INTRODUCTION

GENERAL

This section has the description and repair procedures for the Four–Stage, full free–lift (FFL) mast and the carriages. Checks and Adjustments and Troubleshooting information are at the end of this section.

The mast is used to lift a load vertically. The mast has two movements controlled by hydraulic cylinders: forward and backward tilt and the lifting and lowering of the mast weldments and carriage. The outer weldment can move on the pivot pins at the mast mounts. The operation of the tilt cylinders causes the mast to tilt forward and backward. The tilt cylinders are fastened between the frame of the lift truck and the outer weldment of the mast. Hydraulic lift cylinders are installed vertically on the mast weldments. The lift cylinders and lift chains raise and lower the weldments and the carriage. The hydraulic operation of the lift cylinders and tilt cylinders is described in the section **MAIN CONTROL VALVE.**

CARRIAGES (See FIGURE 1.)

The carriage is a part of the mast assembly and moves within the channels of the inner weldment. Forks or other types of load handling equipment are attached to the carriage. A load backrest extension is attached to the carriage and adds support for a load that has multiple pieces.

The side–shift carriage lets the operator move the forks and load from side–to–side. This function makes it easier for the operator to align the forks with a load or align the load with a stack. The side–shift carriage hangs on the fork bars of the standard carriage. Special bushings fit between the side–shift carriage and the fork bars. A side–shift cylinder is installed on a bracket that fits on the standard carriage. The side–shift cylinder moves the side–shift carriage on the standard carriage.

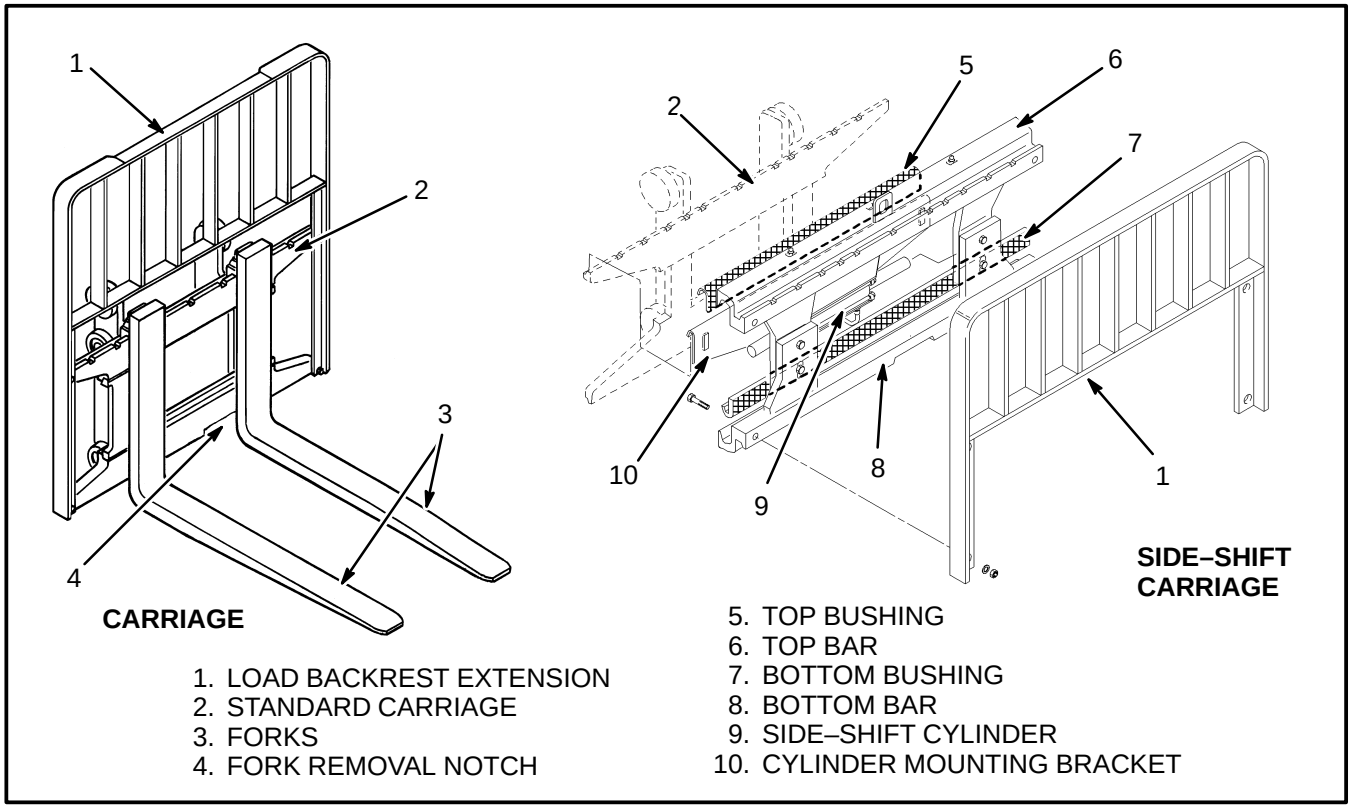


FIGURE 1. CARRIAGE AND FORKS

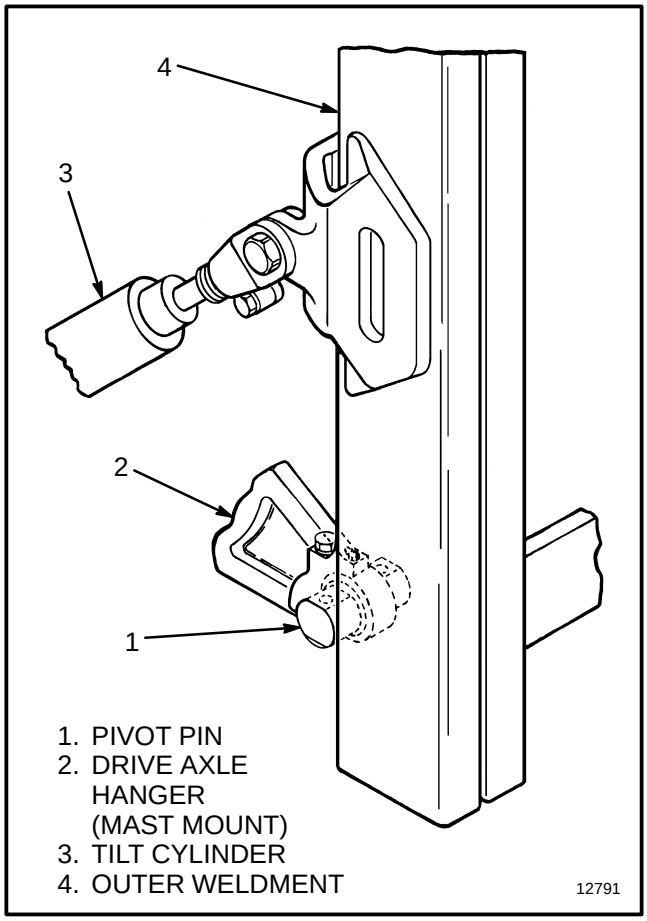


FIGURE 13. MAST MOUNTING

1. Disconnect and remove the hydraulic lines for the free–lift cylinder. Remove the brackets for the free–lift cylinder. Remove the free–lift cylinder. Disconnect the free–lift chains at the crossmember.

2. Disconnect the lift chains at the bottom of the inner weldment and the top of the first intermediate weldment. Remove the lift chains. Push the inner weldment toward the bottom of the mast assembly until the bottom load rollers are seen.

3. Remove the strip bearings at the top of the second intermediate weldment. Remove the load rollers at the bottom of the inner weldment. Remove the load rollers at the top of the second intermediate weldment. Make a note of each shim arrangement and load roller location. The shim arrangements will be approximately the same during assembly.

4. Slide the inner weldment half–way out of the top of the second intermediate weldment. Connect a crane to the center of the inner weldment. See FIGURE 14. Slide the inner weldment out until the stub shafts are in the notches of the second intermediate weldment. Remove the inner weldment from the second intermediate weldment.

5. Disconnect the lift chains at the bottom of the second intermediate weldment and the top of the outer weldment. Remove the lift chains. Push the second intermediate weldment toward the bottom of the mast assembly until the bottom load rollers are seen.

6. Remove the strip bearings and spacers at the top of the first intermediate weldment. Remove the load rollers at the bottom of the second intermediate weldment. Remove the load rollers at the top of the first intermediate weldment. Make a note of each shim arrangement and load roller location. The shim arrangements will be approximately the same during assembly.

7. Slide the second intermediate weldment half–way out of the top of the first intermediate weldment. Connect a crane to the center of the second intermediate weldment. See FIGURE 14. Slide the second intermediate weldment out until the stub shafts are in the notches of the first intermediate weldment. Remove the second intermediate weldment.

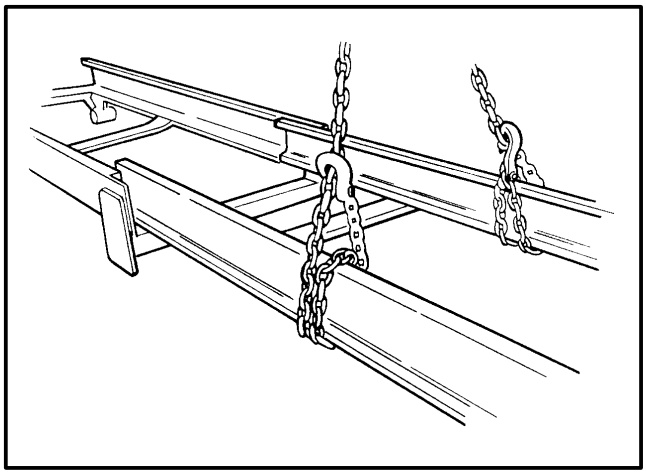


FIGURE 14. REMOVE A WELDMENT

8. Disconnect the hydraulic lines at the top and bottom of the lift cylinders. Disconnect the balance line at the top of the right–hand lift cylinder.

9. Remove the snap rings and washers at the top of the main lift cylinders. Remove the nut, bolt and spacer at the mount near the top of each main lift cylinder.

10. Push the first intermediate weldment to disengage the lift cylinders. Remove the main lift cylinders. Keep the shims from the top of the right–hand lift cylinder with the cylinder.

11. Slide the first intermediate weldment from the bottom of the outer weldment approximately 30 cm (12 in).

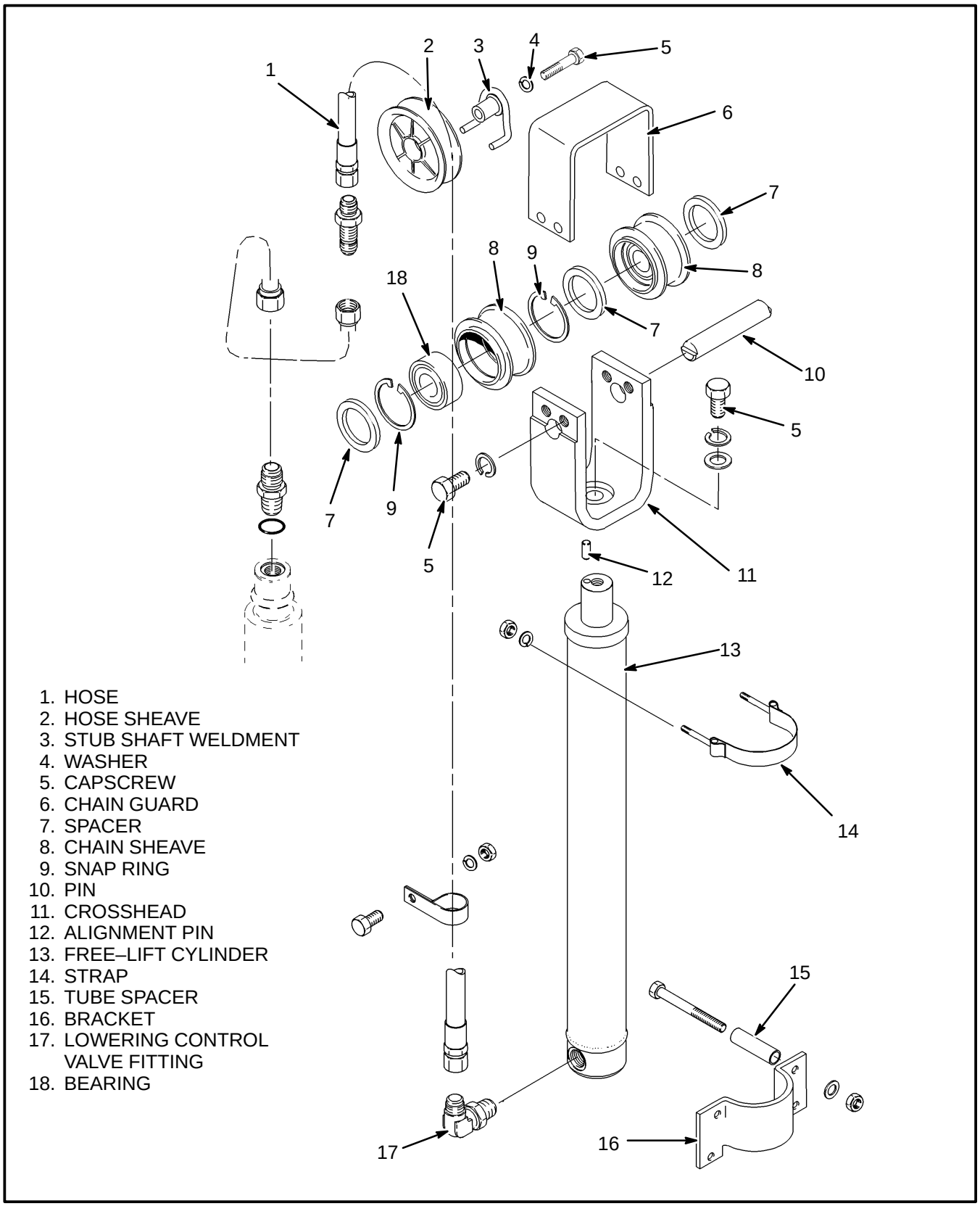


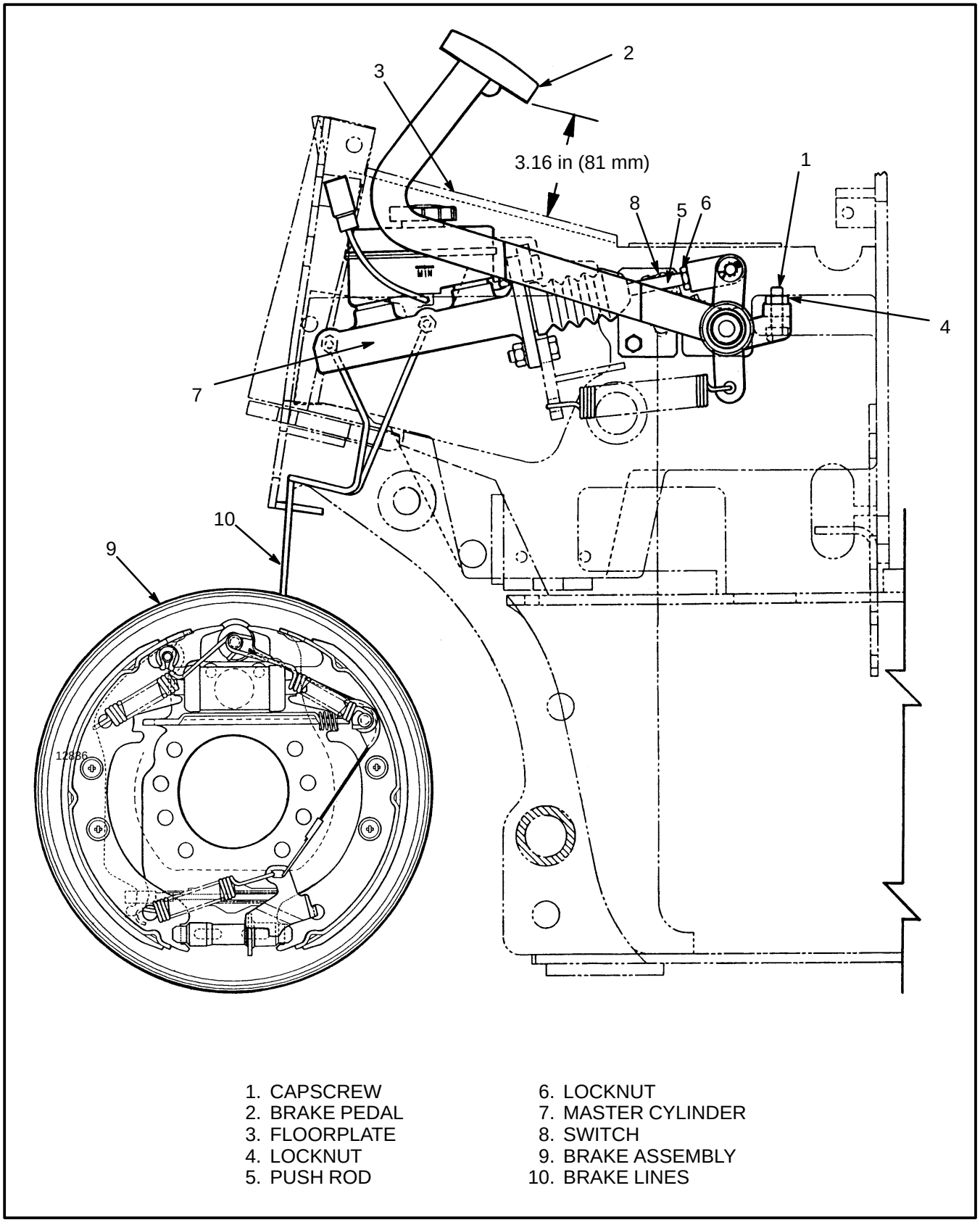
FIGURE 23. CROSSHEAD AND FREE–LIFT CYLINDER ASSEMBLY

2. Install all hose sheaves loosely. Do not tighten capscrews and nuts until header hoses are installed.

3. Make sure the replacement header hose is the correct part number for your mast assembly. Make sure the

TROUBLESHOOTING

PROBLEM	POSSIBLE CAUSE	PROCEDURE OR ACTION
Slow or no movement of lift or tilt cylinders.	Air is in the hydraulic system.	Remove air from hydraulic system.
	The hydraulic pump is worn or damaged.	Repair or replace hydraulic pump.
	Restriction in the hydraulic lines.	Repair hydraulic lines.
	Cylinder seals are damaged.	Repair cylinders.
	Load is greater than capacity.	Reduce load.
	Linkage is disconnected or damaged.	Repair and adjust linkage for control levers.
	Pressure relief valve(s) is not adjusted correctly or is damaged.	Repair or adjust relief valve(s).
	Large leaks between spool and bore.	Replace valve section.
	Spool is not fully extended or retracted.	Adjust linkage to spool.
Rough movement of the mast assembly.	Air is in the hydraulic system.	Remove air from hydraulic system.
	Lift cylinder(s) is damaged.	Repair cylinder(s).
	Mast weldments are damaged or not aligned.	Repair or adjust mast weldments.
	Mast weldments are not lubricated correctly.	Lubricate mast correctly.
Lift or tilt cylinders retract when the spool is in the NEUTRAL position.	Check valve for the lift spool is damaged.	Replace check valve.
	Cylinder seals have leaks.	Repair lift cylinders.
	Hydraulic lines have leaks.	Repair or tighten lines or fittings.
	Leaks between the lift spool and the bore.	Replace valve section.
Tilt cylinders extend when the tilt spool is in the NEUTRAL position.	Cylinder seal have leaks.	Repair tilt cylinders.
	Oil leaks between control valve spool and bore.	Replace valve section.
	Hydraulic lines have leaks.	Repair or tighten lines or fittings.



1. CAPSCREW
2. BRAKE PEDAL
3. FLOORPLATE
4. LOCKNUT
5. PUSH ROD
6. LOCKNUT
7. MASTER CYLINDER
8. SWITCH
9. BRAKE ASSEMBLY
10. BRAKE LINES

FIGURE 9. SERVICE BRAKE

NOTES

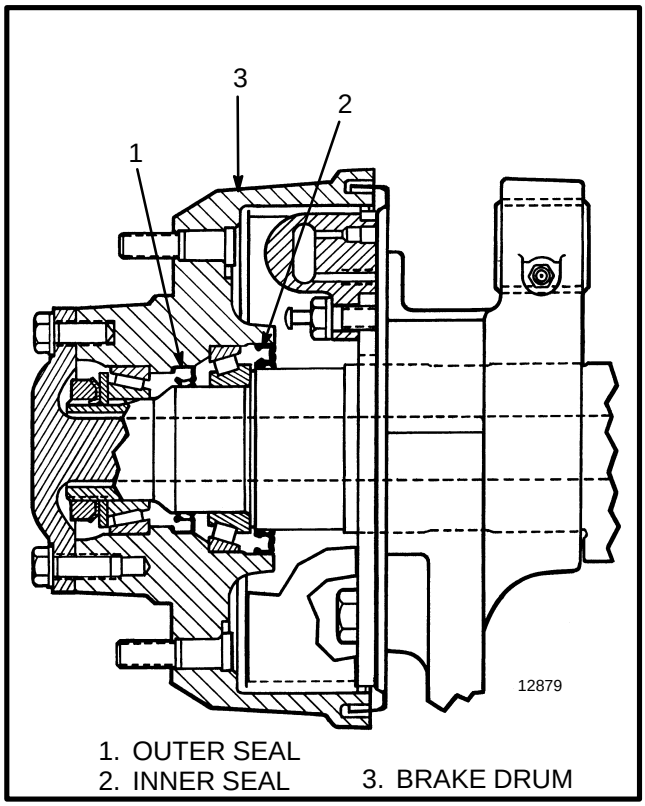


FIGURE 6. LOCATION OF THE GREASE SEALS

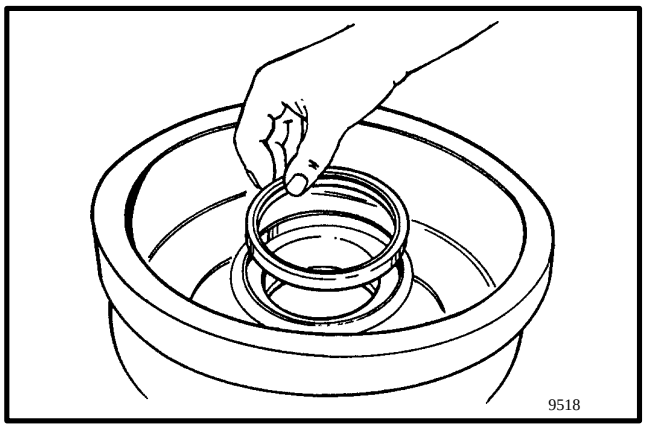


FIGURE 7. INSTALLATION OF THE INNER GREASE SEAL

PARKING BRAKE

Removal And Disassembly (See FIGURE 9.)

If the lever assembly for the parking brake must be removed from the frame, use the following procedure (See FIGURE 9.):

1. Use blocks next to the wheels to make sure the lift truck can not move. Release the parking brake.
2. Turn the adjustment knob (5) so that the link (17) is at the bottom of the adjustment slot (18).
3. Remove the cotter pin (22) and pin (23) to disconnect the parking brake cable from the brake assembly.
4. Remove the cotter pin and anchor pin (8) that connect the link (4) to the parking brake assembly (3).
5. Remove the nuts (10) and washers that hold the parking brake assembly to the bracket (16). Remove the capscrews (9) and spacers (12).
6. Remove the cotter pin, washer, and anchor pin (13) from the link (17).

Assembly And Installation (See FIGURE 9.)

If the lever assembly for the parking brake was removed from the frame, use the following procedure for installation:

1. Make sure the parking brake lever is in the released position. Turn the adjustment knob (5) until the link (17) is adjusted to the bottom of the adjustment slot (18).
2. Install the ends of the cables into the compensator (15). Install the anchor pin (13), washer, and cotter pin into the parking brake assembly. Make sure the anchor pin is through the link and compensator.
3. Install the mounting bolts (9) through the cable clamps (11) and spacers (12). Mount the assembly to the bracket (16).
4. Before tightening the the mounting capscrews (9), push down the parking brake assembly to make sure it is in contact with the frame bracket (19).
5. The following procedure must be used to connect the link (4) to the parking brake assembly (3) and the brake pedal assembly (6): put the parking brake lever (3) in the applied position. Install the anchor pin (8) in the hole in the link (4) that will adjust the bottom side of the parking brake pedal to 28 mm (1.1 in) above the frame. See FIGURE 9. Install the cotter pins. Install the return spring (25) in an empty hole in the link (4).
6. With the brake in the applied position, adjust and tighten the nuts (14) on the end of the cable (20) to

TROUBLESHOOTING

TROUBLE	POSSIBLE CAUSE	PROCEDURE OR ACTION
The parking brake will not hold the lift truck.	Parking brake not adjusted correctly.	Use adjustment knob on parking brake lever to adjust holding force. See adjustment procedure for correct specifications.
	Oil, water, or brake fluid is on the linings.	Clean or install new linings.
	The parking brake cables need adjustment, lubrication, or have damage.	Install new parts. Lubricate and adjust cables.
The parking brake will not release.	The parking brake lever is adjusted too tight.	Adjust parking brake. See adjustment procedure for correct specifications.
	The parking brake cables need adjustment, lubrication, or have damage.	Install new parts. Lubricate and adjust cables.

TORQUE SPECIFICATIONS

ITEM	SPECIFICATION
Back Plate to Axle Mount Capscrews $^5/_8$ in Capscrews $^1/_2$ in Capscrews	 245 N.m (180 lb_f ft) 125 N.m (92 lb_f ft)
Wheel Cylinder Capscrews $^7/_{16}$ in Capscrews $^1/_2$ in Capscrews	 78 to 91 N.m (58 to 67 lb_f ft) 91 to 102 N.m (67 to 75 lb_f ft)
Axle Shaft Capscrews	98 N.m (72 lb_f ft)
Wheel Nuts	237 to 305 N.m (175 to 222 lb_f ft)
Hub Nut	Initial 205 N.m (150 lb_f ft) Final 34 N.m (25 lb_f ft)

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

SCR CONTROLLED STANDARD MOTOR & LARGE 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	0.353 0.396	0.511 0.568	0.559	0.508
	TWO-STAGE Full Free Lift	72 80	0.372 0.415	0.535 0.597	0.508	0.457
	THREE-STAGE Full Free Lift	72 80	0.363 0.406	0.525 0.587	0.528	0.467
	FOUR-STAGE Full Free Lift	72 80	0.310 0.344	0.454 0.506	0.447	0.411
E2.50XM	TWO-STAGE Limited Free Lift	72 80	0.325 0.368	0.511 0.568	0.574	0.508
	TWO-STAGE Full Free Lift	72 80	0.344 0.387	0.535 0.597	0.538	0.457
	THREE-STAGE Full Free Lift	72 80	0.334 0.377	0.525 0.587	0.549	0.467
	FOUR-STAGE Full Free Lift	72 80	0.296 0.329	0.454 0.506	0.447	0.411
E3.00XM	TWO-STAGE Limited Free Lift	72 80	0.282 0.315	0.458 0.511	0.559	0.457
	TWO-STAGE Full Free Lift	72 80	0.291 0.325	0.473 0.530	0.538	0.366
	THREE-STAGE Full Free Lift	72 80	0.291 0.325	0.473 0.525	0.544	0.396
E3.20XM	TWO-STAGE Limited Free Lift	72 80	0.277 0.310	0.458 0.511	0.559	0.457
	TWO-STAGE Full Free Lift	72 80	0.282 0.315	0.473 0.530	0.523	0.366
	THREE-STAGE Full Free Lift	72 80	0.282 0.315	0.473 0.525	0.533	0.396

* Standard 19 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.

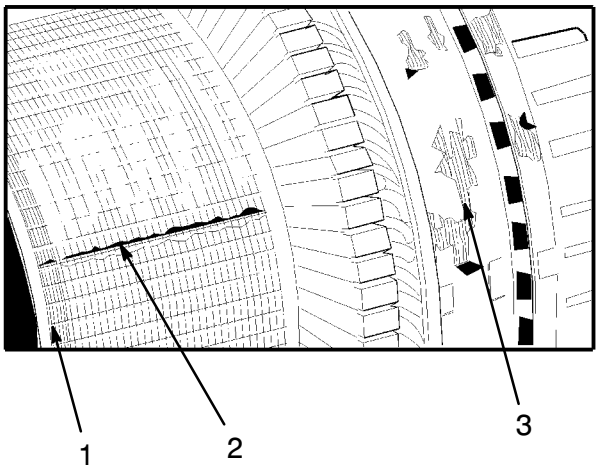
J40-65XM, J40-65XM$_2$, MAST SPEEDS (36 or 48 Volt) (3/99) Americas

190 mm (7.5 in) MOTOR & LARGE LIFT PUMP*										
MODEL	MAST	V	LIFTING				LOWERING			
			RATED LOAD		NO LOAD		RATED LOAD		NO LOAD	
			m/sec	ft/min	m/sec	ft/min	m/sec	ft/min	m/sec	ft/min
J40XM J40XM$_2$	TWO-STAGE Limited Free Lift	36 48	0.188 0.253	61 82	0.513 0.625	101 123	0.339	110	0.308	100
	TWO-STAGE Full Free Lift	36 48	0.191 0.253	62 82	0.472 0.625	93 123	0.308	100	0.277	90
	THREE-STAGE Full Free Lift	36 48	0.188 0.246	61 80	0.462 0.610	91 120	0.320	104	0.283	92
J50XM J50XM$_2$	TWO-STAGE Limited Free Lift	36 48	0.172 0.228	56 74	0.513 0.625	101 123	0.348	113	0.308	100
	TWO-STAGE Full Free Lift	36 48	0.179 0.237	58 77	0.472 0.625	93 123	0.326	106	0.277	90
	THREE-STAGE Full Free Lift	36 48	0.176 0.231	57 75	0.462 0.610	91 120	0.333	108	0.283	92
J60XM J60XM$_2$	TWO-STAGE Limited Free Lift	36 48	0.151 0.188	49 61	0.513 0.625	93 116	0.345	112	0.277	90
	TWO-STAGE Full Free Lift	36 48	0.151 0.200	49 65	0.472 0.625	82 109	0.326	106	0.222	72
	THREE-STAGE Full Free Lift	36 48	0.151 0.200	49 65	0.462 0.610	81 105	0.329	107	0.240	78
J65XM J65XM$_2$	TWO-STAGE Limited Free Lift	36 48	0.157 0.194	51 63	0.513 0.625	93 116	0.339	110	0.277	90
	TWO-STAGE Full Free Lift	36 48	0.148 0.194	48 63	0.472 0.625	82 109	0.317	103	0.222	72
	THREE-STAGE Full Free Lift	36 48	0.148 0.194	48 63	0.462 0.610	81 105	0.323	105	0.240	78

*Standard 19 cubic cm displacement pump,190 mm standard pump motor and 610 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. N/A = Not Available

TORQUE SPECIFICATIONS

ITEM	SPECIFICATION
FRAME	
Overhead Guard	
Front leg M12 X 1.75 X 50 capscrews (3)	Standard Torque Value
Rear leg M12 X 1.75 X 50 capscrews (2)	Standard Torque Value
Counterweight Capscrews	
Upper capscrews (2)	
E2.00-3.20XM (E45-65XM, E45-65XM$_2$)	380 N.m (289 lb$_f$ ft)
J2.00-3.20XM (J40-65XM, J45-65XM$_2$)	320 N.m (236lb$_f$ ft)
Lower (tow pin) M12 X 1.75 X 90 capscrews (2)	66 N.m (49 lb$_f$ ft)
Cover $^3/_8$ UNC X $1^1/_4$ capscrews (2)	52 N.m (38 lb$_f$ ft)
DRIVE AXLE, SPEED REDUCER AND DIFFERENTIAL E2.00-3.20XM (E45-65XM, E45-65XM$_2$ And N30XMH, N30XMH$_2$)	
Wheel Nuts	237-305 N.m (175-225 lbf ft)
Wheel Locknut	205 N.m (151 lb$_f$ ft) Initial 34 N.m (25 lb$_f$ ft) Final
Axle Housing (differential) to Spindle Housing (axle)	
M12 X 1.75 X 35 capscrews (16 each side)	90 N.m (66 lb$_f$ ft)
Axle Flange M12 X 1.75 X 35 Capscrews (16 ea. axle)	90 N.m (66 lb$_f$ ft)
Axle Hangers to Frame	
Torque wrench on Head of Bolt	780 N.m (575 lb$_f$ ft)
Torque wrench on Nut of Bolt	715 N.m (527 lb$_f$ ft)
Back Plate to Axle Mount Capscrews (8)	255 N.m (188 lb$_f$ ft)
Wheel Cylinder M8 X 1.25 capscrews	13-20 N.m (10-15 lb$_f$ ft)
Ring Gear to Differential Case	
7/16 UNF X 1 bolts (12)	111 N.m (82 lb$_f$ ft)
Differential Case Halves	
3/8 UNF x 3-1/2 capscrews (8)	50 N.m (37 lb$_f$ ft)
Bearing Cap Capscrews for Differential Bearings (4)	95-110 N.m (70-80 lb$_f$ ft)
Lock Plate Capscrews for the Adjusting Nuts (2)	19 N.m (14 lb$_f$ ft)
Locknut for Thrust Screw	68-95 N.m (50-70 lb$_f$ ft)
Pinion Nut (use shims to set rotating torque with nut tight)	340 N.m (251 lb$_f$ ft)
Speed Reducer Housing to Axle (differential) Housing	
E2.00-3.20XM (E45-65XM, E45-65XM$_2$) And (N30XMH, N30XMH$_2$) only	
M10 x 1.5 x 30 bolts (6)	38 N.m (28 lb$_f$ ft)
M10 x 1.5 x 40 bolts (2)	38 N.m (28 lb$_f$ ft)
Traction Motor to Speed Reducer	
M10 x 1.5 x 35 bolts (2)	38 N.m (28 lb$_f$ ft)
M10 x 1.5 x 70 bolts (6)	38 N.m (28 lb$_f$ ft)



1. Flashover causes burning of the ends of the commutator bar.

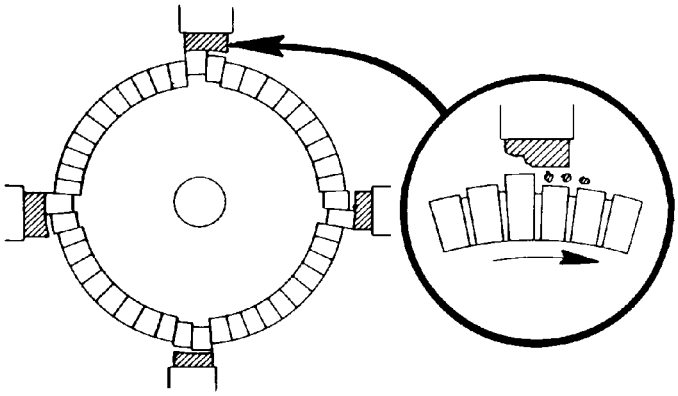
2. Open circuit in winding causes deep burning of adjacent commutator bars.

3. Overheating causes damage to varnish insulation.

Possible Causes:

- Motor has been too hot. Wrong lift truck for the application.
- Motor has been stalled.
- Open armature winding.
- Open field coil.

FIGURE 11. COMMUTATOR PROBLEMS



Check for loose or high commutator bars.

Possible Causes:

- Motor has been stalled.
- Motor has been too hot.

High commutator bars at each brush position can occur if the motor is stalled.

Rapid brush wear from high commutator bars

Brush and commutator damage occurs when the high commutator hits and forces the brush up. Arcing and burns occur as the brush moves back down to the normal surface.

FIGURE 12. COMMUTATOR PROBLEMS

BRUSH REPLACEMENT

1. Motor brushes must be replaced before they are worn enough to damage the surface of the commutator. See the Brush Replacement Guide. Move the brush spring and remove a brush from its brush holder. See FIGURE 13. and FIGURE 14. Install new brushes as a set if the length of any brush is worn to a minimum length. If the brush lead is fastened to the brush with a rivet, install a new set of brushes if one of the brushes is worn to within 3.0 mm (0.060 in) of the rivet. If a brush does not move easily in its holder, a new set of brushes must be installed.

The lead wire for some brushes is installed directly into the carbon compound of the brush. New brushes must be installed before the lead wire cuts a groove in the commutator. Install a new brush set when a brush is worn to a short length.

Brushes are made to different specifications for motors used in different applications. Use only new brushes approved by Hyster Company for that motor.

NOTE: For some model of lift trucks, the battery does not need to be removed to access the electric motors. Other models will require the removal of the battery before gaining access to the electric motors.

ASSEMBLY OF MOTORS

Traction Motor And Hydraulic Pump Motor (See FIGURE 16. through FIGURE 21.)

1. Make sure all of the components are clean. If the bearings were worn, install new bearings in the end frames.

2. If the cooling fan was removed, install it on the armature. Make sure the field coils and pole pieces are installed correctly in the field frame.

3. Install the brush holder assembly in the commutator end frame. Make sure the alignment marks are aligned.

4. Install the drive end frame on the armature.

5. Carefully install the armature and drive end frame in the field frame. Make sure the index marks are aligned. Install and tighten the screws.

6. Carefully install the commutator end frame on the armature and fasten it to the field frame. Install and tighten the hex head screws.

7. Install the brushes and spring assemblies. See the BRUSH REPLACEMENT section in this service manual for information on how to install the brushes and brush springs.

8. On hydraulic motor assemblies, install the key and the coupler hub to the index mark on the armature shaft. Tighten the set screw. Install the other key, align the pump with the coupler and the alignment marks. Install the two capscrews that fasten the pump to the pump motor.

Steering Pump Motor

NOTE: Some electrical trucks use a steering pump motor. Refer to the service manual for your truck model for instructions on the removal and installation of steering pump motors.

1. Replace the seal in the drive end frame. Replace the bearings on the armature by pushing only on the inner races.

2. Install the armature into the field frame so that the commutator is aligned with the brush inspection openings in the field frame.

3. Lubricate the seal lip with hydraulic oil. Align the index marks and carefully install the drive end frame on the armature and field frame assembly.

4. Align the index marks and install the brush holder assembly in the commutator end frame. Install and tighten the two screws.

5. Make sure that the special spring is in position in the commutator end frame. Align the index marks and install the commutator end frame. Carefully install the four long screws through the field frame into the drive end frame. Tighten the screws.

6. Install the brush springs and brushes. Make sure that the angle of the brush is in the correct position on the commutator. Put the end of the brush spring on each brush. Connect the brush wires and the wires for the terminals to the correct brush holder. Install the brush covers.

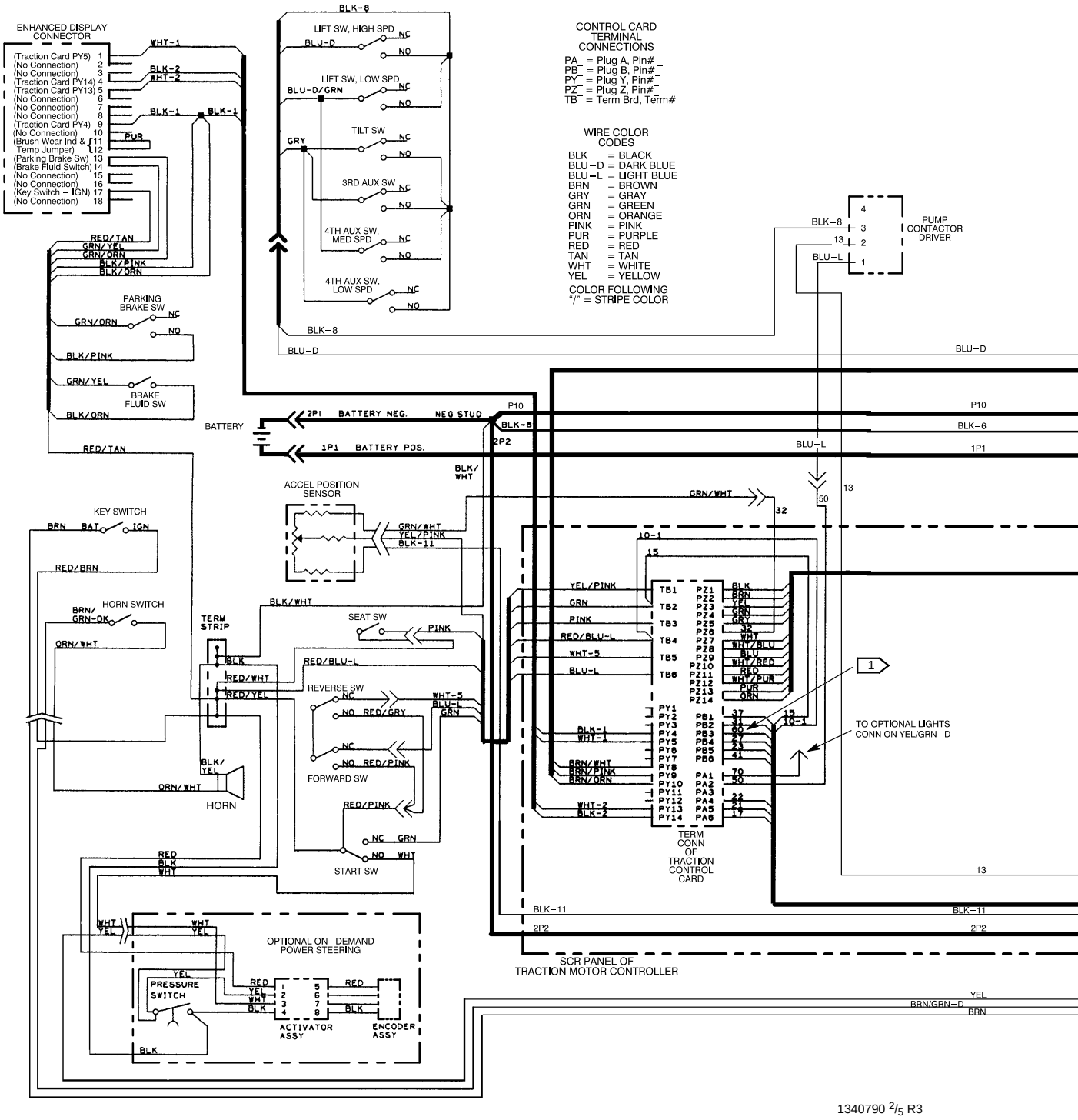
7. Install a new O-ring on the mounting surface of the pump and align the index marks. Align the pump drive tang with the armature and install the pump on the motor. Install and tighten the capscrews.

BRUSH ALIGNMENT, TRACTION AND HYDRAULIC MOTORS

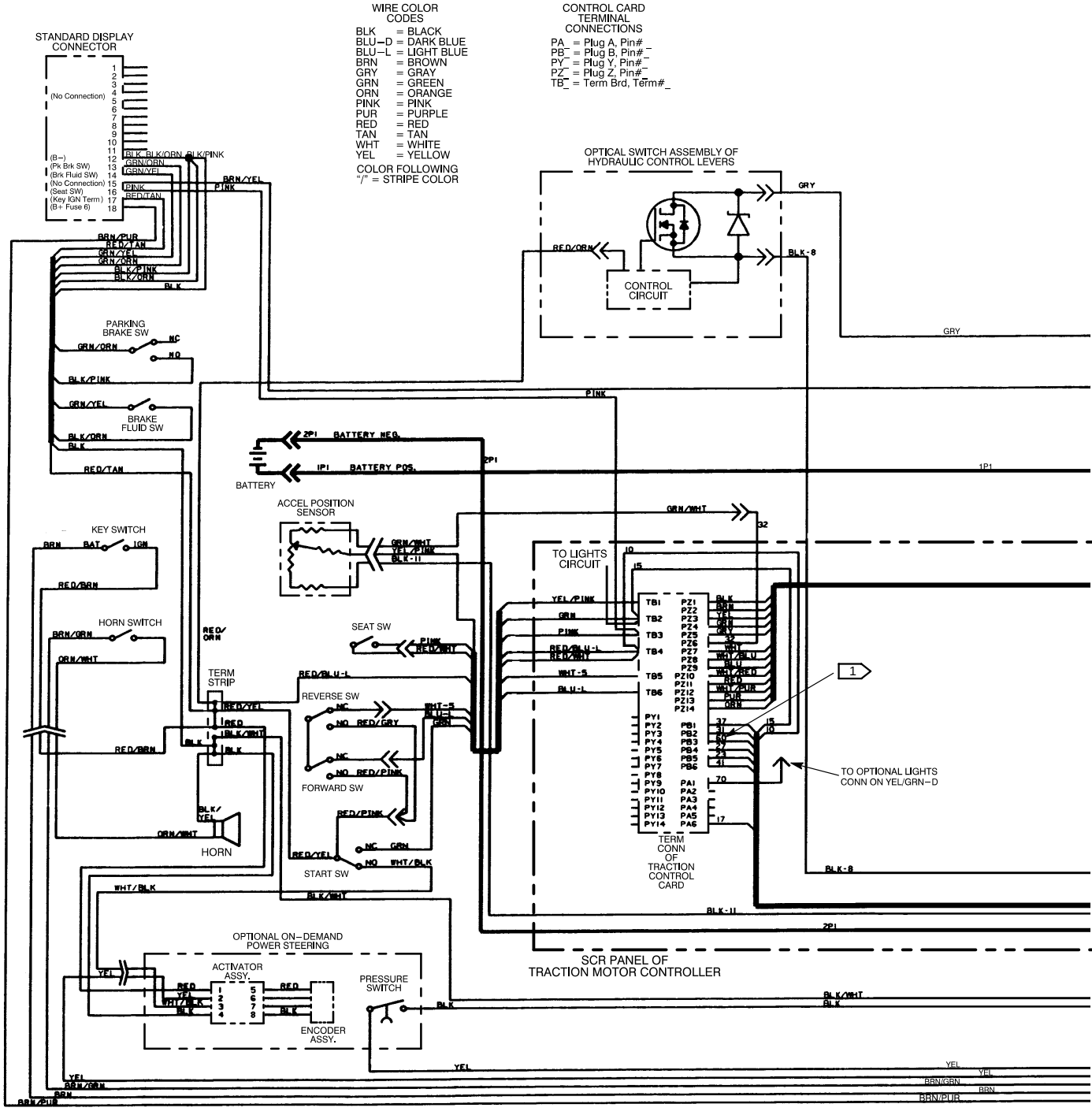
NOTE: The brush holder in these motors can be rotated for timing of the brush alignment with the commutator. This process normally requires special equipment and training. A special repair service for electric motors is required to align the bushes for the correct timing with the commutator. If the brushes are not timed correctly with the commutator, the motor will have a low power output. The procedures for timing an electric motor are not described in this section. Do not rotate the brush holder from its original position.

See FIGURE 14. If the brush holder (1) must be loosened or removed from the end frame for repairs, the brush holder must be installed again in the same position. Make alignment marks between the brush holder and the end frame before the brush mounting plate (4) is released. The brush holder must be installed again in the same position.

If a new brush holder must be installed, there will not be an alignment mark on the new brush holder. Make an alignment mark on the end frame with a reference point on the brush holder that must be removed. Install the new brush holder so that the reference point and the alignment mark are aligned. The new



ALL DEVICES ARE SHOWN IN THE NORMAL POSITION WHEN THE UNIT IS STOPPED WITH NO OPERATOR.



ALL DEVICES ARE SHOWN IN THE NORMAL POSITION WHEN THE UNIT IS STOPPED WITH NO OPERATOR.

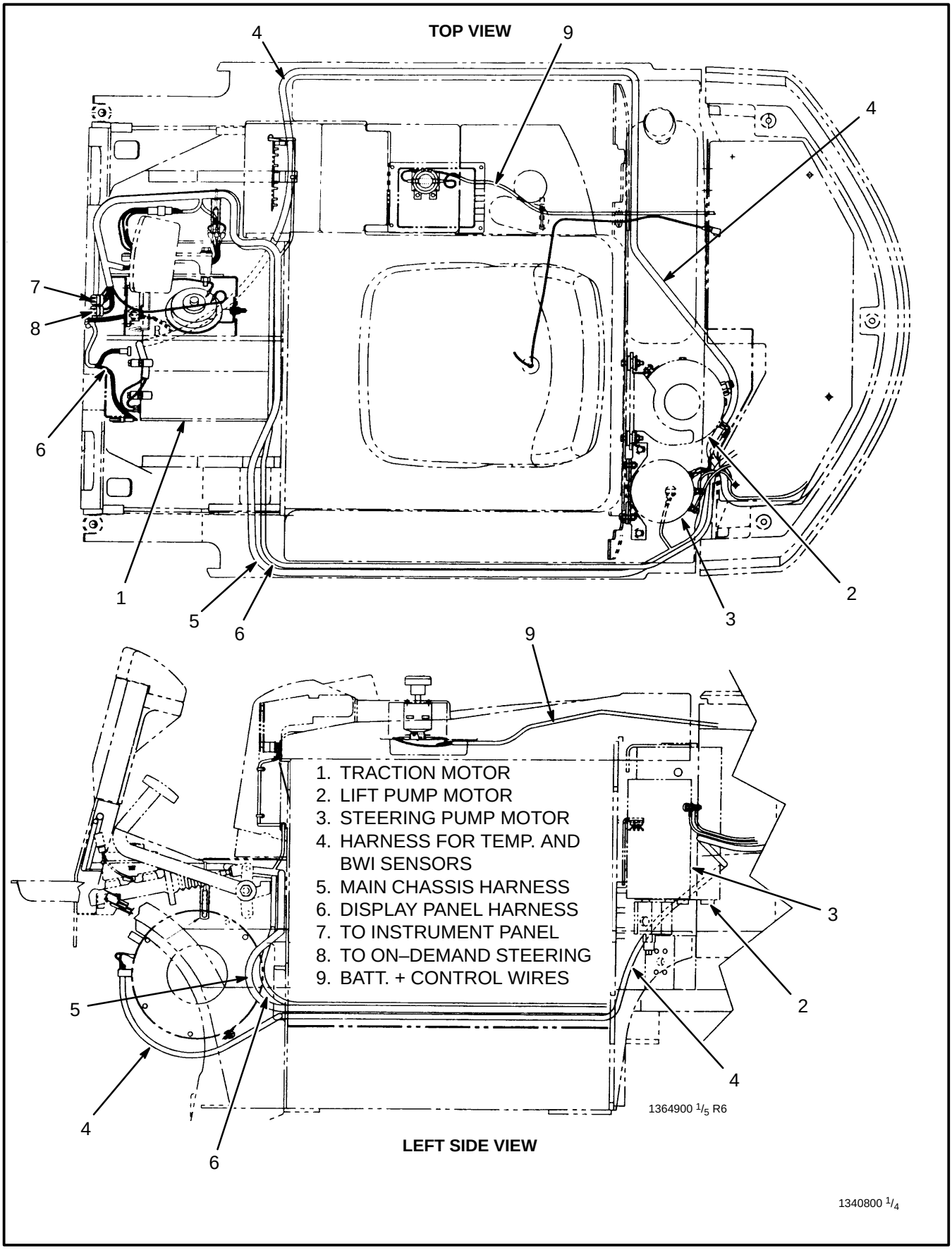
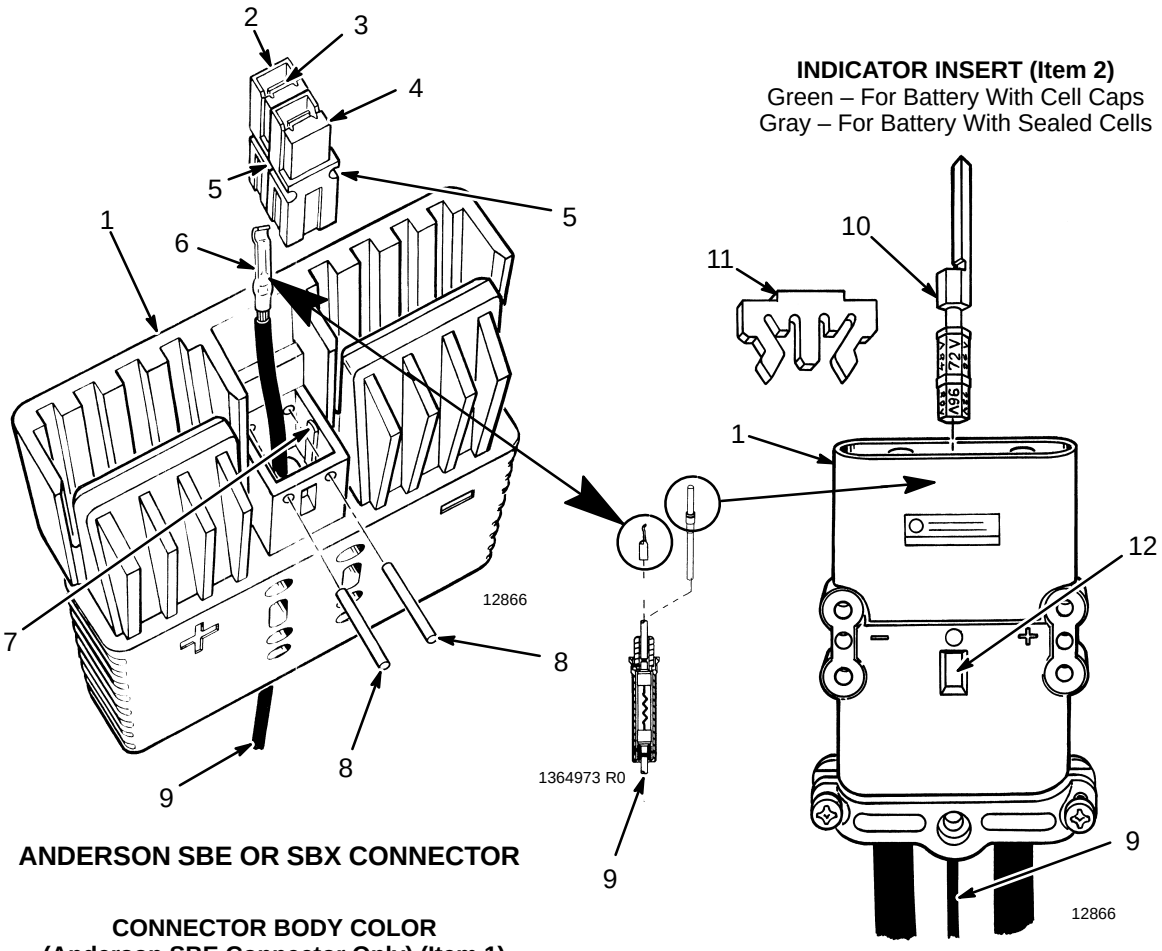


FIGURE 20. TRUCK WIRING HARNESSES AND CABLES, J2.00–3.20XM (J40–65XM)



CONNECTOR BODY COLOR
(Anderson SBE Connector Only) (Item 1)
Gray – 36 Volt Battery
Blue – 48Volt Battery
Green – 72 Volt Battery
Black – 80 Volt Battery

1. HALF OF CONNECTOR SET
2. RED HOUSING FOR +12 VOLT “BATTERY TAP”
3. LOCK SPRING (TIP OF CONTACT MUST LOCK OVER TOP OF LOCK SPRING)
4. BLACK CONNECTOR HOUSING (ASSEMBLED ON RED HOUSING WITH SLOTS FOR LOCK PINS ALIGNED AS SHOWN – NO WIRE OR CONTACT IN HOUSING)
5. SLOT FOR LOCK PIN
6. CONTACT FOR CONNECTOR OF +12 VOLT BATTERY TAP
7. KEY [RED (Item 2) AND BLACK (Item 4) CONNECTORS ALIGN ON KEY]
8. LOCK PINS FOR +12 VOLT CONNECTOR (MUST INSTALL FROM FRONT OF CONNECTOR THROUGH RED & BLACK CONNECTORS)
9. +12 VOLT WIRE TO TRUCK (TRUCK HALF) OR TO BATTERY (BATTERY HALF)
10. INDICATOR INSERT FOR BATTERY VOLTAGE AND BATTERY TYPE [ROTATE FOR CORRECT VOLTAGE IN WINDOW (Item 12). COLOR SHOWS BATTERY TYPE}
11. LOCK FOR ALL CABLE TERMINALS AND INDICATOR
12. WINDOW SHOWING BATTERY VOLTAGE
13. IN–LINE FUSE ASSEMBLY AND CONTACT FOR +12 VOLT CONNECTOR (TRUCK HALF OF BATTERY CONNECTOR ONLY) (SBE/SBX CONTACT SHOWN)

FIGURE 30. DETAIL OF BATTERY CONNECTORS WITH +12 VOLT TAP

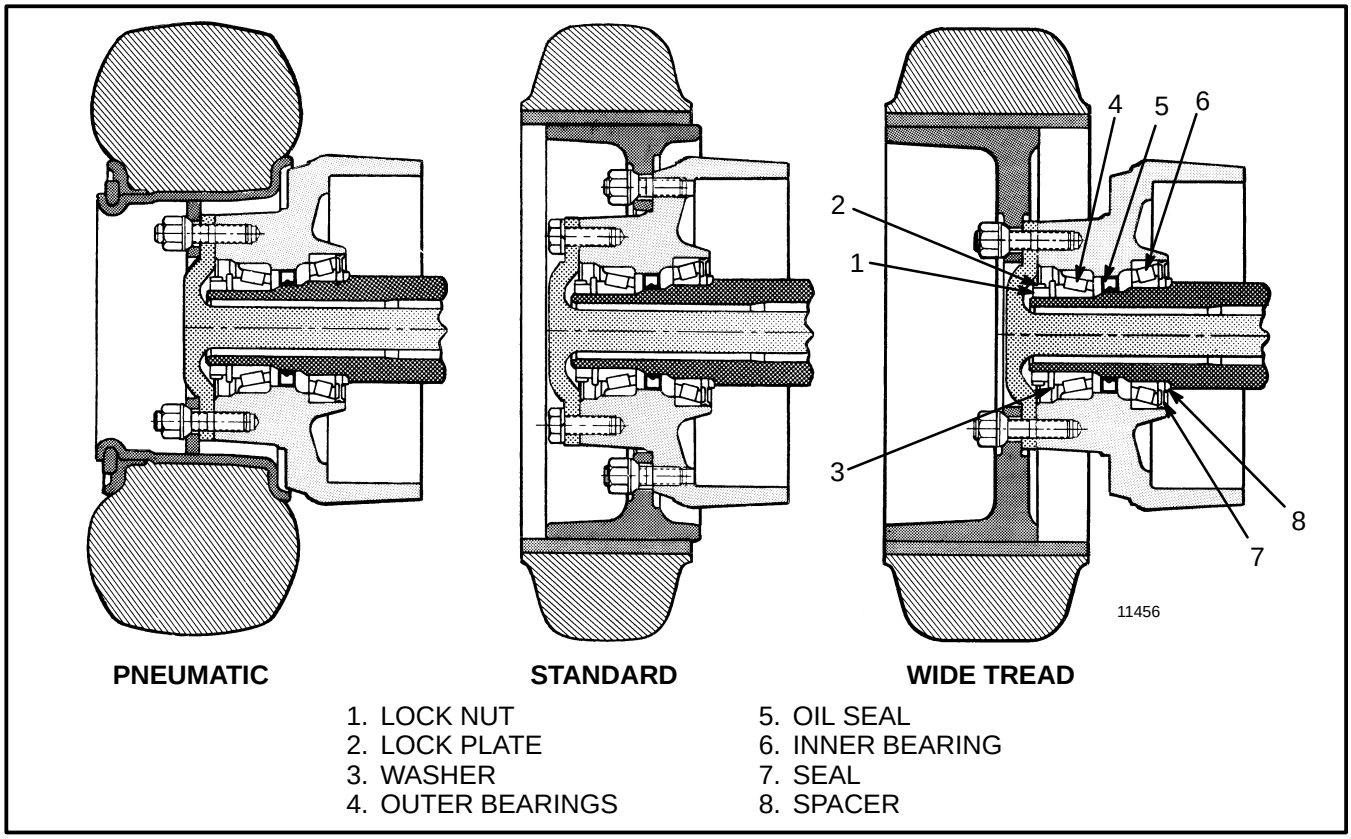


FIGURE 3. DRIVE WHEEL MOUNTING (E/J1.25–1.75XL [E25–35XL])

REPAIRS

REMOVAL OF THE DRIVE AXLE

1. Remove the battery as described in the PERIODIC MAINTENANCE section.

2. Remove the mast assembly as described in the section for THE MASTS. Drain the oil from the differential. Remove the floor plates.

NOTE: The drive axle can be removed with the traction motor as one unit. Many service persons remove the traction motor before the drive axle is removed to reduce the weight of the unit. See THE FRAME section for procedures to remove the traction motor. The procedure in this section will describe removal of the drive axle after the traction motor has been removed.

3. Disconnect the brake lines to the wheel cylinders. Put caps on the open fittings.

4. E/J1.25–1.75XL (E35–35XL). Disconnect the hand lever assembly for the parking brake from the cowl. Loosen the retainer that holds the hydraulic lines and cables near the floor plate. Carefully slide the hand lever assembly and cables past the hydraulic lines and electric wires so that the hand lever assembly and cables can be removed with the drive axle.

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

E2.00–3.20XM (E45–65XM) and N30XMH. Disconnect the return spring from the park brake pedal. Remove the park brake pedal. Disconnect the park brake assembly from the frame. Do not remove the mounting bolts from the park brake assembly. Remove the nuts and washers so that the bolts will keep the park brake assembly in one unit. After the park brake assembly has been removed from the frame bracket, put the nuts and washers on the bolts.

20. Make sure that the special lock nut on the pinion has been tightened to 340 N.m (250 lb_f ft). Use a punch with an 8 mm round tip to lock the special nut on the end of the pinion shaft. Make sure that the metal from the special nut contacts the bottom of the slot in the pinion shaft.

21. Apply liquid sealant to the hub cap and install it in the transmission case at the end of the pinion nut. Apply liquid sealant to the access plate and install it on the transmission case over the speed reducer.

Assembly Of The Drive Axle

1. If the axle spindles were removed from the differential housing, do this step. Install new O–rings on the axle spindles. Install the axle spindle into the differential housing. Install the eight M12 x 1.75 x 35 capscrews and lock washers that fasten each axle spindle to the differential housing.

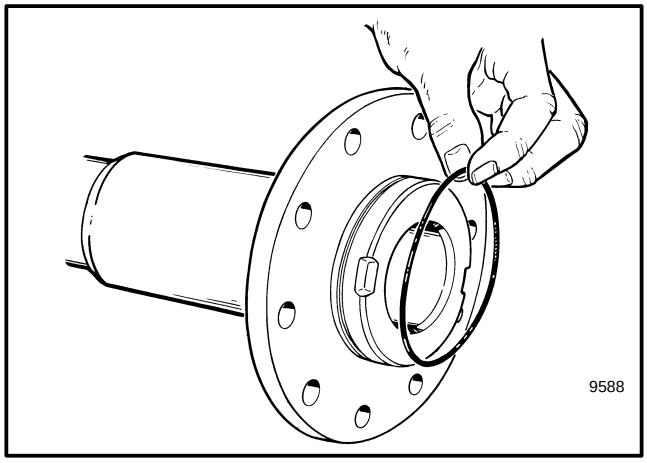


FIGURE 19. INSTALL NEW O–RINGS

E/J1.25–1.75XL (E25–35XL): Tighten the capscrews to 66 N.m (48 lb_f ft).

E/J2.00–3.00XL (E/J40–60XL): Tighten the capscrews to 98 N.m (72 lb_f ft).

E2.00–3.20XM (E45–65XM) and N30XMH: Tighten the capscrews to 90 N.m (66 lb_f ft)

2. Apply liquid sealant to the areas where the two housings are joined. Install the differential assembly and transmission into the differential housing. The two M10 x 1.5 x 40 bolts go into the top holes that fasten the housings together. Install the other six M10 x 1.5 x 30 bolts to fasten the two housings together. Tighten the bolts to 38 N.m (28 lb_f ft).

3. Assemble the brake assembly to the mount for the axle housing as described in the section for THE BRAKES.

4. Lubricate the axle spindles with Never Seez and slide the mount brackets with the brake assembly on the axle spindles.

NOTE: The outer wheel bearing is lubricated by gear oil from the differential housing. The inner wheel bearing is lubricated by wheel bearing grease. Do not use too much grease to lubricate the inner wheel bearing so that grease is pushed past the seal into the area for the brakes.

5. Install a new oil seal in each hub. Install the oil seal with the lip toward the outer bearing. Install the inner bearing and seal as shown in Figures 1 and 2. Put wheel bearing grease on the inner bearing.

6. Install hub assembly on the axle housing. Be careful that the seals are not damaged during installation.

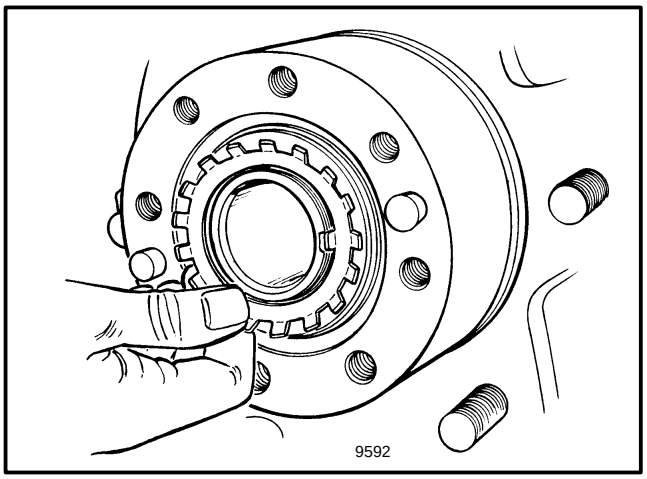


FIGURE 20. INSTALL THE LOCK PLATE

7. Install the outer bearing cone on the axle housing. Install the washer and lock plate. Install the nut. Using the locknut wrench (HYSTER PART NUMBER 1304091), tighten the nut to 205 N.m (150 lb_f ft) while rotating the hub. Loosen the nut until the hub turns freely. The torque must be less than 27 N.m (20 lb_f ft). Tighten the nut to 34 N.m (25 lb_f ft) or until the first alignment position after 34 N.m (25 lb_f ft). Bend the lock plate over the nut.

8. Put liquid sealant on the flange of the axle shaft. Install the axle shafts.

E1.25–1.75XL (E25–35XL). Install the four M8 x 1.25 x 16 capscrews and tighten them to 20 N.m (15 lb_f ft).

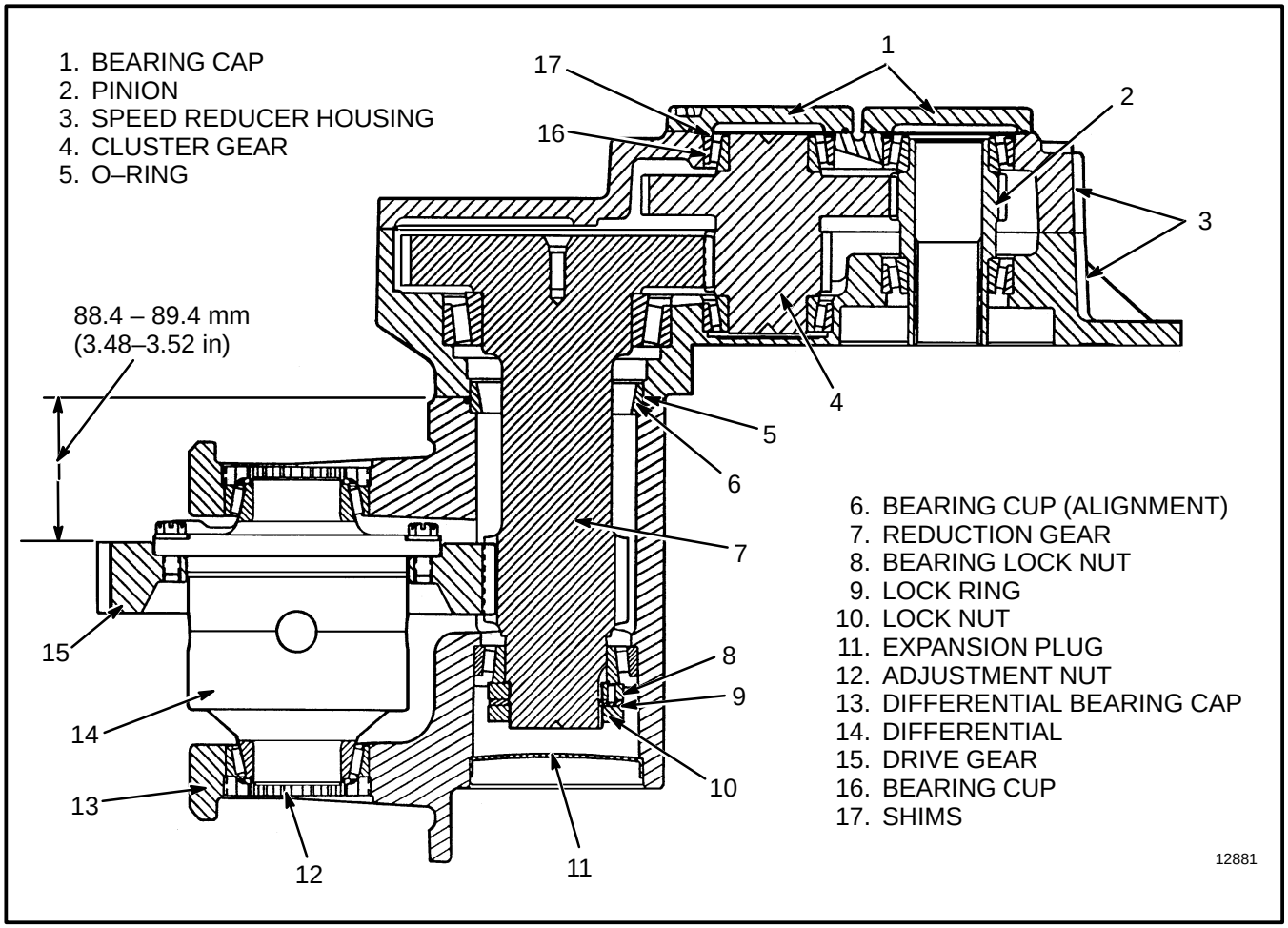


FIGURE 11. SPEED REDUCER AND DIFFERENTIAL

15. Install the bearing cap for the cluster gear with a 2.54 mm (0.100 in) shim pack and the bearing cup. Install the capscrews for the bearing cap and tighten them evenly to 1.2 N.m (10 lb_f in) while rotating the gears. Measure the clearance between the bearing cap and the housing in three places (near the capscrews). Find the average of the three measurements. Add 0.15 mm (0.006 in) to the average measurement. Subtract this dimension from 2.54 mm (0.100 in) to obtain the required shim pack. Install the shims, O–ring and bearing cap. Use a thread sealant on the capscrews and tighten the capscrews to 19 N.m (14 lb_f ft).

16. Adjust and install the bearing cap for the pinion using the procedures described in step 15.

17. Apply a bead of sealant (Loctite 515 or equivalent) to the flange of the axle housing. Install the differential housing onto the axle housing. Tighten the bolts and capscrews that fasten the two housings together to 38 N.m (28 lb_f ft).

18. If removed, install the axle spindles on the axle housing, Install new O–rings on the axle spindles. See FIGURE 12. Install the axle spindle into the axle housing. Tighten the capscrews to 90 N.m (66 lb_f ft). Lubricate the axle spindles with Never Seez® and slide the mounts on the axle spindles.

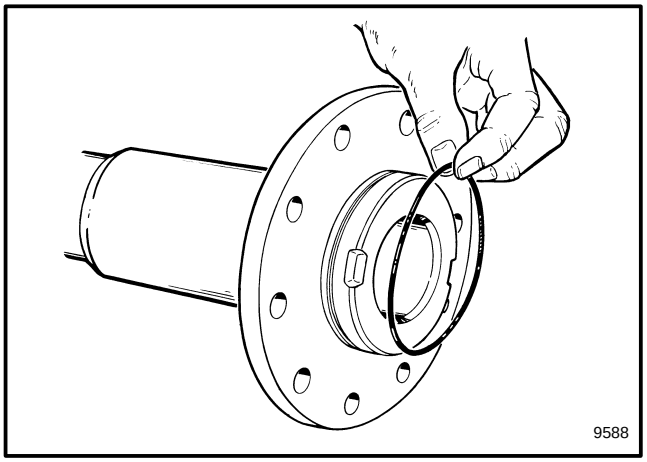


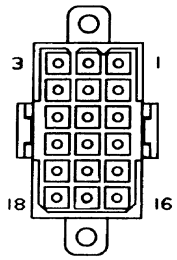
FIGURE 12. INSTALL NEW O–RINGS

Batteries that have different ampere hour ratings or are of different ages can sometimes be used in the same lift truck. It can be necessary to adjust traction Function 14 so that the weakest battery is not damaged. Follow the procedure for adjusting traction function 14 in the Checks And Adjustments.

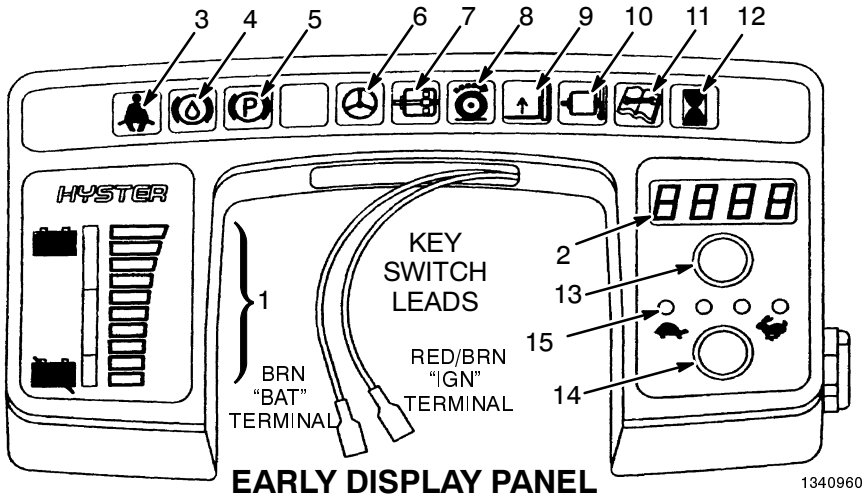
(2) **Digital Display.** This indicator is blank when the lift truck is operating correctly. The status codes and the hourmeter values are shown on this four-digit LCD display. When a fault occurs, the status code will be shown with a dash (-) in the left digit position. The warning light, Service Interval (11) will also be illuminated when a fault occurs.

ENHANCED DISPLAY 18 PIN CONNECTOR

PIN	FUNCTION
1	Traction Card PY 5
2	Pump Card PY 5
3	No Connection
4	Traction Card PY 14
5	Traction Card PY 13
6	Pump Card PY 14
7	Pump Card PY 13
8	No Connection
9	Traction Card PY 4
10	Pump Card PY 4
11	Brush Wear Indicator & Temperature Jumper*
12	*
13	Parking Brake Switch
14	Brake Fluid Switch
15	No Connection
16	No Connection
17	Key Switch (IGN)
18	No Connection



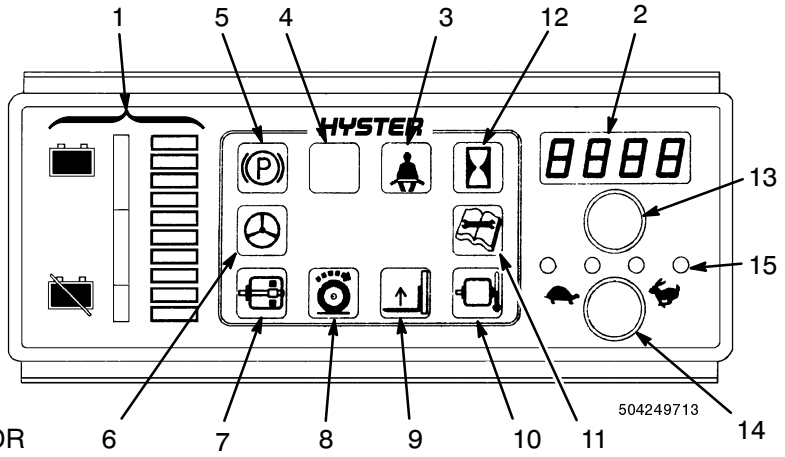
* PIN 11 TO 12 JUMPER (IN WIRE HARNESS). BWI AND TEMPERATURE LED's DISABLED IF CUT.



EARLY DISPLAY PANEL

1340960

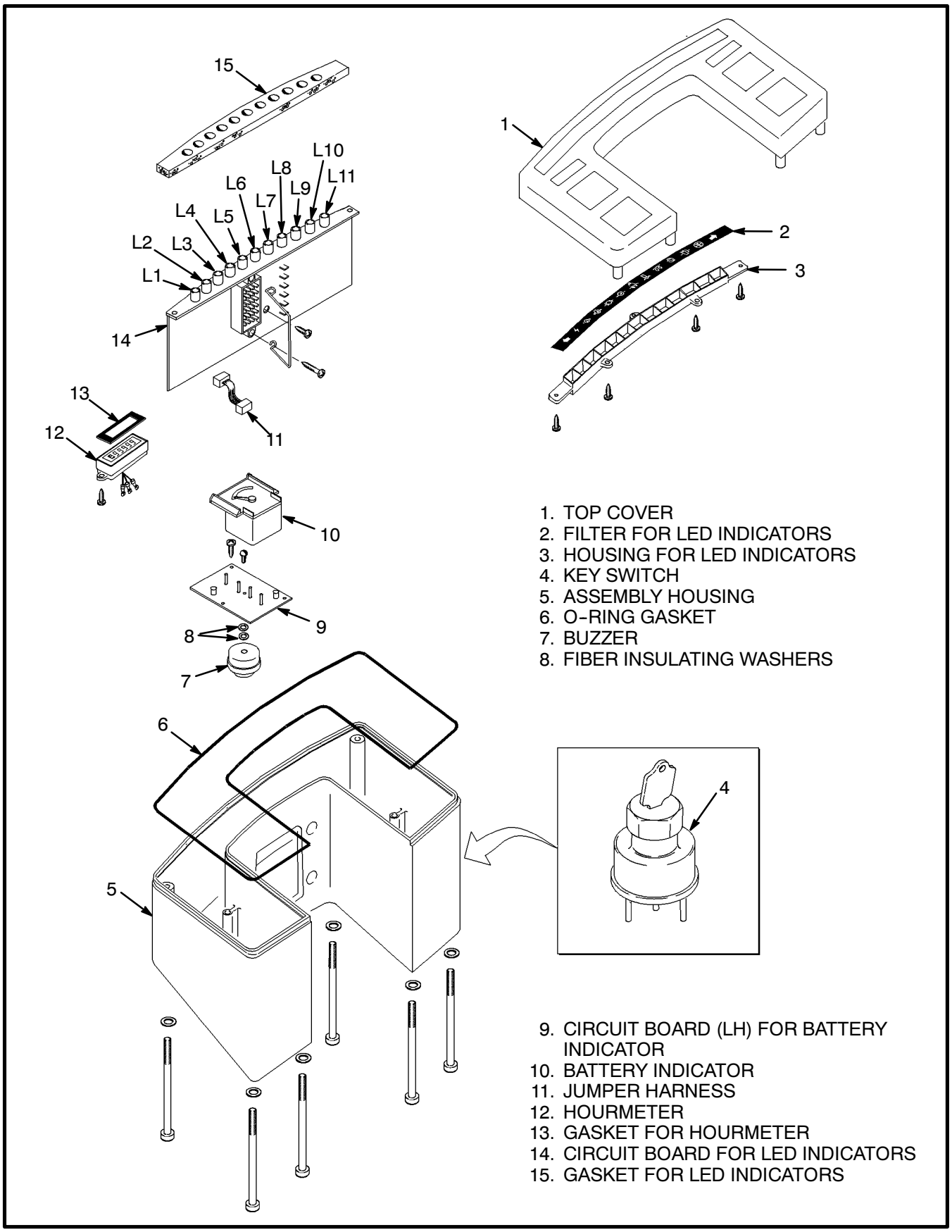
LATER DISPLAY PANEL



504249713

1. BATTERY DISCHARGE INDICATOR
2. DIGITAL DISPLAY
3. FASTEN SEAT BELT INDICATOR
4. BRAKE FLUID TOO LOW INDICATOR
5. PARKING BRAKE INDICATOR
6. STEERING PUMP MOTOR INDICATOR
7. BRUSH WEAR INDICATOR
8. TRACTION MOTOR INDICATOR
9. LIFT PUMP MOTOR INDICATOR
10. MOTOR TEMPERATURE INDICATOR
11. STATUS CODE/MAINTENANCE INDICATOR
12. HOURMETER INDICATOR
13. STATUS CODE BUTTON
14. PERFORMANCE LEVEL BUTTON
15. PERFORMANCE LEVEL LEDS

FIGURE 4. PERFORMANCE DISPLAY PANELS FOR THE EV-100/200ZX MOTOR CONTROLLERS



1. TOP COVER
2. FILTER FOR LED INDICATORS
3. HOUSING FOR LED INDICATORS
4. KEY SWITCH
5. ASSEMBLY HOUSING
6. O-RING GASKET
7. BUZZER
8. FIBER INSULATING WASHERS
9. CIRCUIT BOARD (LH) FOR BATTERY INDICATOR
10. BATTERY INDICATOR
11. JUMPER HARNESS
12. HOURMETER
13. GASKET FOR HOURMETER
14. CIRCUIT BOARD FOR LED INDICATORS
15. GASKET FOR LED INDICATORS

FIGURE 9. BASIC DISPLAY PANEL - "LX" AND "ZX"

display panel will also illuminate to show which motor has worn brushes.

The Over Temperature Sensors are thermal switches. These switches are in the traction and lift pump motors. They send a signal to the control card of the Performance display panel to illuminate the correct indicators to tell the operator that the motor is too hot. The Over Temperature warning indicator will illuminate if the circuit is operating correctly. Motor indicators on the display panel will also illuminate to show which motor is too hot. The control card of the Performance display panel sends a signal to the traction control card for a slower travel speed if either motor is too hot.

Rocker Switches For Lights (See FIGURE 21.)

These switches are ON/OFF switches that control the optional front, rear and operator compartment lights. Rocker switches for the optional lights are mounted to the instrument panel to the right of the steering column. Remove the cover under the instrument panel for access to the under side of the instrument panel or switch mounting surface. Replace a switch as described in the following paragraphs:

1. Disconnect the battery and remove the key.

2. Put tags on the switch wires, or wire harness for correct identification during installation. Remove the wires from the switch terminals.

3. Use a flat blade screw driver or other similar tool and press in on the retainer clips at each side of the switch. Remove the switch from the face of the instrument panel or switch mounting surface while holding the retainer clips in the "released" position.

4. Remove the switch and install the replacement switch in the panel. Make sure the switch is in the correct position for reading by the operator.

5. Connect the wires, or wire harness to the electrical terminals on the switch as removed during removal.

⚠ CAUTION

Make sure wire connectors do not touch other switch or meter terminal wire connectors, metal brackets or the bracket mounting nuts. Make sure there is no tension or binding on the wires or connectors.

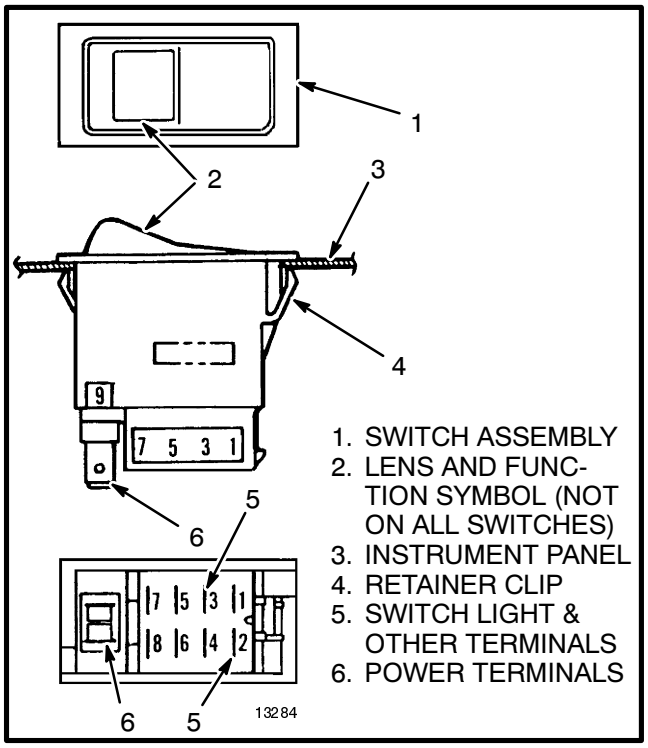


FIGURE 21. ROCKER SWITCH

6. Install the cover under the instrument panel.

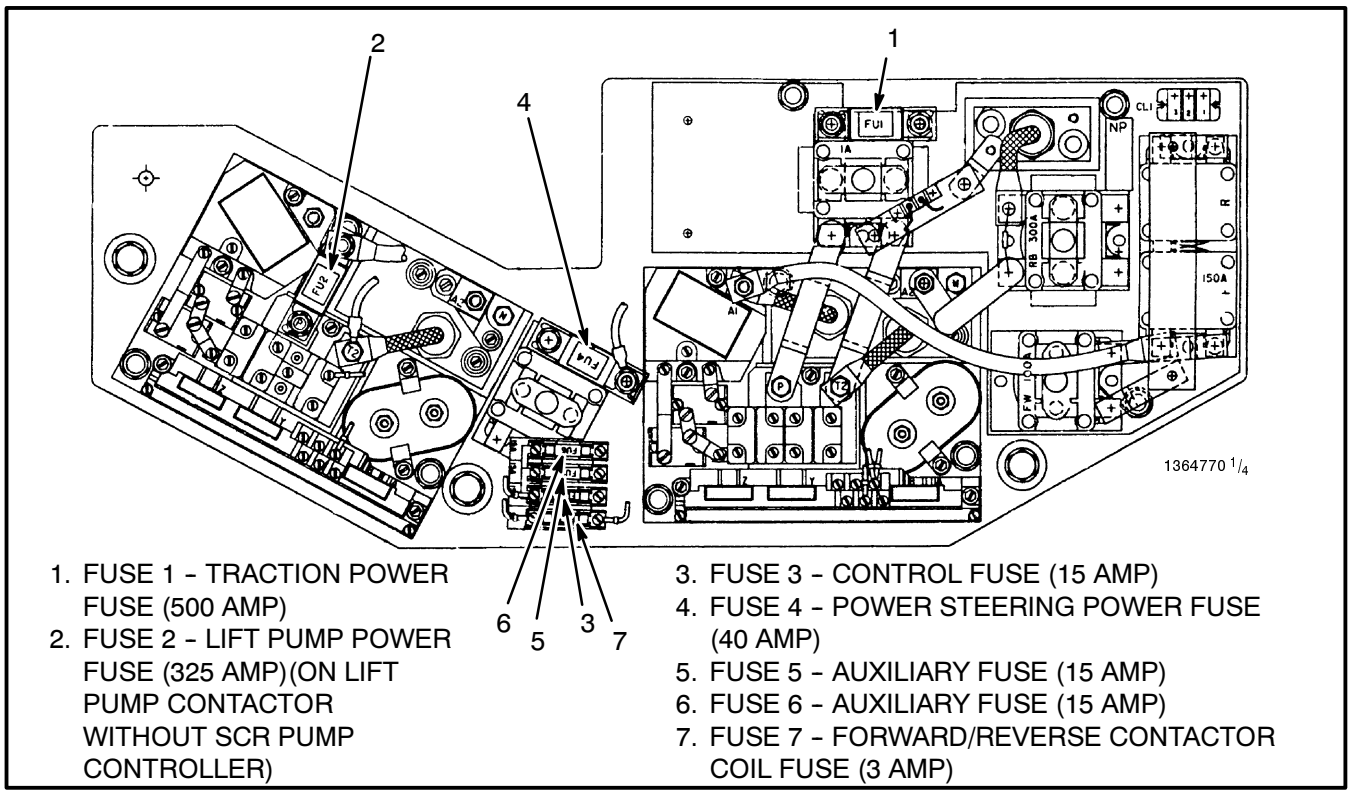
Accelerator Position Sensor (See FIGURE 22.)

The accelerator position sensor is a voltage divider that sends a signal to the control card. The accelerator position sensor has a link to the Monotrol pedal or accelerator pedal. As the Monotrol pedal or accelerator pedal position changes, the signal changes to change the speed. The accelerator position sensor and start switch must be adjusted as shown in FIGURE 22.

NOTE: If you must replace an accelerator position sensor, make sure that you use the correct part number. Many potentiometers look the same and will fit in the same position, but they will NOT work.

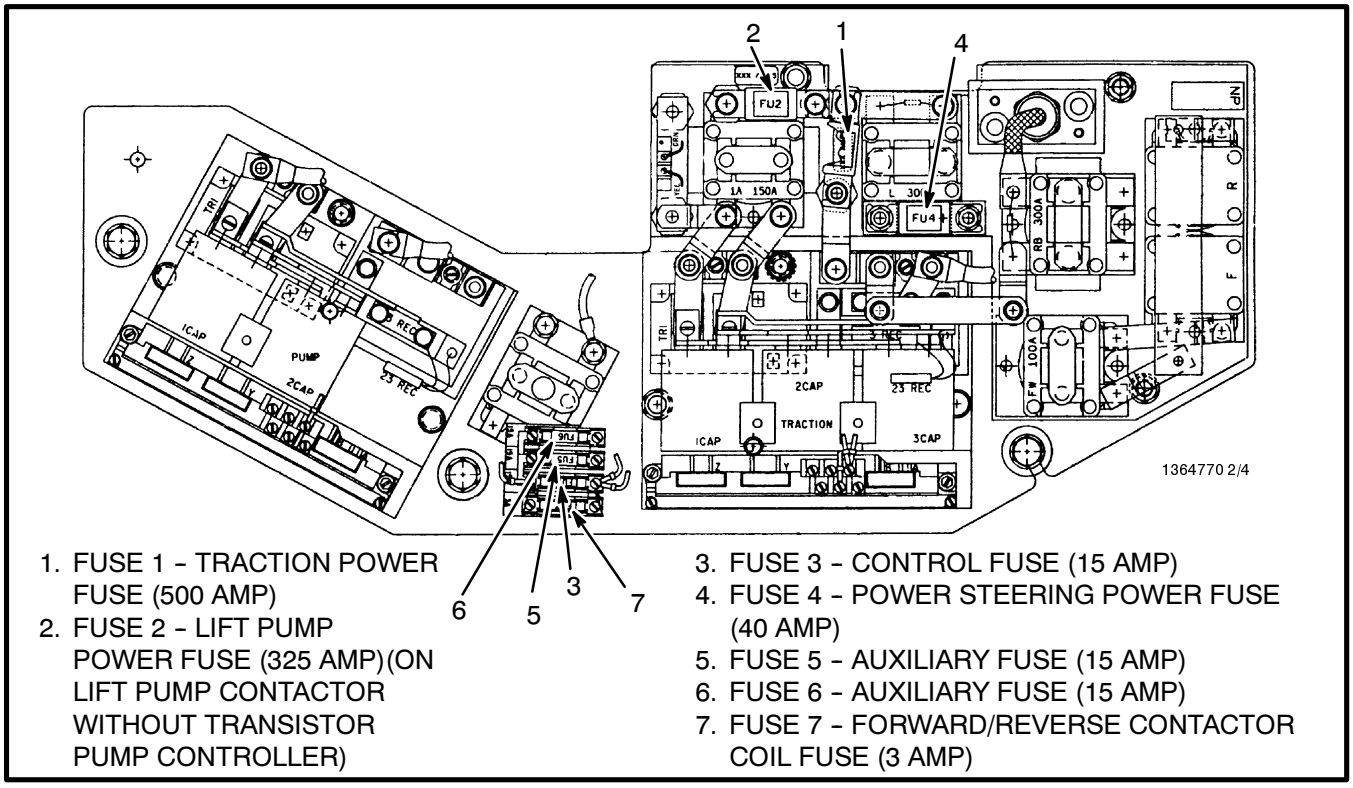
1. Disconnect the battery and remove the key.

2. Remove the floor plates. The accelerator position sensor is under the accelerator or Monotrol pedal. See FIGURE 22. Disconnect the electrical connector for the sensor.



1. FUSE 1 – TRACTION POWER FUSE (500 AMP)
2. FUSE 2 – LIFT PUMP POWER FUSE (325 AMP)(ON LIFT PUMP CONTACTOR WITHOUT SCR PUMP CONTROLLER)
3. FUSE 3 – CONTROL FUSE (15 AMP)
4. FUSE 4 – POWER STEERING POWER FUSE (40 AMP)
5. FUSE 5 – AUXILIARY FUSE (15 AMP)
6. FUSE 6 – AUXILIARY FUSE (15 AMP)
7. FUSE 7 – FORWARD/REVERSE CONTACTOR COIL FUSE (3 AMP)

FIGURE 27. FUSE LOCATIONS FOR THE EV–100ZX SCR MOTOR CONTROLLER OF THE J40–65XM



1. FUSE 1 – TRACTION POWER FUSE (500 AMP)
2. FUSE 2 – LIFT PUMP POWER FUSE (325 AMP)(ON LIFT PUMP CONTACTOR WITHOUT TRANSISTOR PUMP CONTROLLER)
3. FUSE 3 – CONTROL FUSE (15 AMP)
4. FUSE 4 – POWER STEERING POWER FUSE (40 AMP)
5. FUSE 5 – AUXILIARY FUSE (15 AMP)
6. FUSE 6 – AUXILIARY FUSE (15 AMP)
7. FUSE 7 – FORWARD/REVERSE CONTACTOR COIL FUSE (3 AMP)

FIGURE 28. FUSE LOCATIONS FOR THE EV–T100 TRANSISTOR MOTOR CONTROLLER OF THE J40–65XM

NOTES

TABLE 4. Terminal And Plug Wire Connections For Controller With SCR Control Of Traction Circuit And SCR Control Of The Hydraulic Pump Motor — Control Card – Type ZP

Plug or Terminal No.	Wire Color or Wire Number	Function
PA1	GRN/GRY	Signal wire between pump control card and brush wear indicator,steering pump.
PA2	DK–BLU/YEL	Signal wire between pump control card and brush wear indicator,steering pump.
PA3	ORN/PNK	Signal wire between pump control card and temperature switch, traction motor).
PA4	DK–BLU/PNK	Signal wire between pump control card and brush wear indicator, traction motor.
PA5	GRN/PUR	Signal wire between pump control card and brush wear indicator, traction motor.
PA6	ORN/YEL	Signal wire between pump control card and temperature sw. of hyd. pump motor.
PB1	DK–BLU/GRY	Signal wire between hydraulic pump control card and brush wear indicator, hydraulic pump motor.
PB2	GRN/PNK	Signal wire between hydraulic pump control card and brush wear indicator, hydraulic pump motor.
PB3	50	Battery Discharge Indicator enable signal input.
PB4	—	Not used.
PB5	—	Not used.
PB6	—	Not used.
TB1	—	Not used.
TB2	GRY	Input to TILT and low speed auxiliary hydraulic functions.
TB3	DK–BLU/GRN	Input to low speed LIFT hydraulic function and
TB4	10	high speed auxiliary hydraulic functions. Key switch input. Battery voltage supply from key switch.
TB5	—	Not used.
TB6	DK–BLU	Input to high speed LIFT hydraulic function.
PY1	—	Not used.
PY2	—	Not used.
PY3	—	Not used.
PY4	BLK–3	Instrument panel display number 10 input (ground).
PY5	WHT–3	Instrument panel display number 2 input.
PY6	—	Not used.
PY7	—	Not used.
PY8	—	Not used.
PY9	—	Not used.
PY10	BRN/ORN	Signal wire between hydraulic pump control card and traction control card (brush wear indicators, all motors).
PY11	BRN/PNK	Signal wire between hydraulic pump control card and traction control card (brush wear indicators, all motors).
PY12	BRN/WHT	Signal wire between hydraulic pump control card and traction control card (temperature switches, hydraulic pump motor and traction motor).
PY13	WHT–4	Instrument panel display number 7 input.
PY14	BLK–4	Instrument panel display number 6 input.
PZ1	BLK	Signal wire from SCR 1 thermal protector.
PZ2	BRN	Battery negative.
PZ3	YEL	Signal wire from current sensor.
PZ4	GRN	Signal wire from current sensor.
PZ5	GRY	Signal wire from SCR 1 thermal protector.
PZ6	–	Not used.
PZ7	WHT	Battery positive.
PZ8	BLU/WHT	Signal wire to SCR 1 gate.
PZ9	BLU	Signal wire from SCR 1 cathode.
PZ10	WHT/RED	Signal wire to SCR 2 gate.
PZ11	RED	Connection between filter for SCR 2 and control card.
PZ12	WHT/PUR	Signal wire to SCR 5 gate.
PZ13	PUR	Connection between filter for SCR 5 and control card.
PZ14	ORN	Sensor wire for voltage check across capacitor C1.

Function Number 21
MAINTENANCE SPEED LIMIT
(Push CONT and 6)

This register can be set by the service person to control the speed limit (maximum battery volts to the motor) when the Maintenance Alert (Status Code –99) is activated by the control card. The range for this register is 0 to 180.

Function Numbers 22 through 28
TEMPORARY DATA REGISTERS

These registers can be read with the Hand Set, but the data in them changes during lift truck operation. Do not change the parameters in registers for Function numbers 22 through 27. **Function number 28 is the fault indicator pointer and must be set to zero when all faults or malfunctions have been fixed or removed from the controller.**

⚠ CAUTION

Function 25 (temporary storage register for fault data) and Function 26 (temporary storage register for battery charge data) must not be changed by the user to any number above zero. Any number above zero can cause the instrument panel display to not operate correctly and the lift truck can become disabled.

Function Number 29
HOURMETER (Tens/Units)
(Push CONT and 14)

This register has the data for the accumulated operating hours of the lift truck. This register is not normally changed unless a new control card is installed. If a new control card is installed, the total hours from the old control card must be entered so that the total operating hours of the lift truck is correctly recorded.

Function Number 30
HOURMETER (Thousands/Hundreds)
(Push CONT and 15)

This register has the data for the accumulated operating hours of the lift truck. This register is not normally changed unless a new control card is installed. If a new control card is installed, the total hours from the old control card must be entered so that the total operating hours of the lift truck is correctly recorded.

Function Number 48 Through Function Number 62
SET LIFT TRUCK PERFORMANCE.

If the lift truck is equipped with a Premium instrument panel, 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 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. The four performance levels set by the manufacturer are:

a. Low performance for handling fragile loads.
b. Medium speed for less consumption of battery charge during a work shift.
c. Higher performance with higher consumption of battery charge during a work shift.
d. Maximum lift truck performance with higher consumption of battery charge.

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 rabbit). The register interlocks will not permit a higher performance level setting toward the turtle than the adjacent registers toward the rabbit.

NOTE: The Seat Switch must be CLOSED for Function Numbers 48 through 62.

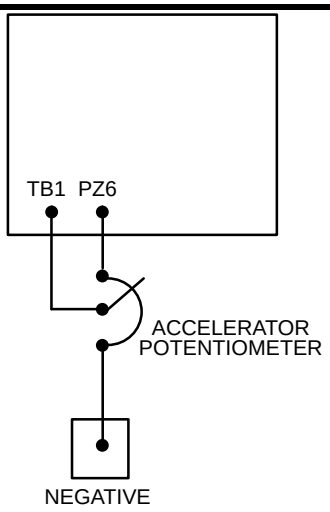
Function Number 48
CONTROLLED ACCELERATION AND 1A TIME
(Push CONT and 1 while the key switch and seat switch are closed)

This register permits the adjustment of the maximum rate of acceleration in MODE 1 (Turtle). 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 3.5 seconds (setting 40) 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

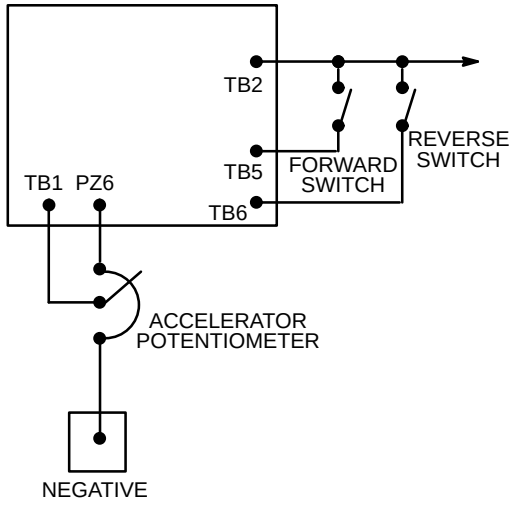
TABLE 6. REGISTER MAP FOR CONTROL CARDS ZH AND ZY (TRACTION) (Continued)

EEPROM Register Number	PC Function Number	Hand Set (HS) Function Number	Function	Access By:	Restrictions
37	38		BDI 2	PC Only	Reset to Zero only
38	39		Hours (Tens/Units) 2	PC Only	Reset to Zero only
39	40		Hours (Thousands/Hundreds) 2	PC Only	Reset to Zero only
40	41		Fault 3	PC Only	Reset to Zero only
41	42		BDI 3	PC Only	Reset to Zero only
42	43		Hours (Tens/Units) 3	PC Only	Reset to Zero only
43	44		Hours (Thousands/Hundreds) 3	PC Only	Reset to Zero only
44	45		Fault 4	PC Only	Reset to Zero only
45	46		BDI 4	PC Only	Reset to Zero only
46	47		Hours (Tens/Units) 4	PC Only	Reset to Zero only
47	48		Hours (Thousands/Hundreds) 4	PC Only	Reset to Zero only
48	49		Fault 5	PC Only	Reset to Zero only
49	50		BDI 5	PC Only	Reset to Zero only
50	51		Hours (Tens/Units) 5	PC Only	Reset to Zero only
51	52		Hours (Thousands/Hundreds) 5	PC Only	Reset to Zero only
52	53		Fault 6	PC Only	Reset to Zero only
53	54		BDI 6	PC Only	Reset to Zero only
54	55		Hours (Tens/Units) 6	PC Only	Reset to Zero only
55	56		Hours (Thousands/Hundreds) 6	PC Only	Reset to Zero only
56	57		Fault 7	PC Only	Reset to Zero only
57	58		BDI 7	PC Only	Reset to Zero only
58	59		Hours (Tens/Units) 7	PC Only	Reset to Zero only
59	60		Hours (Thousands/Hundreds) 7	PC Only	Reset to Zero only
60	61		Fault 8	PC Only	Reset to Zero only
61	62		BDI 8	PC Only	Reset to Zero only
62	63		Hours (Tens/Units) 8	PC Only	Reset to Zero only
63	64		Hours (Thousands/Hundreds) 8	PC Only	Reset to Zero only
64	65		Fault 9	PC Only	Reset to Zero only
65	66		BDI 9	PC Only	Reset to Zero only
66	67		Hours (Tens/Units) 9	PC Only	Reset to Zero only
67	68		Hours (Thousands/Hundreds) 9	PC Only	Reset to Zero only
68	69		Fault 10	PC Only	Reset to Zero only
69	70		BDI 10	PC Only	Reset to Zero only
70	71		Hours (Tens/Units) 10	PC Only	Reset to Zero only
71	72		Hours (Thousands/Hundreds) 10	PC Only	Reset to Zero only
72	73		Fault 11	PC Only	Reset to Zero only
73	74		BDI 11	PC Only	Reset to Zero only
74	75		Hours (Tens/Units) 11	PC Only	Reset to Zero only
75	76		Hours (Thousands/Hundreds) 11	PC Only	Reset to Zero only

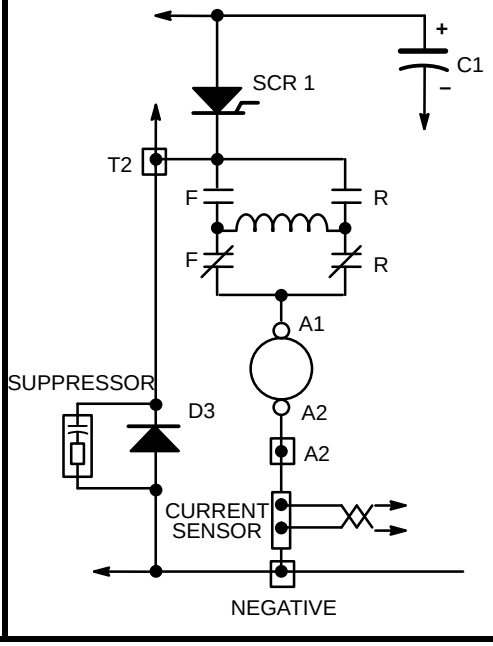
Status Code	Description	Cause Of Status Indication
–08	Accelerator input voltage is too low after the key switch is closed.	This Status Code will be indicated when the accelerator input voltage at TB1 is less than 3.0 volts and the battery connector, or the seat switch or the key switch are opened and closed.

Memory Recall	Indication of Fault	
No	Forward or Reverse contactor will not close.	
Circuit Traction	**Possible Cause** Accelerator potentiometer has a malfunction or needs adjustment. The correct output voltage at TB1 is more than 3.0 volts. Repair or adjust the accelerator potentiometer so that it will correctly change from 3.5 to less than 0.5 volts (minimum 0.30 volts) when the accelerator pedal is actuated. Short–circuit between battery negative and TB1 in the accelerator input circuit. Disconnect wire from TB1. Check for short–circuit from the end of the wire to battery negative. The correct resistance is greater than 4.7k ohms. Control card malfunction. Disconnect the wire from TB1 and measure the voltage between TB1 and battery negative. The correct voltage is greater than 4.5 volts. If the voltage is wrong, replace the control card.	

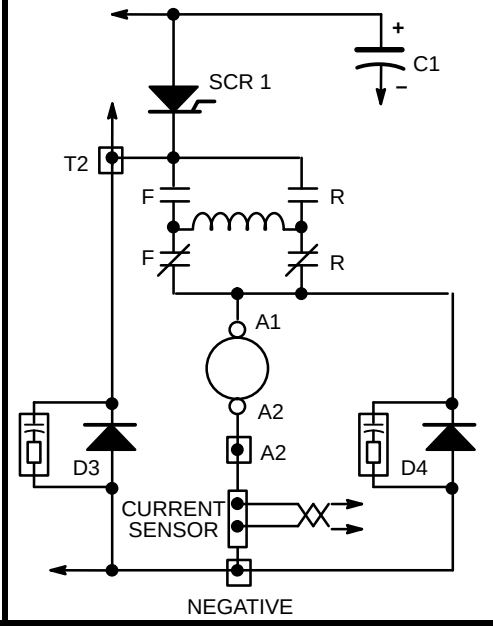
Status Code	Description	Cause Of Status Indication
–09	Both FORWARD and REVERSE direction switches are closed at the same time.	This Status Code will be indicated when TB5 and TB6 are greater than 60% of battery voltage at the same time.

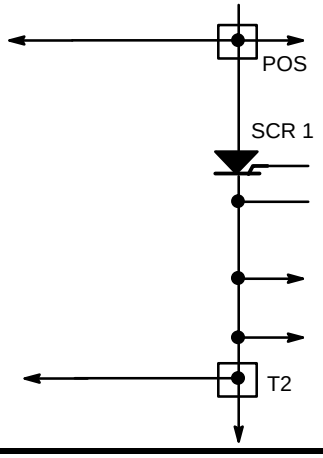
Memory Recall	Indication of Fault	
No	Forward or Reverse contactor will not close.	
Circuit Traction	**Possible Cause** FORWARD or REVERSE direction switches are welded closed or need adjustment. Replace or adjust the direction switches to make sure that they are both open when the direction control lever is in NEUTRAL.. Short–circuit between battery positive and TB5 or TB6. Disconnect the wires from TB5 and TB6 and check for a short–circuit between the end of the wire and the battery positive side of the direction switch. Control card malfunction. Disconnect the wires and measure the voltage at TB5 and TB6. The correct voltage will be less than 60% of battery voltage.	

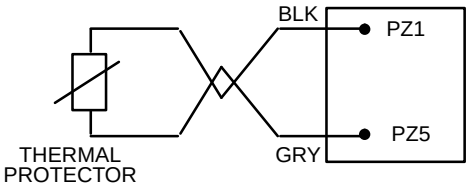
Status Code	Description	Cause Of Status Indication
–51	Voltage on C1 too high when motor current is high.	This Status Code will be indicated when the voltage on C1 is greater than 225 volts and the motor current is greater than 300 amps.

Memory Recall	Indication of Fault	
Yes **Circuit** Traction	Forward or Reverse contactors open and close, then will only close when the key switch is opened and closed. **Possible Cause** Too much inductance from cables. Check that the battery cables are too long. Check that additional cables for other equipment have been added. Motor current too high. Check for a short–circuit a field winding. Check for a short–circuit across an armature winding.	

Status Code	Description	Cause Of Status Indication
–52	Voltage on C1 too high when motor current is low.	This Status Code will be indicated when the voltage on C1 is greater than 225 volts and the motor current is less than 200 amps.

Memory Recall	Indication of Fault	
Yes **Circuit** Traction	Forward or Reverse contactors open and close, then will only close when the key switch is opened and closed. **Possible Cause** Too much inductance from cables. Check that the battery cables are too long. Check that additional cables for other equipment have been added. Malfunction of diode D4 circuit. Check for a short–circuit across D4. Check for an open circuit or loose connection in the D4 circuit. Malfunction of diode D3 circuit. Check for an open circuit or loose connection in the D3 circuit.	

Status Code	Description	Cause Of Status Indication
–125	Hydraulic pump contactor does not open or opens slowly.	This Status Code will be indicated when T2 voltage is greater than 12% of battery voltage and the electronic driver for the hydraulic pump is energized.
Memory Recall No **Circuit** Hydraulic Pump	**Indication of Fault** Contacts wear quickly on contactor 1A or the hydraulic pump contactor. **Possible Cause** **NOTE:** This status code can only be seen by using the Hand Set or a PC and looking at Function 1. This status code is added as help when trouble shooting status code 146. Coil for contactor 1A is damaged. Do the checks in code –146.	

Status Code	Description	Cause Of Status Indication
–141	Open thermal protector or motor controller is too hot.	This Status Code will be indicated when the voltage between PZ1 and PZ5 is greater 1.8 volts.
Memory Recall No **Circuit** Hydraulic Pump	**Indication of Fault** The hydraulic pump motor has reduced power on no power in the SCR range. **Possible Cause** Open circuit, thermal protector. Check for a loose or broken wire between the following points: Black wire between thermal protector and PZ1 Gray wire between thermal protector and PZ5. Malfunction of thermal protector. Disconnect the wires from PZ1 and PZ5. When the temperature is approximately 25°C (75°F), measure the resistance between the black and gray wire. The correct resistance is approximately 300 ohms. Thermal protector is operating because motor controller is too hot. Permit the motor controller to cool.	

or you will damage the SCR. Make sure the polarity of your test circuit is correct.

THE SCR ASSEMBLY

The SCR assembly cannot be disassembled. The SCR assembly includes an SCR fastened between two metal blocks used as heat sinks. The heat sinks are also the power connections for the SCR. A plastic case holds the complete assembly. There is a thin sheet of electrical insulation between the SCR 1 assembly and the base plate. The insulator permits heat to transfer from the heat sinks to the base plate.

NOTE: Silicon compound (Part No. 1198757) is used between the heat sinks and the parts of the controller. The purpose of this compound is to fill in the micrometer size spaces between the parts to give better heat flow. Always use a very thin layer of compound between the parts. Too much compound will be an insulator and cause both electrical and heat faults. It is better to use no compound instead of too much. DO NOT USE this silicon compound on the threads of the diodes.

THERMAL PROTECTOR

The SCR 1 has a thermal protector fastened to the cathode heat sink. See FIGURE 2. The thermal protector is a resistor that changes resistance when the temperature changes. When the temperature is greater than 85°C (185°F), the thermal protector changes the signal voltage to the control card. The control card decreases the percent of **ON** time to decrease the SCR 1 temperature. The normal resistance for the thermal protector is 120 to 150 ohms at 18°C (65°F) when measured between pins PZ1 and PZ5.

REPLACE THE SCR 1 ASSEMBLY

1. Make notes of the positions of the suppressors and remove the suppressors from the mount over SCR 1. Disconnect the electric connections to the SCR 1 assembly.

2. Remove the thermal protector from the heat sink. Remove the two capscrews that connect the power cables to the heat sinks (make a note of the cathode sensor wire). Remove the two mounting screws that hold the SCR 1 assembly to the base plate.

3. Check the insulator between the SCR 1 assembly and the base plate. Replace the insulator if it is damaged. The insulator is also a heat conductor. Use a very thin coat of silicon compound (Part Number 1198757 or approved equivalent) between the surfaces of the parts. Keep dirt from the surfaces.

⚠ CAUTION

The insulator is very thin. Dirt between the surfaces of SCR 1 and the base plate can damage the insulator and cause a short–circuit.

4. Install the new SCR 1 assembly. Make sure the heat sinks make full contact with the insulator and base plate. Check the resistance between both heat sinks and the base plate with an ohmmeter. A correct installation will indicate infinity on the ohmmeter.

5. Install the electrical connections to the SCR 1 assembly. Install the thermal protector on the heat sink.

6. Install the mount and the suppressors over the SCR 1 assembly. Make sure the connections are made correctly.

THE “OFF” CIRCUIT FOR SCR 1

⚠ WARNING

Make sure you disconnect the battery and separate the connector before you disassemble any part of the controller. Make sure you also discharge capacitor C1.

The “OFF” circuit for SCR 1 has the following parts:

- Reactor assembly (Inductor L1 and 1X)
- SCR 2
- SCR 5
- Suppressors for SCR 2 and SCR 5
- Capacitor C1

The inductor and a capacitor assembly generates the reverse polarity voltage to change the SCR 1 to **OFF** for each pulse. SCR 2 and SCR 5 control the operation of the “OFF” circuit. The suppressors protect the SCRs from electrical noise.

Check The Reactor Assembly

The reactor assembly is in a plastic case that fastens to the base plate. The connections for the reactor are under the mount for the suppressors and are difficult to check with an ohmmeter. A fault does not often occur in the reactor assembly. Most faults that do occur at the reactor

The SCR 1 "OFF" Circuit

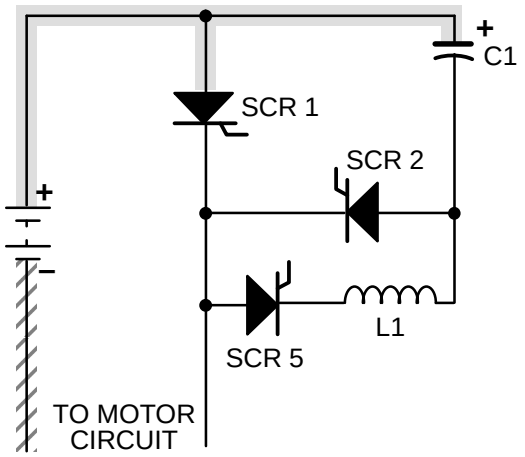
A special circuit is necessary to generate a momentary interruption in current flow to change SCR 1 to **OFF**. The parts of this circuit are the capacitor C1, inductor assembly L1, SCR 2, and SCR 5. SCR 2 discharges the capacitor C1 to the cathode of SCR 1. This discharge changes SCR 1 to **OFF**. SCR 5 and the inductor L1 are used to charge the capacitor C1 with the correct polarity.

An SCR controller uses the principle of self–induction in its operation. It is important to remember that self–induction is like a flywheel in a mechanical device. When the torque is increased or decreased in a mechanical device, the flywheel gives a resistance to any change in speed. Self–induction does the same function in an electric circuit and resists any change in current flow.

The current flow through the motor circuit creates a magnetic field around the power cables. When SCR 1 is changed to **OFF**, this magnetic field decreases rapidly and creates an induction voltage that is proportional to the current flow. At maximum current flow, this induction voltage can be greater than 300 volts when measured across the capacitor C1.

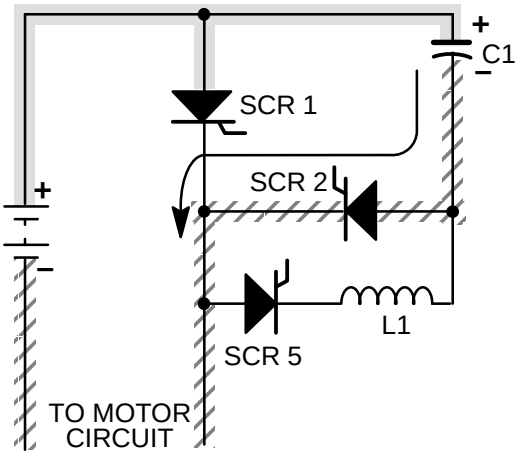
NOTE: The inductor L2 shown in step d of FIGURE 5. is not a component in the motor controller. The inductor L2 is the symbol for the inductance caused by the power cables when electric current flows through them as described in the above paragraph.

The operation of the SCR 1 "OFF" circuit is described in the following steps:



a. When the battery is first connected, the top plate of C1 is connected to battery positive. The direction contactor is closed in preparation to operate the lift truck. C1 can not charge immediately to battery voltage because there is no electrical path to the bottom plate. C1 will slowly charge to battery voltage in approximately four minutes because there is a high resistance path through the control card. The SCRs are not **ON**.

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



b. A signal is sent to SCR 2 to go **ON**, which closes the electrical path to the bottom plate of C1. This action leaves the bottom plate of C1 equal to battery negative and C1 is charged to battery voltage. When C1 is charged, SCR 2 goes **OFF** because there is no current flow.

FIGURE 5. OPERATION OF THE SCR 1 "OFF" CIRCUIT (2 OF 3)

TABLE 1. Terminal And Plug Wire Connections For TMM1 Module					
Input Terminal No.	Function	Output Terminal No.	Actuation	Output Voltage	Fault Code
TB1	Signal wire for temperature switch, traction motor.	TB7	Battery –	0.6 volts	90
TB2	Not Used.	—	—	—	—
TB3	Signal wire for temperature switch, hydraulic pump motor.	TB7	Battery –	1.6 volts	91
TB4	Not Used.	—	—	—	—
TB5	Signal wire for brush wear indicator,steering pump.	TB9	Battery –	0.6 volts	93
TB6	Signal wire for brush wear indicator,steering pump.	TB9	Battery –	0.6 volts	93
TB7	Not Used	—	—	—	—
TB8	Signal wire for brush wear indicator, traction motor.	TB9	Battery –	1.6 volts	94
TB9	Not Used	—	—	—	—
TB10	Signal wire for brush wear indicator, traction motor.	TB9	Battery –	1.6 volts	94
TB11	Signal wire for brush wear indicator, hydraulic pump motor.	TB9	Battery –	2.3 volts	95
TB12	Signal wire for brush wear indicator, hydraulic pump motor.	TB9	Battery –	2.3 volts	95
TB13	5–volt supply				
TB15	Battery negative				

DISPLAY PANELS

⚠ WARNING

Some adjustments can cause the lift truck to operate differently than normal. This different operation of the truck can result in personal injury or damage. Do NOT try to make adjustments for the instrument panel display without using the procedures in the section EV–100/200ZX MOTOR CONTROLLER Parameter Tables, 2200 SRM 595.

Display Panel

There are two display panels available on lift trucks with the EV–100ZX SCR motor controller. Some lift trucks can only have one of the two panel displays:

- a basic display that gives the operator basic information about the operation of the lift truck
- a performance display that includes diagnostic capabilities similar to the Hand Set.

Basic Display (See FIGURE 17.)

The EV–100 "ZX" Series motor controller can have two Basic display panels that includes one of two types of Battery Indicators.

EARLY DISPLAY PANEL

When the key switch is turned to the **ON** position, 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) **Hourmeter.** 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.

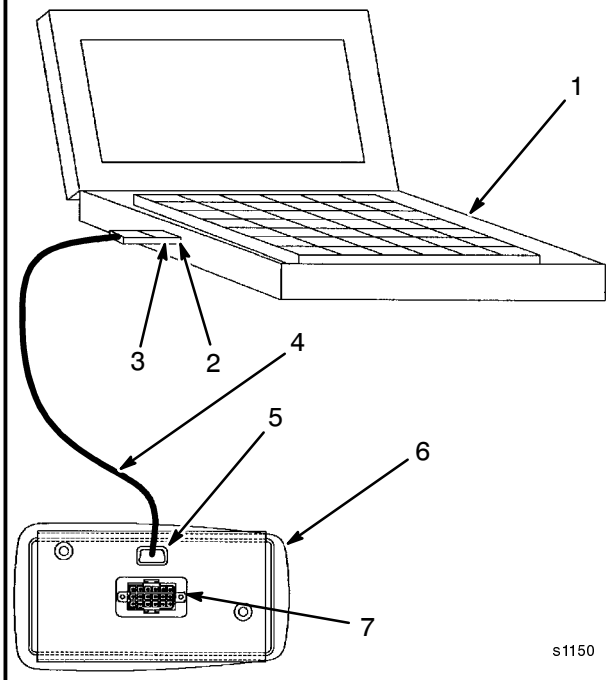
(2) **Voltmeter.** The earlier Basic Display Panel has a battery indicator without lift interrupt (voltmeter). This meter has a green, yellow and red band on the meter face to indicate the voltage of the battery. The needle starts in the green band with a fully charged battery and moves to the red band as the battery discharges. The battery must have a current draw (load) to check the battery charge. Hold the tilt lever in the tilt BACKWARD position or for the N30XMH, hold the rotate lever in the ROTATE position and look at the indicator. If the needle is in the red band, charge the battery. Operating the lift truck with the needle in the red band can decrease battery life. Continued operation with a discharged battery can damage the battery, motors or the contactors.

(3) **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.

(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** after one second. If the warning light is **ON** during operation, the brake fluid level in the reservoir is too low.

Type ZH (36 to 48V) (Continued)		Default		Permitted Range	
Fcn. No.	**Description**	**Factory Parameter**	**Factory Value**	**Min/Max Parameter**	**Value (Min/Max)**
53	FW Pick–Up Current	0	None	Fcn. No. 49	Fcn. No. 57
54	Speed Limit 1	0	None	Fcn. No. 58	Fcn. No. 50
55	Not Used				
	MODE 3				
56	Controlled Acceleration	20	1.8 sec	Fcn. No. 60	Fcn. No. 52
57	FW Pick–Up Current	36	110 amps	Fcn. No. 53	Fcn. No. 61
58	Speed Limit 1	0	None	Fcn. No. 62	Fcn. No. 54
59	Not Used				
	MODE 4				
60	Controlled Acceleration	10	0.94 sec	8	Fcn. No. 56
61	FW Pick–Up Current	83	185 amps	Fcn. No. 57	110
62	Speed Limit 1	0	None	0	Fcn. No. 107
The following registers store information used by the controller and the HYTECH software and do not have function numbers assigned.					
	Not Used				
	Secure Hourmeter (tens/units)				Read Only
	Secure Hourmeter (thousands/hundreds)				Read Only
	Secure Auxiliary Hourmeter (tens/units)				Read Only
	Secure Auxiliary Hourmeter (thousands/hundreds)				Read Only
	Reserved for use by GE				GE Use Only
	Reserved for use by GE				GE Use Only
	Reserved for use by GE				GE Use Only
	Reserved for use by GE				GE Use Only
	Lift Truck Serial Number				
	Lift Truck Serial Number				
	Lift Truck Serial Number				
	Lift Truck Serial Number				
	Lift Truck Serial Number				
	Lift Truck Serial Number				
	Lift truck number assigned by user (tens/units)				0 to 99
	Lift truck number assigned by user (thousands/hundreds)				100 to 9900

TABLE 5. EV–100ZX Parameters – E2.00–3.20XM (72 to 80V) (Low Energy Usage) (Traction Card Type ZY With 9–inch Motor, 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	30	2.6 sec	8/255	0.77 to 22 seconds
4	Current Limit (C/L)	125	max. amp	0/130	max. amperes
5	Plugging Distance (Current)	50	357 amp	0/55	200 to 373 amperes
6	1A Drop–Out Current	12	489 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	50	185 amp	0/55	75 to 196 amp
10	Regenerative Braking Start (% **ON** time)	10	3.70%	0/255	0% to 96% of battery voltage
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	12[3]	—	5/25	—
[3] Average value for most batteries. See procedure for more accurate value.					
15	Battery Volts	75	72 V	70/80	72 volt operation
15	Battery Volts	85	80 V	81/183	80 volt operation
16	Pedal Position Plugging	40	228 amp	0/85	100 to 373 amperes
17	Card Type Selection	42		42	Select control card with correct functions: Regen. Braking
18	Steering Pump Time Delay (Seat Switch)	25	14 sec	0/128	1.5 to 65 seconds
19	Maintenance Alert (hours)	99			0 to 99
20	Maintenance Alert (hours)	99			100 to 9900



1. PERSONAL COMPUTER (PC)
2. COMPUTER SERIAL PORT
3. ADAPTER (PART OF KIT HYSTER P/N 1361412)
4. CABLE ASSEMBLY (PART OF KIT HYSTER P/N 1361412)
5. SMALL (9 PIN) CONNECTOR
6. BACK OF DISPLAY PANEL
7. LARGE (18 PIN) CONNECTOR FOR MOTOR CONTROLLERS

FIGURE 1. CONNECTING PC TO DISPLAY PANEL

NOTE: The programs on the diskette can be copied to a hard disk drive on the PC. Some files in the subdirectories have the same file name as files in other subdirectories, but are not the same. Make sure all files for a program are installed correctly in their subdirectory or the programs will not work.

NOTE: Future releases of this software diskette will have programs for other kinds of controllers. Make sure the correct program is used for your motor controller.

Connect A PC To A Control Card

⚠ WARNING

Prevent movement of the lift truck and possible injury when making checks and adjustments. Before the PC is connected or disconnected to the control card or SEM Display Panel of the lift truck, do the following steps:

1. **Raise the drive wheels. as described in the OPERATING MANUAL or the section PERIODIC MAINTENANCE of the SERVICE MANUAL for this lift truck.**
2. **Turn the key to the OFF position, disconnect the battery and discharge the capacitor(s) as described in the motor controller section of the SERVICE MANUAL for your lift truck.**

   The capacitors can be discharged on lift trucks with the SEM Display Panel using the horn. Disconnect the battery connector, move the key to the OFF position and operate horn until it stops making a sound. Do NOT make a short-circuit at any of these motor controller terminals.

Connect the personal computer (PC) to the small (9 pin) connector on the back of the SEM Display Panel (under instrument panel). Connect the PC as shown in FIGURE 1. All other units without the SEM Display Panel, require connecting the computer at the motor controller. Connect the battery.

NOTE: The ITW Switches program allows a technician to use the HYTECH or GE SENTRY SOFTWARE program through the SEM Display Panel. These programs allow the technician to create different lift truck operating parameters for different users. The ITW Switches program is available on a 3.5 inch software diskette. Refer to How To Start The ITW Program (SEM Display Panel) of this manual.

Use this procedure to connect the computer to the control card or the SR or SP motor controller in units without the SEM Display Panel. Turn the key switch to OFF. Connect the PC adapter cable at the connector Plug Y on the control card (EV-100ZX, EV-T100) or to the 12-pin connector of the SR or SP motor controllers. See TABLE 3.

NOTE: If the control card or motor controller is on the bench, make sure that the control card or motor controller is connected to a 24 vdc, 0.5 A power source. See the section **TRANSISTOR MOTOR CONTROLLERS (SR AND SP)** to make the connections to the SR and SP motor controllers.

FIGURE 15. SAVING THE STATUS CODES TO DISK

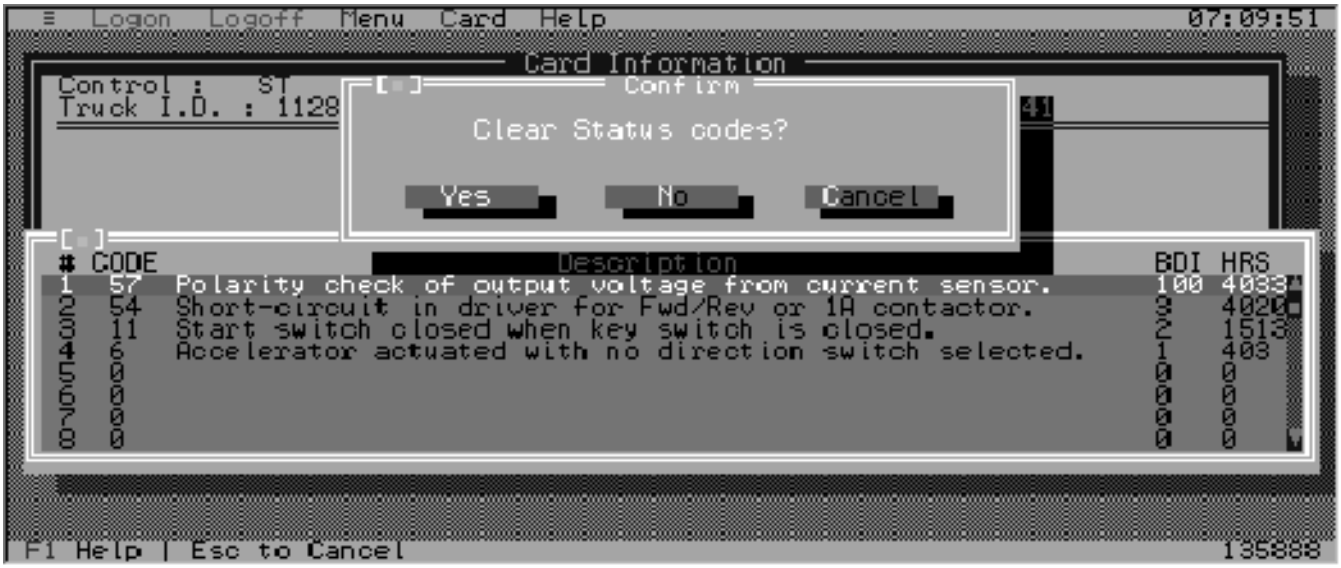


FIGURE 16. CLOSING AND CLEARING STATUS CODES

Closing and Clearing The Status Code List

To close the status codes list, press Alt F3**.** The `Confirm` dialogue box is displayed with the message `Clear Status Codes?` and the options `Yes`, `No` and `Cancel`. See FIGURE 16.

Use the Tab key to move to the different options. Selecting `Yes` clears the `Status Code` screen and closes the dialogue boxes. Selecting `No` closes the `Confirm` dialogue box and and the `Status Code` screen and returns you to the HYSTER Desktop Display, see FIGURE 2. Selecting `Cancel`. closes the `Confirm` dialogue box and returns you to the `Status Code` list.

COMMUNICATIONS PROGRAM (MODEM)

The HYTECH software diskette has a communications program (MODEM.EXE) that permits a remote computer to connect to a local control card through a telephone and modem connection. This communications program permits a service engineer at a remote location to run the HYTECH software programs and make checks and adjustments to the lift truck. Cable connector pin assignments are shown in TABLE 4.

OVERHEAD GUARD

⚠ WARNING

Do not weld, drill, grind or cut the overhead guard for mounts for lights or accessories. The strength of the overhead guard can be reduced.

Removal (See FIGURE 5.)

1. Remove the battery as described in the section **PERIODIC MAINTENANCE, 8000 SRM 552** or the **PERIODIC MAINTENANCE (N30XMH), 8000 SRM 555** under "**How to Change the Battery**".

2. Access to the capscrews that hold the rear legs of the overhead guard to the frame is from the battery compartment. Remove the two capscrews that fasten each leg.

3. Remove the three M12 capscrews and washers that hold each front leg of the overhead guard to the cowl. Disconnect any electric wires from under the cowl that go through the front legs of the overhead guard. When the overhead guard is lifted from the frame, make sure these electric wires move through the holes in the frame at the front and rear so that they are not damaged.

4. Use a lifting device or another person to help lift the overhead guard from the lift truck.

Installation (See FIGURE 5.)

If necessary, align the attachment plate on each front leg and install the set screws. Put the overhead guard on the lift truck. Install any electric wires from the overhead guard legs through the holes in the frame. Install the three M12 capscrews and washers that hold each front leg to the frame. Tighten the capscrews. Install the capscrews, washers and nuts that hold the rear legs to the frame. Tighten the capscrews. Install the battery.

BATTERY RESTRAINT AND SEAT ASSEMBLY

⚠ WARNING

On units with a shorter frame, the gas spring for the hood can raise the hood at a rapid rate and cause an injury. Do NOT get over hood when raising hood.

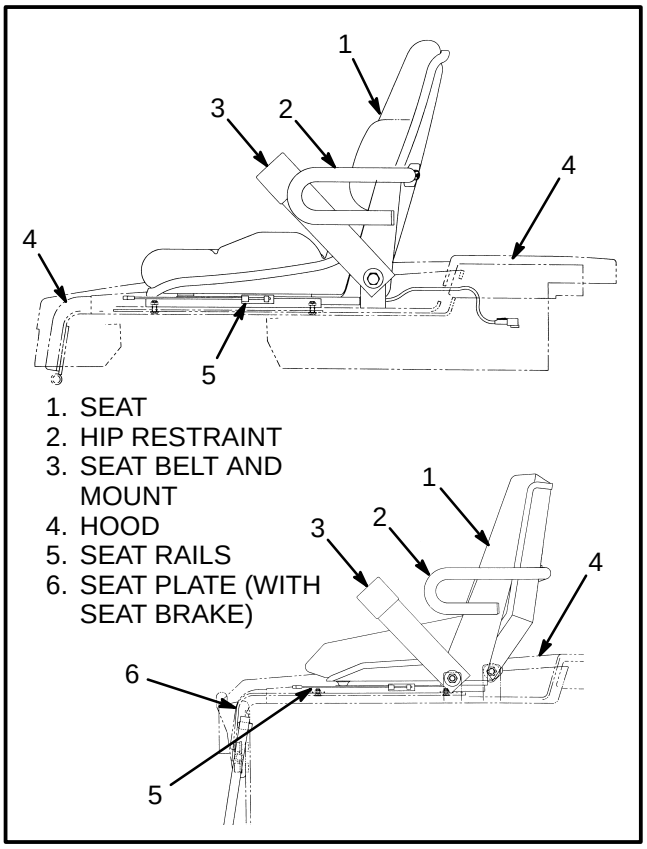


FIGURE 6. SEAT ASSEMBLY

A battery restraint system is installed as a safety device. See FIGURE 3. The function of the battery restraint system, when correctly locked in the down position, is to hold the battery in the battery compartment if an accident causes the lift truck to tip over. The battery restraint is a steel weldment that is connected to the frame with a hinge. A sliding latch mechanism (see FIGURE 4.) locks the battery restraint in the down position for operation. The latch, at the top center of the counterweight, unlocks the battery restraint from the frame so that the battery restraint can be raised to the up position for access to the battery. The battery restraint is also the support for the hood. A gas spring helps lift the hood assembly. A rod is used to hold the hood in the up position on units with a longer frame. The operator must hold the hood assembly with one hand. Use the other hand to move the rod to the storage position. Lower the hood and battery restraint assembly to the operating position. Make sure that the battery restraint is correctly locked to the frame for operation of the lift truck.

INTRODUCTION

GENERAL

This section has a description and the service procedures for the parts of the frame. These parts include the frame, counterweight assembly, overhead guard, hood and seat assembly, access panels, and label positions. The procedure for removing the traction motor is also described in this section.

DESCRIPTION

Main Frame (See FIGURE 1.)

The main frame is a single weldment. The main frame has mounts for the following: 1) counterweight, 2) overhead guard, 3) battery restraint and hood, 4) tilt cylinders, 5) steering axle, 6) drive axle assembly, 7) cowl assembly, 8) floor pedals and floor plates, 9) side step and fender weldments, 10) hydraulic tank, pump and motor assemblies, 11) control valves and 12) the levers. The hood is part of the operator and battery restraint system. The seat is part of the operator restraint system. The floor plates can be removed for access to components. The panels on the sides of the battery compartment can also be easily removed. The hydraulic tank, lift pump motor assembly and the steering pump motor assembly are in a compartment between the battery and the counterweight. The SCR (silicon controlled rectifier) or transistor electronic controllers and contactors are in the top of the counterweight. The top cover of the counterweight can be removed for access to the controllers and contactors. See FIGURE 3.

There are two main frames for lift trucks made for use in North America and two main frames for lift trucks made for use in Europe. The frames are different because of the different battery compartment sizes. There are two battery compartment lengths. The battery compartment widths are also different for Europe and North America. See BATTERY SPECIFICATIONS, at the back of this manual.

The weight of the battery is a large part of the counterweight system on an electric lift truck. Make sure that the battery is within the weight limits indicated on the nameplate. Each model of lift truck has a cast–iron counterweight that provides the additional weight necessary for the indicated capacity.

Other Frame Weldments (See FIGURE 1.)

These frame parts are the right–hand and left–hand side step and fender weldments, and the cowl weldment. Each part is a weldment fastened to the main frame to make the frame assembly. The cowl weldment is a mount for the front of the overhead guard (see FIGURE 3.), the steering column assembly (see FIGURE 4.), the release linkage of the parking brake and the instrument panel with light switches. The display panel (see FIGURE 4.) is not part of the instrument panel. The steering column housing is the mount for the display panel assembly.

Overhead Guard (See FIGURE 3.)

⚠ WARNING

Do not operate the lift truck without the overhead guard and cowl correctly fastened to the lift truck.

The overhead guard is a weldment that fastens to the main frame and cowl to help protect the operator from falling objects. A slot in the overhead guard permits removal of the battery without removing the overhead guard.

Battery Restraint, Hood And Seat Assembly (See FIGURE 2., FIGURE 6. and FIGURE 7.)

⚠ WARNING

The hood and battery restraint as well as the latch for the hand lever assembly must operate correctly before a lift truck is operated. These parts are part of the battery restraint system. The battery restraint system must operate correctly to help provide reasonable protection to the operator if the lift truck tips over.

A battery restraint system is installed as a safety device. See FIGURE 7. The function on the battery restraint system is to hold the battery in the battery compartment in case of a tip over. Part of the battery restraint system is a battery restraint at the rear of the battery compartment. See FIGURE 6. This restraint rod extends over the rear edge of the battery case to help hold the battery within the battery compartment during a tip over. A handle is used to move the restraint rod. The handle of the battery

HYDRAULIC TANK

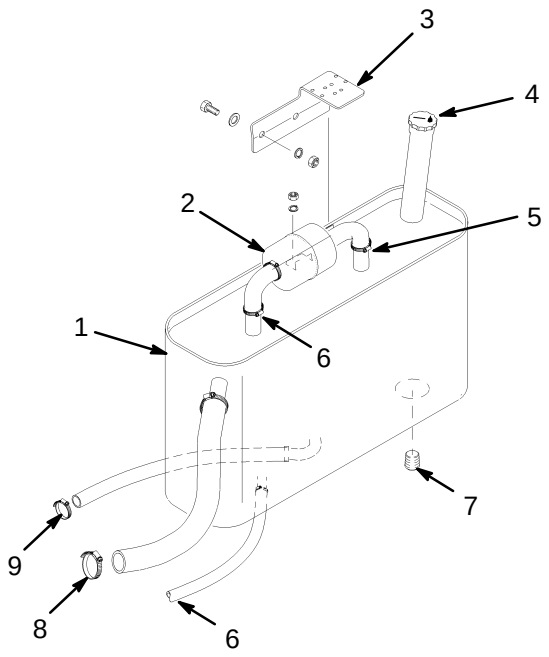
Tank Removal (See FIGURE 10.)

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.



1. HYDRAULIC TANK
2. FILTER
3. MOUNT BRACKET ASSEMBLY
4. FILL CAP/BREATHER/DIPSTICK
5. RETURN TO TANK
6. RETURN FROM SYSTEM
7. DRAIN PLUG
8. LIFT PUMP SUPPLY PORT
9. STEERING PUMP SUPPLY PORT

FIGURE 10. J2.00–3.20XM (J40–65XM) HYDRAULIC TANK ASSEMBLY

3. Turn the steering wheel for a full left turn for access to the drain plug near the front of the right rear wheel. Install a container under the drain plug of the hydraulic tank with enough capacity. See the SPECIFICATIONS table at the back of this section.

4. Remove the drain plug and let the oil drain from the hydraulic tank. Install and tighten the drain plug.

5. Remove and install plugs in all the hoses fastened to the hydraulic tank. Remove the breather/dipstick/fill cap and install a plug in the opening of the fill tube.

6. Remove the screws from the bracket that fastens the bracket holding the hydraulic tank in the truck frame. See item 3 of FIGURE 10. Remove the bracket assembly.

7. Carefully lift the hydraulic tank up out of the frame.

8. Make repairs to the hydraulic tank.

Tank Inspection

Make a visual inspection of all sides of the tank. Inspect the welds for cracks and leakage. Check for wet areas, accumulation of dirt, and loose or missing paint caused by leakage. Areas of the tank that are not easily seen can be checked with an inspection mirror and a light that is approved for locations with flammable vapors.

The hydraulic tank is a separate sheet metal tank and can be removed from the lift truck if necessary to check for leaks or for replacement. Repairs for leaks in the hydraulic tank can require special procedures described in the next paragraphs. The most common cause of leaks is from rust caused by the moisture of condensation. Drain any water out of the tank by removing the drain plug and letting the tank drain until there is no water in the oil.

Tank Repairs, Small Leaks

Use the following procedure to seal small leaks:

a. Use steam to clean the area around the leak. Remove all paint and dirt around the leak.

⚠ WARNING

Do not use tools that can make sparks, heat or static electricity. The vapors in the tank can cause an explosion.

b. Apply Loctite® 290 to the leak. Follow the instructions of the manufacturer.

Tank Repairs, Large Leaks

1. Use one of the procedures described under Tank Cleaning, Steam Method Of Cleaning Tank or Chemical

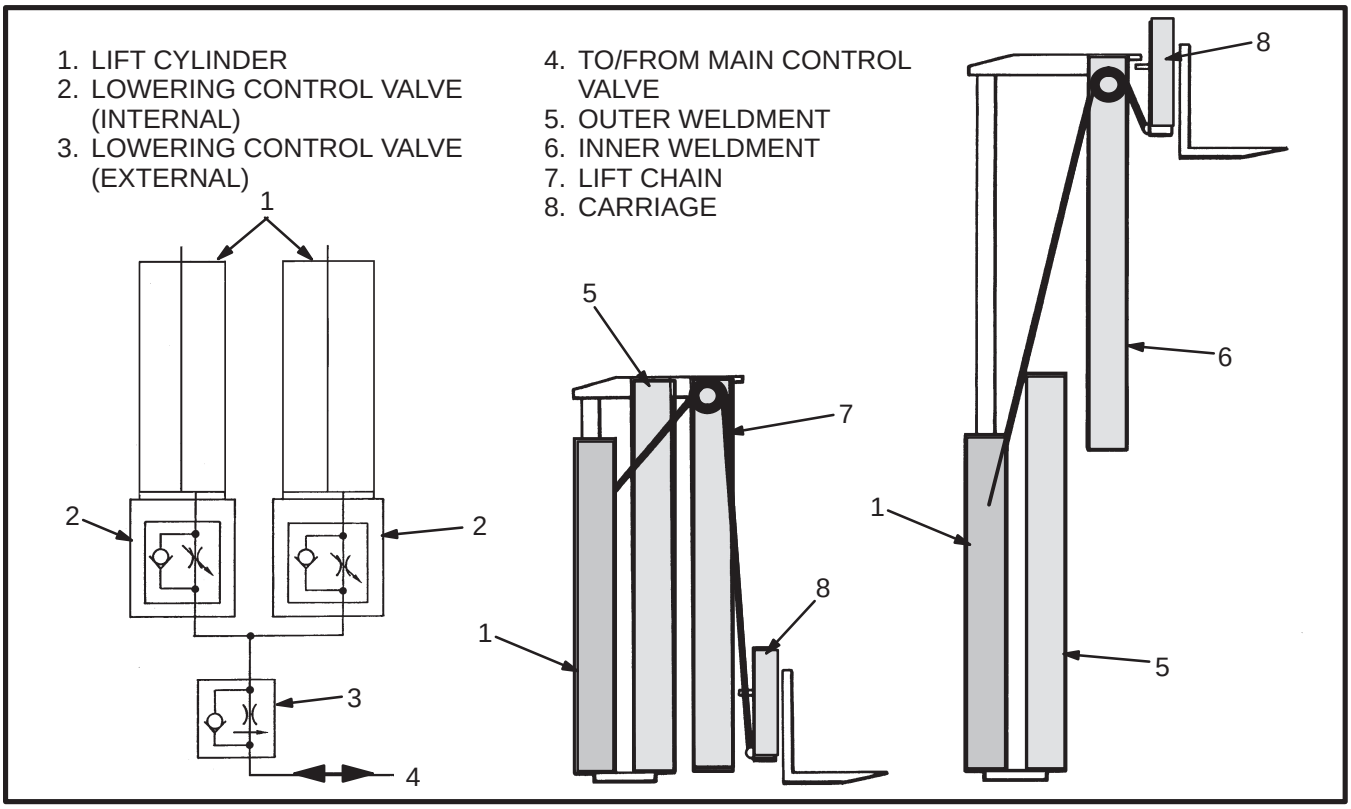
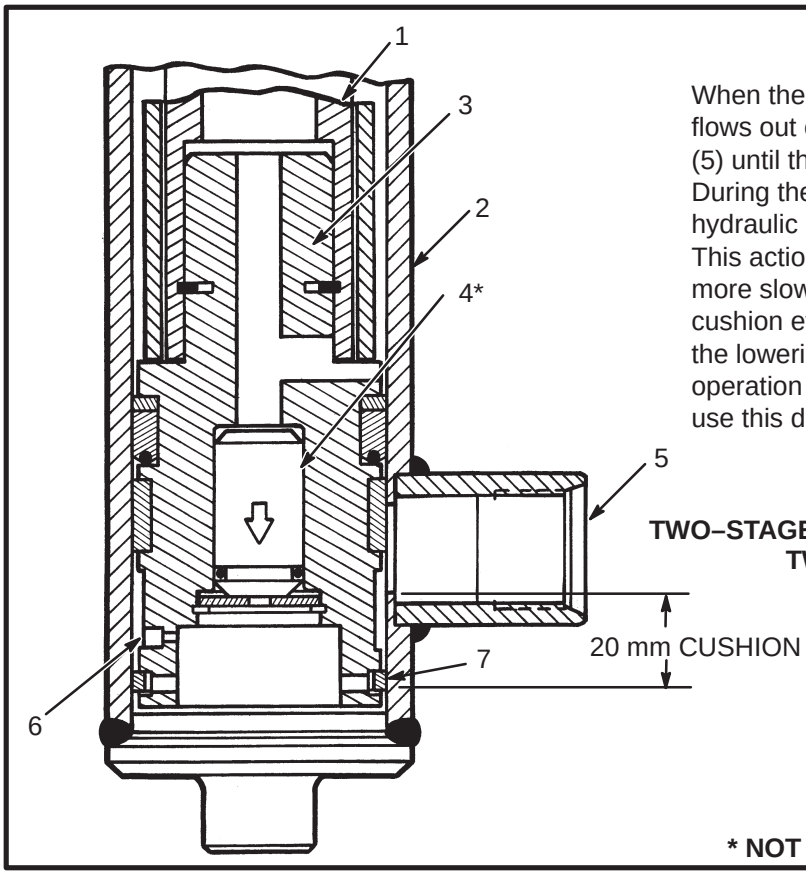


FIGURE 4. OPERATION OF THE TWO–STAGE, LIMITED FREE–LIFT MAST



When the main lift cylinders retract, the hydraulic oil flows out of the cylinder through the hydraulic port (5) until the piston seal (7) moves past port (5). During the last 20 mm of the retraction stroke, the hydraulic oil must flow through the small orifice (6). This action causes the cylinder rod to move much more slowly at the end of the retraction stroke. This cushion effect prevents a sudden stop at the end of the lowering sequence which makes a smoother operation during lowering. All masts in this section use this design in the main lift cylinders.

TWO–STAGE LFL and THREE–STAGE FFL SHOWN
TWO–STAGE FFL IS SIMILAR

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

*** NOT USED ON THE TWO–STAGE FFL**

FIGURE 5. CYLINDER CUSHION DURING LOWERING SEQUENCE, MAIN LIFT CYLINDER PISTON

4. Connect the top and bottom carriage bars by installing the two bottom capscrews. Do NOT tighten the capscrews. Lubricate the outer surface of the bottom bushing with multi–purpose grease. Install the bottom bushing in the bottom carriage bar.

5. Make sure the standard carriage is completely lowered. Connect a crane (the capacity of the crane must be at least 908 kg {2 000 lb}) to the lifting eye. Install the side–shift carriage on the standard carriage. Put blocks under the bottom bar of the side–shift carriage so that the bottom bushing moves tight against the standard carriage when the lifting device is lowered.

6. Install the two top capscrews into the side–shift carriage. On the H/S/E1.50–1.75XM, H/S/E2.00XMS (H/S/E25–35XM, H/S/E40XMS); H/S/E/J2.00–2.75XM (H/S/E/J40–55XM); S/E/J2.00–2.50XL (S/E/J40–50XL); and J1.60–2.00XMT (J30–40XMT) units, tighten all of the capscrews to 435 Nm (320 lb_f ft). On H/S/E/J3.00–3.20XM (H/S/E/J60–65XM) and S/E/J3.00XL (S/E/J60XL) units, tighten all of the capscrews to 755 Nm (557 lb_f ft).

7. Remove the lifting device. Lubricate the top bushing at the grease fittings.

MAST

Removal (See FIGURE 6.)

NOTE: If the mast needs to be disassembled, remove the forks and carriage. If only the lift cylinders need to be removed for repair, the mast does not need to be removed from the lift truck. See the procedures for the **LIFT CYLINDERS**.

NOTE: The length of the lift chains must be checked before the mast is removed. See Step 2 in **Cleaning and Inspection**.

1. Fully lower all of the mast weldments and the carriage. Tilt the mast fully forward. Connect a crane (the capacity of the crane must be at least 1 600 kg {3 500 lb}) to the top of the mast using chains. Make sure all the weldments are fastened together. Make sure the chains will not damage the sheaves, tubing, or other parts of the mast.

2. Put a drain pan under the area of the hydraulic fittings. Disconnect the hydraulic line at the external lowering control valve on the outer weldment.

⚠ WARNING

Use a driver, NOT your fingers, to push the anchor pins from the clevises on the tilt cylinders. The cylinder or mast can move and cause serious injury.

3. Remove the cotter pins and anchor pins or the capscrews, washers, and anchor pins at the tilt cylinder mounts on the mast.

4. On the H/S/E/J2.00–3.20XM (H/S/E/J40–65XM) remove the capscrews that hold the mast to the pivot pins at the mounts. On the H/S/E1.50–1.75XM, H/S/E2.00XMS (H/S/E25–35XM, H/S/E40XMS); J1.60–2.00XMT (J30–40XMT); and S/E/J2.00–3.00XL (S/E/J40–60XL) remove the capscrews that hold the retainer caps to the mast mounts.

5. Use the crane to lift the mast assembly from the lift truck. Put the mast on the floor so that the back of the mast is toward the floor.

Disassembly, Two–Stage LFL And Two–Stage FFL Masts (See FIGURE 7. And FIGURE 8.)

NOTE: If only the lift cylinders need to be removed and repaired, see the procedures for the **LIFT CYLINDERS**. When the mast has header hoses, see the procedures for the **HEADER HOSE**.

1. Clean the area around the hydraulic fittings for the lift cylinders. Disconnect the fittings at the lift cylinders and put caps on the open lines.

NOTE: On the two–stage FFL mast, remove the brackets and disconnect the hydraulic line for the free–lift cylinder. Remove the free–lift cylinder. Disconnect the free–lift chains at the crossmember.

⚠ WARNING

Be careful when removing or installing snap rings. These snap rings 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 rings and washers from the top of each main lift cylinder. Remove the nut, bolt, and spacer at the mount near the top of each main lift cylinder. Disconnect the main lift chains at the mounts.

NOTE: On the H/S/E/J2.00–3.20XM (H/S/E/J40–65XM) and S/E/J2.00–3.00XL (S/E/J40–60XL) two–stage FFL mast, remove the hydraulic fitting from

(J30–40XMT) two–stage FFL masts, install the washers at the top of the left–hand cylinder. Push the inner weldment to engage the rods of the lift cylinders. Check the clearance at the top of the lift cylinder mounts. Add or remove washers at the left–hand cylinder until it is even with the right–hand cylinder. Install the snap ring at the top of the left–hand lift cylinder. Install the hydraulic fitting on the right–hand cylinder.

5. Install the spacers, nuts, and bolts at the mounts for the lift cylinders. Tighten the bolts to 53 Nm (40 lb_f ft).

6. Install the housing for the lowering control valve on the outer weldment. Tighten the nuts for the lowering control valve to 18 Nm (13 lb_f ft). Install the lowering control valve in the housing. Connect the hydraulic lines and fittings between the lowering control valve and the main lift cylinders.

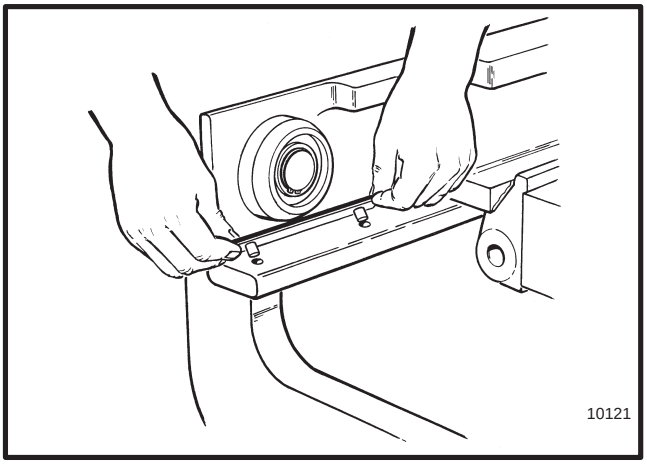


FIGURE 12. STRIP BEARINGS

7. On the two–stage LFL mast, install the chain sheaves at the inner weldment. On the H/S/E/J2.00–3.20XM (H/S/E/J40–65XM) and S/E/J2.00–3.00XL (S/E/J40–60XL), be sure to install both set screws that hold the shaft for the chain sheave in position. Tighten the set screws to 8 Nm (71 lb_f in). Connect the lift chains to the chain anchors at the main lift cylinder mounts. Attach wires between the ends of the lift chains and the crossmember to control the lift chains during mast installation.

8. On the two–stage FFL mast:

a. Install the free–lift cylinder in the mounts on the inner weldment. Install the brackets for the cylinder and tighten the bolts to 53 Nm (40 lb_f ft).

b. Install the tubing and brackets that connect the free–lift cylinder to the main lift cylinder.

c. Connect the free–lift chains to the chain anchors at the crossmember. Attach a wire between the end of the lift chain and the bottom of the mast to control the lift chain during installation.

Assembly, Three–Stage FFL Mast (See FIGURE 10.)

NOTE: The shims for the load rollers keep the weldments parallel and give correct clearance. During assembly, the shim arrangement will be approximately the same as before disassembly. Check the clearance and adjust the shims for wear or for changes caused by repairs. The strip bearings are also adjusted by using shims. See **CHECKS AND ADJUSTMENTS** in this section for the adjustment procedures.

NOTE: When the mast has header hoses, see the procedures for the **HEADER HOSES**.

1. Put the outer weldment on the floor with the mast pivots toward the floor. Connect a crane (the capacity of the crane must be at least 681 kg {1 500 lb}) to the center of the intermediate weldment. Fit the lower stub shafts of the intermediate weldment into the notches in the top of the outer weldment. Slide the intermediate weldment into the outer weldment so that the stub shafts are seen at the top and bottom of both weldments.

2. Install the strip bearings and the shims on the channels of the outer weldment. See FIGURE 12. Apply grease to the bearing surfaces. Check the clearance of the strip bearings as described in **CHECKS AND ADJUSTMENTS**.

3. Install the load rollers and the shims on the outer weldment and at the bottom of the intermediate weldment. Before doing the next step, adjust the intermediate weldment and check the clearance of the load rollers as described in **CHECKS AND ADJUSTMENTS**.

4. Install the main lift cylinders. Push the intermediate weldment to engage the lift cylinders. Check the clearance at the top of the lift cylinder mounts. Add or remove washers at the top of the cylinder rods until they are even. Install the snap ring and washer at the top of the lift cylinders.

5. Install the housing for the lowering control valve on the outer weldment. Tighten the nuts for the lowering control valve to 18 Nm (13 lb_f ft). Install the lowering control valve in the housing. Connect the hydraulic lines and fittings between the lowering control valve and the main lift cylinders.

New Hose Installation, Two–Stage FFL Mast (See FIGURE 22. Through FIGURE 24., And FIGURE 28.)

⚠ WARNING

Before working on or near the mast, see SAFETY PROCEDURES WHEN WORKING NEAR THE MAST in this section.

NOTE: This procedure is for the four function option. The three function option will have hoses "**A**" and "**B**" only.

NOTE: The carriage height must be correct before the header hoses can be adjusted. See **ADJUST THE LIFT CHAINS** for the carriage adjustment procedure.

1. Mark each hose with a single letter, "**A**," "**B**," "**C**," or "**D**."

2. Use a calculator to calculate dimension "**E**." See FIGURE 22.

3. Clamp the end of the hose (the smaller fitting) that attaches to the carriage in a vise (do NOT clamp on the threads), pull on the other end until the hose is straight. Do NOT apply enough force to stretch the hose. See FIGURE 22.

4. Mark the hoses with dimension "**E**" (all measurements are made from the carriage end of the hose [the smaller fitting]). See FIGURE 22.

5. See FIGURE 23. Attach the hoses to the carriage bracket (15) with clamp (9).

6. Put the header hoses (10) over the free–lift chains (11).

7. Put the clamps (7) over the hoses and attach the clamps to the lower bracket (16) (do NOT tighten the hardware).

NOTE: To make the alignment of dimension "**E**" easier, use a crane (the capacity of the crane must be at least 908 kg {2 000 lb}) to raise the carriage high enough to install a safety chain.

8. Align mark "**E**" at the bottom of the clamp (7). Tighten the hardware to 8 Nm (71 lb_f in).

9. Install the hose guards (2) at the free–lift crosshead. Tighten the capscrews that mount the guards to 66 Nm (49 lb_f ft).

NOTE: The proper hose alignment is shown in FIGURE 24.

10. Apply a spray lubricant onto the hoses in the area that will contact the channels. Make sure the hoses are properly aligned in the channels (8). Put the clamps (12) over the hoses and attach the clamps to the channels. Tighten the hardware to 8 Nm (71 lb_f in). See FIGURE 24.

11. Connect the header hoses (10, C, and D) to the cowl hoses (1). Connect the header hoses (10, A, and B) to the tubes (13).

12. Use the rubber clamps and strap clamps to attach the hoses to the main lift cylinders. Make sure the cowl hoses (1) do not stretch or fold while tilting the mast fully forward and backward.

13. With no load on the forks, operate the mast through the full lift cycle two times. With the mast at full lift height, attach clamp (17) at the bottom of the hose loop on the third and/or fourth function hoses. This action allows the hoses to fit properly in the hose channel.

14. With no load on the forks, check the header hose adjustment by operating the mast through the full lift cycle two times. When properly adjusted, the hoses will not be so tight that they compress when they pass over the sheaves nor will they be so loose that they touch the load backrest or any crossmember that is next to a sheave. If the hoses require additional adjustment, see **Adjustment Of Hoses After Installation, Two–Stage FFL Mast.**

Adjustment Of Hoses After Installation, Two–Stage FFL Mast (See FIGURE 22. through FIGURE 24., And FIGURE 28.)

1. Loosen the clamps (7) and pull (if the hoses are loose) or push (if the hoses are tight) on the hoses so that they move 15 mm (0.6 in). Tighten the hardware to 8 Nm (71 lb_f in).

2. With no load on the forks, check the header hose adjustment by operating the mast through the full lift cycle two times. When properly adjusted, the hoses will not be so tight that they compress when they pass over the sheaves nor will they be so loose that they touch the load backrest or any crossmember that is next to a sheave. If necessary, repeat step 1 until the hoses are properly adjusted.

The following procedures must be used when installing safety chains for the header hose installation. Additional precautions and procedures can be required when repairing or removing the mast. See SAFETY PROCEDURES WHEN WORKING NEAR THE MAST in GENERAL PROCEDURES at the front of this section for additional procedures for the installation of safety chains.

⚠ WARNING **Mast parts are heavy and can move. Distances between parts are small. Serious injury or death can result if part of the body is hit by parts of the mast or the carriage.**

- **Never put any part of the body into or under the mast or carriage unless all parts are completely lowered or a safety chain is installed. Also make sure that the power is off, the key is removed, and the parking brake is applied.**
  Put a "DO NOT OPERATE" tag in the operator's compartment.
- **Be careful of the forks. When the mast is raised, the forks can be at a height to cause an injury.**
- **DO NOT climb on the mast or lift truck at any time. Use a ladder or personnel lift to work on the mast.**
- **DO NOT use blocks to support the mast weldments nor to restrain their movement.**
- **Mast repairs require disassembly and removal of parts and can require removal of the mast or carriage. Follow the repair procedures in the correct Service Manual for the mast.**

SAFETY CHAIN INSTALLATION WHEN THE CARRIAGE IS RAISED:

a. Put the mast in a vertical position.

b. Raise the carriage approximately 300 mm (12 in).

c. Use a $^{3}/_{8}$ inch minimum safety chain with a hook. Attach one end of the chain around all the top crossmembers. Make sure the hook (1) is completely engaged with a link in the chain.

d. Attach a shackle (2) to the lifting eye on the carriage. Install the chain through the shackle. Make sure the hook is completely engaged with a link in the chain. Make sure the safety chain does not touch lift chains, chain sheaves, tubes, hoses, fittings, or other parts of the mast.

e. Lower the crane until there is tension in the safety chain. Make sure both hooks are properly engaged before working on the mast. Install a **"DO NOT REMOVE"** tag on the safety chain.

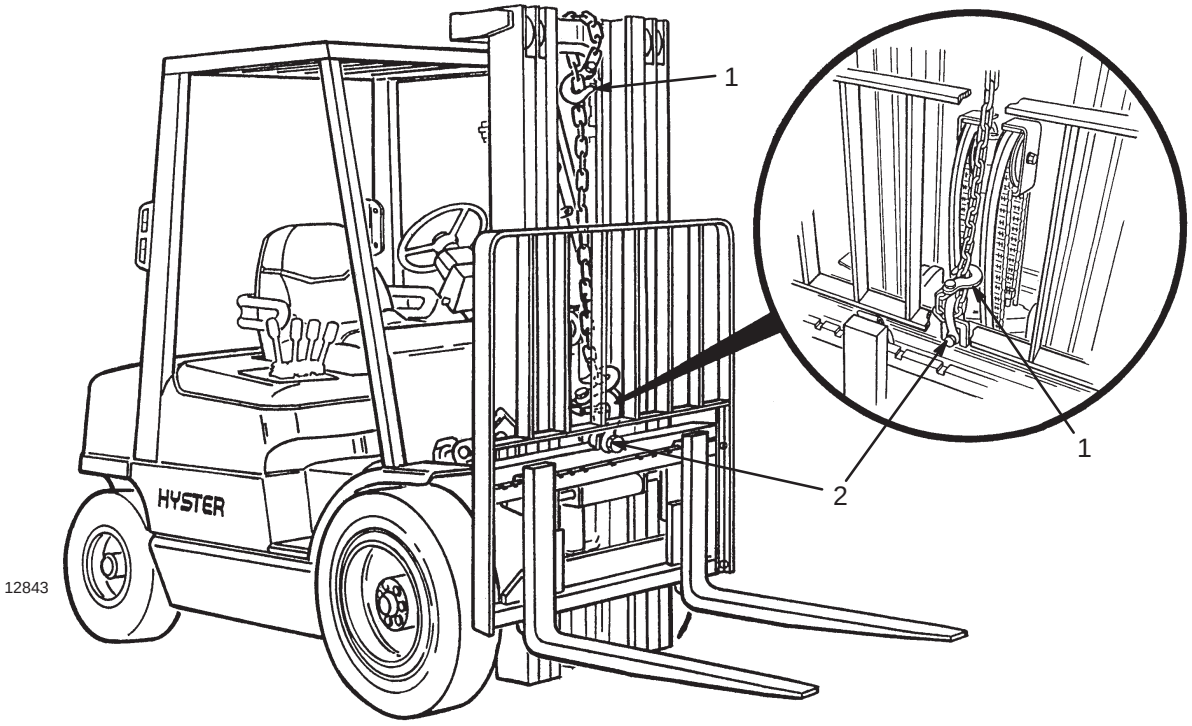


FIGURE 28. SAFETY CHAIN INSTALLATION – TWO–STAGE FULL FREE–LIFT AND THREE–STAGE FULL FREE–LIFT MAST (1 OF 2)

*** METRIC FORMULAS (ALL DIMENSIONS ARE IN MILLIMETERS)**

@ DIMENSION “E” = (Y – Z – 246) x 0.985

DIMENSION “E” = (Y – Z – 746) x 0.985

DIMENSION “G” = (1.965 x Y) – (0.985 x Z) + 57.57

EXAMPLE: DIMENSION “E” = (Y – Z – 246) x 0.985

STEP 1. DIMENSION “E” = (1840 – 135 – 246) x 0.985

STEP 2. DIMENSION “E” = 1459 x 0.985

STEP 3. DIMENSION “E” = 1437

THE CALCULATION FOR DIMENSION “G” IS SIMILAR TO DIMENSION “E.”

*** INCH FORMULAS (ALL DIMENSIONS ARE IN INCHES)**

@ DIMENSION “E” = (Y – Z – 9.7) x 0.985

DIMENSION “E” = (Y – Z – 29.3) x 0.985

DIMENSION “G” = (1.965 x Y) – (0.985 x Z) + 2.3

EXAMPLE: DIMENSION “E” = (Y – Z – 9.7) x 0.985

STEP 1. DIMENSION “E” = (72.4 – 5.3 – 9.7) x 0.985

STEP 2. DIMENSION “E” = 57.4 x 0.985

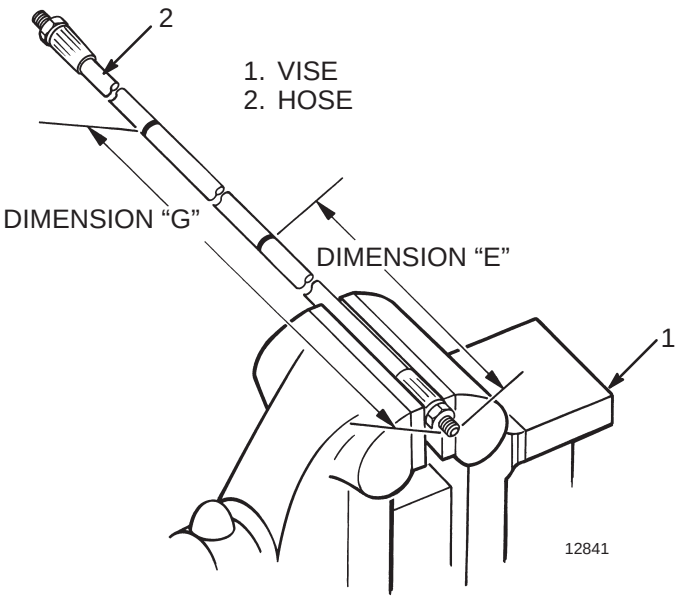
STEP 3. DIMENSION “E” = 56.5

THE CALCULATION FOR DIMENSION “G” IS SIMILAR TO DIMENSION “E.”

* ALL OF THE MEASUREMENTS ARE MADE WITH MAST VERTICAL AND FULLY LOWERED.

@ FOR MASTS WITH DIMENSION “Y” LESS THAN 2600 mm (102.2 in)

FOR MASTS WITH DIMENSION “Y” GREATER THAN 2600 mm (102.2 in)



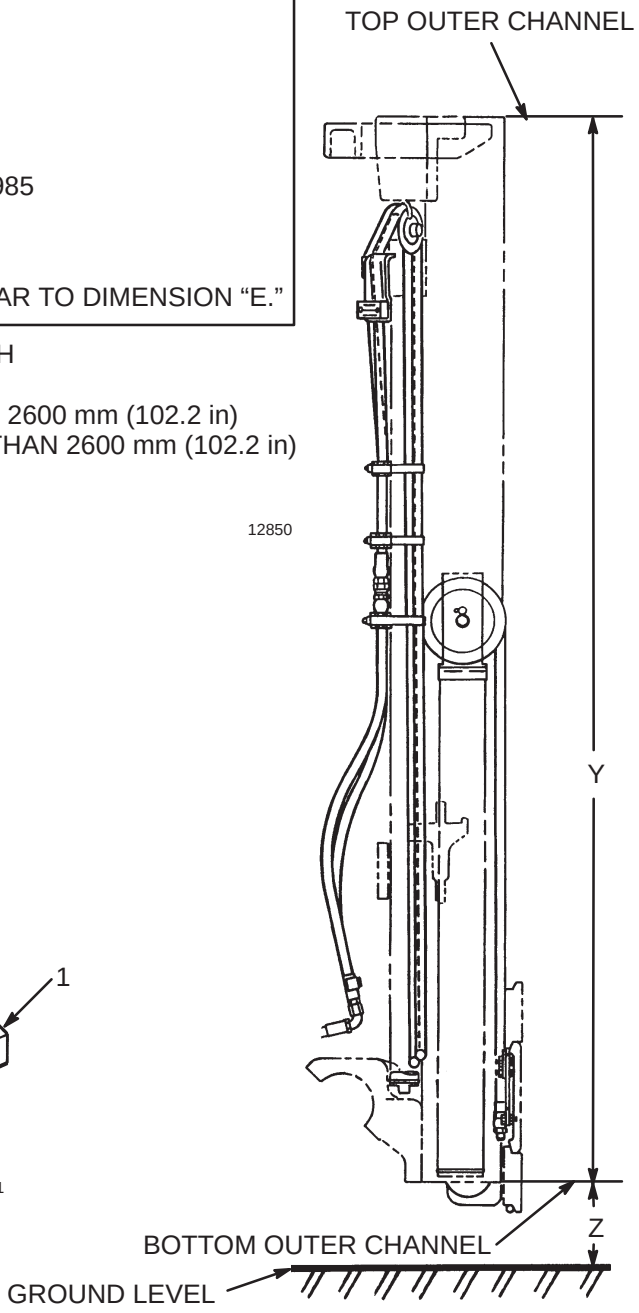


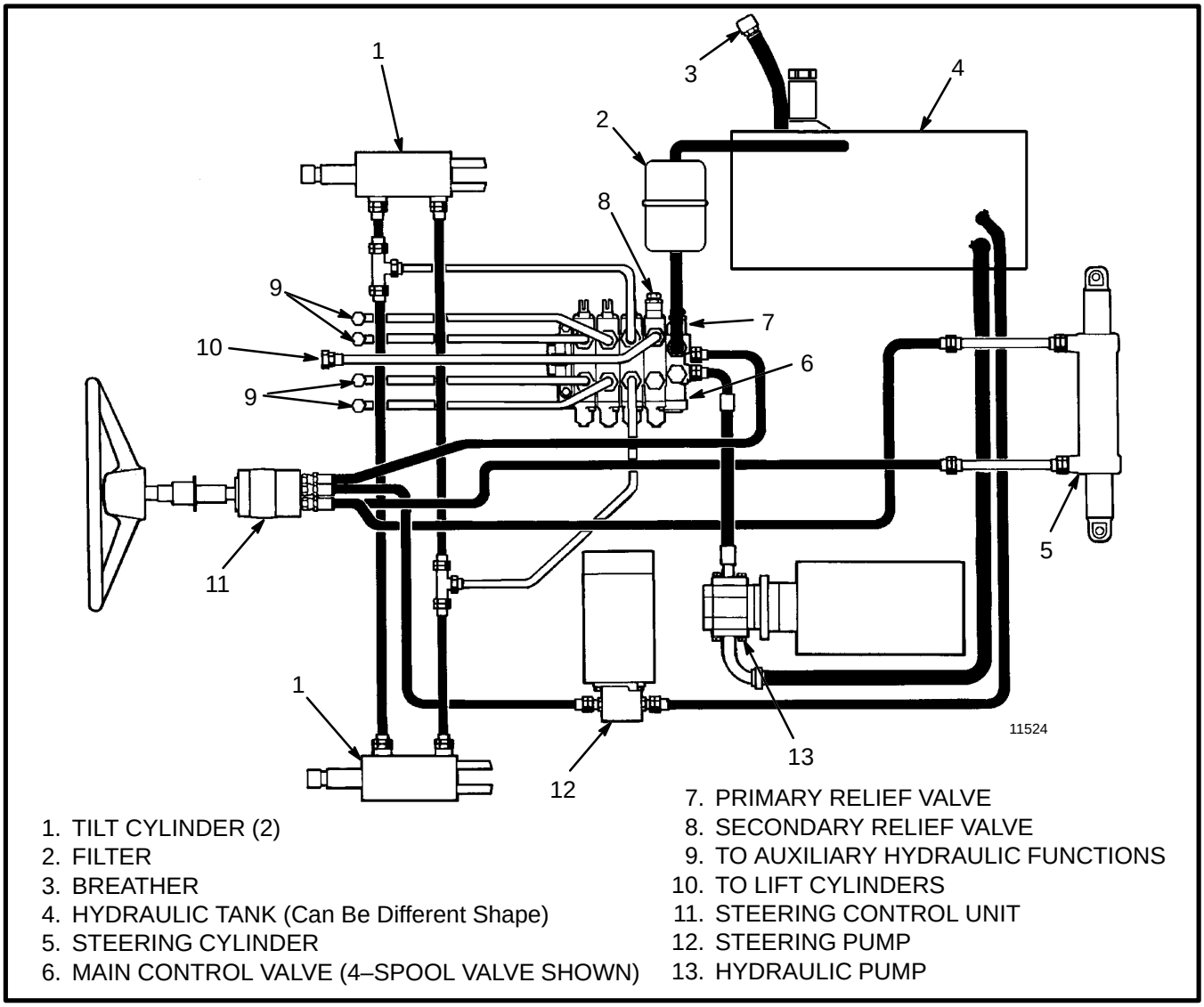
FIGURE 34. HEADER HOSE MEASUREMENT – THREE–STAGE FULL FREE–LIFT MAST

INTRODUCTION

GENERAL

This section describes the hydraulic system and the steering system. The section includes REPAIR, CHECKS AND ADJUSTMENTS and TROUBLESHOOTING. This section has repair procedures for the main hydraulic pump and the steering pump. Other repair procedures are in the following sections:

- **MAIN CONTROL VALVE, 2000 SRM 562**
- **MAST – Repair, 4000 SRM 522**
- **FOUR STAGE MAST – Repair, 4000 SRM 563**
- **VISTA MAST – Repair, 4000 SRM 482 (N30XMH ONLY)**
- **TILT CYLINDERS, 2100 SRM 103**
- **LIFT CYLINDERS, 4000 SRM 481 (N30XMH ONLY)**
- **STEERING HOUSING AND CONTROL UNIT, 1600 SRM 512**
- **STEERING AXLE, 1600 SRM 258**
- **DC MOTOR MAINTENANCE, 620 SRM 294**



1. TILT CYLINDER (2)
2. FILTER
3. BREATHER
4. HYDRAULIC TANK (Can Be Different Shape)
5. STEERING CYLINDER
6. MAIN CONTROL VALVE (4–SPOOL VALVE SHOWN)
7. PRIMARY RELIEF VALVE
8. SECONDARY RELIEF VALVE
9. TO AUXILIARY HYDRAULIC FUNCTIONS
10. TO LIFT CYLINDERS
11. STEERING CONTROL UNIT
12. STEERING PUMP
13. HYDRAULIC PUMP

FIGURE 1. E1.50–3.20XM (E25–65XM) HYDRAULIC SYSTEM

The hydraulic tank is a separate sheet metal tank and can be removed from the lift truck if necessary to check for leaks or for replacement. Repairs for leaks in the hydraulic tank can require special procedures described in the next paragraphs. The most common cause of leaks is from rust caused by the moisture of condensation. Drain any water out of the tank by removing the drain plug and letting the tank drain until there is no water in the oil.

Tank Repairs, Small Leaks

Use the following procedure to seal small leaks:

a. Use steam to clean the area around the leak. Remove all paint and dirt around the leak.

⚠ WARNING

Do not use tools that can make sparks, heat or static electricity. The vapors in the tank can cause an explosion.

b. Apply Loctite® 290 to the leak. Follow the instructions of the manufacturer.

Tank Repairs, Large Leaks

1. Use one of the procedures described under Tank Cleaning, Steam Method Of Cleaning Tank or Chemical Solution Method Of Cleaning Tank to clean and prepare the tank for repairs.

2. Use acceptable welding practices to repair the tank. See the American National Standard *Safety In Welding And Cutting* ANSI Z 49.1 – 1973.

Tank Cleaning

⚠ WARNING

Special procedures must be followed when large leaks or other repairs need welding or cutting. All work must be done by authorized personnel. If the tank is cleaned inside of a building, make sure there is enough ventilation. See the following manuals for additional information:

- **Safe Practices For Welding And Cutting Containers That Have Held Combustibles" by the American Welding Society, A6.0–65.**
- **Safety In Welding And Cutting", American National Standard, ANSI Z 49.1 – 1973.**

When cleaning the tank, do not use solutions that make dangerous gases at normal temperatures or when heated. Wear eye and face protection. Protect the body from burns.

Steam Method Of Cleaning Tank

When cleaning with steam, use a hose with a minimum diameter of 19 mm (0.75 inch). Control the pressure of the steam by a valve installed at the nozzle of the hose. If a metal nozzle is used, it must be made of a material that does not make sparks. Make an electrical connection between the nozzle and the tank. Connect a ground wire to the tank to prevent static electricity.

Use the following procedure to clean the tank with steam:

a. Remove all the parts from the tank. Install the drain plug.

b. Fill the tank 1/4 full with a solution of water and sodium bicarbonate (baking soda) or sodium carbonate. Mix 0.5 kg (1 lb) per 4 litres (1 gal) of water.

c. Mix the solution in the tank using air pressure. Make sure all the surfaces on the inside of the tank are flushed with the solution. Drain the tank.

d. Put steam into the tank until the tank does not have odors and the metal is hot. Steam vapors must come from all the openings.

e. Flush the inside of the tank with boiling water. Make sure all the loose material is removed from the inside of the tank.

f. Make an inspection of the inside of the tank. If it is not clean, repeat Steps d and e and make another inspection. When making inspections, use a light that is approved for locations with flammable vapors.

g. Put plugs in all the openings in the tank. Wait 15 minutes, then remove the inlet and outlet plugs. Test a sample of the vapor with a special indicator for gas vapors. If the amount of flammable vapors is above the lower flammable limit, repeat the cleaning procedures.

Chemical Solution Method Of Cleaning Tank

If the tank cannot be cleaned with steam, use the following procedure:

a. Mix a solution of water and trisodium phosphate or a cleaning compound with an alkali base. Follow the instructions given by the manufacturer.

NOTE: Tighten the connections for power cables at M8 X 1.25 or 5/16 UNC terminals on General Electric motors to 18 to 22 Nm (13 to 16 lb_f ft). Tighten all other connections for power cables as follows:

$^5/_{16}$ UNC threads – 13.5 to 17.5 Nm (10.0 to 12.9 lb_f ft)

$^1/_4$ UNC threads – 4.0 to 6.0 Nm (3.0 to 4.4 lb_f ft)

#6 UNC threads – 0.73 to 1.02 Nm (0.5 to 0.8 lb_f ft)

M8 X 1.25 threads – 13.5 to 17.5 Nm (10.0 to 12.9 lb_f ft)

M10 X 1.5 threads – 15.0 to 18.0 Nm (11.1 to 13.3 lb_f ft)

8. Remove the plug from the breather hose and install the breather. Install the battery as described in one of the following **SERVICE MANUAL** sections for the correct procedure.:
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
Install the floor plate. Operate the steering system and check for leaks.

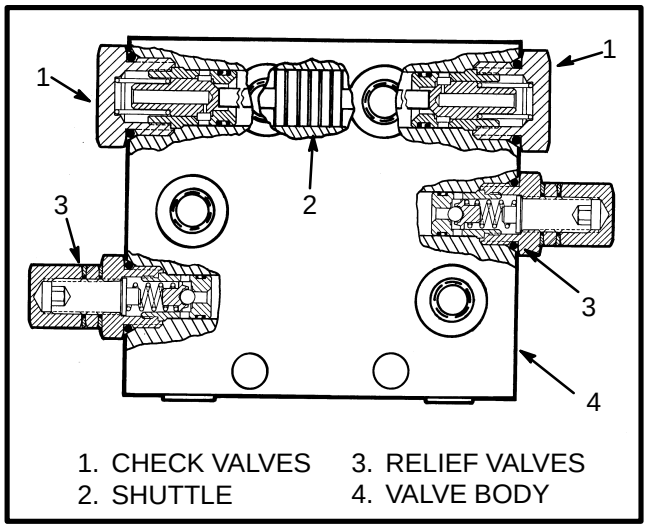


FIGURE 18. ROTARY ACTUATOR VALVE

ROTARY ACTUATOR VALVE (See FIGURE 18.)

The rotating actuator valve and the bypass valve are found on the attachment for the N30XMH. The instructions for the removal and installation and the adjustment procedures for these valves are in the ATTACHMENTS section, 5000 SRM 580.

Disassembly, Cleaning and Inspection

1. Turn the cap with a wrench to remove the check valve assembly from the valve body. Push the shuttle out of the valve body.

2. Inspect the seat and poppet for dirt or scratches. The poppet must slide freely in the seat sleeve. The spring must not be bent or broken.

3. Inspect the shuttle and bore for dirt or scratches. The shuttle must slide freely in the bore.

4. Remove the two relief valves from the valve body by turning the bushings with a wrench.

⚠ CAUTION

The adjustment of the relief valves is set at the factory. DO NOT loosen the cap or jam nut from the bushings. DO NOT turn the adjuster screw.

5. Inspect the poppet, ball, and seat for dirt or scratches. Make sure the spring is not bent or broken.

6. Clean all parts of the rotating actuator valve with solvent. Use compressed air to dry the parts and to remove dirt from the passages.

Assembly

1. Lubricate the relief valve parts with hydraulic oil. Install new O–rings on the bushing.

2. Install the relief valves into the valve body. Use a wrench to tighten the bushing.

3. Lubricate and install new O–rings and install one check valve into the valve body. Lubricate the shuttle and slide it into the bore for the check valves. Lubricate and install the other check valve.

4. Install new O–rings on the fittings that were removed. Lubricate and install the fittings.

STEERING CONTROL UNIT

NOTE: See the **SERVICE MANUAL** section **STEERING HOUSING AND CONTROL UNIT, 1600 SRM 512** to repair the steering control unit. Following is the correct procedure to remove and install the steering control unit.

NOTE: The repair procedures for the instrument cluster are in the **SERVICE MANUAL** section **ELECTRICAL SYSTEM, 2200 SRM 560**.

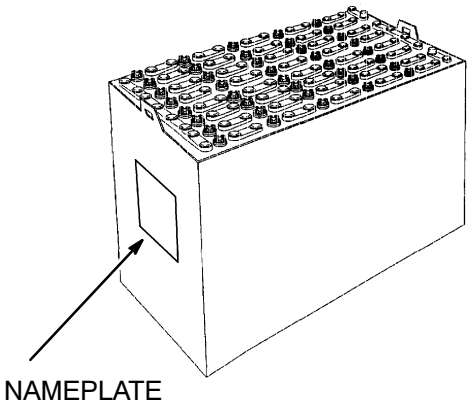
INTRODUCTION

GENERAL

This section describes how to select and do the maintenance for large batteries used in electric lift trucks. This information is for service personnel who must do the maintenance on large lead-acid batteries. Battery repair requires special training and equipment. Do not try to repair a battery unless you have the correct tools,equipment and experience. Most battery repairs are done by a special repair service. Some batteries have a nameplate attached to the face of the battery cover. This nameplate communicates specific information about the battery. See FIGURE 1. for more information of what can be found on a battery nameplate.

LEAD-ACID BATTERIES

A lead-acid battery converts chemical energy into electrical energy. Chemical changes within the battery gives the electrical energy. When the chemical reaction has occurred so that the battery will not give its rated voltage and current, the battery is discharged. A reverse chemical action must occur so that the battery can be used again.



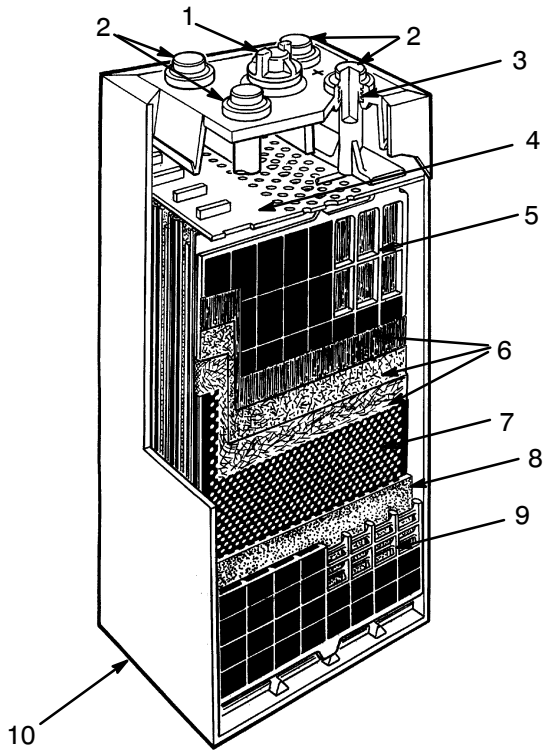
NAMEPLATE CONTAINS:

- NAME OF BATTERY MANUFACTURER
- BATTERY TYPE
- SERIAL NUMBER
- NOMINAL VOLTAGE
- CAPACITY IN AMPERE HOURS AT THE 5 HOUR RATE
- SERVICE MASS (WITH BALLAST IF USED TO COMPENSATE FOR LACK OF BATTERY MASS)

FIGURE 1. LEAD-ACID INDUSTRIAL BATTERY

The batteries described in this section can be charged again by an electric voltage and current from an outside source so that there is a reverse chemical action. The lead-acid chemicals store the electric energy until the electric energy is needed to operate an electric device.

A lead-acid battery is made from several lead-acid batteries called cells. Each cell has positive and negative plates with dielectric spacers between each plate. All of the plates are set within a solution of electrolyte. See FIGURE 2.



1. VENT AND FILL CAP
2. POST
3. POST SEAL
4. PLATE PROTECTOR (SHIELD)
5. POSITIVE PLATE
6. EXPANSION MATS
7. RETAINER
8. SEPARATOR
9. NEGATIVE PLATE
10. BATTERY JAR

FIGURE 2. THE BATTERY CELL

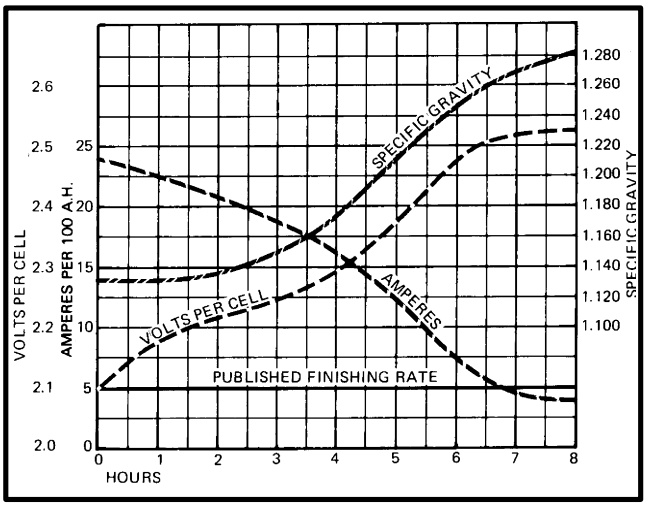


FIGURE 20. SPECIFIC GRAVITY COMPARED TO CHARGING TIME

NOTE: Sometimes the capacity of a battery is not enough to complete a work period. Check for the following conditions:

- The battery is too small for the job.
- The battery is not fully charged.
- The battery charger is not operating correctly.
- The battery is near the end of its service life.

Methods Of Charging

There are three methods of charging a battery.

1. GRADUAL CHARGE. This method uses a solid state automatic battery charger. The charging rate begins at 20 to 25 amps/100 amp-hours and decreases to less than 5 amps/100 amp-hours when the battery is 80% charged. The charging current decreases when the voltage across the cell increases during the charging cycle is shown in FIGURE 20. The increase in the voltage from the charger is approximately the same as the increase in the specific gravity in the cells.

2. MODIFIED CONSTANT VOLTAGE. This method uses a generator to generate a constant voltage that is controlled by a resistor. When the charging current decreases, the voltage across the resistor increases. The increasing voltage across the resistor causes an increasing voltage at the battery terminals. The charging is similar to the gradual charge The resistor must be correctly set or the charging rate will be wrong. The typical graphs for a modified constant voltage charger is shown in FIGURE 21.

3. TWO-RATE CHARGE. This method also uses a high charging rate at the beginning followed by a lower rate. Two resistors control the charging rate. One resistor controls the charging rate at the beginning of the cycle and a second resistor reduces the charging rate when the voltage in the cells reach 2.37 volts. A relay automatically controls the second resistor. The two-rate charging cycle is shown in FIGURE 22.

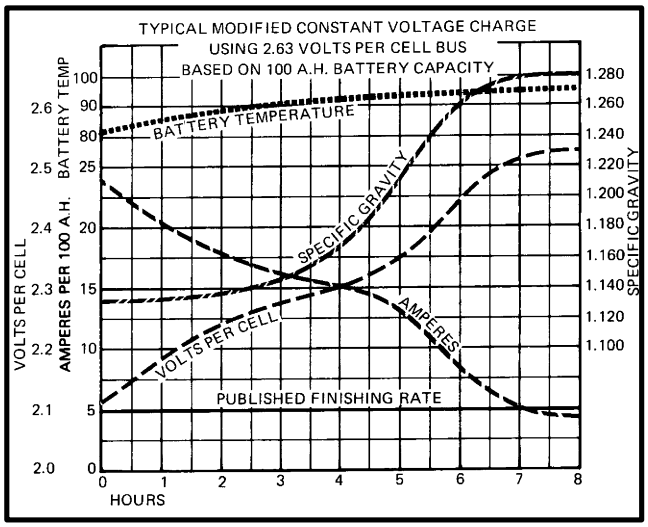


FIGURE 21. MODIFIED CONSTANT VOLTAGE CHARGER

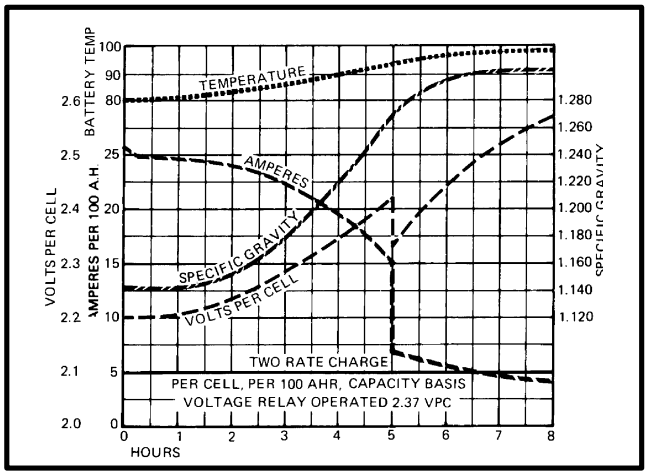
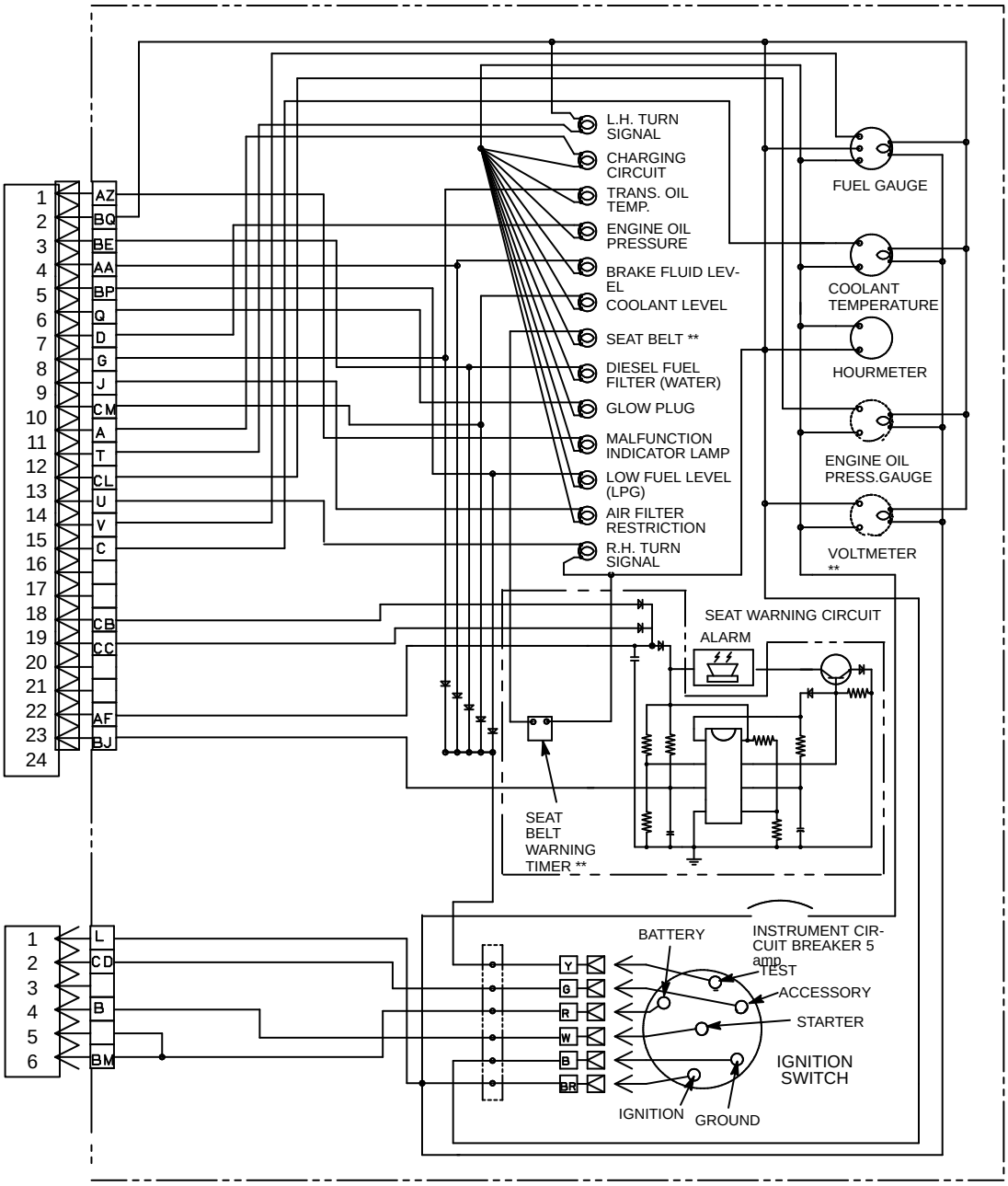


FIGURE 22. TWO-RATE CHARGING CYCLE

NOTE: Many users have battery chargers that can follow a program to automatically charge a battery according to recommendations of the battery manufacturer. Use the recommendations of the battery manufacturer for charging the battery.

Troubleshooting The Charger

Battery chargers normally operate automatically without constant attention. It is necessary to make a periodic



**NOT USED IN EUROPE

1352092

24 PIN CONNECTOR FUNCTIONS

1. MALFUNCTION INDICATOR (GM GAS ONLY)
2. CLUSTER GROUND
3. DIESEL FUEL FILTER
4. LOW BRAKE FLUID LEVEL
5. LOW FUEL LEVEL (LPG)
6. GLOW PLUG
7. ENGINE OIL PRESSURE
8. TRANS. OIL TEMP.
9. AIR FILTER RESTRICTION
10. LOW COOLANT LEVEL
11. CHARGING CIRCUIT
12. L.H. TURN SIGNAL
13. ENGINE OIL PRESS. GAUGE
14. R.H. TURN SIGNAL
15. FUEL GAUGE
16. COOLANT TEMP.
17. NOT USED
18. NOT USED
19. REVERSE
20. FORWARD
21. NOT USED
22. NOT USED
23. PARKING BRAKE
24. SEAT SWITCH

6 PIN CONNECTOR FUNCTIONS

1. IGNITION
2. ACCESSORY
3. NOT USED
4. STARTER
5. BATTERY
6. BATTERY

FIGURE 4. INSTRUMENT CLUSTER SCHEMATIC

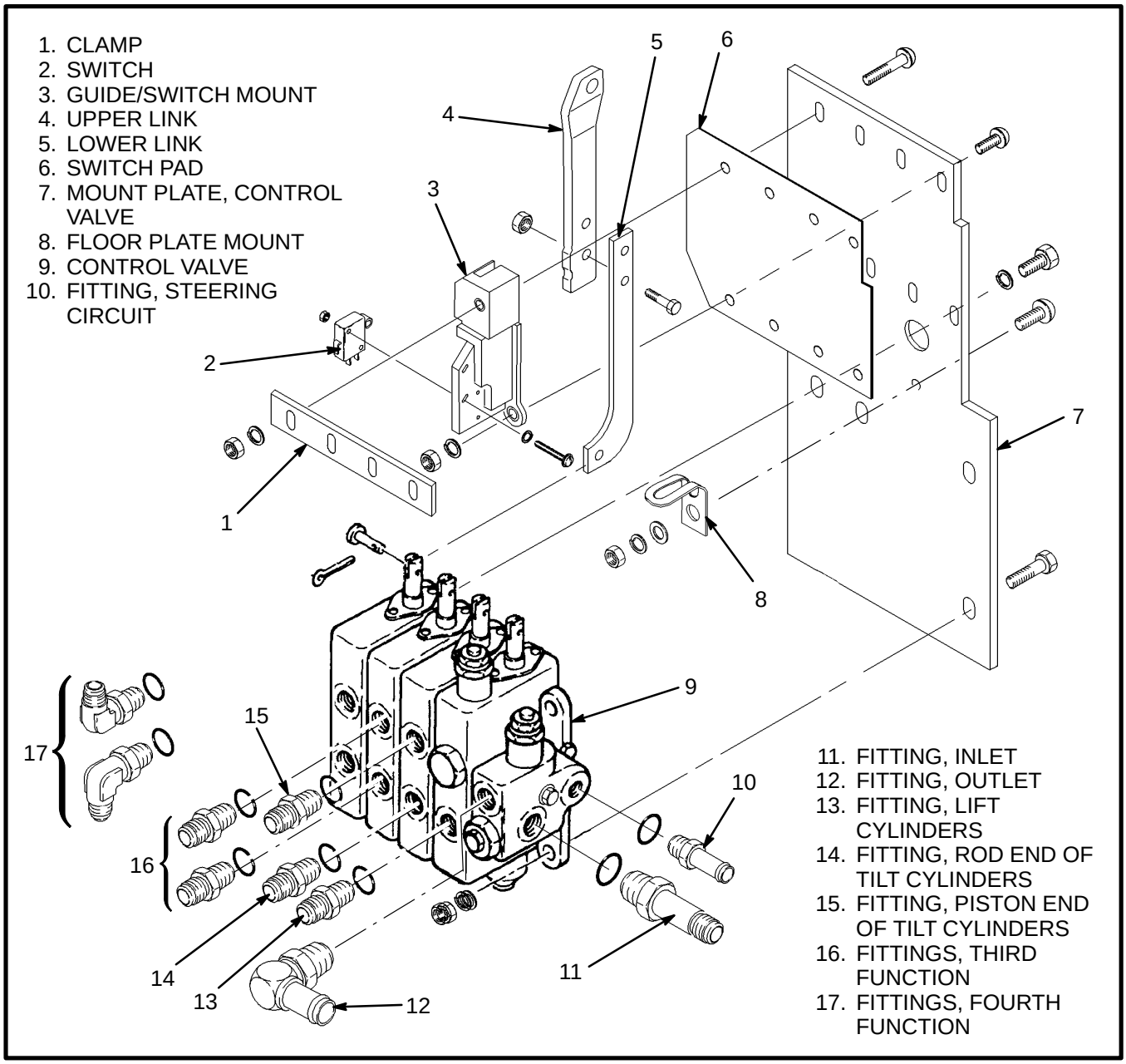


FIGURE 8. CONTROL VALVE MOUNTING, E1.50–3.20XM (E25–65XM)

INTRODUCTION

GENERAL

On lift trucks before "XM_2" when turning the key switch to the **ON** position the Brush Wear Indicator and Motor Temperature Indicator will illuminate. On "XM_2" lift trucks, there is no brush wear indicator, but the LCD screen will show a status code indicating that the brushes need replacing as described in the **OPERATING MANUAL**. Contact your dealer if any LED Indicators do not illuminate during the "check" part of initial lift truck operation.

This section contains a MAINTENANCE SCHEDULE and the instructions for maintenance and inspection.

The MAINTENANCE SCHEDULE has time intervals for inspection, lubrication and maintenance. The time intervals are based on a normal operation. A normal operation is considered to be one eight hour shift per day in a relatively clean environment on an improved surface. Multiple shifts, dirty operating conditions, etc., will require a reduction in the recommended time periods in the MAINTENANCE SCHEDULE.

Your dealer for Hyster lift trucks has the equipment and trained service personnel to do a complete program of inspection, lubrication and maintenance. A regular program of inspection, lubrication and maintenance will help your lift truck give more efficient performance and operate for a longer period of time.

Some users have service personnel and equipment to do the inspection, lubrication and maintenance shown in the MAINTENANCE SCHEDULE. Service Manuals are available from your dealer for Hyster lift trucks to help users who do their own maintenance.

⚠ WARNING

Do not make repairs or adjustments unless you have both authorization and training. Repairs and adjustments that are not correct can make a dangerous operating condition.

Do not operate a lift truck that needs repairs. Report the need for repairs immediately. If repair is necessary, put a "DO NOT OPERATE" tag in the operator's area. Remove the key from the key switch. Disconnect the battery connector.

⚠ CAUTION

Disposal of lubricants and fluids must meet local environmental regulations.

Disposal of batteries must meet local environmental regulations.

SERIAL NUMBER DATA

The serial number code for the lift truck is on the nameplate. The code is also stamped on top of the rear bulkhead of the frame. It is on the bulkhead inside the right rear leg of the overhead guard.

HOW TO MOVE A DISABLED LIFT TRUCK

⚠ WARNING

Use extra caution when towing a lift truck if any of the following conditions exist:

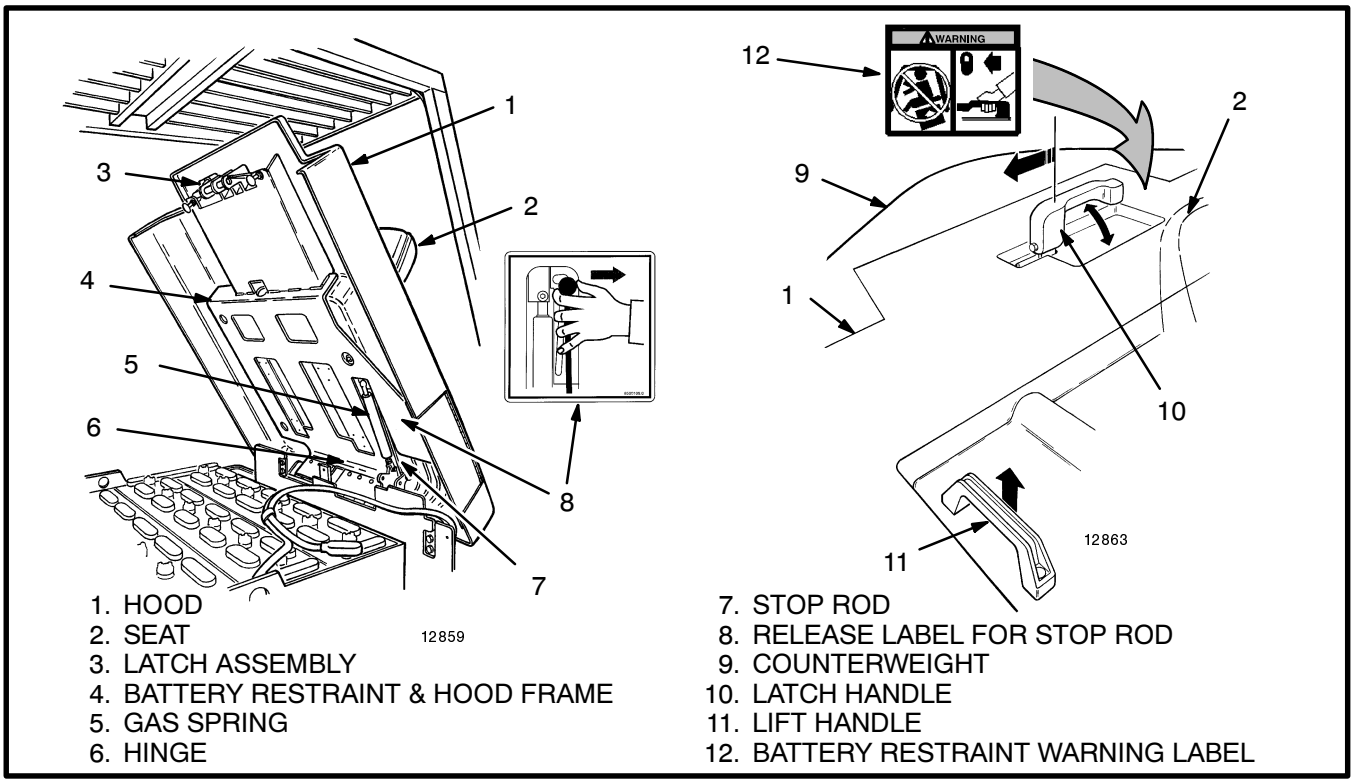
- **Brakes do not operate correctly**.
- **Steering does not operate correctly**.
- **Tires are damaged**.
- **Traction conditions are bad**.
- **The lift truck must be moved on a steep grade**.

If the steering pump motor does not operate, steering control of the lift truck can be slow and difficult. Do NOT tow the lift truck if there is no power. Poor traction can cause the disabled lift truck or towing vehicle to slide. Steep grades will require additional brake force to stop the lift truck.

Never carry a disabled lift truck unless the lift truck MUST be moved and cannot be towed. The lift truck used to carry the disabled lift truck MUST have a rated capacity equal to or greater than the weight of the disabled lift truck. The capacity must be for a load center equal to half the width of the disabled lift truck. See the nameplate of the disabled lift truck for the approximate total weight. The forks must extend the full width of the disabled lift truck. Put the weight center of the disabled lift truck on the load center of the forks. Do not damage the under side of the lift truck.

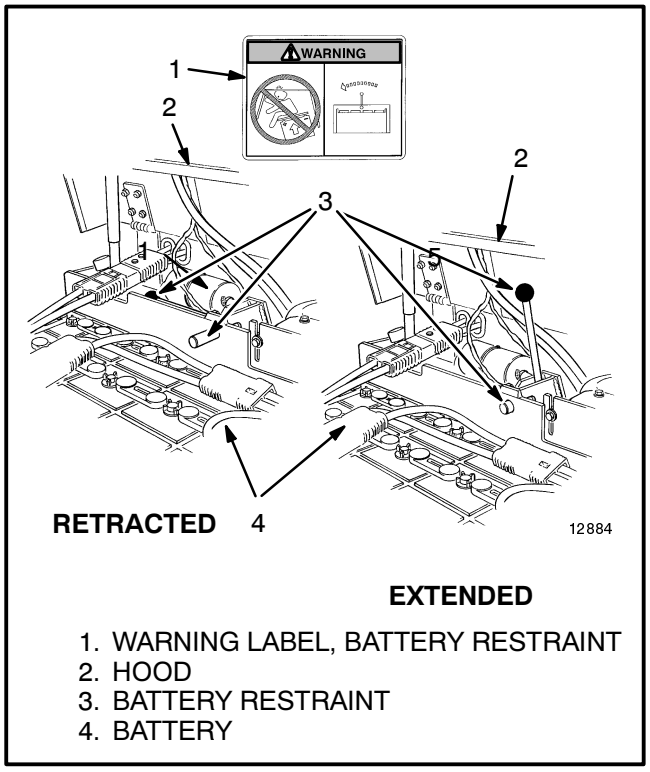
How To Tow A Lift Truck

1. The towed lift truck must have an operator.



1. HOOD
2. SEAT
3. LATCH ASSEMBLY
4. BATTERY RESTRAINT & HOOD FRAME
5. GAS SPRING
6. HINGE
7. STOP ROD
8. RELEASE LABEL FOR STOP ROD
9. COUNTERWEIGHT
10. LATCH HANDLE
11. LIFT HANDLE
12. BATTERY RESTRAINT WARNING LABEL

FIGURE 11. BATTERY RESTRAINT, E25-65XM, E25-65XM$_2$



1. WARNING LABEL, BATTERY RESTRAINT
2. HOOD
3. BATTERY RESTRAINT
4. BATTERY

FIGURE 12. BATTERY RESTRAINT - J40-65XM, J40-65XM$_2$

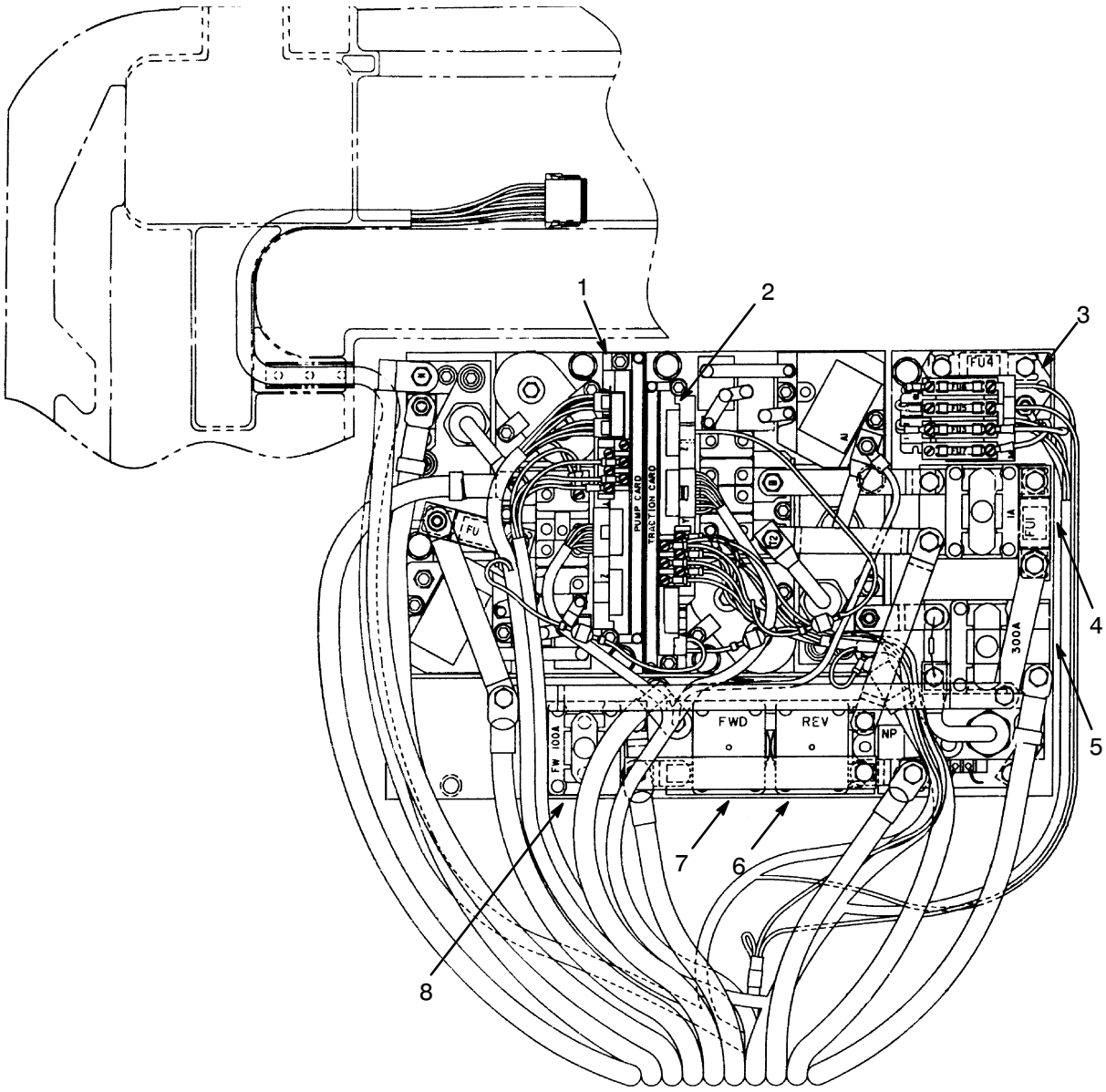
Battery Restraint System - J40-65XM, J40-65XM$_2$ (See FIGURE 12.)

The battery restraint is a heavy steel rod at the rear of the battery compartment. An adjustable spacer plate is used inside the battery compartment to prevent forward and backward movement of the battery. The batteries for these lift trucks must fit the battery compartment width with a maximum of 13 mm (0.5 in) clearance.

The hood cannot be closed unless the battery restraint is engaged. The battery restraint rod at the top rear of the battery compartment must be aligned over the edge of the battery. The handle of the battery restraint must also be in the down position to close the hood. Use the handle to move the battery restraint rod over the edge of the battery so that the handle can be moved to the down position.

Battery

NOTE: There can be one of two types of batteries. One type has removable cell caps. The other type has sealed cells. The sealed batteries require a different charger, the electrolyte level or specific gravity cannot be checked and water cannot be added to the electrolyte.



MOTOR CONTROLLER WITH REGENERATIVE BRAKING, 1A BY-PASS, FIELD WEAKENING AND SCR CONTROLLER FOR HYDRAULIC PUMP MOTOR

1. CONTROL CARD, SCR CONTROL FOR HYDRAULIC PUMP MOTOR
2. CONTROL CARD, TRACTION, WITH REGENERATIVE BRAKING
3. CONTACTOR, POWER STEERING
4. CONTACTOR, 1A
5. CONTACTOR, REGENERATIVE BRAKING
6. CONTACTOR, REVERSE DIRECTION
7. CONTACTOR, FORWARD DIRECTION
8. CONTACTOR, FIELD WEAKENING

FIGURE 22. EV-100ZX SCR MOTOR CONTROLLER FOR E45-65XM

d. Any cleaning cloths that will be washed must be cleaned so that fibers are not released into the air.

NOTE: Some lift trucks are used in operations where the automatic adjusters can be slow to adjust the brake shoes. If the brakes need adjustment, operate the lift truck in forward and reverse 10 times. Apply the brake pedal firmly, but do not cause the wheels to slide. If the automatic adjusters do not adjust the brake shoes, a qualified service person must check the operation and condition of the brakes.

⚠ CAUTION

Do NOT use an oil solvent to clean the wheel cylinder. Use a solvent approved for cleaning of brake parts. Do not permit oil or grease in the brake fluid or on the brake linings.

Check the brake lining and parts of the brake assembly for wear or damage. See the sections **THE BRAKE SYSTEM** of the **SERVICE MANUAL,** for the removal and installation procedures of the drive wheels and hubs. If the brake linings or brake shoes are worn or damaged, they must be replaced. Brake shoes must be replaced in complete sets. Inspect the brake drums for cracks or damage. Replace any damaged parts.

CONTACTORS

Always replace the contacts of a contactor as a complete set. See the motor controller sections of the **SERVICE MANUAL** for replacement and adjustment procedures.

WHEEL BEARINGS

Steer Wheels, Lubrication

Lubricate the wheel bearings in the hubs for the steer wheels with multi-purpose grease as described in the section **THE STEERING AXLE, 1600 SRM 619** E25-40XMS, E25-40XMS$_2$, the section **THE STEERING AXLE, 1600 SRM 258** E45-65XM, E45-65XM$_2$ or the section **THE STEERING AXLE, 1600 SRM 316** J40-65XM, J40-65XM$_2$ of the **SERVICE MANUAL**

Drive Wheels, Lubrication

Lubricate the inner wheel bearings in the hubs for the drive wheels with multi-purpose grease as described in the section **DRIVE AXLE, SPEED REDUCER AND DIFFERENTIAL, 1400 SRM 618** E25-40XMS, E25-40XMS$_2$, the section **DRIVE AXLE, SPEED REDUCER AND DIFFERENTIAL, 1400 SRM 285** E45-65XM, E45-65XM$_2$ or the section **DRIVE AXLE, SPEED REDUCER AND DIFFERENTIAL, 1400 SRM 575** J40-65XM, J40-65XM$_2$ of the **SERVICE MANUAL.**

LIFT CHAINS

⚠ WARNING

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

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.

Remove the lift chains. Clean the lift chains by soaking them in a solvent that has a petroleum base for at least 30 minutes. Use compressed air to completely dry the chains when they are clean.

Lubricate the lift chains by soaking them in 30W engine oil for at least 30 minutes. Remove the chains from the oil. Hang the chains for one hour so that excess oil will drain from the chains.

GENERAL PROCEDURES

HOW TO CHARGE THE BATTERY

⚠ WARNING

The acid in the electrolyte can cause injury. If electrolyte is spilled, use water to flush the area. Make the acid neutral with a solution of sodium bicarbonate (soda) and water. Acid in the eyes must be immediately flushed with water.

Batteries generate explosive fumes when they are being charged. Keep fire, sparks and burning material

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 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 the sections:

- **TRANSISTOR MOTOR CONTROLLERS (SR AND SP), Description & Operation And Repairs & Adjustments, 2200 SRM 724**

10. Disconnect the battery, open the electrical compartment and discharge capacitors C1 as described in the earlier WARNING.

11. Connect the gate lead, disconnect any jumper wires or connect the F1 or F2 leads. Connect the battery. Raise the drive wheels and remove the blocks. Check for normal operation of the traction motor.

WELDING REPAIRS

Some repairs require welding. If an acetylene or arc welder is used, do the procedures in the following WARNING and CAUTION.

⚠ WARNING

Welding can cause a fire or an explosion. Always follow the instructions in the FRAME section of the SERVICE MANUAL if a fuel or hydraulic tank must be welded. Make sure there is no fuel, oil, or grease near the weld area. Make sure there is good ventilation in the area where the welding must be done.

Do not heat, weld, or bend forks. Forks are made of special steel using special methods. Get information from your dealer for Hyster lift trucks before welding on a mast.

⚠ CAUTION

When an arc welder is used, always disconnect the battery connector on the lift truck. This action will prevent damage to the SCR control.

Connect the ground clamp for the arc welder as close as possible to the weld area. This action will prevent damage to a bearing from the large current from the welder.

CHANGES TO THE OVERHEAD GUARD

⚠ WARNING

Do not operate the lift truck without the overhead guard correctly fastened to the lift truck.

Do not make changes to the overhead guard by welding or drilling. Welding, or drilling holes that are too big in the wrong location, can reduce the strength of the overhead guard. See your dealer for Hyster lift trucks before making any changes to the overhead guard.

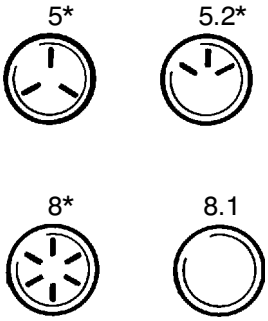
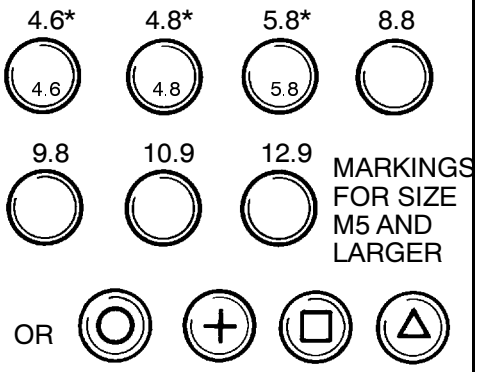
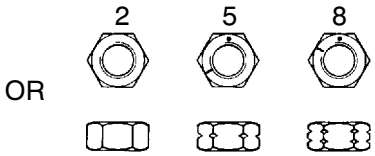
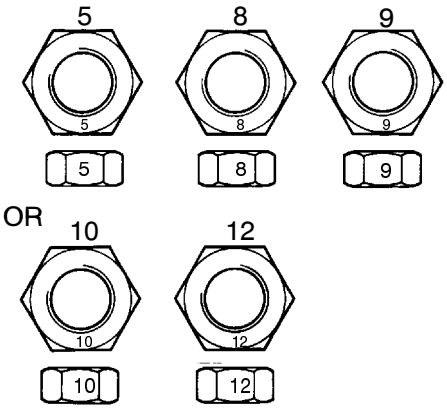
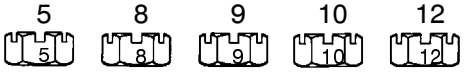
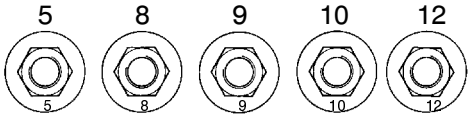
TIRES AND WHEELS, E25-65XM, E25-65XM$_2$

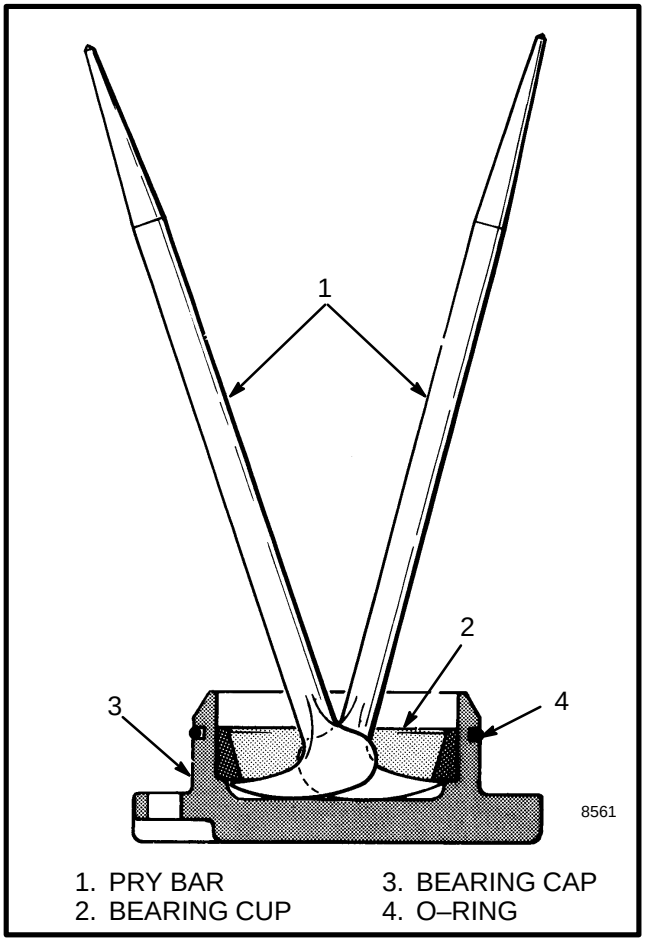
This series of lift trucks use solid rubber tires. See FIGURE 41. Solid rubber tires made from softer or harder material can be installed as optional equipment. The tread on the solid rubber tires can be either smooth or it can have lugs. Electric compound tires are recommended. Do not mix types of tires or tread on the lift truck.

⚠ WARNING

The type of tire is shown on the nameplate. Make sure the nameplate is correct for the type of tires on the lift truck.

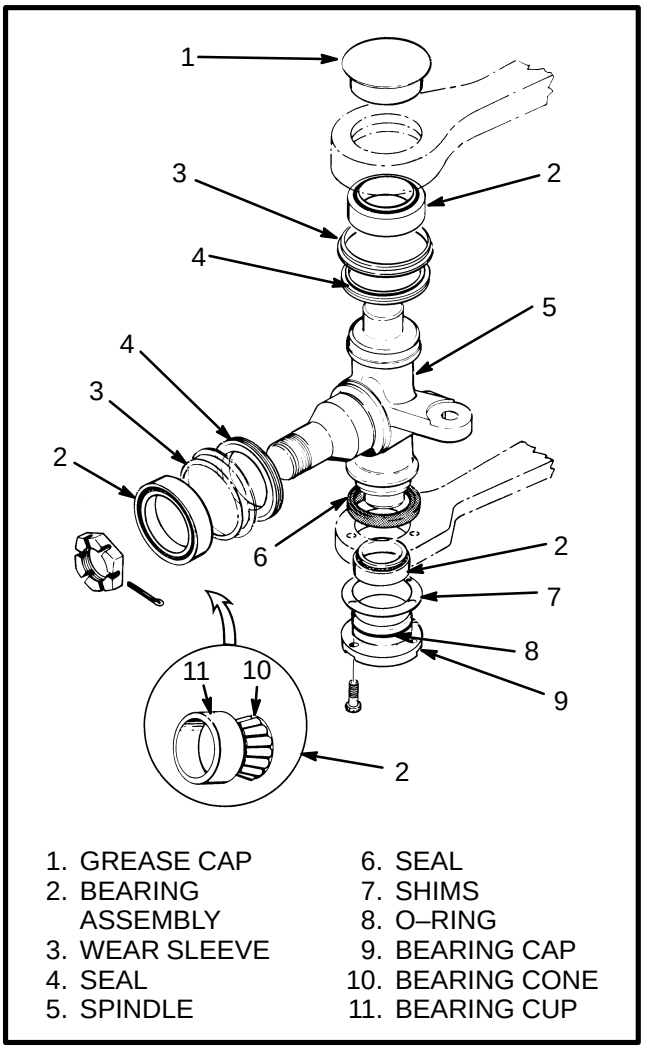
TABLE 2. STUDS AND NUTS

TYPE OF FASTENER	INCH FASTENERS STRENGTH LEVELS: SAE GRADES * MARKINGS NOT REQUIRED	METRIC FASTENERS STRENGTH LEVELS: PROPERTY CLASS * MARKINGS NOT REQUIRED
 STUDS	 	
 HEX NUTS	 	
 HEX SLOTTED NUTS	MARKINGS NOT REQUIRED	
 HEX FLANGE NUTS	MARKINGS NOT REQUIRED	



1. PRY BAR
2. BEARING CUP
3. BEARING CAP
4. O–RING

FIGURE 3. REMOVE THE BEARING CUP



1. GREASE CAP
2. BEARING ASSEMBLY
3. WEAR SLEEVE
4. SEAL
5. SPINDLE
6. SEAL
7. SHIMS
8. O–RING
9. BEARING CAP
10. BEARING CONE
11. BEARING CUP

FIGURE 4. SPINDLE ASSEMBLY

3. Tilt the spindle and lift the spindle from the axle. If necessary, remove the bearing and seals from the spindle. If necessary, remove the wear sleeve and bearing cup from the axle frame.

4. Repeat the procedure for the other spindle and tie rod.

Assembly And Installation (See FIGURE 4.)

1. Install new seals on the spindle. Lubricate the seals with grease. If necessary, press new bearing cones on the spindle.

2. Lubricate the bearings with wheel bearing grease. Make sure the bearings are filled with grease. If necessary, press the new bearing cups into the steering axle frame and bearing cap. Install the wear sleeve in the steering axle frame.

3. Install the spindle in the steering axle. Install the bearing cap without the O–rings. Measure the clearance between the bearing cap and the axle. See FIGURE 2. Remove the bearing cap and install enough shims to give a preload of 0.00 to 0.13 mm (0.000 to 0.005 in).

NOTE: The spindle bearings must have no clearance. Install shims 0.00 mm to 0.13 mm (0.000 to 0.005 in) less than the measured gap.

4. Install the O–ring on the bearing cap. Install the bearing cap and capscrews. Tighten the capscrews to 44 Nm (32 lb_f ft).

5. Install the tie rod to the spindle arm or steering cylinder. If removed, tighten the castle nut to 163 Nm (120 lb_f ft). Tighten the castle nut until the cotter pin can be installed.

6. Install the grease cap on the top of the steering axle.

7. Repeat the procedure for the other spindle and tie rod.

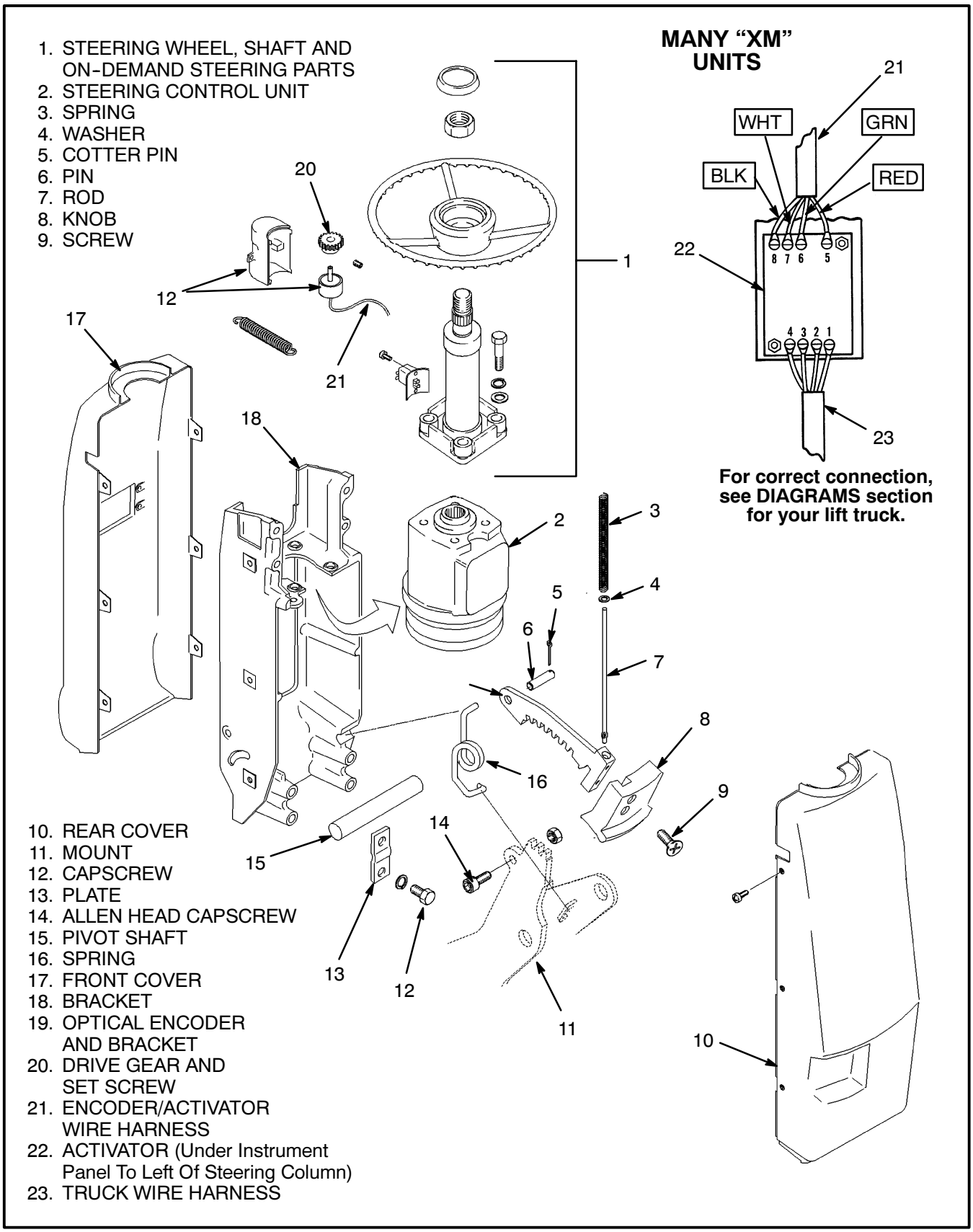


FIGURE 4. STEERING WHEEL AND STEERING COLUMN ASSEMBLY (3 of 3)

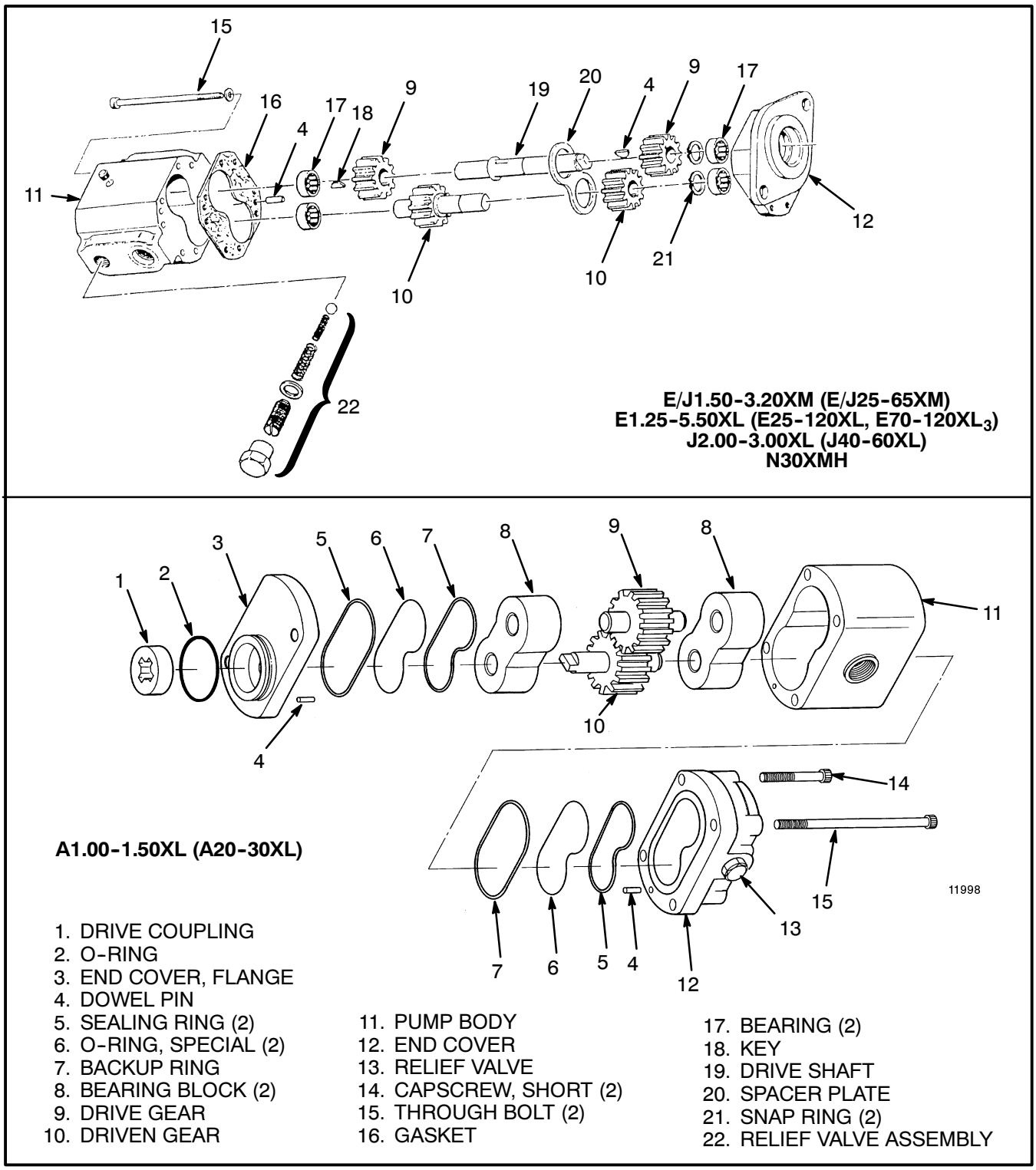


FIGURE 10. POWER STEERING PUMP

REPAIRS, POWER STEERING PUMP

Seals that are worn or damaged are the most common cause of pump repair. The pump bearings, gears, and shafts also wear. Most service persons do not repair a worn pump. The cost of repairs can be greater than the cost of a new pump. The seals can be replaced in the hydraulic pump. Replace a hydraulic pump that is worn or damaged.

The power steering pump is a single section gear pump that is fastened to the power steering motor. The inlet

NOTES