motor will show which motor has the problem.
- (10) **Warning light, Motor Temperature Over Limit.** The traction motor and the hydraulic pump motor have thermal switches inside the motors. When the temperature increases to the limit set by the manufacturer of the motor, the thermal switch closes and the warning light on the display panel illuminates. The indicator light for traction motor (8) or for the hydraulic motor (9) will show which motor has the problem.

(14, 15) **Set Lift Truck Performance.** The lift truck can be set to four performance levels by the operator. (If the customer does not want this function available to the operator, a service person can set all four levels to the same setting.) Each time the operator pushes the button (14), performance level will increase by one step. At the maximum (rabbit) level, the performance levels will begin at the lowest (turtle) level again. The four performance levels set by the manufacturer are:

1. Low performance for handling fragile loads.
2. Medium speed for less consumption of battery charge during a work shift.
3. Higher performance with higher consumption of battery charge during a work shift.
4. Maximum lift truck performance with maximum consumption of battery charge.

The performance settings can be made with either the PC or the Hand Set (Functions 11, 12, and 13).

The four performance levels can be set to any level up to the maximum limits. Two or more adjacent performance levels can be set to the same limits. The performance levels must be set at the same or in ascending order (from turtle to

Status Code Or Performance Level Switches And Indicator LEDs (Performance Display Panel Only)

NOTE: These switches of the Performance display panel cannot be replaced as separate components. The switches must be replaced as part of the Performance display panel. See Replacing Display Panel Assembly of this section.

Replace Parts Of The Basic Display Panel (See FIGURE 9.)

NOTE: The parts of the Basic Display Panel can be replaced with the display panel on the steering column. If the assembly housing will be replaced, remove the complete assembly from the steering column as described in Replacing Display Panel Assembly.

NOTE: The following is a complete disassembly procedure. Do ONLY those steps necessary to replace the part you want replaced.

Remove and replace the components of the Basic display panel as follows:

1. Disconnect the battery and remove the key.
2. Remove the eight screws that fasten the top cover to the panel housing. The screws are at the bottom of the housing. See FIGURE 9. The hourmeter is fastened to the top cover with the electrical connector on the circuit board inside the housing. Carefully lift the top cover up off the housing and the indicator LEDs without damaging the O-ring gasket. The gasket for the LED indicators can stick to the LED housing as the top cover is removed. Do not lose or damage the gasket. Disconnect the three wire connector for the hourmeter.
3. If the housing or filter for the indicators will be replaced, remove the screws that fasten the LED housing to the cover. If the hourmeter or hourmeter gasket will be replaced, remove the screws that fasten it to the top cover. Install the replacement parts to the top cover. Make sure that the hourmeter is installed so that it can be read after the cover is installed.
4. Remove the nut that fastens the key switch. See FIGURE 8. Remove the key switch from the housing. Make a note of which wires are on which terminals and disconnect the wires. Install the wires on the same terminals of the replacement switch.

5. Align the notch in the shaft housing of the key switch with the tab in the housing of the display panel. Install the replacement switch. Tighten the nut and connect the wires.

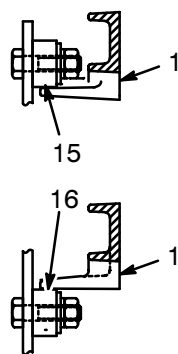
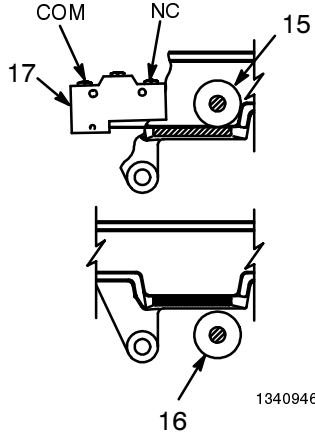
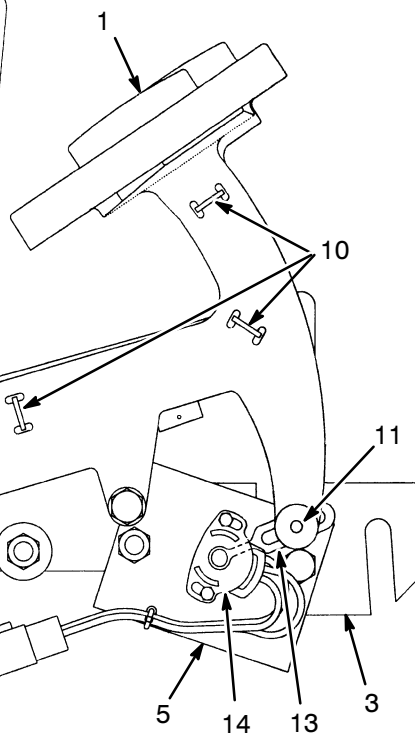
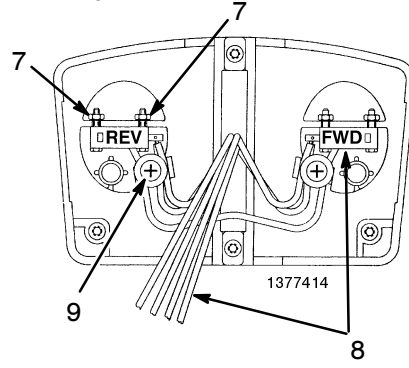
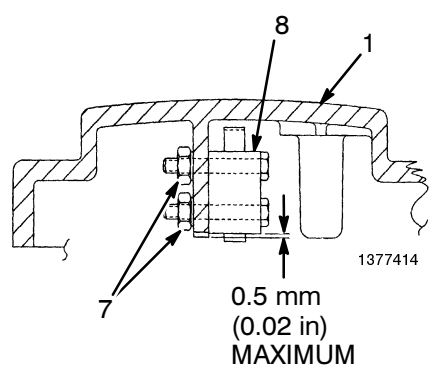
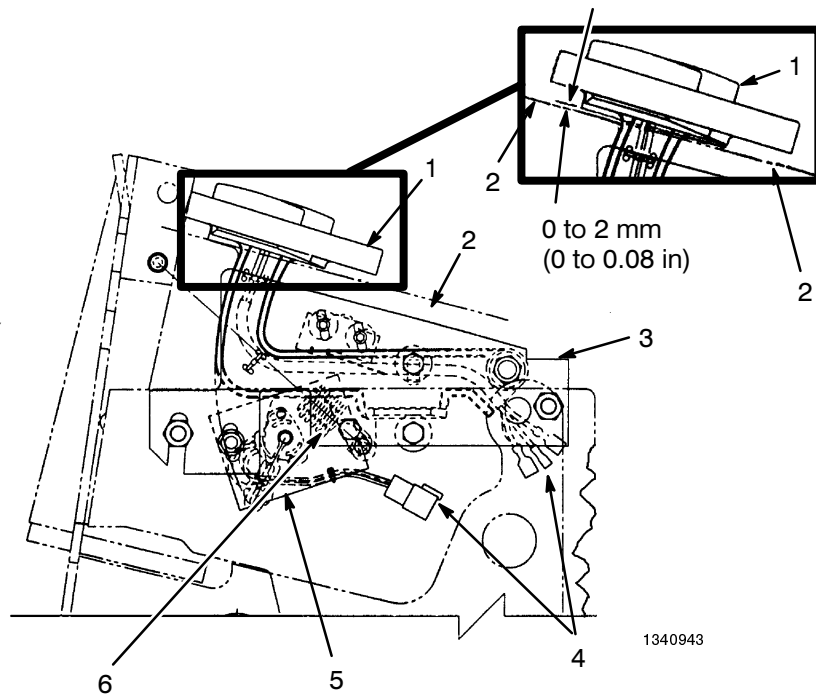
NOTE: It is not necessary to do Step 6 if only the meter movement of the battery indicator will be replaced on the existing circuit board. Carefully lift the meter movement up off the pins of the circuit board without bending the pins. See FIGURE 9. Carefully install the replacement meter movement on the pins. Make sure the pins are correctly aligned on the back of the meter before pushing the meter on the pins.

6. If the battery indicator, circuit board for the hour meter or the buzzer will be replaced, remove the screws that fasten the circuit board to the housing. Disconnect the connector from the circuit board. Remove the buzzer from the bottom of the circuit board. Make sure to install the fiber washer when installing the replacement buzzer on the replacement circuit board. If necessary, carefully lift the meter movement up off the pins of the circuit board without bending the pins. See FIGURE 9. Carefully install the replacement meter movement on the pins of the replacement circuit board. Make sure the pins are correctly aligned on the back of the meter before pushing the meter on the pins. Connect the electrical connector to the circuit board and install the circuit board assembly in the housing.

7. If the LED indicator assembly will be replaced, first remove the 18 pin connector. It is necessary to remove the front steering column cover with the display panel assembly attached for access to the connector. After removing the screws that fasten the front cover, carefully disconnect the connector. It can be necessary to disconnect the key switch wires (Step 4) and the two wire connector for enough clearance to disconnect the 18 pin connector. Remove the two screws that fasten the LED assembly to the housing. Install the replacement LED assembly, carefully connect all connectors and wires. Install the front steering column cover with the display panel assembly attached. Install the LED gasket over the LED indicators.

8. If necessary, install a new O-ring gasket. Carefully install the O-ring gasket in the groove of the top cover. Carefully install the top cover assembly over the LED indicators and assembly housing without damaging either the LED gasket or O-ring gasket. Make sure the O-ring gasket is still correctly aligned with the cover and

1. ACCELERATOR OR MONOTROL PEDAL
2. FLOOR PLATE
3. PEDAL MOUNT PLATE
4. ELECTRICAL CONNECTIONS
5. SENSOR MOUNT PLATE
6. SPRING
7. MOUNT NUT
8. FORWARD/REVERSE SWITCH & CABLE ASSEMBLY
9. CLAMP SCREW
10. CABLE TIES
11. PIN
12. PIVOT CAPSCREW
13. SENSOR ARM
14. ACCELERATOR POSITION SENSOR
15. PEDAL UP STOP
16. PEDAL DOWN STOP
17. START SWITCH



NOTE: Adjust the Forward/Reverse switches before installing the pedal pad. Adjust the pedal fully depressed (down) position first. Then adjust the start switch and then the accelerator or Monotrol pedal position sensor. See the text for the adjustment procedures.

FIGURE 22. MONOTROL OR ACCELERATOR PEDAL - ADJUSTMENT AND REPAIR

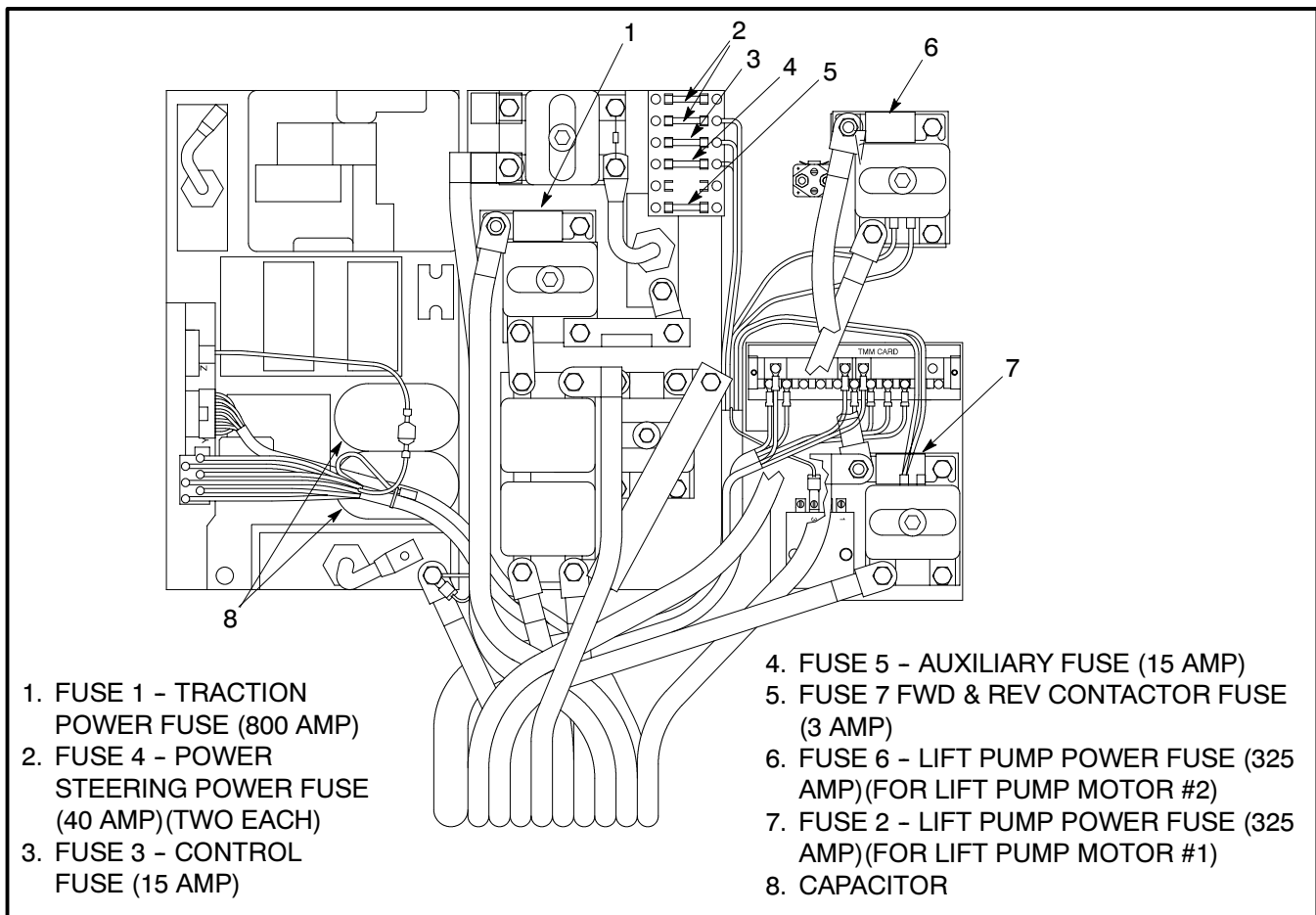


FIGURE 29. FUSE LOCATIONS FOR THE EV-100ZX SCR MOTOR CONTROLLER OF THE E70-120XL

CONTROL AND POWER FUSES - SEM
(See FIGURE 30. and FIGURE 31.)

The condition of fuses can normally be checked by looking at them. Some fuses do not change in appearance and must be checked with an ohmmeter. Disconnect the battery and push and hold the horn button until

the horn stops making a sound before checking fuses. This action will discharge the capacitors in the motor controllers. Sizes and locations of the fuses are shown in FIGURE 30. or FIGURE 31.

Replace all bad fuses. Check to see what caused the fuse to open before connecting the battery.

EV-100ZX™ SCR MOTOR CONTROLLER, Description, Adjustments, Troubleshooting, Repairs, and Theory

GENERAL

Four **SERVICE MANUAL** sections are required for the complete Description, Checks, Adjustments, Repairs, and Troubleshooting of this motor controller:

- **EV-100ZX SCR MOTOR CONTROLLER, Description, Adjustments, Troubleshooting, Repairs, and Theory, 2200 SRM 557** (this section)
- **TROUBLESHOOTING AND ADJUSTMENTS WITH A COMPUTER For EV-100ZX And EV-T100 Motor Controllers, 2200 SRM 597**
- **EV-100ZX SCR MOTOR CONTROLLER, Parameter Tables, 2200 SRM XXX** (different SRM number for different lift truck models)
- **ELECTRICAL SYSTEM, Repairs, Checks And Adjustments, 2200 SRM 560**

This section describes the operation and the functions of the EV-100ZX motor controller. The EV-100 and the EV-200 series of motor controllers, used to control the operation of electric lift trucks, are made by the General Electric Company.

The EV-100 and the EV-200 series of motor controllers are similar in design and function, but have different control cards.

The “ZX” letters identify the controllers that have the “ZX” series of diagnostic control cards. These control cards can use an adapter for a serial cable that will connect to a serial port on a personal computer for checks, adjustments, and troubleshooting.

- a. A Cable Kit, Control Card to Computer, is required (Hyster Part No. 1358471).
- b. The HYTECH™ software for a personal computer is available on a 3.5 inch diskette (Hyster Part No. 897702).
- c. The Cable Kit and the 3.5 inch diskette with the HYTECH™ software are available from your dealer for Hyster lift trucks.

These control cards have logic circuits and registers that control and keep a record of the operations of the motor

controller. The registers also keep a record of possible malfunctions of the motor controller that can indicate the problems during troubleshooting.

This section has the following components:

- a. A “Description” for the EV-100ZX SCR Motor Controller.
- b. A series of “Status Code Charts” that describe an indication of a fault and its possible causes when the code is shown on the instrument panel display.
- c. Checks and replacement of the components of the motor controller are described in “Repairs”.
- d. A basic “Theory Of Operation” on how an SCR motor controller operates.

An electronic diagnostic and adjustment device can also be used to check and adjust the control cards. This electronic diagnostic and adjustment device is called a “Hand Set” and is described later in this section. A computer with the control software installed has access to 128 function registers on the control cards. The Hand Set has access to less function registers on the control card and can only make changes to a limited number of the registers on the ZX control cards.

A description and the replacement of the instrument panel display is also included in the repair section.

Most of the components of the EV-100 motor controller can not be repaired, but must be replaced. This section describes the procedures for using the electronic diagnostic and adjustment devices for checking and adjusting the operation of the motor controller.

There are electrical components that are not part of the motor controller, but give input signals to it. These components include the following:

- a. Key switch
- b. START switch (earlier production units only).
- c. Brake switch
- d. Foot switch
- e. Seat switch
- f. Direction (FORWARD and REVERSE) switches

REGISTER PARAMETERS

General

The “ZX” series of control cards have an electronic device called an **EEPROM** (Electrically–Erasable–Programmable–Read–Only–Memory). The EEPROM has a number of memory elements called **registers**. These registers can have electronic data stored in them to control an operation. The range of data that can be stored in the registers is called a **parameter**. A parameter is a measurement number that works with other measurement numbers (parameters) to define a system. The EEPROM in the control card is a control system for the operation of the lift truck.

The EEPROM used in the “ZX” series of control cards has 128 registers.

WARNING

Each register in each control card has a range of numbers so that the control card can be used on different models of lift trucks. This variation is needed for lift trucks of different sizes and operating voltages. Adjustment of the register to the wrong number for your lift truck model can cause the truck to operate differently than normal. This different operation of the truck can cause an injury.

Do NOT adjust any of the registers without using the parameters shown in EV-100ZX SCR MOTOR CONTROLLER, Parameter Tables, 2200 SRM 595.

NOTE: The **Parameter Tables** show the permitted ranges and the default setting for each control function. The Factory Set Parameters are the recommended settings for new units. These settings will give satisfactory performance for most applications.

Some functions can be adjusted within the permitted range to change the lift truck operation for a specific application. Adjustment of a register to a number that is different than the factory setting is allowed, but follow the instructions carefully and stay within the minimum and maximum limits. Adjustments other than the factory settings will cause the lift truck to operate differently and can cause increased wear of parts.

Function Numbers

The Function Numbers are code numbers for the different parameters that can be set for the “ZX” series control

cards. The Personal Computer or the Hand Set **must** be used to adjust the parameters for the control card. There is a description of the code numbers for the different control cards in the **Parameter Tables**. These **Parameter Tables** have the correct setting numbers for the parameters on each control card.

CONTROL CARD, CHECKS AND ADJUSTMENTS

A Personal Computer (PC) or a Hand Set is used to permit **Authorized Personnel** to make the following checks and adjustments:

- Check the system status codes for both traction and hydraulic pump SCR systems
- Check for status codes that are not regular nor constant
- Check the state of charge of the battery on motor controllers with type ZH and ZY control cards
- Check the hourmeter readings on the traction circuit and hydraulic pump SCR controllers
- Monitor or adjust the following control functions:
 - ◆ Creep Speed
 - ◆ Controlled Acceleration and 1A Time
 - ◆ Current Limit
 - ◆ Steering pump time delay and define signal input (seat switch or directional switch)
 - ◆ Plugging distance (Current)
 - ◆ Accelerator pedal position, plug range or disable
 - ◆ 1A drop out current or disable
 - ◆ Field Weakening drop-out
 - ◆ Field Weakening pick-up
 - ◆ Regenerative Braking current limit
 - ◆ Regenerative Braking drop-out
 - ◆ Speed limit points (SL1, SL2 and SL3)
 - ◆ Internal resistance compensation for battery state of charge indication
 - ◆ Battery voltage (36/48V is auto ranging)
- Selection of type of card operation:
 - ◆ Traction circuit with Field Weakening
 - ◆ Traction circuit with Regenerative Braking and Field Weakening
 - ◆ High or low current limit for all of the above functions

speed control input is less than 0.5 volt (accelerator potentiometer set at less than 50 ohms). Do not set the number in the register to less than the parameter in the register for Function Number 52.

Function Number 49
FIELD WEAKENING PICK UP
(Push CONT and 2 while the key switch and seat switch are closed)

This register permits the adjustment of the current value at which the FW contactor will energize (close). This parameter permits the FW contactor to close when the lift truck has returned to approximately 150% of its running current with a full load on a level surface. The minimum parameter is zero. Do not set the number in the register greater than the number in the register for Function Number 53.

Function Number 50
SPEED LIMIT 1
(Push CONT and 3 while the key switch and seat switch are closed)

This parameter permits adjustment of the speed limit (maximum battery volts to the motor). The range is 0% to 96%. There is no speed limit switch for this function. This function will be disabled if the parameter in the register is set to zero. Do not set the number in the register to less than the parameter for Function Number 54. Do not set the number in the register greater than 180.

Function Number 52
CONTROLLED ACCELERATION AND 1A TIME
(Push CONT and 5 while the key switch and seat switch are closed)

This register permits the adjustment of the maximum rate of acceleration in MODE 2. The parameter determines the time allowed to reach maximum SCR speed after the accelerator is set for maximum speed from stop. The control will stay in SCR acceleration for 2.6 seconds (setting 30) before the 1A contactor will close. The numbers in () are the parameters for the times shown. The 1A contactor will automatically close 0.2 second after the controlled acceleration stops. The speed control input is less than 0.5 volt (accelerator potentiometer set at less than 50 ohms). Do not set the number in the register to less than the parameter for

Function Number 56. Do not set the number in the register greater than the number in the register for Function Number 48.

Function Number 53
FIELD WEAKENING PICK UP
(Push CONT and 6 while the key switch and seat switch are closed)

This register permits the adjustment of the current value at which the FW contactor will energize (close). This parameter permits the FW contactor to close when the lift truck has returned to approximately 150% of its running current with a full load on a level surface. Do not set the number in the register to less than the parameter for Function Number 49. Do not set the number in the register greater than the number in the register for Function Number 57.

Function Number 54
SPEED LIMIT 1
(Push CONT and 7 while the key switch and seat switch are closed)

This parameter permits adjustment of the speed limit (maximum battery volts to the motor). The range is 0% to 96%. There is no speed limit switch for this function. This function will be disabled if the parameter in the register is set to zero. Do not set the number in the register to less than the parameter for Function Number 58. Do not set the number in the register greater than the number in the register for Function Number 50.

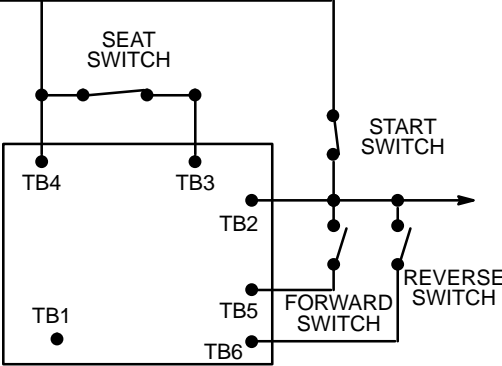
Function Number 56
CONTROLLED ACCELERATION AND 1A TIME
(Push CONT and 9 while the key switch and seat switch are closed)

This register permits the adjustment of the maximum rate of acceleration in MODE 3. The parameter determines the time allowed to reach maximum SCR speed after the accelerator is set for maximum speed from stop. The control will stay in SCR acceleration for 1.8 seconds (setting 20) before the 1A contactor will close. The numbers in () are the parameters for the times shown. The 1A contactor will automatically close 0.2 second after the controlled acceleration stops. The speed control input is less than 0.5 volt (accelerator potentiometer set at less than 50 ohms). Do not set the number in the register to less than the parameter for

TABLE 6. REGISTER MAP FOR CONTROL CARDS ZH AND ZY (TRACTION) (Continued)

EEPROM Register Number	PC Function Number	Hand Set (HS) Function Number	Function	Access By:	Restrictions
76	77		Fault 12	PC Only	Reset to Zero only
77	78		BDI 12	PC Only	Reset to Zero only
78	79		Hours (Tens/Units) 12	PC Only	Reset to Zero only
79	80		Hours (Thousands/Hundreds) 12	PC Only	Reset to Zero only
80	81		Fault 13	PC Only	Reset to Zero only
81	82		BDI 13	PC Only	Reset to Zero only
82	83		Hours (Tens/Units) 13	PC Only	Reset to Zero only
83	84		Hours (Thousands/Hundreds) 13	PC Only	Reset to Zero only
84	85		Fault 14	PC Only	Reset to Zero only
85	86		BDI 14	PC Only	Reset to Zero only
86	87		Hours (Tens/Units) 14	PC Only	Reset to Zero only
87	88		Hours (Thousands/Hundreds) 14	PC Only	Reset to Zero only
88	89		Fault 15	PC Only	Reset to Zero only
89	90		BDI 15	PC Only	Reset to Zero only
90	91		Hours (Tens/Units) 15	PC Only	Reset to Zero only
91	92		Hours (Thousands/Hundreds) 15	PC Only	Reset to Zero only
92	93		Fault 16	PC Only	Reset to Zero only
93	94		BDI 16	PC Only	Reset to Zero only
94	95		Hours (Tens/Units) 16	PC Only	Reset to Zero only
95	96		Hours (Thousands/Hundreds) 16	PC Only	Reset to Zero only
96	97	48	Instrument Panel Display CA-1	HS or PC	None
97	98	49	Instrument Panel Display FWPU-1	HS or PC	None
98	99	50	Instrument Panel Display SL1-1	HS or PC	None
99	100	51	NOT USED	HS or PC	None
100	101	52	Instrument Panel Display CA-2	HS or PC	None
101	102	53	Instrument Panel Display FWPU-2	HS or PC	None
102	103	54	Instrument Panel Display SL1-2	HS or PC	None
103	104	55	NOT USED	HS or PC	None
104	105	56	Instrument Panel Display CA-3	HS or PC	None
105	106	57	Instrument Panel Display FWPU-3	HS or PC	None
106	107	58	Instrument Panel Display SL1-3	HS or PC	None
107	108	59	NOT USED	HS or PC	None
108	109	60	Instrument Panel Display CA-4	HS or PC	None
109	110	61	Instrument Panel Display FWPU-4	HS or PC	None
110	111	62	Instrument Panel Display SL1-4	HS or PC	None
111	112		NOT USED	PC Only	
112	113		Secure Hourmeter (Tens/Units)	PC Only	Read Only
113	114		Secure Hourmeter (Thousands/Hundreds)	PC Only	Read Only

Status Code Charts

<p>Status Code -11</p>	<p>Description</p> <p>The START switch is closed when the key switch is closed and voltage is applied to the control card.</p>	<p>Cause Of Status Indication</p> <p>This Status Code will be indicated when TB2 is greater than 60% of battery voltage when the key switch is closed.</p>
<p>Memory Recall No</p> <p>Circuit Traction (ZX Control Card Only)</p>	<p>Indication of Fault</p> <p>Forward or Reverse contactor will not close.</p> <p>Possible Cause</p> <p><u>START switch needs adjustment or is damaged.</u></p> <p>Input voltage must be less than 60% of battery voltage when the key switch is closed. Replace or adjust the START switch.</p> <p><u>Short-circuit between battery positive and TB2 in START switch circuit.</u></p> <p>Disconnect the wire from TB2. Check for a short-circuit between the end of the wire and the battery positive. Resistance must be greater than 4.7 K ohms.</p> <p><u>Control card malfunction.</u></p> <p>Disconnect the wire from TB3 and measure the voltage from TB3 to battery negative. If the voltage is not zero, replace the control card.</p>	

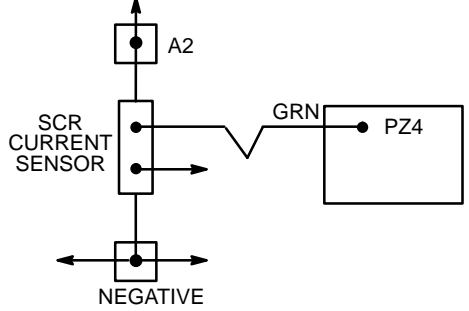
<p>Status Code -15</p>	<p>Description</p> <p>Battery voltage is too low.</p>	<p>Cause Of Status Indication</p> <p>This Status Code will be indicated when the battery volts are less than 1.95 volts per cell when the key switch is turned to ON.</p>										
<p>Memory Recall No</p> <p>Circuit Traction</p>	<p>Indication of Fault</p> <p>Forward or Reverse contactor will not close.</p> <p>Possible Cause</p> <p><u>Discharged battery.</u></p> <p>Check the battery for the correct open circuit voltage as shown in the illustration at right and charge the battery as required.</p> <p><u>Bad connection at battery connector or in the power cables.</u></p> <p>Check the power cables and the battery connector.</p> <p><u>Battery malfunction.</u></p> <p>Check each battery cell for the correct voltage (greater than 1.95 volts per cell). Replace or repair the battery.</p> <p><u>Control card needs adjustment.</u></p> <p>Check Function 15 for the correct adjustment for the battery that is being used. See the instructions for the Hand Set. Make the correct adjustments.</p>	<table border="1" data-bbox="1008 1367 1268 1608"> <thead> <tr> <th>NOMINAL BATTERY VOLTS</th> <th>MINIMUM BATTERY VOLTAGE AT 1.95 VOLTS PER CELL</th> </tr> </thead> <tbody> <tr> <td>36</td> <td>35.1</td> </tr> <tr> <td>48</td> <td>46.8</td> </tr> <tr> <td>72</td> <td>70.2</td> </tr> <tr> <td>80</td> <td>81.9</td> </tr> </tbody> </table>	NOMINAL BATTERY VOLTS	MINIMUM BATTERY VOLTAGE AT 1.95 VOLTS PER CELL	36	35.1	48	46.8	72	70.2	80	81.9
NOMINAL BATTERY VOLTS	MINIMUM BATTERY VOLTAGE AT 1.95 VOLTS PER CELL											
36	35.1											
48	46.8											
72	70.2											
80	81.9											

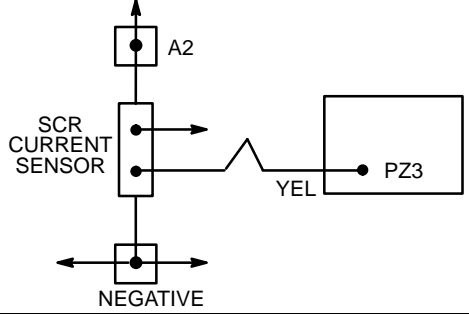
Status Code Charts

Status Code -53	Description SCR 1 does not go OFF correctly during plugging cycle.	Cause Of Status Indication This Status Code will be indicated when any failure of SCR 1 to go OFF during the plugging cycle.
Memory Recall Yes Circuit Traction	<p>Indication of Fault</p> <p>Forward or Reverse contactors open and close, then will only close when the key switch is opened and closed.</p> <p>Possible Cause</p> <p><u>SCR 1 failure is not caused by plugging.</u></p> <p>Cause the traction motor to stall in both directions and check for a new status code that will also indicate the failure. Do Troubleshooting for the new or additional Status Code.</p> <p><u>SCR 1 failure is caused by plugging.</u></p> <p>Check for an open circuit across D4.</p> <p>Check for an open circuit or loose connection in the D4 circuit.</p> <p>Check current sensor for loose or open connections. Check the yellow and green wire from the current sensor to the control card for open or loose connections.</p> <p><u>Malfunction in motor circuit.</u></p> <p>Check motor circuit for open or loose connections.</p> <p>Check motor brushes for wear and installed correctly.</p> <p><u>Check for Forward or Reverse contactors momentarily opening and closing.</u></p> <p>Check for Forward or Reverse contactors momentarily opening and closing during operation when traveling over bumps and dock plates.</p>	

Status Code -54	Description Short-circuit in an electronic driver for the Forward, or Reverse, or 1A contactor.	Cause Of Status Indication This Status Code will be indicated when the control card has a short-circuit in one of the electronic drivers for the Forward, or Reverse, or 1A contactor.
Memory Recall Yes Circuit Traction	<p>Indication of Fault</p> <p>Motor controller will not operate.</p> <p>Possible Cause</p> <p><u>Fuse 7 is open.</u></p> <p>Check for a short-circuit that can cause Fuse 7 to open. Replace Fuse 7.</p> <p><u>Control card malfunction.</u></p> <p>Replace the control card.</p>	

Status Code Charts

Status Code -142	Description Input missing from motor current sensor.	Cause Of Status Indication This Status Code will be indicated when the voltage between PY7 and battery negative is greater than 1.6 volts and no current is flowing through the hydraulic pump motor circuit.
Memory Recall No Circuit Hydraulic Pump	Indication of Fault No power to the hydraulic pump motor in the SCR range. Possible Cause <u>Open sensor wire circuit to PZ4.</u> Check for a loose or broken wire (green wire) between the current sensor and PZ4 on the control card.	 <p>The diagram shows a vertical stack of components: A2 at the top, followed by the SCR CURRENT SENSOR, and NEGATIVE at the bottom. A green wire labeled GRN connects the SCR CURRENT SENSOR to PZ4 on a control card.</p>

Status Code -143	Description Input missing from motor current sensor.	Cause Of Status Indication This Status Code will be indicated when the voltage between PY7 and battery negative is less than 0.84 volts and no current is flowing through the hydraulic pump motor circuit.
Memory Recall No Circuit Hydraulic Pump	Indication of Fault Stall currents in the SCR range are higher than normal and can not be controlled with the C/L adjustment. Possible Cause <u>Open sensor wire circuit to PZ3.</u> Check for a loose or broken wire (yellow wire) between the current sensor and PZ3 on the control card.	 <p>The diagram shows a vertical stack of components: A2 at the top, followed by the SCR CURRENT SENSOR, and NEGATIVE at the bottom. A yellow wire labeled YEL connects the SCR CURRENT SENSOR to PZ3 on a control card.</p>

Repairs

assembly are caused by loose connections. The normal repair of the reactor assembly is to replace it. This reactor assembly has two inductor windings (L1 and 1X) joined by a common connection. A good inductor winding will indicate approximately zero ohms on the R x 1 scale.

Check Suppressors For SCR 2 And SCR 5

The suppressors are one or more resistors and capacitors in a small plastic block. (See items 11 and 12 in FIGURE 1.) The suppressors prevent damage to the SCRs from electrical noise. Sometimes a suppressor will not indicate a defect except when in an operating circuit and will cause a fault that does not occur regularly during lift truck operation. A bad suppressor can cause a fault similar to a bad SCR 2 or a bad SCR 5.

The best method to check for a bad suppressor is to replace it and then check the operation of the lift truck. The same suppressor is used for all functions.

Check SCR 2 And SCR 5

NOTE: The plastic cases for SCR 2 and SCR 5 are the same, but the part numbers are different because the electrical components inside of the case are different. An SCR 2 has a higher electrical rating than an SCR 5. An SCR 2 can be used as an SCR 5, but do not use an SCR 5 as an SCR 2. Check the part number to make sure that you are using the correct SCR.

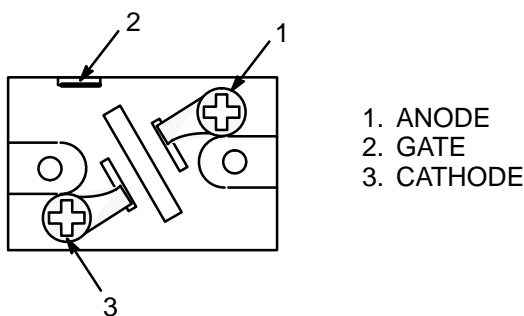


FIGURE 3. SCR 2 AND SCR 5

1. Disconnect either the (+) or (-) power connection. (The power connections have a (+) and (-) mark in the plastic case.) Touch the probes of an ohmmeter to the (+) and (-) power connections of the SCR. Measure the resistance. Change the probe connections to the reverse direction and measure the resistance. Replace the SCR if

the resistance indicates less than 50 000 ohms in either direction.

2. Measure the resistance between the gate connection and the cathode. Change the probe connections to the reverse direction and measure the resistance again. Replace the SCR if the resistance indicates zero or infinity on the R x 1 scale in either direction.

NOTE: Six volts is needed as a gate signal to check the SCRs. Use an ohmmeter and a six volt supply for a gate signal to check the SCRs.

3. Momentarily connect six volts from the battery between the gate (+) and the cathode (-). The resistance indication on the ohmmeter will decrease to less than 10 ohms on the R x 1 Scale. Replace the SCR if the resistance does not decrease when a six volt gate signal is applied momentarily. Make sure you touch the gate wire momentarily with the six volt connection or you will damage the SCR. Make sure the polarity of your test circuit is correct.

Replace SCR 2 And SCR 5

Disconnect the electrical connections to the SCR. Remove the two screws that hold the SCR.

Use a thin layer of silicon compound (Part No. 1198757 or approved equivalent) between the surfaces of the heat sink and the replacement SCR. Install the SCR. Connect the electrical connections.

Check Capacitor C1

Discharge C1 and disconnect the terminals before checking C1 for a short-circuit. Measure the resistance between the terminals. The ohmmeter will indicate a low resistance and increase to more than 100 000 ohms. A capacitor with a short-circuit must be replaced. The capacitor is fastened with two screws and brackets.

DIODES D3 AND D4

The heat sink assembly for the diodes D3 and D4 is also the connection for the (-) power cable. The heat sink assembly is connected to the base plate. A thin insulator with a silicone surface separates the heat sink assembly from the base plate.

NOTE: The optional SCR controller used for the hydraulic pump only has a diode D3.

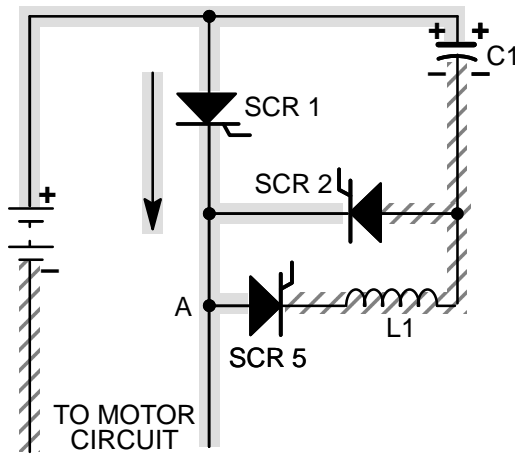
CLICK HERE TO **DOWNLOAD** THE COMPLETE MANUAL

- Thank you very much for reading the preview of the manual.
- You can download the complete manual from: www.heydownloads.com by clicking the link below

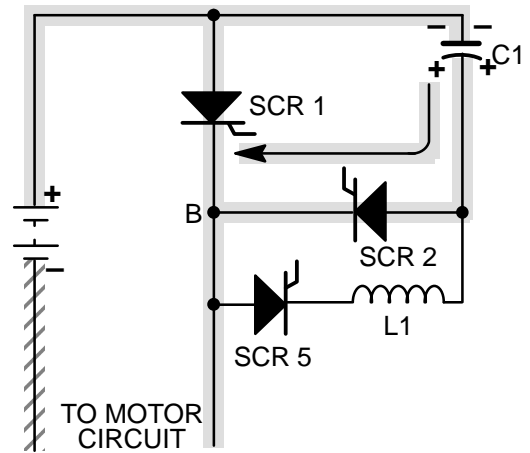


- Please note: If there is no response to CLICKING the link, please download this PDF first and then click on it.

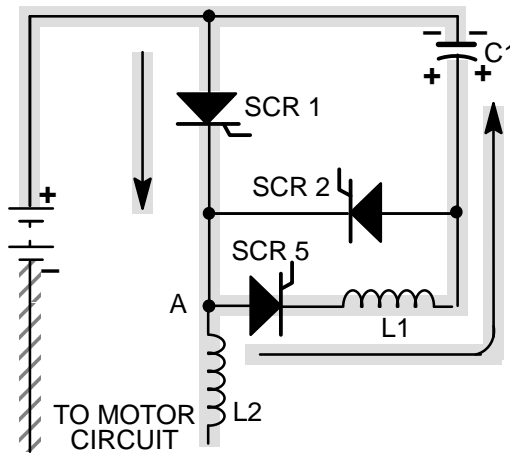
CLICK HERE TO **DOWNLOAD** THE COMPLETE MANUAL



c. A signal is sent to SCR 1 and SCR 5 to go **ON**. Current flows through SCR 1, the motor current and returns to battery negative. The polarity at point **A** is now positive compared to the bottom plate of C1 because SCR 1 is **ON**.

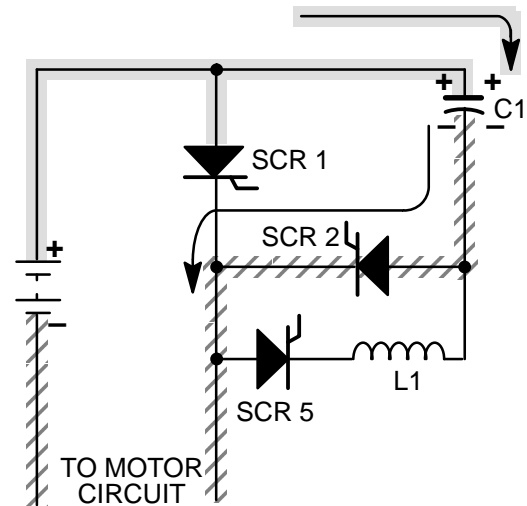


e. The current flows through SCR 1 until a signal is sent to SCR 2 to go **ON**. When SCR 2 goes **ON**, the higher positive voltage moves from C1 and momentarily makes point **B** more positive than the battery. This momentary positive voltage makes SCR 1 go **OFF**.



d. When SCR 5 is **ON**, the positive charge at point **A** now moves through SCR 5 to change the charge on C1. The momentary current flow through L1 creates a magnetic field. When C1 is charged, the current flow through SCR 5 stops and SCR 5 goes **OFF**. The magnetic fields decreases and the induction voltage causes a current flow from L1 into the bottom plate of C1. This action of L1 charges C1 to a voltage higher than battery voltage, making the battery side of the capacitor (+) to appear (-) when compared to the charge on the bottom plate. This action leaves the top plate of C1 negative compared to the bottom plate, and C1 now has a "reverse charge". This action takes less than one millisecond.

NOTE: The inductor L2 shown in step d is not a component in the motor controller. L2 is the symbol for the inductance caused by the power cables when electric current flows through them.



f. When SCR 1 is **OFF**, the magnetic field around the power cables begins to decrease. This decrease in the magnetic field generates a voltage that causes the bottom plate of C1 to become more negative than battery negative. The voltage across C1 can now be as high as 150 volts. When the current flow through SCR 2 stops, SCR 2 goes **OFF**. This action leaves C1 charged at a much higher voltage. C1 is now charged for the next cycle.

The fast pulse times and the necessary signals to the SCRs require a special electronic control. These control cards can not be repaired except by the manufacturer. A service person must replace a bad control card with a new or rebuilt control card.

FIGURE 5. OPERATION OF THE SCR 1 "OFF" CIRCUIT (3 OF 3)

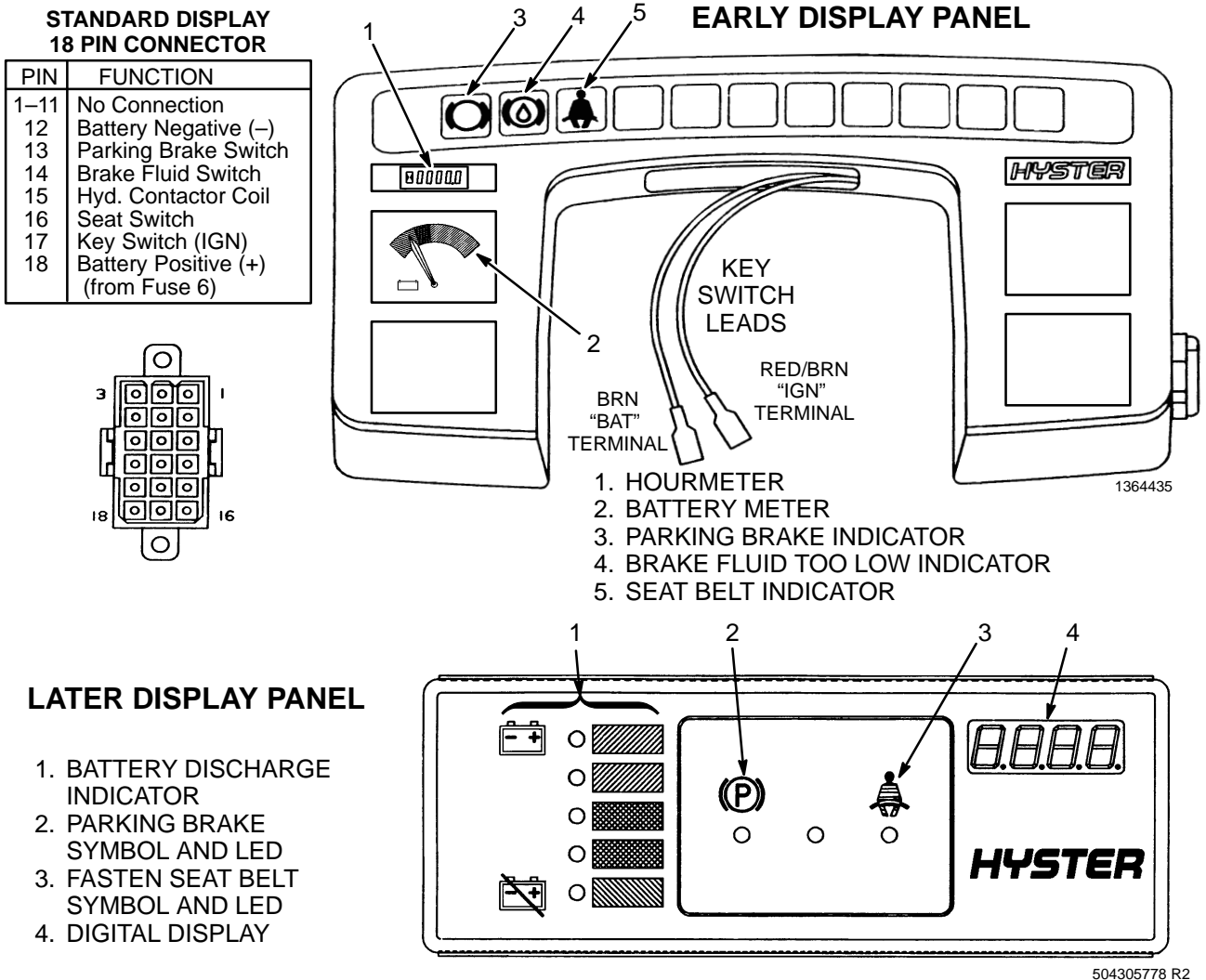


FIGURE 17. BASIC DISPLAY PANEL AND PLUG CONNECTOR

- (5) **Warning light, fasten seat belt.** The red light is **ON** for eight to ten seconds after the key switch is turned to the **ON** position.

LATER DISPLAY PANEL

When the key switch is turned to **ON**, a start program will cause each warning light to illuminate to show that the function is operating. This early display panel has the following functions:

(1) **Battery Charge Indicator With Lift Interrupt.**

Later Basic display panels have a battery indicator that is a scale with a series of 5 round LEDs in three colors (green, orange, red). See FIGURE 17. There are two green LEDs and bars at the top, two orange LEDs and bars in the center and a red LED and bar at the bottom. As the battery voltage decreases during operation, different

LEDs illuminate to indicate a discharged battery. No more than two LEDs are illuminated at one time. When the battery is fully charged, the two green LEDs of the scale are illuminated. When the battery discharges during operation, the LEDs illuminate from top to bottom (green to red). The red LED indicates that the battery is discharged. The battery must be charged or a charged battery must be installed before lift truck operation can continue.

The battery charge indicator uses the traction control shunt to measure the current during operation. This current and battery voltage are checked at the same time for an accurate reading of battery voltage with a load (during use). This method can make operation of the lift truck different when the battery is low or a different bat-

**TABLE 2. EV-100ZX Parameters – E2.00-3.20XM (E45-65XM) and N30XMH (36 to 48V)
(Traction Card Type ZY NO Regenerative Braking and NO Field Weakening)**

		Default		Permitted Range	
Fcn. No.	Description	Factory Parameter	Factory Value	Min/Max Parameter	Value (Min/Max)
1	Stored Statue Code	0 ¹	—	0 ¹ /255	—
¹ Any number other than “zero” can be read as a possible fault.					
2	Creep Speed	0	5%	0/255	5% to 15%
3	Controlled Acceleration and 1A Time	20	1.8 sec	8/255	0.77 to 21.5 seconds
4	Current Limit (C/L)	255	max. amp	0/255	max. amperes
5	Plugging Distance (Current)	65	400 amp	0/70	200 to 416 amperes
6	1A Drop-Out Current	77	700 amp	0/250 ²	450 to 1260 amperes
² Settings greater than 250 will disable the 1A Drop-Out function					
7	Field Weakening Pick-Up (Current)	N/A	N/A	N/A	N/A
8	Field Weakening Drop-Out (Current)	N/A	N/A	N/A	N/A
9	Regenerative Braking Current Limit	N/A	N/A	N/A	N/A
10	Regenerative Braking Start (% ON time)	N/A	N/A	N/A	N/A
11	Speed Limit 1 (maximum motor speed, Voltage with NC switch open)	0	96% of batt. volts	0/180	96% to 0% of battery voltage
12	Speed Limit 2 (maximum motor speed, Voltage with NC switch open)	0	96% of batt. volts	0/180	96% to 0% of battery voltage
13	Speed Limit 3 (maximum motor speed, Voltage with NC switch open)	120	64% of batt. volts	0/180	96% to 0% of battery voltage
14	Internal Resistance Compensation	20 ³	—	5/25	—
³ Average value for most batteries. See procedure for more accurate value.					
15	Battery Volts	200	36/48 V	184/250	36 or 48 volt operation
16	Pedal Position Plugging	40	228 amp	0/134	100 to 530 amperes
17	Card Type Selection	2		2	Select control card with correct functions: Plugging only
18	Steering Pump Time Delay (Seat Switch)	0 25 ⁴	1.5 sec 14 sec ⁴	0/128 21/128 ⁴	1.5 sec to 65 sec 12 sec to 65 sec (Note ⁴)
⁴ Setting of 21 (12 seconds) <u>minimum</u> without seat brake.					
19	Maintenance Alert (hours)	99			0 to 99

Type ZY [9–inch Motor (Continued)]		Default		Permitted Range	
Fcn. No.	Description	Factory Parameter	Factory Value	Min/Max Parameter	Value (Min/Max)
21	Maintenance Speed Limit	0	None	0	180
22	Mode Reference (Reference register for the instrument panel display when the battery is connected.)	—	None	None	—
23	Hourmeter (minutes)	0			
24	Hourmeter (seconds)	0			
25	Monitor Register	0	—	None	(Temporary storage register.)
26	Monitor Register	0	—	None	(Temporary storage register.)
27	Battery Volts Data	—	—	None	(Temporary storage register for battery voltage data.)
28	Fault Count Pointer (Must be reset to zero to clear Status Codes)	—	—	None	(Temporary storage register that points to location of last recorded fault.)
29	Set Hourmeter (tens/units)	0	0		0–99
30	Set Hourmeter (thousands/hundreds)	0	0		100 to 9900

Function Numbers 31 through 47 can be read and cleared with a Hand Set. These registers store the fault codes and other data that the controller senses during the operation of the lift truck. These registers can only be reset to zero. The PC software program automatically resets these registers to zero.

Function Numbers 48 through 62 enable the lift truck to be set to four performance levels by the operator. (If the customer does not want this function available to the operator, a service person can set all four levels to the same setting.) Each time the operator pushes the button on the instrument panel, the performance level will increase by one step. At the maximum (rabbit) level, the performance levels will begin at the lowest (turtle) level again.

Fcn. No.				Minimum Parameter	Maximum Parameter
	MODE 1				
48	Controlled Acceleration	60	5.0 sec	Fcn. No. 52	255
49	FW Pick–Up Current	N/A	N/A	0	N/A
50	Speed Limit 1	120	64%	Fcn. No. 54	180
51	Not Used				
	MODE 2				
52	Controlled Acceleration	40	3.5 sec	Fcn. No. 56	Fcn. No. 48
53	FW Pick–Up Current	N/A	None	0	N/A
54	Speed Limit 1	85	80%	Fcn. No. 58	Fcn. No. 50
55	Not Used				
	MODE 3				

TABLE 3. PLUG-Z CONNECTION

Plug-Z	24 vdc Power Source
Pin 2	Negative terminal
Pin 7	Positive terminal
SR or SP Motor Ctrl.	24 vdc Power Source
Pin 1 (23-Pin)	Positive terminal
NEG Power Terminal	Negative terminal

HYTECH™ SOFTWARE PROGRAM

How To Start The Program

If the HYTECH software has been installed on a hard disk in the PC (normally drive C), enter the program from that directory. Check to see if a directory HYSTERSC has been created on the hard drive. If not it will have to be created and the program copied into it from the computers disk drive. Then you can start the program from the hard drive. At the prompt enter:

```
C:\>CD HYSTERSC [RETURN]
```

At the prompt C:\>HYSTERSC enter:

```
HYSTER [RETURN]
```

The screen displays a list of languages as follows:

```
English
Francais
Deutsch
Italiano
Espanol
```

Select the language by entering that number.

After selecting the language, the screen momentarily displays the copyright data for the program. The screen then displays the HYSTER desktop shown in FIGURE 2.



FIGURE 2. HYSTER DESKTOP DISPLAY

NOTE: The user must have enough experience to connect a modem to a PC and be able to enter the correct commands in the registers of the modem.

TABLE 4. CABLE CONNECTIONS - MODEM TO CONTROLLER

Model EV-100 and EV-T100 CONTROLLER	
Modem Connector (9-Pin)	Controller Connector (14-Pin)
Pin 2 (Receive)	Pin 13
Pin 3 (Transmit)	Pin 14
Pin 5 (Signal Ground)	Pin 4
Pin 4 to pin 6 (Jumper)	
Pin 7 to pin 8 (Jumper)	
Model SR CONTROLLER	
Modem Connector (9-Pin)	Controller Connector (12-Pin)
Pin 2 (Receive)	Pin 11
Pin 3 (Transmit)	Pin 12
Pin 7 (Signal Ground)	Pin 4
Pin 4 to pin 6 (Jumper)	
Pin 7 to pin 8 (Jumper)	

Requirements

The requirements for the connection to the control card are:

- A telephone connection between the modem and a dial-in telephone line. This connection is normally through a telephone extension wire with RJ-11 connections on both ends of the wire. This connection is often not reliable if the telephone line goes through a telephone switchboard.
- A 9600 bps modem that uses a Hayes® command set that is compatible with the remote modem. Not all modems are compatible with each other because some modems use error correction functions that are special to that model of modem. A recommendation is to disable error correction functions if communications problems occur.
- The MODEM Transmit and Receive lines are reversed when compared to the PC-to-card (motor controller) cable.

See FIGURE 17. This message appears on the screen when the command MODEM is entered.

NOTE: This modem program was developed for an Intel 14.4EX modem. (Other modem initiation scripts have been developed and are installed on the HYTECH disk. Contact a field service engineer for Hyster Company if a different modem initiation program is needed.) All modems are not compatible with each other. Some testing can be necessary to find the correct modem parameters that enable two modems to communicate with each other.

NOTE: A standard analog telephone connection is required. The modem program will not operate correctly if it is connected to a digital telephone system and the modem can be damaged. Also, the telephone connection can be unreliable if the connection is through some older types of PBX systems.

The function keys do the following operations:

F1 - This command is used to dial a remote modem that is connected to a motor controller.

F2 - This command causes the modems to disconnect (Hang-up) from each other.

F3 - This command is used to set a modem (to be used as the remote modem) to receive when it is connected to a motor controller. The modem must be first connected to a PC and this function is used to prepare the modem for use. After the modem is prepared for use, it is disconnected from the PC and connected to the controller.

NOTE: It is not necessary that the HYTECH software program must be used to prepare the remote modem. Many other communications programs will permit the user to program a modem (set the communications registers) before use. Most modems are sold with a communications program that permits the user to program the modem and the initialization string. See the user's manual for a specific modem. The initialization string for the Intel 14.4EX modem used in the EV-100ZX Software Program is AT & F V0&D0&C0&S0\N\Q0 B8 S0 = I&W for remote and AT & F B8VI&D0\Q0 for local connection.

F4 - This command is used to set the local modem to call the remote modem. This modem must be connected to the PC that is running the communications program.

F5 - This command is a toggle that enables and disables the speaker on the local modem.

⚠ WARNING

Correct operation of the battery restraint system requires that the battery does not move more than 13 mm (0.5 in) horizontally. Make sure that the battery spacer plate is correctly adjusted.

To operate correctly, the battery restraint must be locked in the down position. The battery must have the spacer plate correctly adjusted to prevent movement in any one horizontal direction of 13 mm (0.5 in) maximum. See FIGURE 1. Raise the seat. Use the knob for the latch to release the battery restraint. See FIGURE 4. Use the handle on the hood to raise the battery restraint and hood. Make sure that the battery cannot move more than a total of 13 mm (0.5 in) in any one horizontal direction. Make sure the spacer plate is correctly adjusted to prevent the movement. Push the hood and the battery restraint down until the latch locks. Make sure the battery restraint is locked securely. Lift on the handle to make sure it is latched and will not move.

⚠ WARNING

The battery restraint and its latch mechanisms must operate correctly before a lift truck is operated.

The operator restraint system has the seat, hip restraints and the seat belt. The system helps the operator stay within the lift truck in case of a tipover. See FIGURE 6.

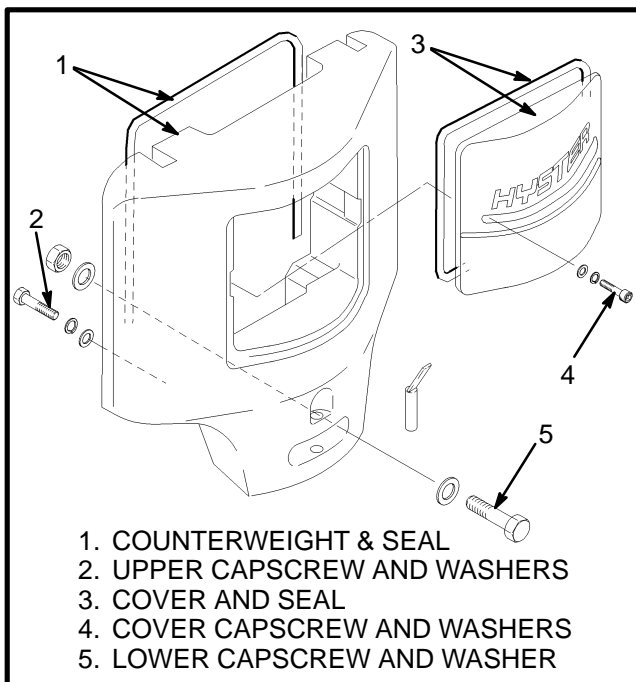


FIGURE 7. COUNTERWEIGHT ASSEMBLY

COUNTERWEIGHT
(See FIGURE 7. and TABLE 1.)

If the lift truck must be put on blocks for maintenance and repair, see the section PERIODIC MAINTENANCE, 8000 SRM 552 or the PERIODIC MAINTENANCE (N30XMH), 8000 SRM 555 of the SERVICE MANUAL under “How to put a Lift Truck on Blocks”.

⚠ WARNING

The counterweight is very heavy. Make sure that the crane and lifting devices have enough lifting capacity to safely lift the counterweight. The weights of the counterweights are shown in TABLE 2.

The counterweight normally is not removed for most repairs. Replacement of some large parts of the SCR electronic controller is easier when the counterweight is removed. The counterweight is fastened to the frame with four capscrews. The weights for the counterweights are in TABLE 2.

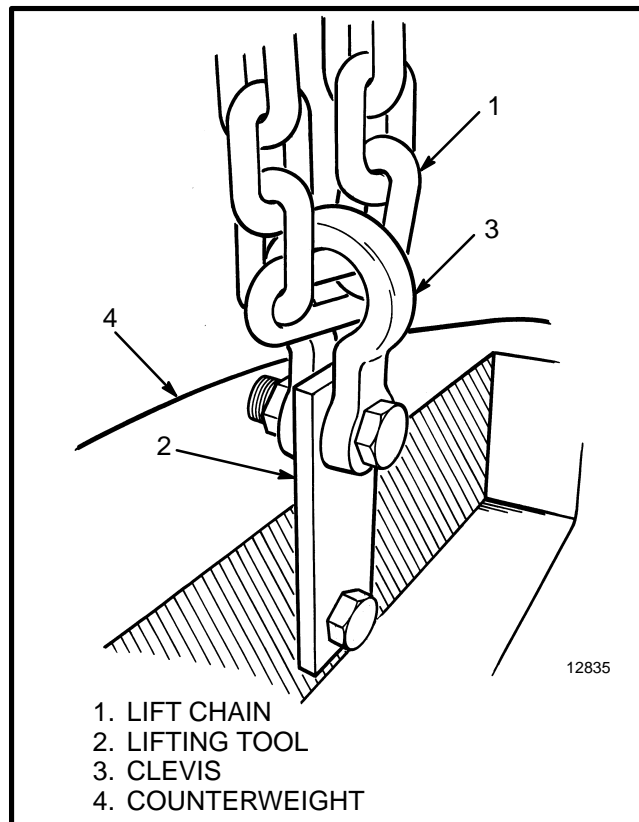


FIGURE 8. LIFT THE COUNTERWEIGHT

Removal (See FIGURE 7., and FIGURE 8.)

1. Remove the battery. See the section PERIODIC MAINTENANCE, 8000 SRM 552 or the PERIODIC MAINTENANCE (N30XMH), 8000 SRM 555 of the

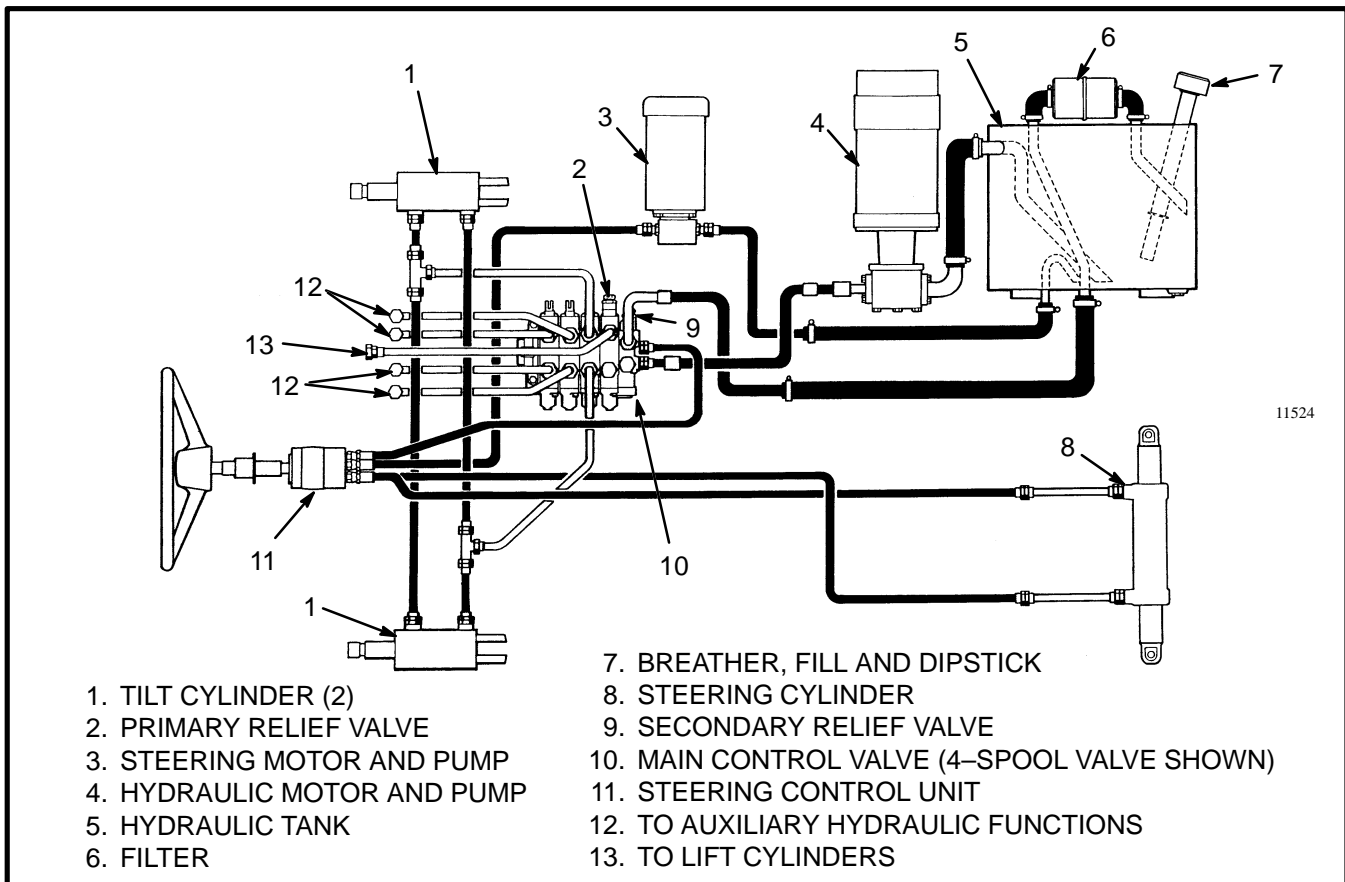


FIGURE 2. J2.00-3.20XM (J40-65XM) HYDRAULIC SYSTEM

DESCRIPTION

Hydraulic System

(See FIGURE 1., FIGURE 2. or FIGURE 3.)

The parts of the hydraulic system for the E1.50-3.20XM (E25-65XM) are shown in FIGURE 1. The parts of the hydraulic system for the J2.00-3.20XM (J40-65XM) are shown in FIGURE 2. The parts of the hydraulic system for the N30XMH are shown in FIGURE 3. The diagrams show components and interconnections that are typical of all models. It does not show all hydraulic systems. Not all units have a four spool valve.

The hydraulic system includes the steering system and the lift system. One hydraulic tank supplies both systems. The steering system and the lift system have separate pumps. Both pumps are gear pumps.

OPERATION

Hydraulic System

(See FIGURE 4. or FIGURE 5.)

The hydraulic pump causes oil to flow from the tank to

the main control valve. The main control valve controls the flow of oil to the lift cylinders, tilt cylinders, traverse cylinder, rotary actuator and auxiliary functions when applicable. A relief valve on the main control valve keeps pressure within the design limits of the hydraulic system. A test port for checking the pressure when the relief valve opens is on the main control valve.

Some auxiliary functions require less pressure than the lift function. A secondary relief valve on the main control valve provides lower pressure for auxiliary functions.

The steering pump causes oil to flow from the tank to the steering control unit. The steering control unit is a metering pump actuated by the steering wheel. When the steering wheel is turned, oil flows to actuate the steering cylinder. Oil returns from the steering control unit to the main control valve. A relief valve in the pump keeps pressure within the design limits of the steering system.

- b. Fill the tank with the cleaning solution. Use compressed air to mix the solution in the tank.
- c. Drain the tank. Flush the inside of the tank with hot (boiling) water. Make sure all the cleaning compound is removed.
- d. Make an inspection of the inside of the tank. If the tank is not clean, repeat Steps a through c. Make another inspection of the tank. When making inspections, use a light that is approved for locations with flammable vapors.
- e. Check the tank for flammable vapors as described in the previous section Step g. If the amount of flammable vapors is not below the lower flammable limit, repeat the cleaning procedures.

Additional Preparations For Tank Repair

If nitrogen gas or carbon dioxide gas is available, prepare the tank for welding using these gases. See the manual *Safe Practices For Welding and Cutting Containers That Have Held Combustibles* by the American Welding Society, A6.0–65. If these gases are not available, another method using water can be used as follows:

- a. Fill the tank with water to just below the point where the work will be done. Make sure the space above the level of the water has a vent.
- b. Use acceptable welding practices to repair the tank. See the American National Standard “Safety in Welding and Cutting,” ANSI Z 49.1 – 1973.

E1.50–3.20XM (E25–65XM) And N30XMH Tank Installation (See FIGURE 9. or FIGURE 11.)

NOTE: Make sure to install the tank so that the fill neck is centered in the opening in the step of the frame. Make sure to install all plugs, hoses and clamps to prevent leaks when oil is added to the tank.

1. Install the repaired or replacement hydraulic tank in the truck frame. Make sure the tank is correctly aligned for connection of the hoses. Make sure the pads are installed between the tank and truck frame.
2. Install the bracket assembly to hold the tank in position. Do not tighten the screws.
3. Remove the plugs and install all hoses at the same locations as during removal. Do NOT remove the drain

plug. Align the tank so that the fill tube and fill cap will be in the center of the access hole. Install the fill tube and fill cap. Tighten the screws that fasten the mount bracket assembly.

CAUTION

Do NOT fill the tank above the FULL mark on the dipstick. If the tank is too full, oil will come out the breather during operation.

4. Make sure all hoses and plugs are installed and tight. Fill the tank using the oil specified in one of the following **SERVICE MANUAL** sections:
PERIODIC MAINTENANCE, 8000 SRM 632 for the E1.50–2.00XM (E25–40XM) trucks
PERIODIC MAINTENANCE, 8000 SRM 552 for the E2.00–3.20XM (E45–65XM) trucks
PERIODIC MAINTENANCE, 8000 SRM 555 for the N30XMH trucks

Loosen the clamp at the inlet hose of the hydraulic pump to let the air out until the hose fills with oil. Tighten the hose clamp as soon as oil leaks out of the hose. Do the same procedure for the steering pump.

5. Install the traction motor as described in one of the following **SERVICE MANUAL** sections:
DRIVE AXLE, SPEED REDUCER AND DIFFERENTIAL, 1400 SRM 618 for the E1.50–2.00XM (E25–40XM) trucks
DRIVE AXLE, SPEED REDUCER AND DIFFERENTIAL, 1400 SRM 285 for the E2.00–3.20XM (E45–65XM) and N30XMH trucks
6. Operate the lift and steering systems and check for leaks.

J2.00–3.20XM (J40–65XM) Tank Installation (See FIGURE 10.)

1. Turn the key to the **OFF** position and remove the key.

WARNING

Never put tools or other metal on the battery. Metal on the battery can cause a short circuit and possible damage or injury.

2. Open the hood and install a cardboard or plywood cover on the top of the battery to prevent accidental short circuits.
3. Carefully position the hydraulic tank over the correct position in the frame and install the hoses on the bottom

Control Unit Removal (See FIGURE 19.)

1. Disconnect the battery connector. Move the steering column to the forward position. Remove the panel under the steering column for access to the hoses of the steering control unit.
2. Remove the front and rear covers for the steering column. The instrument cluster is fastened to the front cover. Install tags and disconnect the wires for the horn connector and if installed, on-demand power steering and the forward/reverse switches. If installed, remove the parts for on-demand power steering and the forward/reverse switches and lever. See the **SERVICE MANUAL** sections **STEERING SYSTEM, 1600 SRM 485** and **STEERING HOUSING AND CONTROL UNIT, 1600 SRM 512**.
3. Put tags for identification on the hydraulic hoses at the steering control unit so that they can be connected correctly during assembly. Disconnect the hydraulic hoses at the bottom of the steering control unit. Install plugs at all hose fittings and control unit ports to prevent dirt from entering the steering hydraulic system.
4. Hold the steering column and remove the capscrews that hold the steering column and pivot shaft to the bracket. See FIGURE 19. Remove the two plates, pivot shaft and spring. Remove the steering column assembly. Do not lose the rod, washer and spring for the latch.
5. Make a note of the alignment of the steering control unit in the bracket for correct installation. Remove the four capscrews that fasten the steering shaft assembly and steering control unit in the steering column bracket. Do not let the steering control unit or steering wheel and shaft assembly fall. Do not let the washers fall. It is not necessary to remove the steering wheel or on-demand steering parts from the shaft.

Control Unit Installation (See FIGURE 19.)

1. Install the steering control unit in the bracket. Make sure it is in correct alignment, as noted during removal, so that the hoses can be correctly connected. Install the washers, spacers, steering shaft assembly and capscrews to hold all parts in the bracket.
2. Hold the bracket assembly in alignment and install the pivot shaft, spring, plates, washers and capscrews to

hold the assembly on the mount. Install the spring, washer and rod for the latch. Install the knob on the latch. Install the allen screw and nut.

WARNING

The hydraulic hoses MUST be connected to the correct ports or the steering system will not operate as expected. This operation that is not expected can cause damage or personal injury. Make sure the hoses are identified and connected correctly.

3. Connect the hydraulic hoses at the steering control unit as marked during removal OR see the **SERVICE MANUAL** section **STEERING HOUSING AND CONTROL UNIT, 1600 SRM 512** for correct connections.
4. If removed, install the parts for on-demand power steering and the forward/reverse switches and lever. See the **SERVICE MANUAL** sections **STEERING SYSTEM, 1600 SRM 485** and **STEERING HOUSING AND CONTROL UNIT, 1600 SRM 512**.
5. Connect the wires for the horn connector and if installed, the on-demand power steering and forward/reverse switches. Install the front and rear covers for the steering column.

WARNING

After making repairs, do not extend hands or arms through the center of the steering wheel. Wrong assembly or connections can make the steering wheel rotate with a strong force when the steering pump operates. This strong force can cause serious injury. If this action occurs, disassemble the control unit and correct the problem.

6. Operate the steering system and check for leaks and correct operation.

STEERING CYLINDER

NOTE: The correct procedure for the removal and repair of the steering cylinder is in the following sections of the **SERVICE MANUAL**:
STEERING AXLE, 1600 SRM 619 for the E1.50–2.00XM (E25–40XM) trucks
STEERING AXLE, 1600 SRM 258 for the other trucks

SPECIFIC GRAVITY

The strength of the electrolyte is measured in points of specific gravity. For example, a solution of sulfuric acid has a specific gravity of 1.835. Water has a specific gravity of 1.000. Electrolyte is 27% acid and 73% water and has a specific gravity of 1.275.

⚠ CAUTION

Never pour water into concentrated acid. The quick generation of heat can cause the acid to boil and splash out of the container. Always pour concentrated acid into water when making a dilute solution of acid.

THE CHEMICAL REACTION IN A CELL

In a fully charged cell, the electrolyte has a specific gravity of 1.270 to 1.130. Never discharge a battery below a specific gravity of 1.130. The battery can have permanent damage if discharged below 1.130.

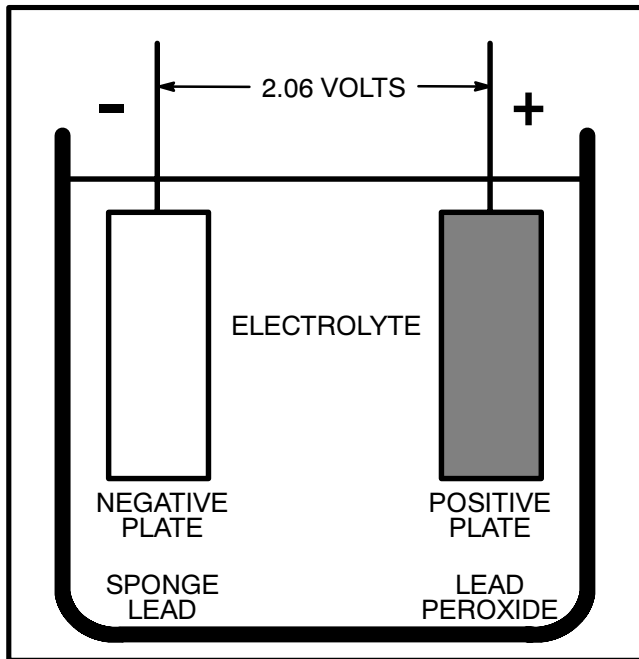


FIGURE 3. FULLY CHARGED CELL

The cell generates a voltage (potential difference) when two different types of metal are in the electrolyte. The two metals in a lead-acid cell are lead peroxide (PbO_2) for positive plates, and sponge lead (Pb) for negative plates. See FIGURE 3. A potential difference of approximately two volts per cell is generated. The potential difference does not vary according to the size of the cell.

During the discharge of the cell, lead peroxide and sponge lead mix with sulfuric acid to make lead sulfate ($PbSO_4$) on both plates. See FIGURE 4. This action decreases the voltage in the cell. When the sulfuric acid is removed from the electrolyte, the specific gravity of the electrolyte decreases. See FIGURE 5. The potential difference of a discharged cell is approximately 1.75 volts.

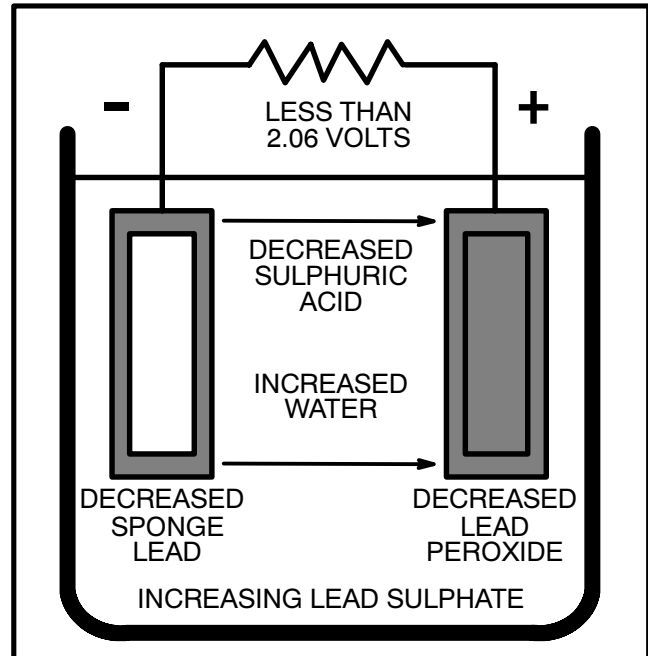


FIGURE 4. CELL IS DISCHARGING

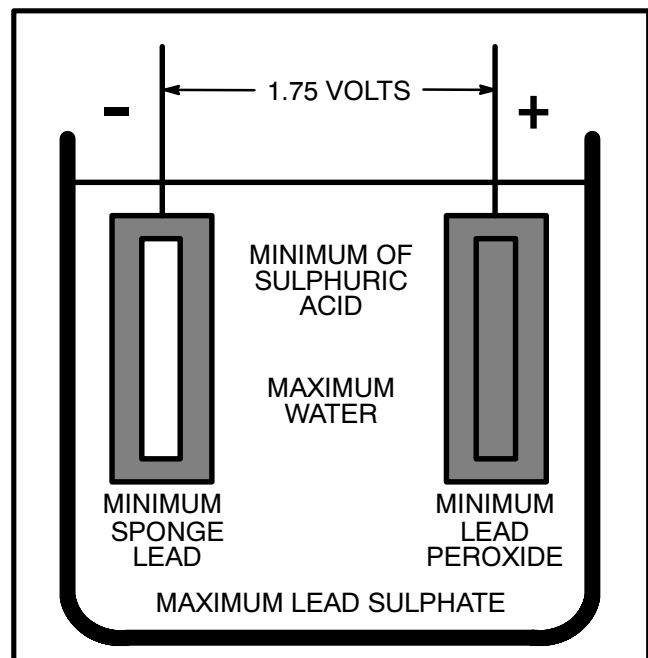


FIGURE 5. DISCHARGED CELL

check to ensure the charger is operating correctly. Check for the following conditions:

1. Battery temperature is too high. The temperature in a battery will not normally rise more than 14°C (25°F) during an eight hour charging period. Higher temperatures indicate that the charging rate needs adjustment.
2. Continuous operation of the charger. Check the automatic controls on the charger. Check the charging rate. A low charging rate can be the problem.
3. Continuous operation of a charger at a high rate. Normally, the charging rate begins at a high rate and decreases as the battery becomes charged. If the rate does not decrease, the controls need repair or adjustment.

WARNING

Always connect the positive cable to the positive terminal and connect the negative cable to the negative terminal. Any other connection will cause injury and damage.

Always charge the battery at the end of the work period (shift). Never let the specific gravity decrease to a level less than the limits shown in the manual.

Always deenergize the charger before you connect or disconnect the charger from the battery.

Never connect the battery charger plug to the plug of the lift truck. You can damage the traction control circuit. Make sure the charger voltage is the correct voltage for the battery.

How To Know When The Battery Is Fully Charged

1. During charging, the voltage increases slowly. When the battery is fully charged, the voltage level is constant.
2. Remove a vent cap and look in the opening. If you see bubbles in the electrolyte, the battery is either fully charged or in the final stage of charging.
3. The specific gravity reading is constant and within the limits of a charged battery. If the temperature increases after the battery is charged, the specific gravity will decrease a small amount.
4. Constant meter indications on the charger will indicate the end of the charging cycle.

WHERE TO CHARGE THE BATTERIES

To increase the service life and reduce maintenance, a special area is needed for charging the batteries. The following information is necessary for the design of this area:

- Location of power supply.
- Ventilation. Hydrogen gas is generated from the batteries during charging.
- Drains for cleaning the batteries.
- Type and size of the batteries.
- Type of lift trucks.
- Distances that the lift trucks must travel for service.
- Safety regulations and instructions.

Equipment Needed

- A lifting device to remove the battery from the lift truck.
- Racks to hold the batteries during charging and storage. These racks must be made of wood or other materials that are not made of metal. Metal racks that are covered with an insulating material can be used.
- A battery charger that will charge your batteries.
- Tools for maintenance.
- An area with a drain for cleaning batteries and battery compartments.
- Distilled water.
- Air and water supplies for cleaning.
- Maintenance records. See FIGURE 11. and FIGURE 12.
- A work bench.
- Spare parts and repair equipment.
- Protective clothing and safety equipment for handling batteries.
- Water source for washing eyes and preventing acid burns.
- Install a NO SMOKING sign in the service area.
- Keep the charger in a clean, dry area with good ventilation.

INTRODUCTION

GENERAL

This section has the description for the lift cylinders used in Vista masts on the N30FR and N40-45FR, and the instructions for their repair. See the section **LIFT CYLINDERS, 4000 SRM 135** for lift cylinders used on other units. See the section **REACH CARRIAGES, 4000 SRM 483** for repair of the hydraulic cylinders use on the N30FR and N40-45FR reach carriages.

DESCRIPTION (See FIGURE 4.)

The VISTA two-stage mast has two main lift cylinders. The VISTA three-stage mast also has two main lift cylinders as well as a shorter free-lift cylinder. (See FIGURE 1. and FIGURE 3.)

All these lift cylinders are single acting cylinders. The hydraulic force is applied only in one direction. When hydraulic oil enters one end of the lift cylinder, the hydraulic force extends the piston rod. When the force is removed, the weight of the mast components and carriage retracts the piston rod.

These cylinders are also single-stage lift cylinders. A single-stage lift cylinder has only one rod. See FIGURE 1. There are two types of single-stage cylinders used on these lift trucks. One type is the piston cylinder. The main-lift cylinders are piston cylinders. The other type is a displacement cylinder. The free-lift cylinder is a displacement cylinder.

Piston cylinders operate by hydraulic oil entering under the piston of the cylinder rod. Seals are used in the piston to keep the oil from moving from under the piston to the top of the piston. As the hydraulic oil raises the piston, the air within the upper part of the cylinder is compressed into a chamber of the piston rod. Any oil that is above the piston will be forced, under pressure through a check valve back under the piston.

Displacement cylinders operate by hydraulic oil entering the cylinder and displacing the rod. Seals are located in the retainer and the entire cylinder is filled with oil. This type of cylinder will have a bleed screw located near the top of the cylinder to remove air from the cylinder. The rod of displacement cylinders is almost the size of the inside of the shell. See FIGURE 1.

The design and repairs for these displacement cylinders are similar to the other lift cylinders in this section. A displacement cylinder does not have a piston or piston seal. The rod diameter is almost the same as the inside diameter of the cylinder shell. There are wear rings on the rod that are the bearings between the rod and the walls of the cylinder. The wiper seal at the top of the cylinder is also the high pressure seal for these cylinders. See FIGURE 3.

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

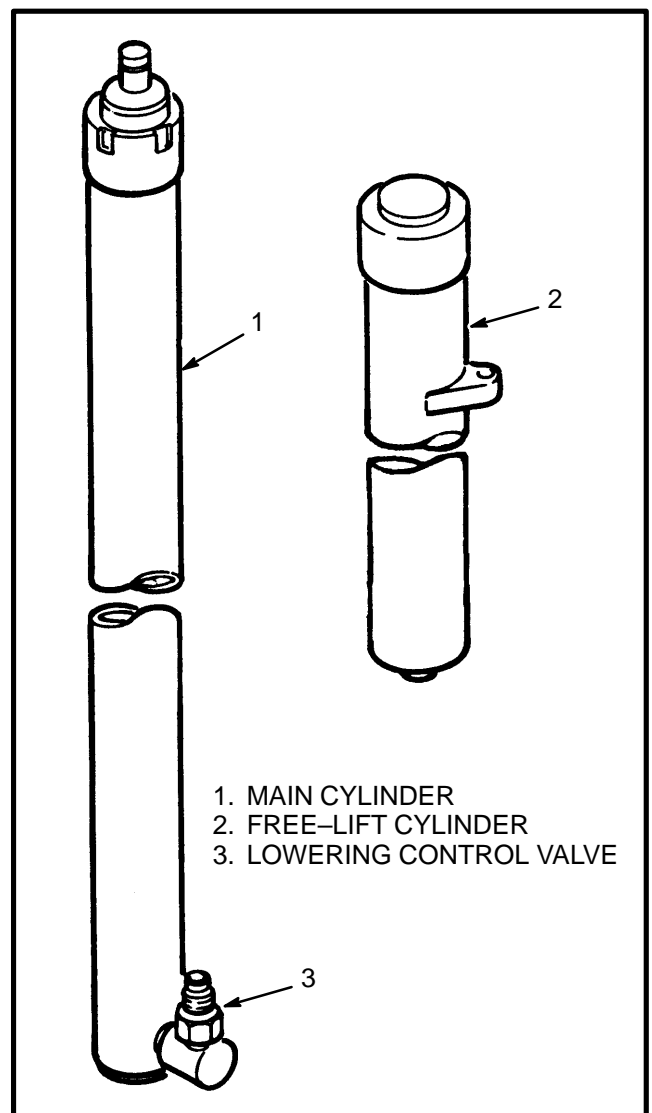


FIGURE 1. VISTA LIFT CYLINDERS

1. LOWERING CONTROL VALVES (INTERNAL)
2. LIFT CYLINDERS
3. LOWERING CONTROL VALVE (EXTERNAL)
4. MAIN CONTROL VALVE
5. LIFT/LOWER SPOOL
6. AUXILIARY SPOOL,
7. TRAVERSE SPOOL
8. ROTARY SPOOL
9. HYDRAULIC PUMP
10. FILTER

11. RELIEF VALVE (LIFT CIRCUIT)
12. RELIEF VALVE (TRAVERSE,
ROTARY, AND AUXILIARY CIRCUITS)
13. HYDRAULIC TANK
14. BYPASS VALVE
15. ROTARY ACTUATOR VALVE
16. SHUTTLE
17. ROTARY ACTUATOR
18. TRAVERSE CYLINDER
19. FROM STEERING CIRCUIT

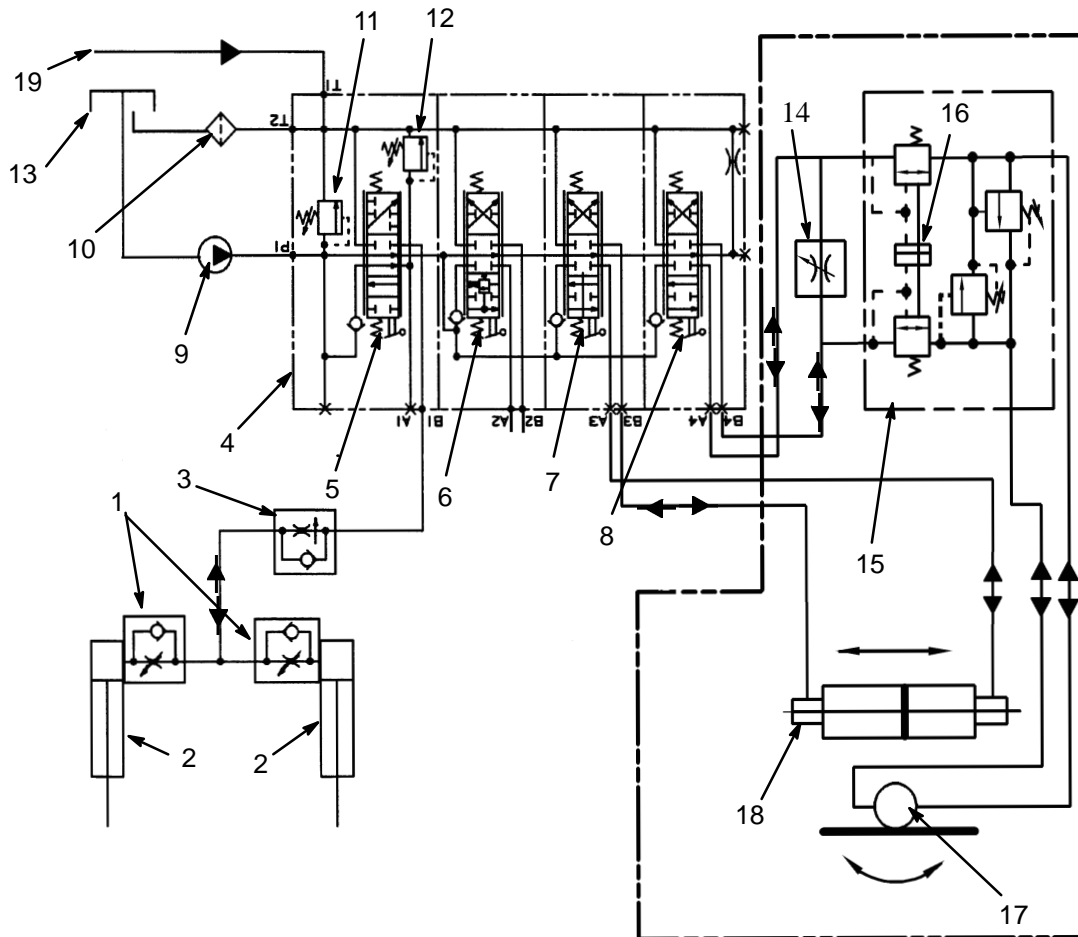


FIGURE 2. HYDRAULIC SCHEMATIC

Each spool has a spring that returns the spool to the neutral position when the control lever is released. Each valve section has a check valve in the valve body. The check valve and spring is held in the valve body by the next section.

OPERATION

The main control valve is an open center, parallel circuit valve. When open center valve spools are in the neutral position, the hydraulic oil flows through the valve with

minimum restriction. The oil returns through the drain passage and returns to the steering control unit and hydraulic tank. Except during lifting, each spool can be operated without preventing the flow of oil to another spool.

The N30XMH valve has four parallel passages through the valve. See FIGURE 2.. When the spools are in the neutral position, the oil flows through the open center passage. At the end of the valve, the oil returns through the drain passage and returns to the hydraulic tank.

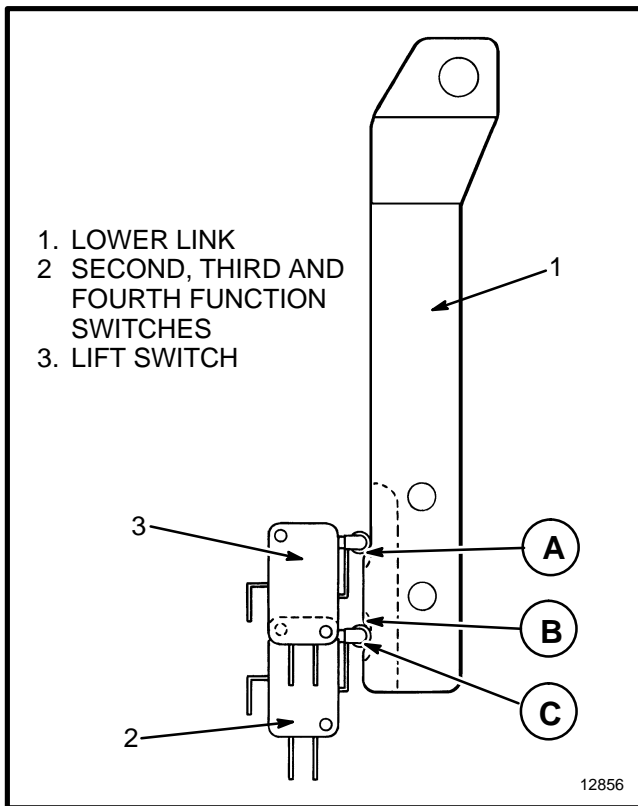


FIGURE 11. SWITCH ADJUSTMENTS,

CHECKS AND ADJUSTMENTS

PRESSURE RELIEF VALVES

NOTE: The main control valve has two relief valves, a primary relief valve and a secondary relief valve. The primary relief valve is in the inlet section of the control valve. The secondary relief valve is in the lift/lower section of the control valve.

⚠ WARNING

Never allow anyone under a raised carriage. Do not put any part of your body in or through the lift mechanism unless all parts of the mast are completely lowered and the key switch is "OFF".

Primary Relief Valve (See FIGURE 12.)

1. Connect a 25 MPa (3500 psi) gauge to the test port at the inlet section of the control valve.
2. Loosen the jam nut.
3. Operate the hydraulic system to warm the oil temperature to 55 to 65°C (130 to 150°F).

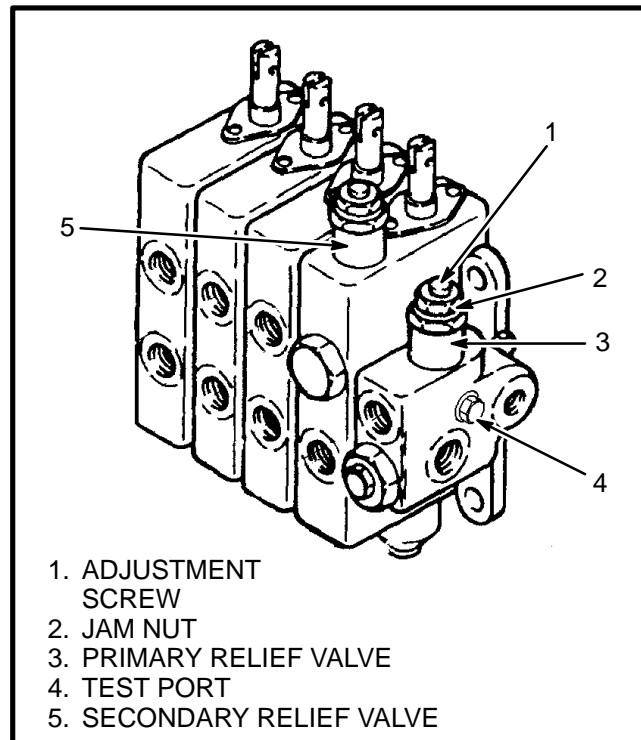


FIGURE 12. RELIEF VALVE LOCATIONS

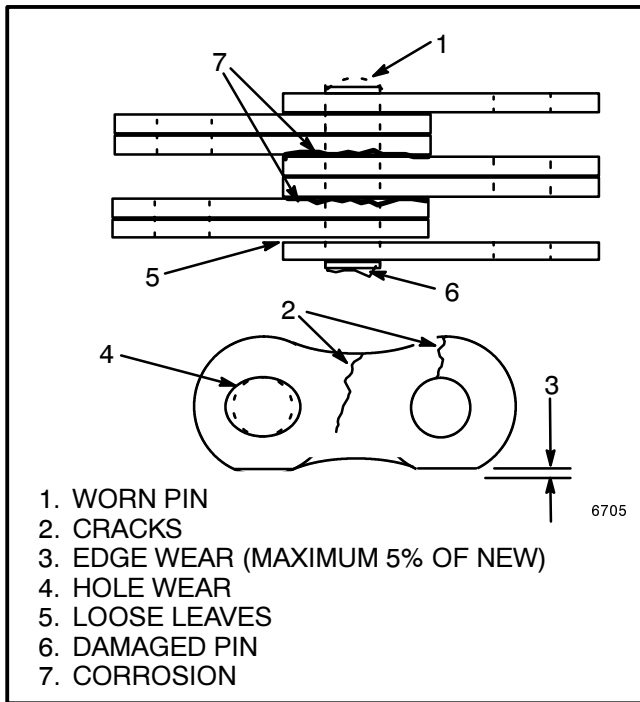


FIGURE 6. CHECK THE LIFT CHAINS

1. Inspect the welds on the mast, attachment and fork carriage for cracks. Make sure that the nuts and bolts are tight.

2. Inspect the channel for excessive wear in the areas of roller contact. Check the rollers for wear or damage.

3. Inspect the forks for cracks and wear. Check that the fork tips when pointed straight ahead are aligned as shown in FIGURE 7. Check that the bottom of the fork is not worn (item 4).

4. Replace any damaged or broken parts that are used to keep the forks locked in position.

5. If the lift truck is equipped with a side shift carriage, inspect the parts for cracks and wear. Make sure the parts that fasten the attachment to the carriage are in good condition.

6. Inspect the lift and traverse chains for the correct lubrication. Use engine oil or Hyster Chain and Cable Lubricant available from your dealer for Hyster lift trucks.

7. Inspect the lift and traverse chains for cracks or broken links and pins. See FIGURE 6.

8. Inspect the chain anchors and pins for cracks and damage.

9. Make sure the lift and traverse chains are adjusted so that they have equal tension. If the chains need repair or adjustment, it must be done by authorized personnel.

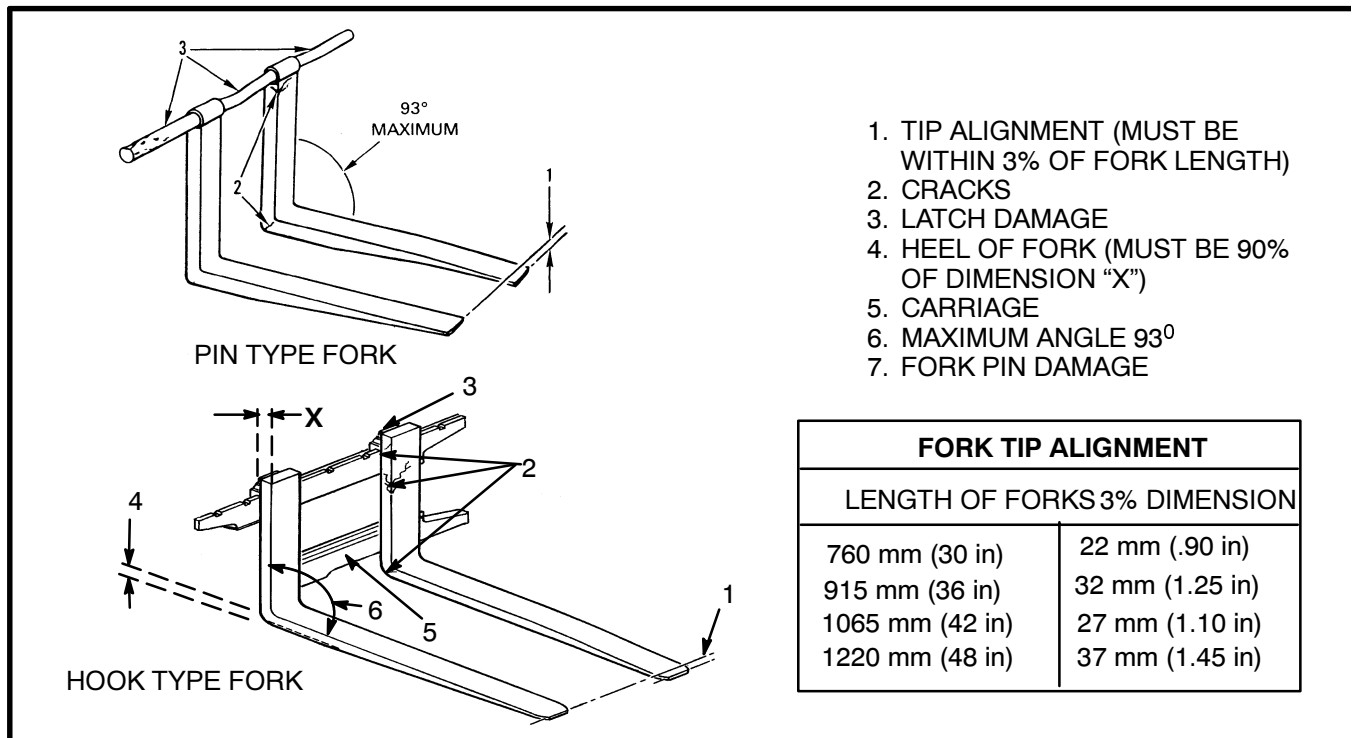
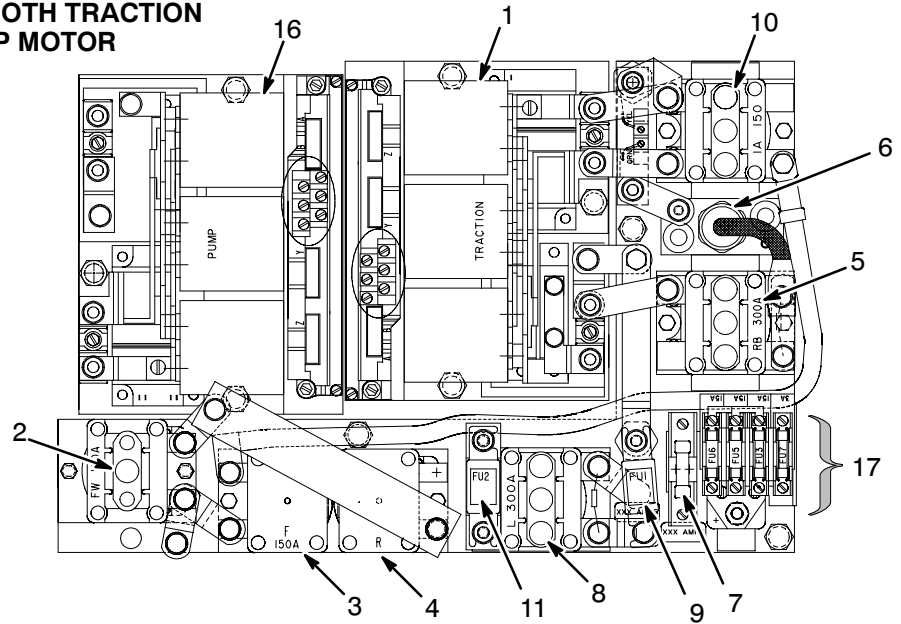
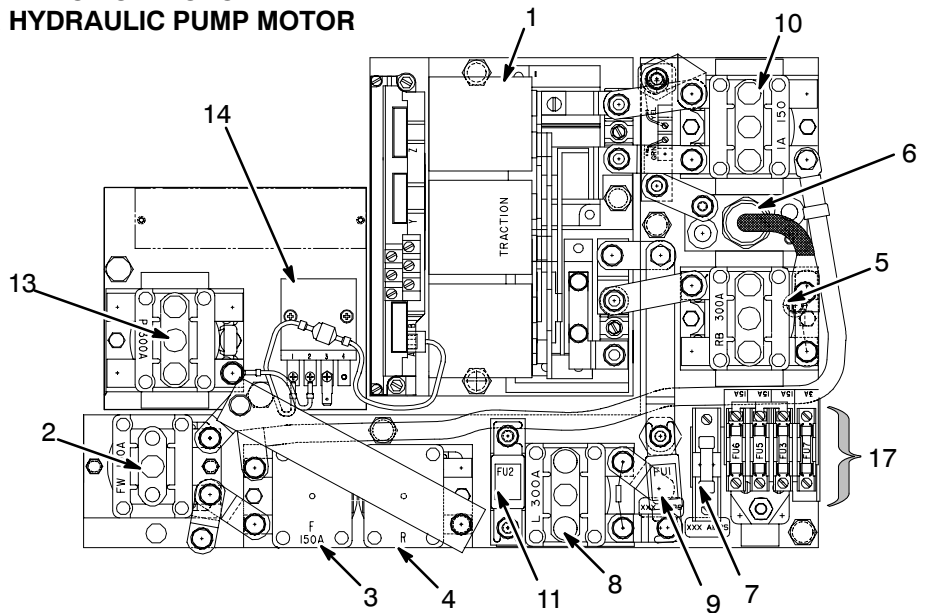


FIGURE 7. CHECK THE FORKS

TRANSISTOR CONTROL FOR BOTH TRACTION MOTOR AND HYDRAULIC PUMP MOTOR



TRANSISTOR CONTROL FOR TRACTION MOTOR AND CONTACTOR CONTROL FOR HYDRAULIC PUMP MOTOR



- | | |
|--|---|
| 1. TRANSISTOR MOTOR CONTROLLER | 11. FUSE 2, HYDRAULIC PUMP CIRCUIT |
| 2. FIELD WEAKENING CONTACTOR | 12. STEERING PUMP CONTACTOR (UNDER FUSE PANEL 17) |
| 3. FORWARD DIRECTION CONTACTOR (F) | 13. HYDRAULIC PUMP CONTACTOR |
| 4. REVERSE DIRECTION CONTACTOR (R) | 14. ELECTRONIC DRIVER, HYDRAULIC PUMP CONTACTOR |
| 5. REGENERATIVE BRAKING CONTACTOR (RB) | 15. TMM1 MODULE |
| 6. DIODE D7 ASSEMBLY, REGENERATIVE BRAKING | 16. TRANSISTOR CONTROLLER, HYDRAULIC PUMP MOTOR |
| 7. FUSE 4, POWER STEERING CIRCUIT | 17. FUSE PANEL (FU 7, FU 3, FU 5, FU 6) |
| 8. CONTACTOR L | |
| 9. FUSE 1, TRACTION CIRCUIT | |
| 10. CONTACTOR 1A | |

FIGURE 16. TYPICAL CONFIGURATIONS OF THE EV-T100 TRANSISTOR MOTOR CONTROLLER IN N30XMH LIFT TRUCKS

HOW TO CHECK THE PMT CIRCUIT

WARNING

Some malfunctions can make the traction motor run at high speed with no control by the speed controller. The PMT circuit prevents operation if these malfunctions occur. Do not operate the lift truck if the PMT circuit does not operate correctly.

The Pulse Monitor Trip (PMT) circuit only functions if a fault occurs. To check the circuit, we must cause a temporary malfunction. Check the PMT circuit for correct operation as follows:

1. Raise the drive wheels and put the lift truck on blocks. See “How To Raise The Drive Tires” in this section. Release the parking brake.

WARNING

Disconnect the battery connector before making any inspections or repairs. Personal injury or equipment and tool damage can occur if the battery is not disconnected.

On unit before “XM₂” units, do not touch the terminals of capacitor C1 of the traction or lift control circuits. The charge on the capacitors can cause electrical shock and personal injury. Use an insulated screwdriver or jumper wire to make a short-circuit across the capacitor terminals to discharge each capacitor. This will discharge the capacitors to prevent electrical shocks.

On “XM₂” units, do not touch the power terminals of the motor controllers. The charge on the capacitors can cause electrical shock and personal injury. Disconnect the battery connector and push the horn button until the horn stops making a noise to discharge the capacitors.

2. Disconnect the battery and discharge capacitor(s) C1 as previously described in the WARNING.

2. Disconnect the battery, open the electrical compartment and discharge capacitor(s) C1 on the SCR control panels.

3. **EV-100ZX™ MOTOR CONTROLLER.** Disconnect the gate lead from the SCR 5 (SCR panel) for the traction circuit. The gate lead has a push-on connector on the SCR panel. Make sure that the end of the gate lead does not touch any other surface. See the section **DIA-**

GRAMS, 2200 SRM 551 that came with the lift truck for the location of the gate lead.

EV-T100 Transistor Controller. Connect a jumper wire across the bus bars for the Contactor 1A. The logic circuit will sense a short-circuit and the operation of the motor controller.

4. Connect the battery.

5. Sit on the seat to close the seat switch and turn the key to the **ON** position. Actuate the Monotrol control pedal or the direction control lever and accelerator for slow movement in the FORWARD or REVERSE direction.

6. Listen for the direction contactor to open. The traction system will not operate. The traction motor controller will allow two power pulses before opening the contactor.

7. When the PMT circuit disables the traction control, turn the key to the “**OFF**” position. If the PMT circuit does not disable the traction control, replace the control card. See the sections:

- **EV-100ZX™ MOTOR CONTROLLER, Description & Operation And Repairs & Adjustments, 2200 SRM 557.**
- **EV-T100™ TRANSISTOR MOTOR CONTROLLER, Description & Operation And Repairs & Adjustments, 2200 SRM 581**

8. **SR (SEM) Transistor motor controller:** Disconnect the battery and discharge capacitor(s) C1 as previously described in the WARNING. Disconnect one of the power leads for the motor field (F1 or F2) at the top of the SR motor controller. Make sure that the end of the F1 or F2 lead does not touch any other surface. Connect the battery. Apply the service brakes and actuate the Monotrol control pedal or the direction control lever and accelerator for slow movement in the FORWARD or REVERSE direction. The traction motor will try to run for approximately one second and then not operate. A status code 49 will appear on the LCD screen of the SEM Display Panel.

9. When the PMT circuit disables the traction control, turn the key to the “**OFF**” position. If the PMT circuit does not disable the traction control, replace the motor controller. See the sections:

TABLE 6. TORQUE VALUES FOR METRIC FASTENERS*

SIZE AND PITCH	PROPERTY CLASS 5.8 ¹		GRADE 8.8 ²		GRADE 10.9 ³	
	Nm	lb _f ft	Nm	lb _f ft	Nm	lb _f ft
M3 x 0.5	0.62	0.5	0.99	0.7	1.34	1.0
M3.5 x 0.6	0.97	0.7	1.55	1.1	2.11	1.6
M4 x 0.7	1.44	1.1	2.30	2.1	3.13	2.3
M5 x 0.8	2.91	2.1	4.65	3.6	6.33	4.7
M6 x 1	4.94	3.6	7.90	6	10.8	8
M8 x 1.25	12.0	9	19.2	14	26.1	19
M8 x 1	12.8	9	20.5	15	27.9	21
M10 x 1.5	23.8	18	38.0	28	52	38
M10 x 1.25	25.1	19	40.1	30	55	41
M12 x 1.75	41.4	31	66	49	90	66
M12 x 1.25	45.3	33	72	53	98	72
M14 x 2	66	49	105	77	145	105
M14 x 1.5	72	53	115	85	155	115
M16 x 2	105	77	165	122	225	165
M16 x 1.5	110	81	175	130	240	175
M20 x 2.5	200	150	320	235	435	320
M20 x 1.5	225	165	355	260	485	360
M24 x 3	345	255	555	410	755	560
M24 x 2	375	275	605	445	820	605
M27 x 3	505	370	810	600	1,100	810
M27 x 2	550	405	875	645	1,190	880
M30 x 3.5	690	510	1,100	810	1,500	1,100
M30 x 3	715	530	1,140	840	1,550	1,140
M30 x 2	765	565	1,220	900	1,660	1,230
M33 x 3.5	940	695	1,500	1,100	2,040	1,510
M33 x 2	1,030	760	1,640	1,210	2,240	1,660
M36 x 4	1,200	885	1,930	1,430	2,620	1,940
M36 x 3	1,280	945	2,040	1,510	2,780	2,050
M39 x 4	1,560	1,150	2,490	1,840	3,390	2,500
M39 x 3	1,640	1,210	2,630	1,940	3,570	2,640
M42 x 4.5	1,930	1,430	3,080	2,280	4,200	3,100
M42 x 3	2,070	1,530	3,320	2,450	4,510	3,330
M45 x 4.5	2,410	1,780	3,850	2,840	5,240	3,870
M45 x 3	2,580	1,910	4,120	3,040	5,610	4,140
M48 x 5	2,900	2,140	4,630	3,420	6,300	4,650
M48 x 3	3,160	2,330	5,040	3,720	6,860	5,060

* Unless otherwise specified

¹ Approximately equal to Grade 2

² Approximately equal to Grade 5

³ Approximately equal to Grade 8

INTRODUCTION

GENERAL

This section has the description and repair procedures for the steering housing and the steering control unit. Additional information on parts of the steering system are in the following sections: **STEERING AXLE** and **HYDRAULIC SYSTEM**.

DESCRIPTION

This section covers the steering column assembly used on the “XM” series of lift trucks. This assembly uses a steering control unit with hose connections on the bottom of the unit. See FIGURE 4. The steering housing has the mounts for the steering column and the steering control unit. The steering wheel is installed on the steering column. The housing is adjustable and is held in position by a latch. The position of the housing can be changed for operator comfort. The steering housing is also the mount for some control levers and the instrument cluster.

The steering system is a hydraulic system that does not have a mechanical connection between the steering wheel and the steering axle. The control of the steering is through a hydraulic circuit.

If the hydraulic pump for the steering system does not operate, steering is still possible. A check valve permits the steering control unit to control the steering cylinder. The lift truck is difficult to steer when the steering pump is not operating, but the steering control unit can operate the steering cylinder and make steering possible.

OPERATION (See FIGURE 2.)

The steering control unit is a rotary valve operated by the steering wheel. During the steering operation, the steering control unit controls the direction of flow and amount of oil that flows to the steering cylinder. The steering cylinder in the axle actuates the steering linkage to move the steer tires. Hydraulic oil returns from the steering cylinder to the steering control unit and then returns to the hydraulic tank.

Turning the steering wheel actuates three main parts of the steering control unit: (1) The spool for the control section, (2) the sleeve for the control section and (3) the rotor in the metering section. When the steering wheel is not moving, the spool and sleeve are held in the neutral (center) position by springs. During this time, oil flows

freely through the steering control unit. The oil does not flow to the steering cylinder.

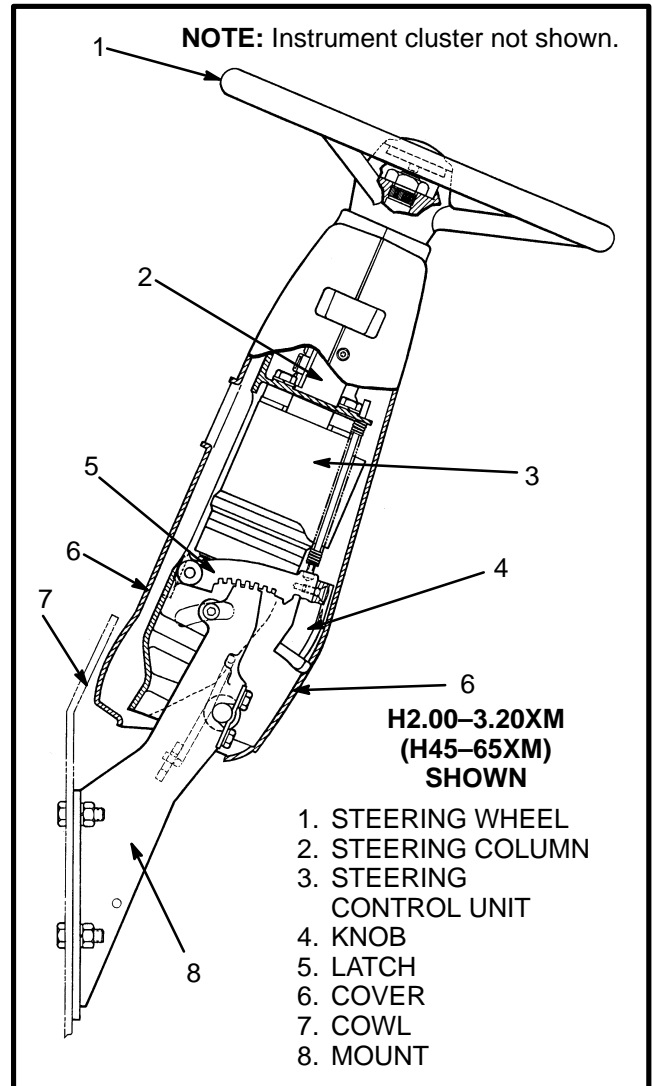


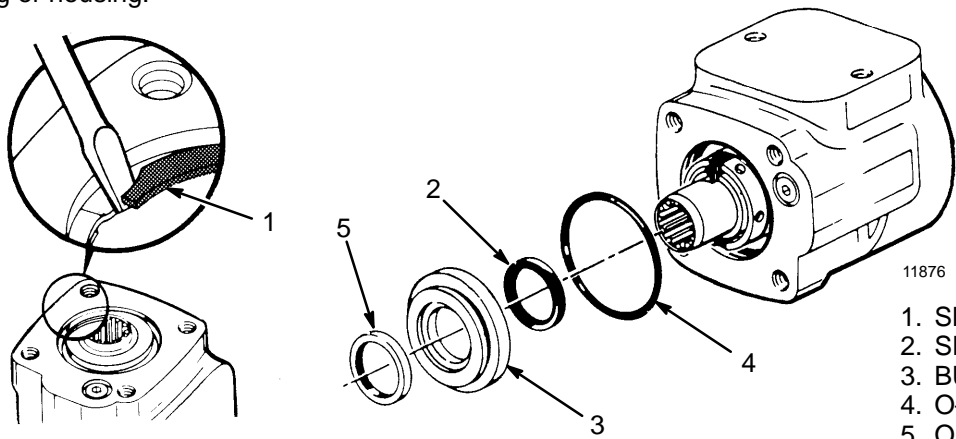
FIGURE 1. STEERING HOUSING ASSEMBLY

As the steering wheel is turned, the spool just begins to rotate. The springs try to move the sleeve to keep the neutral position between the spool and sleeve. However, the force necessary to turn the rotor is greater than the pressure of the springs. The springs begin to bend, letting the spool move a small amount within the sleeve. The spool stops moving when it touches the center pin. In this position, the holes in the sleeve and the spool are aligned. Oil coming into the control unit flows to the metering section.

More rotation of the steering wheel causes the spool to rotate the pin. This action causes the rotation of the sleeve and the rotor in the metering section. The oil then

STEP 6.

When installed, remove the snap ring, bushing, O-ring and seal ring. Remove the oil seal from the bushing or housing.

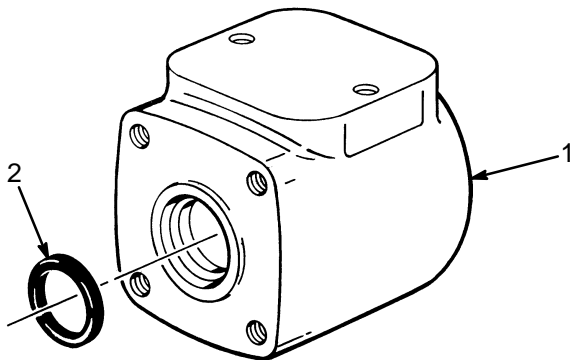


- 1. SNAP RING
- 2. SEAL
- 3. BUSHING
- 4. O-RING
- 5. OIL SEAL

FIGURE 7. DISASSEMBLY OF THE STEERING CONTROL UNIT (3 of 3)

STEP 1.

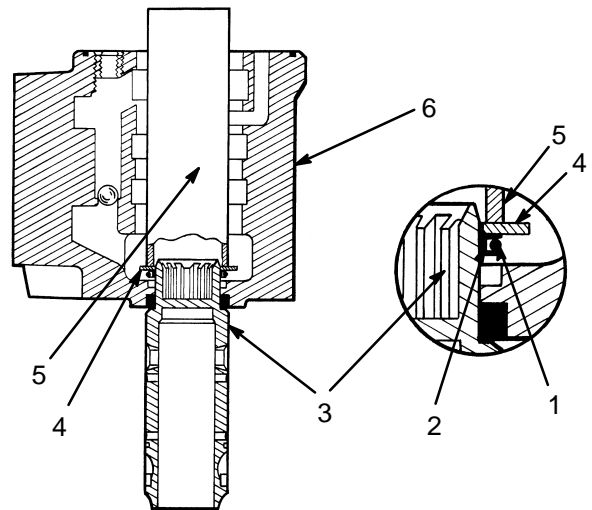
Install the seal.



- 1. HOUSING
- 2. SEAL

STEP 2.

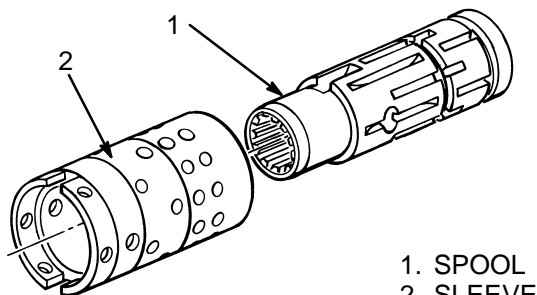
Put the spool (3) on the work bench then put the housing (6) onto the spool as shown. Install the guide ring (2) with the O-ring (1) on the end of the spool. Put the thrust washer (4), (see STEP 6) on top of the guide ring and O-ring assembly. Use a socket or tube (5) to push on the washer and install the O-ring and guide ring in the housing. Carefully remove the washer, tube and spool from the housing.



- 1. O-RING
- 2. GUIDE RING
- 3. SPOOL
- 4. WASHER
- 5. TUBE
- 6. HOUSING

STEP 3.

Carefully assemble the spool and sleeve. Make sure the spool rotates freely in the sleeve.



- 1. SPOOL
- 2. SLEEVE

FIGURE 8. ASSEMBLY OF THE STEERING CONTROL UNIT (1 of 4)

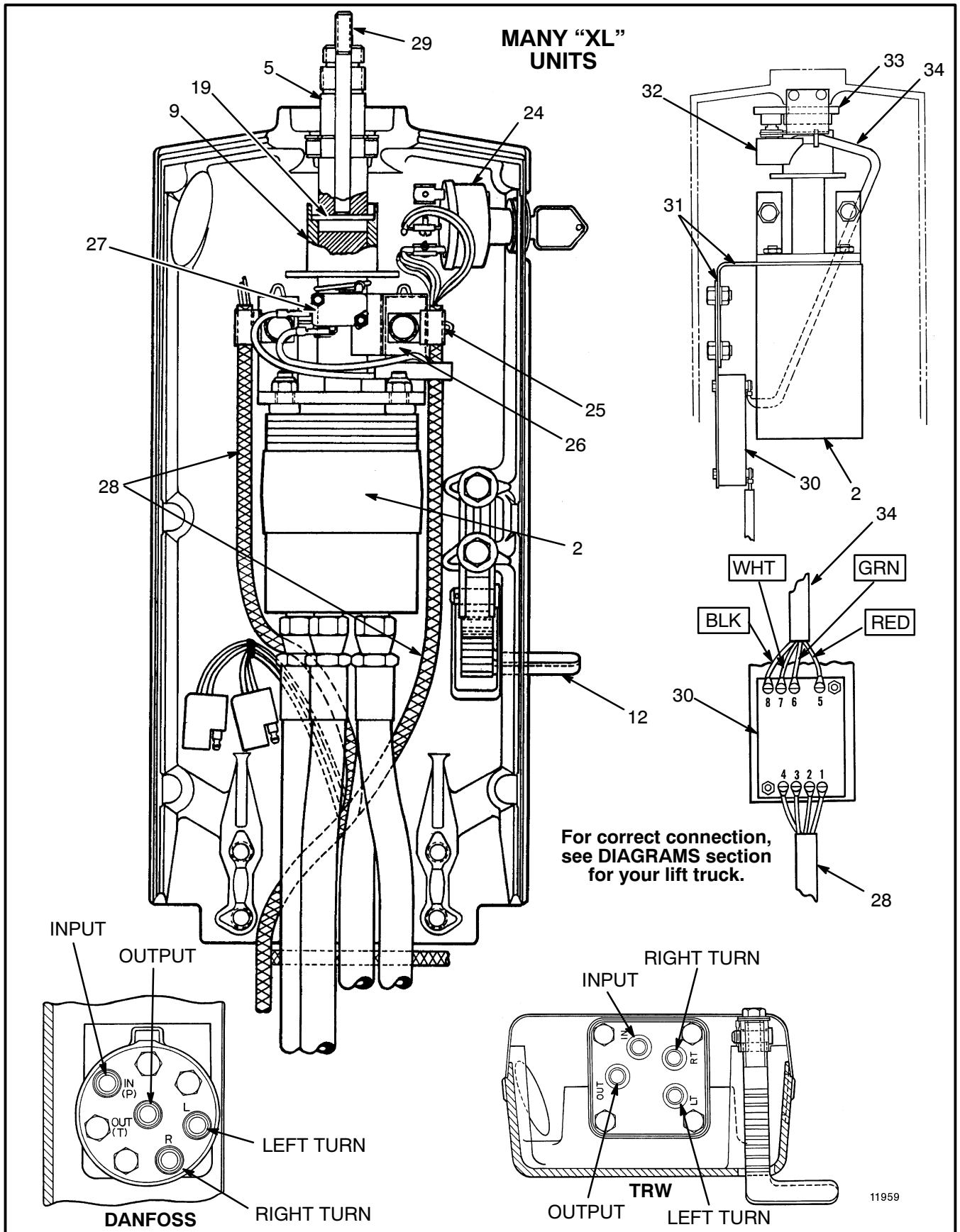
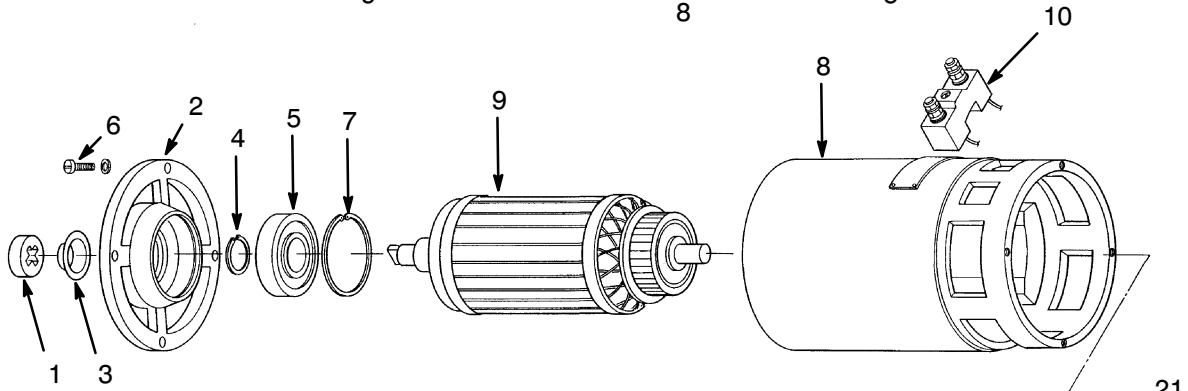
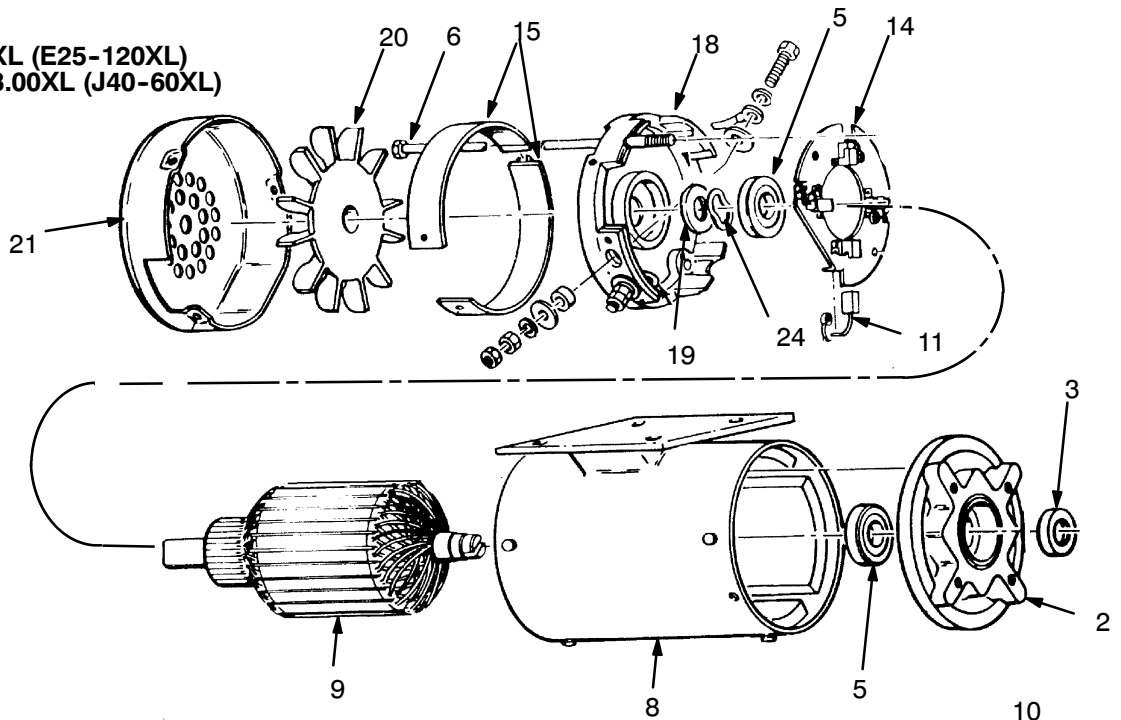


FIGURE 4. STEERING WHEEL AND STEERING COLUMN ASSEMBLY (1 of 3)

E1.25-5.50XL (E25-120XL)
and J2.00-3.00XL (J40-60XL)



A1.00-1.50XL
(A20-30XL)

- | | | |
|---------------------|-----------------------|----------------------------|
| 1. COUPLING | 9. ARMATURE | 17. DISK |
| 2. END PLATE, DRIVE | 10. POWER TERMINAL | 18. END PLATE, COMMUTATOR |
| 3. SEAL | 11. BRUSH | 19. SHIM |
| 4. RETAINING RING | 12. BRUSH HOLDER | 20. FAN |
| 5. BEARING | 13. PLATE NUT | 21. FAN COVER |
| 6. SCREW, HOUSING | 14. BRUSH PLATE | 22. BRUSH PLATE SCREWS (2) |
| 7. RETAINING RING | 15. COVER, COMMUTATOR | 23. SCREW, FAN COVER |
| 8. MOTOR HOUSING | 16. BEARING | 24. SPRING WASHER |

11997

FIGURE 9. POWER STEERING PUMP MOTOR

TROUBLESHOOTING

TROUBLE	POSSIBLE CAUSE	PROCEDURE OR ACTION
The steering wheels do not move when the steering wheel is turned.	<p>The oil level is low or there is no oil in the tank.</p> <p>The steering control unit is damaged.</p> <p>No oil flow from the steering control unit to the steering cylinder.</p> <p>The sleeve and spool in the control unit will not move.</p> <p>Hydraulic hoses not connected or have damage.</p>	<p>Fill tank to the correct level. Check for leaks.</p> <p>Repair or install new control unit.</p> <p>Repair or install new components. Check for leaks.</p> <p>Install new components.</p> <p>Check for leaks. Tighten connections. Install new components as necessary.</p>
Slow or difficult steering.	<p>Relief valve for the steering system is not adjusted correctly.</p> <p>Low oil pressure from the hydraulic pump.</p> <p>Seal in the steering cylinder has a leak.</p> <p>Hydraulic lines are too small or have restrictions.</p> <p>Steering control unit is worn, not assembled correctly or has damage.</p>	<p>Adjust or install new relief valve.</p> <p>Check for restrictions. See Troubleshooting Chart, "Hydraulic System" 1900 SRM 286.</p> <p>Repair cylinder. Install new seal or new cylinder.</p> <p>Remove restrictions. Install larger or new hydraulic lines.</p> <p>Repair or install new control unit.</p>
Steering wheel turns the tires in the wrong direction.	The hydraulic lines are not connected correctly at the steering cylinder or at the steering control unit.	Connect lines correctly. Remove air from the system.
Steering function continues after the steering wheel stops.	The steering control unit is assembled wrong or has damage.	Repair or install new control unit.
The steering operation is not smooth.	<p>The oil level in the tank is low.</p> <p>Air was not removed after repair to the hydraulic system.</p> <p>The steering control unit is assembled wrong or has damage.</p> <p>The hydraulic pump has a leak at the inlet.</p>	<p>Fill tank to the correct level. Check for leaks.</p> <p>Remove air from the system.</p> <p>Repair or install new control unit.</p> <p>Fix leaks. Remove air from the system.</p>
The pump motor will not stop operating after steering wheel stops turning	<p>Check for damaged pressure switch</p> <p>Check steering contactor for welded contacts</p>	<p>Replace the switch.</p> <p>Replace the contactor.</p>

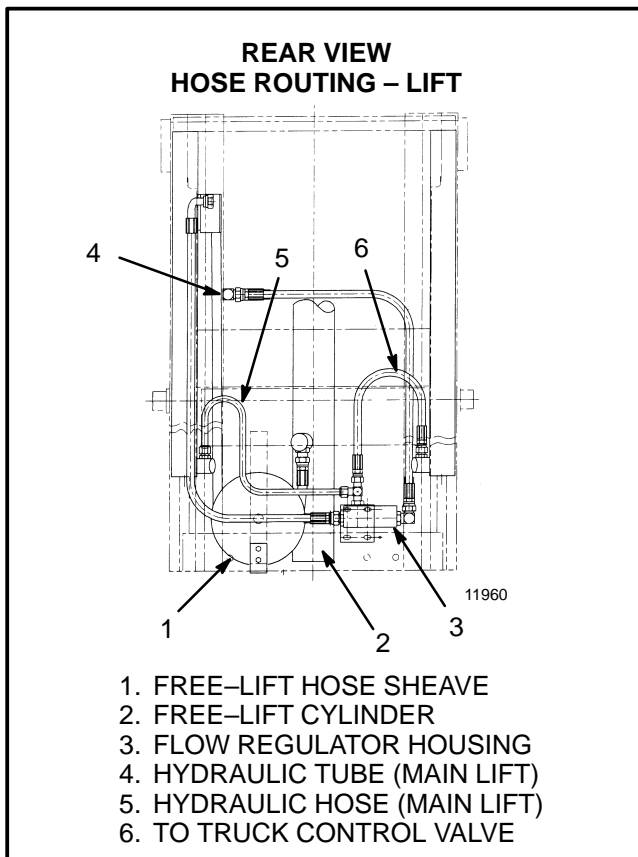


FIGURE 9. HYDRAULIC CONNECTIONS – VISTA THREE-STAGE MAST

The hoist chains fasten to the anchors near the top rear of the outer mast weldment. The chains go over the sheaves at the top of the intermediate mast weldment. The other end of the chains fasten to the chain anchors at the bottom of the inner mast weldment. When the main cylinders raise the intermediate mast weldment, the

chains raise the inner mast weldment, the free-lift cylinder and the carriage.

OPERATION

The Vista three-stage mast operates in two phases. First, the free-lift cylinder extends and lifts the carriage to the top of the mast assembly. When the free-lift cylinder reaches the end of its stroke, the main cylinders begin to extend. The main cylinders raise the intermediate mast weldment. Since the hoist chains go over the sheaves of the intermediate mast weldment, the inner mast weldment also raises. The inner mast weldment travels at two times the speed of the intermediate mast weldment.

The three main cylinders are connected hydraulically in parallel. When the LIFT function begins, the pressure of the oil is increased in all the main cylinders. The free-lift cylinder raises the weight of the carriage and the load on the forks. The main cylinders must raise the carriage, the load on the forks, plus the weight of the intermediate and inner mast weldments. It takes less force to extend the rod of the free-lift cylinder, so this rod and the carriage will move first.

When the LOWER function begins, the oil from the main cylinders returns to the hydraulic tank. The main cylinders lower first since they have a greater load. When the main cylinder rods have fully retracted, the free-lift rod retracts. All the oil from the cylinders returns to the hydraulic tank through the flow control valves located in the manifold attached to the bottom of the outer mast weldment. Each cylinder has a lowering control valve installed in its base. These lowering control valves control the lowering speed of a load if a hydraulic line breaks.

5. Use a prybar to remove the load roller from the stub shaft for the load roller. See FIGURE 4.
6. Use a cloth to clean each load roller. Inspect the load rollers for cracks, flat spots or bearings that do not turn freely. Replace any roller that shows wear or is damaged.
7. Install the carriage. See CARRIAGE ASSEMBLY – REMOVAL AND INSTALLATION.
8. Adjust the carriage. See CARRIAGE ADJUSTMENTS in CHECKS AND ADJUSTMENTS.

SIDE ROLLERS – DISASSEMBLY AND ASSEMBLY
(See FIGURE 1. and FIGURE 2.)

1. Remove the carriage assembly from the mast to replace the side rollers. See CARRIAGE ASSEMBLY REMOVAL AND INSTALLATION to remove the carriage.
2. Remove the capscrews that fasten the side roller bracket.

NOTE: Observe the position of the shims.

3. Inspect and replace all damaged or worn parts.
4. Reverse the procedure to install the side rollers. Adjust the carriage side rollers during assembly. See CARRIAGE ADJUSTMENTS in CHECKS AND ADJUSTMENTS.

NOTE: To remove and replace load rollers, wear plugs, weldments or lift cylinders, it is necessary to remove the two-stage mast assembly from the truck.

FORK REPLACEMENT

Read and follow the **SAFETY PROCEDURES** in the **GENERAL** section on pages 1 and 2 as well as all **WARNINGS** and **CAUTIONS**.

⚠ WARNING

Forks are heavy and can cause an injury. Do not try to remove forks without using a lifting device.

Forks – N50FA and N30XMH Carriage
(See FIGURE 1. and FIGURE 5.)

These forks are connected to the carriage by hooks. Latch pins fit through the top fork hooks and into slots on the top crossmember of the carriage to keep the forks in position. Remove the forks as follows:

Lift the latch lever and slide the fork to the fork removal notch on the carriage. The removal notch is in the bottom crossmember of the carriage as shown in FIGURE 1. Lower the carriage with a blocks under the fork or raise the fork tip. The bottom hook of the fork will move through the fork removal notch. Lower the carriage further or raise the fork so that the top hook of the fork is disengaged from the top crossmember. Move the carriage away from the fork, or use the lifting device to move the fork away from the carriage. Follow the same procedure to remove the other fork. Install the forks as follows:

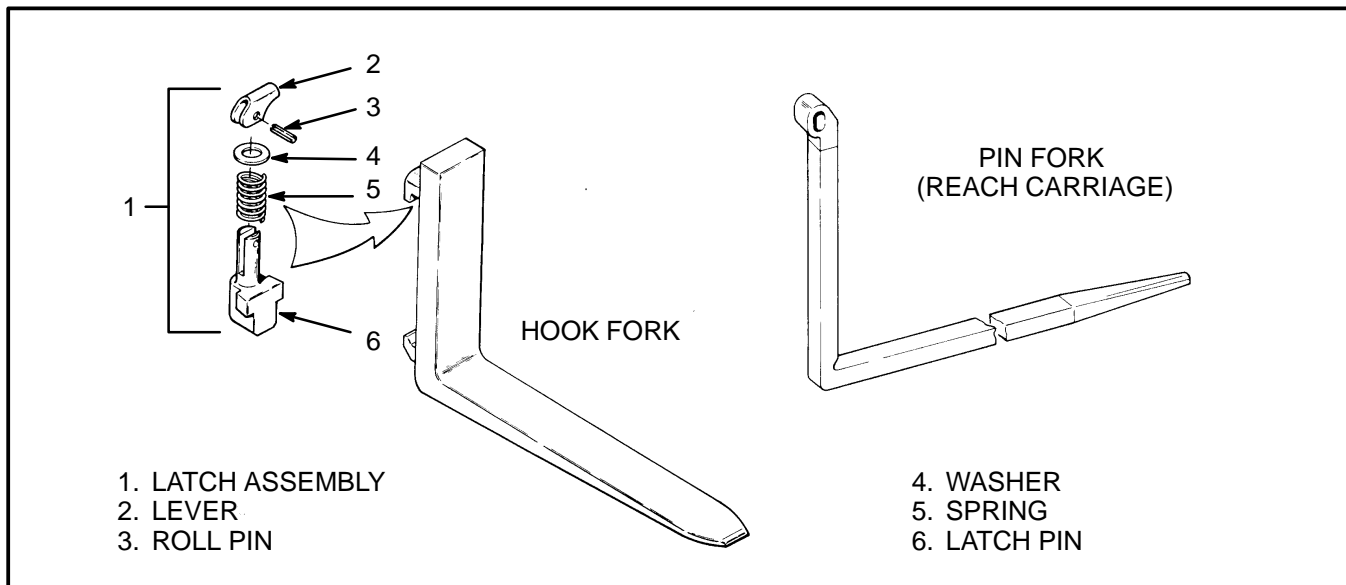


FIGURE 5. FORKS

THREE-STAGE MAST ASSEMBLY

THREE-STAGE MAST ASSEMBLY – REMOVAL (See FIGURE 13. and FIGURE 14.)

Read and follow the **SAFETY PROCEDURES** in the **GENERAL** section on pages 1 and 2 as well as all **WARNINGS** and **CAUTIONS**.

NOTE: If the mast assembly will be disassembled after it is removed from the truck, first remove the N50FA carriage or the N40-45FR reach carriage or the N30XMH as a complete assembly. See **CARRIAGE ASSEMBLY REMOVAL AND INSTALLATION**. If the reach carriage will be removed with the mast assembly, operate the **REACH/RETRACT** control lever to fully retract the forks. Install safety chains so that the forks cannot extend. Install the safety chains around the center plates of the scissor arm weldment and a crossmember of the mast. Make sure a safety chain does not touch the mount for the hose sheave, lift chains, chain or hose sheaves, hoses, tubes or fittings. If installed, operate the **SIDE-SHIFT** control lever to move the side-shift frame to the center position.

N40-45FR, N50FA

1. Remove the capscrew and nuts that fasten the mast operator guard and remove the guard. See FIGURE 7.
2. Remove the capscrews that fasten the rear legs to the overhead guard. See FIGURE 7. The overhead guard will be removed with the mast assembly.

CAUTION

Do NOT move the control lever for the reach, retract, tilt or side-shift functions. Oil will flow from the hoses for these functions.

3. Operate the **LIFT/LOWER** control lever to raise the inner weldment high enough to remove the four capscrews, the shims and the nut plates that fasten the bottom of the mast to the truck frame. See FIGURE 8.
4. Install safety chains to keep the mast components from moving. Remove the capscrews, washers and clamps that fasten the lift cylinder hoses to the mast weldments. Do NOT disconnect any hydraulic fittings.
5. Remove the safety chains installed in Step 4. Do not damage hydraulic hoses as the mast lowers. Carefully

operate the **LIFT/LOWER** control lever to fully lower the inner weldment. Make sure that all hydraulic pressure is removed from the system.

6. Mark the trunnion caps so they can be reassembled in the same position and on the same trunnion from which they are removed. Use chain to connect a crane or other lifting device to the top of the mast assembly. Make sure the chains will not damage the sheaves or other parts of the mast assembly. Make sure the chains and crane have the capacity to lift approximately 2000 kg (4500 lbs). Use safety chains to fasten all the mast weldments together so that they cannot move. If installed, install a chain or sling to the reach carriage to keep the mast assembly from tipping during removal. Remove the four capscrews that fasten the trunnion caps.

7. Operate the crane until it gives support to the weight of the mast assembly. Move the crane to a position so that the mast assembly will be lifted vertically. Raise the mast assembly high enough to clear the trunnions. Move the mast assembly approximately 30 cm (1 ft) away from the truck for access to the hoses.

8. Install labels on the bulkhead hoses for correct connection during installation. Disconnect the mast and carriage hoses from their fittings as required. Install caps on the fittings and hoses to prevent leakage.

9. Install labels on all plugs and wires for the electrical cable for correct connection during installation. Disconnect the plugs and wires so that the cable is completely disconnected from the truck. The plugs are near the cable tension device inside the electrical compartment above the battery.

10. Move the mast assembly away from the truck.

11. If the mast will be disassembled, put the mast on a level floor with the overhead guard on the bottom as a support. Install a support under the other end. Make sure the mast is level. Keep the safety chains on the mast assembly that were installed in Step 6.

12. If the mast will NOT be disassembled, put the mast on a level floor with the overhead guard on top.

2. Lower the carriage so that the safety chains are the support for the carriage and the lift chains do not have tension.

NOTE: Removing the pins, at the chain anchors, will disconnect the lift chains without changing the chain adjustment. Always adjust the chains if new lift chains or other components are installed.

3. Fasten both free-lift chains so that they cannot move over the sheaves of the sheave support. Remove the chain anchor pins at each end of both free-lift chains. Hold each chain to keep it from moving too fast and carefully remove them.

4. Inspect the free-lift chains as described in **CHECKS AND ADJUSTMENTS**. Replace the free-lift chains if necessary.

5. Reverse the procedure to install the free-lift chains.

6. Adjust the free-lift chains as described in **CHECKS AND ADJUSTMENTS**.

Main-Lift Chains

1. Raise the mast until the lower chain anchors are visible on the inner weldment.

2. Use safety chains to fasten the inner weldment so that it cannot move. Operate the LOWER hand lever to lower the masts until the safety chains are a support for the inner weldment and lift chains do not have tension.

NOTE: Removing the pins, at the chain anchors, will disconnect the lift chains without changing the chain adjustment. Always adjust the chains if new lift chains or other components are installed.

3. Fasten both main-lift chains so that they cannot move over the sheaves. Remove the chain anchor pins at each end of both main-lift chains. Hold each chain to keep it from moving too fast and carefully remove them.

4. Inspect the main-lift chains as described in **CHECKS AND ADJUSTMENTS**. Replace the main-lift chains if necessary.

5. Reverse the procedure to install the main-lift chains.

6. Adjust the main-lift chains as described in **CHECKS AND ADJUSTMENTS**.

THREE-STAGE CHAIN SHEAVES – DISASSEMBLY AND ASSEMBLY (See FIGURE 13. and FIGURE 14.)

Read and follow the **SAFETY PROCEDURES** in the GENERAL section on pages 1 and 2 as well as all WARNINGS and CAUTIONS.

Free-Lift Chain Sheaves

1. If necessary, remove the free-lift chains as described in THREE-STAGE LIFT CHAINS – REMOVAL AND INSTALLATION.

WARNING

Be careful when removing or installing snap rings. These snap rings are large and can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers and wear eye and face protection during removal or installation.

2. Remove the snap ring from the shaft in the sheave support.

3. Use a drift to tap the shaft out of the sheave support.

4. Remove the sheaves and spacers as a group. Inspect all components for wear or damage. Replace any part that is worn or damaged.

5. Reverse the procedure to install the chain sheaves.

Main-Lift Chain Sheaves

1. If necessary, remove the main-lift chains as described in THREE-STAGE LIFT CHAINS – REMOVAL AND INSTALLATION.

2. Remove both pins from the chain anchors at the rear of the free-lift cylinder. Remove each lift chain from the sheaves.

WARNING

Be careful when removing or installing snap rings. These snap rings are large and can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers and wear eye and face protection during removal or installation.

3. Remove the snap ring from the chain sheave bracket.

4. Use a prybar to remove the chain sheave from the bracket. Inspect all components for wear or damage. Replace any item that is worn or damaged.

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