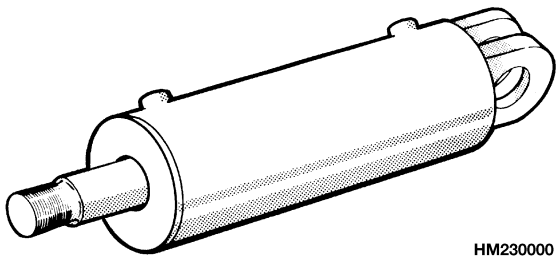
TILT CYLINDERS

ALL MODELS EXCEPT GLP/GDP3.5-5.5LJ/MJ (GP/GLP/GDP70-120LJ/MJ) [C813, E813]; GC070-120LJ/MJ [C818, D818]; ESC030-040FA [A883]; MCW025/030/040-E [C819]



HM230000

*Table 6. Torque Values for Inch Fasteners**

Size and Pitch		Grade 2[1]		Grade 5[2]		Grade 8[3]	
		lbf ft	N•m	lbf ft	N•m	lbf ft	N•m
1/4 1/4	20 UNC 28 UNF	4 5	6 6	6 7	9 10	9 10	12 14
5/16 5/16	18 UNC 24 UNF	8 9	11 13	13 14	18 20	18 20	25 28
3/8 3/8	16 UNC 24 UNF	15 17	20 23	23 26	31 36	33 37	44 50
7/16 7/16	14 UNC 20 UNF	24 27	33 36	37 41	50 56	52 58	71 79
1/2 1/2	13 UNC 20 UNF	37 41	50 56	57 85	77 115	80 90	110 120
9/16 9/16	12 UNC 18 UNF	53 59	72 80	82 91	110 125	115 130	155 175
5/8 5/8	11 UNC 18 UNF	73 83	99 110	115 130	155 175	160 180	215 245
3/4 3/4	10 UNC 16 UNF	130 145	175 195	200 225	270 300	280 315	380 425
7/8 7/8	9 UNC 14 UNF	125 140	170 185	320 355	435 480	455 500	615 680
1 1	8 UNC 14 UNF	185 210	255 285	485 540	655 735	680 765	925 1,040
1-1/8 1-1/8	7 UNC 12 UNF	265 300	360 405	595 670	805 905	965 1,080	1,310 1,470
1-1/4 1-1/4	7 UNC 12 UNF	375 415	510 565	840 930	1,140 1,260	1,360 1,500	1,850 2,050
1-3/8 1-3/8	6 UNC 12 UNF	490 560	665 760	1,100 1,250	1,490 1,700	1,780 2,040	2,420 2,760
1-1/2 1-1/2	6 UNC 12 UNF	650 735	885 995	1,460 1,650	1,980 2,230	2,370 2,670	3,210 3,620

* Unless otherwise specified [1] Approximately equal to metric Property Class 5.8 [2] Approximately equal to metric Property Class 8.8 [3] Approximately equal to metric Property Class 10.9

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

When a direct current is applied to a discharged cell, the lead sulfate is changed into lead and sulfuric acid. The lead goes to the positive plate and stays as lead and to the negative plate and stays as lead peroxide. See Figure 6. The concentration of sulfuric acid in the electrolyte increases. The specific gravity of the electrolyte increases as the concentration of sulfuric acid increases. In a fully charged cell, the positive plate again contains the lead peroxide and the negative plate contains the sponge lead.

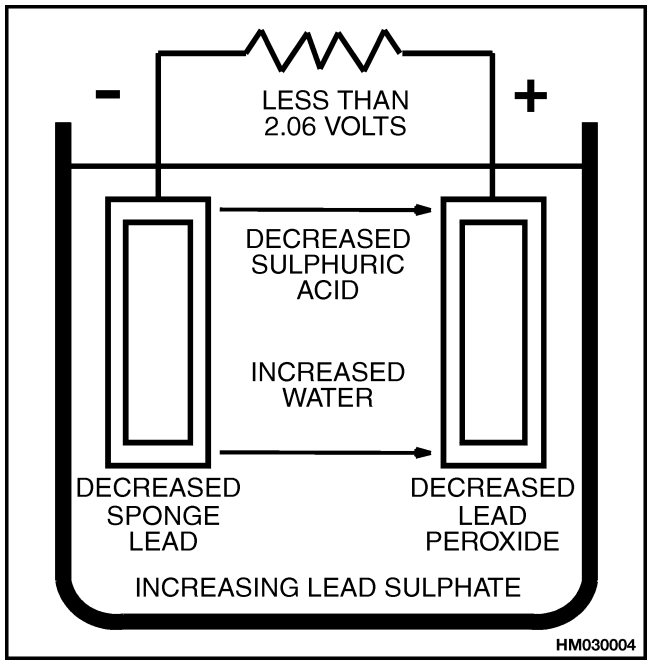


Figure 4. Discharging Cell

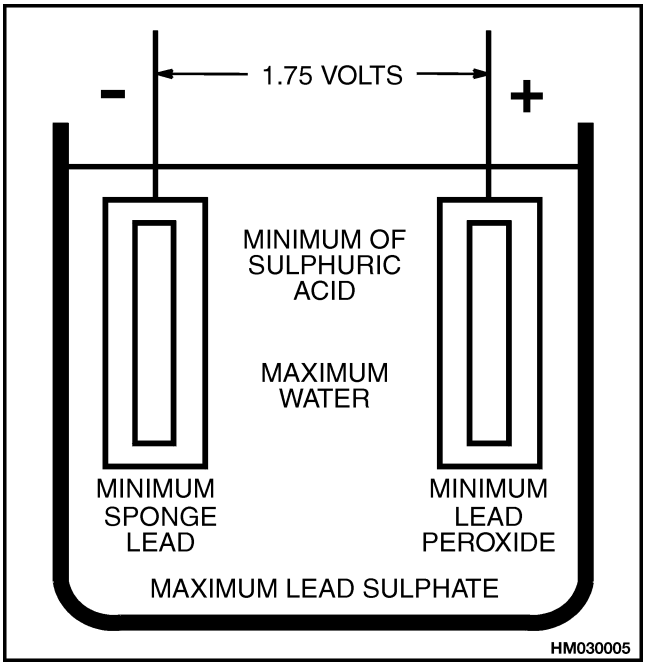


Figure 5. Discharged Cell

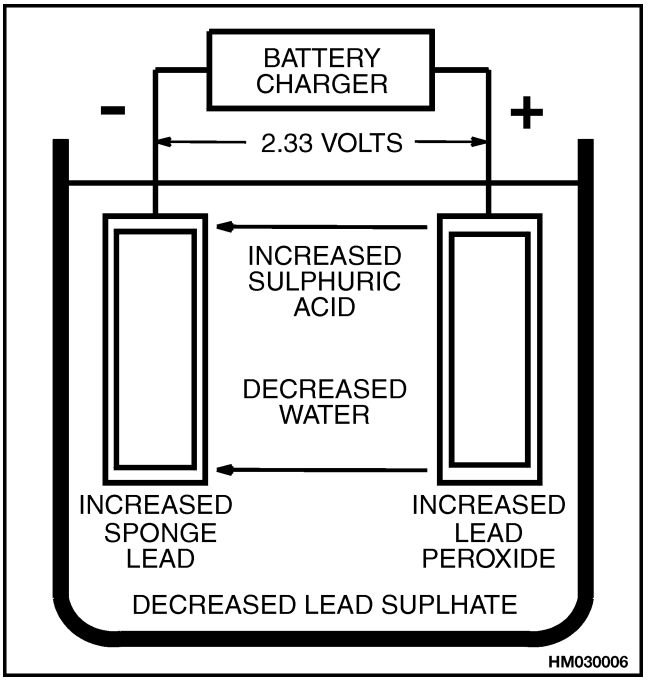
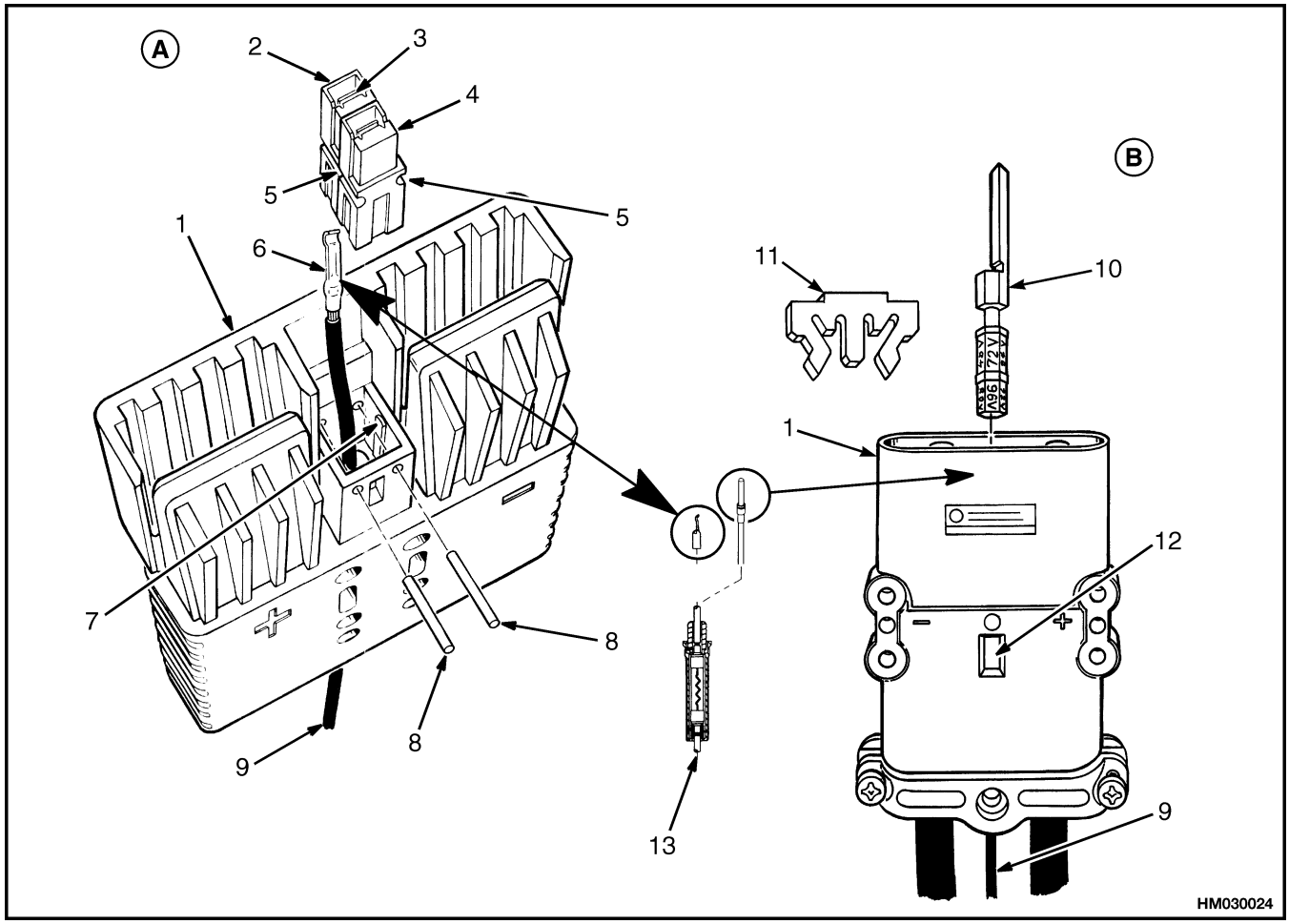


Figure 6. Charging Cell



NOTE: INDICATOR INSERT (2). GREEN - FOR BATTERY WITH CELL CAPS. GRAY - FOR BATTERY WITH SEALED CELLS.

NOTE: CONNECTOR BODY COLOR [ANDERSON SBE CONNECTOR ONLY (1)]. GRAY - 36-VOLT BATTERY. BLUE - 48-VOLT BATTERY. GREEN - 72-VOLT BATTERY. BLACK - 80-VOLT BATTERY.

A. ANDERSON SBE OR SBX CONNECTOR

B. FEM OR DIN CONNECTOR

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 (2) AND BLACK (4) CONNECTORS ALIGN ON KEY]
8. LOCK PINS FOR +12 VOLT CONNECTOR (MUST INSTALL FROM FRONT OF CONNECTOR THROUGH RED AND 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 (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 23. Detail of Battery Connectors With +12 Volt Tap

Spindles, Bearings, and Tie Rods Repair

REMOVE

WARNING

PUTTING THE LIFT TRUCK ON BLOCKS

The lift truck must be put on blocks for some types of maintenance and repair. The removal of the following assemblies will cause large changes in the center of gravity: drive axle, battery, or counterweight. When the lift truck is put on blocks, put additional blocks in the following positions:

1. **If the mast and drive axle are removed, put blocks under the counterweight so the lift truck cannot fall backward.**
2. **If the battery (electric lift trucks) or counterweight is removed, put blocks under the mast so the lift truck cannot fall forward.**

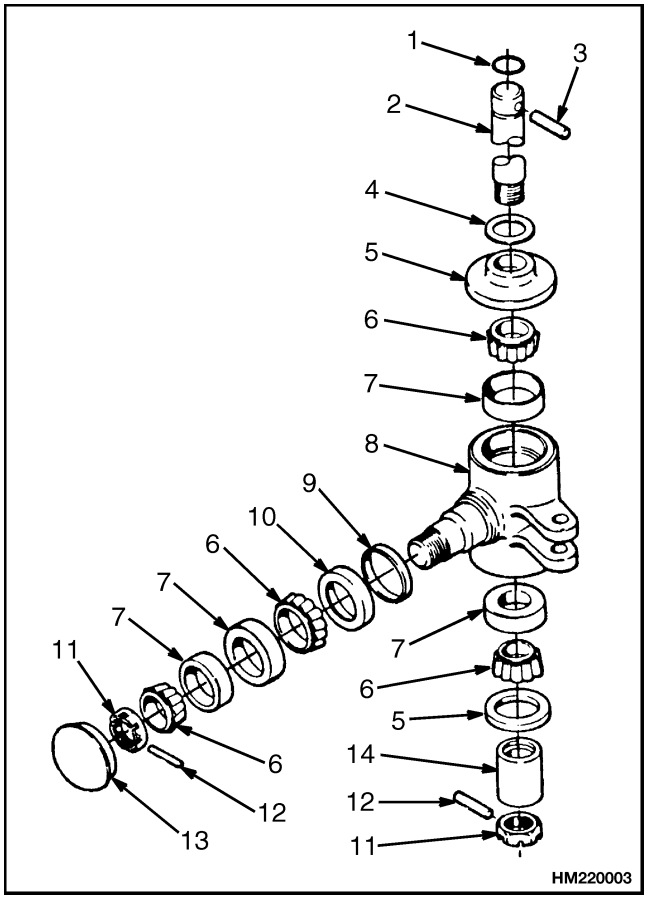
Put the lift truck on blocks on a solid, even, and level surface. Verify the blocks of stands have enough capacity to hold the lift truck. Use additional blocks next to the tires as necessary to prevent movement of the lift truck. Verify the lifting devices used during repairs can lift the weight of the parts and assemblies.

NOTE: Dirt and corrosion can make the spacer difficult to remove from the steering axle frame. A machined space is made in the top of the spacer so that the spacer can be removed with a bearing puller.

Remove wheel or hub from steering axle spindle. See Figure 3. Remove pin to disconnect tie rod from spindle. Remove cotter pin and castle nut from bottom of kingpin. Use a driver to remove kingpin. Remove sleeve and then spindle from axle. Use a driver to remove bearings and seals from spindle.

INSTALL

1. Use new bearings and seals. See Figure 2 and Figure 3. Apply grease to bearings and kingpin as they are installed in axle. Install bearings in spindle. Install seals in correct position. Align spindle in axle and install kingpin. Make sure new O-ring is installed at top of kingpin. Install sleeve on bottom of kingpin. Install castle nut and tighten it to 90 N•m (66 lbf ft). Loosen castle nut to less than 34 N•m (25 lbf ft). Tighten nut to 34 N•m (25 lbf ft). If cotter pin cannot be installed with nut tightened to 34 N•m (25 lbf ft), tighten castle nut until cotter pin can be installed. Install cotter pin.



1. O-RING
2. KINGPIN
3. GROOVE PIN
4. SPACER
5. SEAL
6. BEARING CONE
7. BEARING CUP
8. SPINDLE
9. SEAL
10. WEAR SLEEVE
11. CASTLE NUT
12. COTTER PIN
13. GREASE CAP
14. SLEEVE

Figure 3. Spindle Assembly

2. Connect tie rods. Verify belleville washers are installed on both sides of bushings.

3. Install wheels or hubs. See the section Wheels and Hubs Repair for proper installation procedure. Tighten wheel nuts to 237 to 305 N•m (175 to 225 lbf ft).

When the steering wheel stops moving, the metering action in the metering section also stops. The **NEUTRAL** position springs return the sleeve to the **NEUTRAL** position, stopping oil flow to or from the cylinder. The pressure stays in the steering cylinder to keep the steer tires in position. Oil from the pump flows through the steering control unit to the tank or other parts of the system. To return the steer wheels to the straight position, the steering wheel must be rotated in the opposite direction. The steering control unit will operate as described, but all parts will rotate in the opposite direction.

Steering Wheel and Column Assembly Repair

The upper end of the steering shaft has splines for the steering wheel. A large hex nut holds the steering wheel onto the steering column. The horn button is the cover for the center of the steering wheel. The lower end of the steering column has splines or a tang to engage the steering control unit. See Figure 5 and Figure 6.

The steering column assembly is adjustable and held in position by a latch. The position of the steering column assembly can be changed as needed for different operator requirements. An access cover on the steering column gives access to the steering control unit, key switch, horn switch, and if installed, the direction switch.

ASSEMBLY COMPONENTS, REMOVE

NOTE: This procedure is for the removal of all components of the steering column assembly. All components are not often removed for a repair procedure. Do only those steps of the procedure necessary to remove the required component. See Figure 5 and Figure 6.

WARNING

The hydraulic hoses must be connected to the correct ports or the steering system will not operate as expected, which can cause damage or personal injury. Make sure the hoses are identified and connected correctly.

CAUTION

Disconnect the negative battery cable on internal combustion trucks. Disconnect the battery connector on electric trucks. Disconnect the battery before removing any covers.

1. Attach a tag on the battery connector or negative cable stating DO NOT CONNECT BATTERY. Move the steering column to the most **FORWARD** position. Remove the column tilt lever. Remove the upper and lower access covers from the steering column.
2. Remove the key switch and static strap from the housing of the steering column. Make an identification of the electric wires and disconnect them from the key switch.
3. On units with the Direction Control Handle, Remove the direction switch assembly from the housing of the steering column. Make an identification of the electric wires and disconnect them from the direction switch. See Figure 3.
4. Remove the plastic rivets that fasten the bracket for the horn switch to the housing of the steering column. Move the horn switch and bracket away from the steering column. See Figure 5 and Figure 6.

CAUTION

If a puller tool is used to remove steering wheel from steering column, be careful not to damage the horn wires.

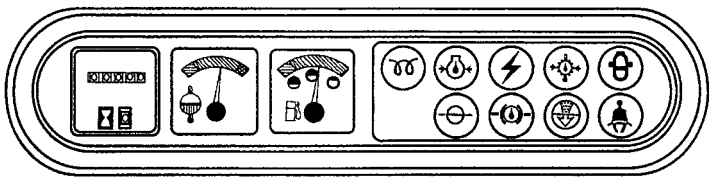
5. Remove the horn button assembly and electrical wires. Remove the large hex nut and the steering wheel from the shaft. A puller tool makes removal of the steering wheel easier, but not all steering wheels have puller holes.
6. On lift truck models ERC/P16-20AAF (ERC030-040AG/BG) (A814), (ERC20-30AGF (ERC040-065RG/ZG) (E108), and ERP20-30ALF (B216) units, remove the optical encoder housing and optical encoder from the steering column. Make an identification of the electrical wires and disconnect them from the assemblies. See Figure 5.

Yale

Maintenance

INSTRUMENT CLUSTER

GP/GLP/GDP16-20AF/BF
(GP/GLP/GDP030-040AF/BF) [A810];
ERC/P12-16-20AAF
(ERC030-040AF) [A814];
ERP20-30ALF [B216];
ERC20-30AGF
(ERC040-065RF/ZF) [E108];
GP/GLP/GDP2.00-3.00RF/TF
(GP/GLP/GDP040-060RG/TG/ZG) [A875];
GLP/GDP16-20AF
(GP/GLP/GDP030-040AF) [B810];
NR/NDR030-045AD [B815];
NS040-050AE [B816];
GC/GLC040-065RG/TG/ZG [E187];
NR/NDR030-045CA [C829];
GC/GLC030-040AF [B809]



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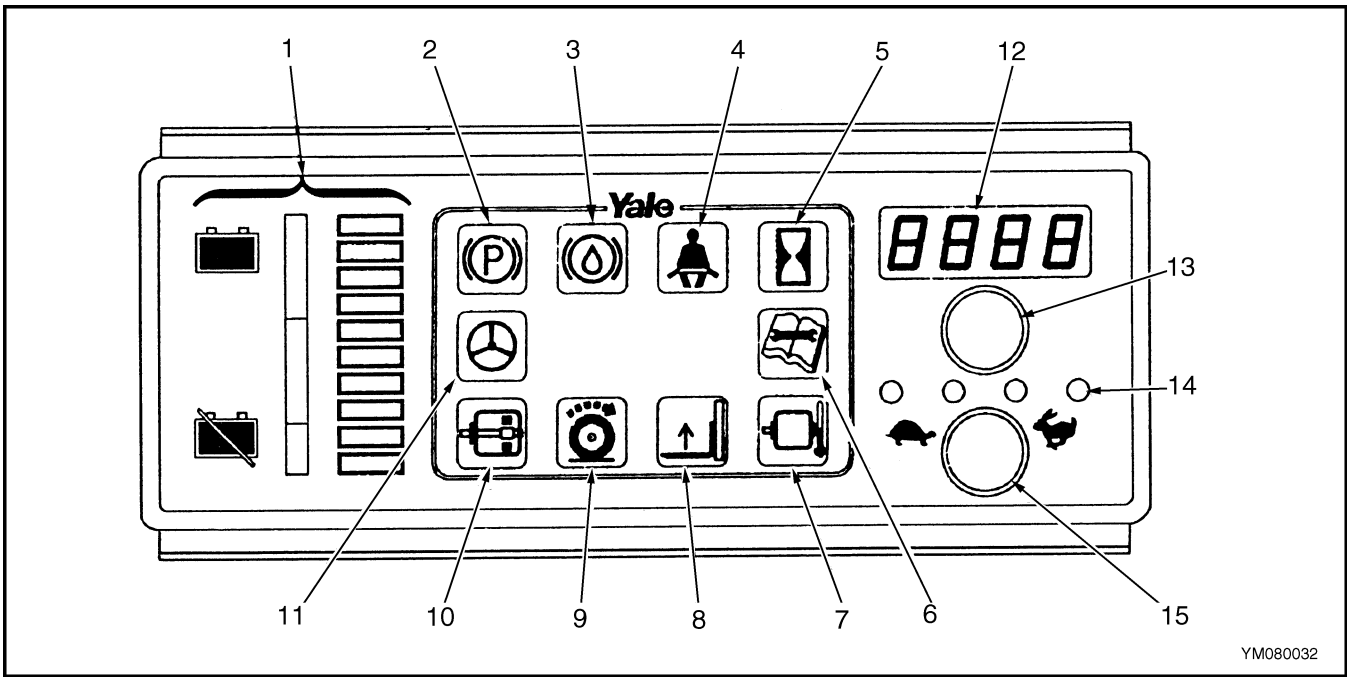


1. BATTERY INDICATOR
2. PARKING BRAKE INDICATOR
3. BRAKE FLUID LOW INDICATOR
4. FASTEN SEAT BELT INDICATOR
5. HOURMETER FUNCTION INDICATOR
6. STATUS CODE FUNCTION INDICATOR
7. MOTOR TEMPERATURE INDICATOR
8. LIFT PUMP MOTOR INDICATOR
9. TRACTION MOTOR INDICATOR
10. BRUSH WEAR INDICATOR
11. STEERING PUMP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

Figure 5. Premium Display Panel

Description of Features on the Premium Display Panel

Battery Indicator

The battery indicator is a scale with a series of 10 Light Emitting Diodes (LED)s in three colors (green, orange, and red). As the battery voltage decreases during operation, different LEDs illuminate to indicate a discharged battery. No more than two LEDs are illuminated at one time. When the battery is fully charged, the two green LEDs at the end of the scale are illuminated. When the battery discharges during operation, the LEDs illuminate from top to bottom (green to red). See Figure 5. See the section **Battery Indicators** 2260 YRM 138 for a more complete description of the operation, adjustment, and repair procedures.

All lift trucks with this type of warning indicator display have a lift interrupt. When the battery is discharged to the red section of the battery discharge indicator, the last two LEDs begin to flash just before the lift interrupt is enabled. When the last two LEDs are illuminated continuously, the controller for the battery discharge indicator stops the power to the hydraulic pump motor. This action prevents the lift truck from lifting. Enough battery power is normally available to move the lift truck to a battery charger or to a place where a charged battery can be installed.

Parking Brake Indicator

This red indicator is **ON** for 1 second after the key is moved to the **ON** position. This on-time checks that the indicator is operating. The indicator will also be **ON** when the parking brake is applied and the seat switch is closed. The indicator will go **OFF** when the parking brake is released.

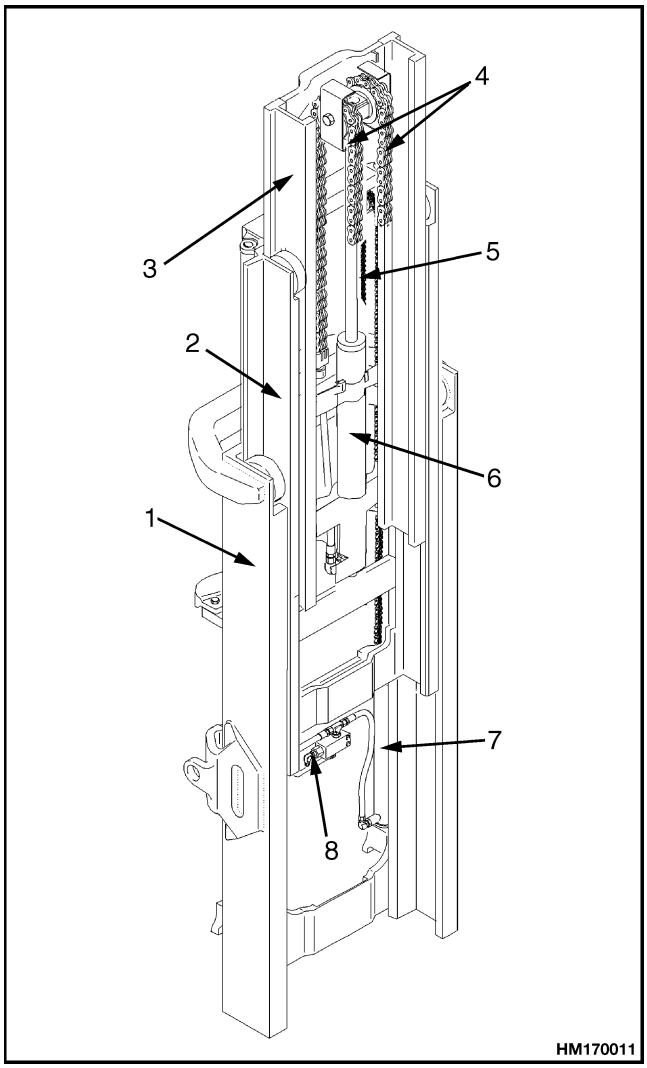
If the parking brake is NOT applied and the operator leaves the seat or turns the key to the **OFF** position, a warning buzzer will make a noise for approximately 10 seconds.

The three hydraulic cylinders are connected by hoses and tubing as shown in Figure 11. To extend the mast, oil from the main control valve flows to all cylinders at the same time. The free-lift cylinder extends first because it lifts the least amount of weight. The free-lift cylinder raises the carriage to the top of the inner weldment. After the free-lift cylinder reaches the end of its stroke, the main lift cylinders begin to extend. As the main lift cylinders extend, the intermediate weldment is raised by the lift cylinders and the inner weldment is raised by the lift chains.

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

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

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



NOTE: TYPICAL MAST ASSEMBLY IS SHOWN HERE.

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

Figure 10. Three-Stage Mast

General

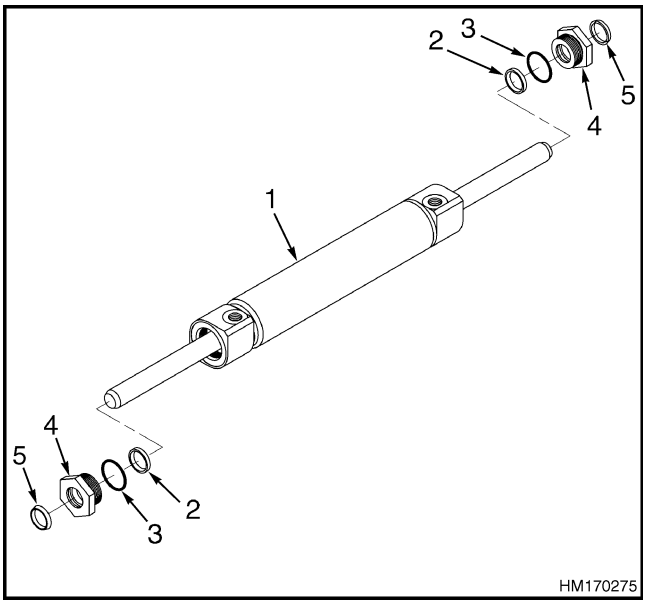
WARNING

Before working on or near the mast, see Safety Procedures When Working Near Mast in this section.

This section has the repair procedures for the Two-Stage, Limited Free-Lift (LFL); Two-Stage, Full Free-Lift (FFL); Three-Stage, Full Free-Lift (FFL) masts; and for the sideshift carriages. Carriage Adjustment and Troubleshooting are at the end of this section. See the section **Mast**, **Description** 4000 YRM 521 for the description and operation of the masts.

NOTE: For models ERP1.60-1.80-2.0ATF (ERP030-040TH) [F807], refer to **Mast Repairs**, **2-, 3-, and 4-Stage Masts** 4000 YRM 1148 for information on Four-Stage masts.

NOTE: Hoses have a service life that is determined by application and time. All hoses must be inspected at the intervals specified in the Maintenance Schedule for the hydraulic system. Install a new hose if the hose is worn, damaged, soft or hard, and no longer flexible. If necessary, make a comparison to a new hose that is the correct replacement for the hose you are inspecting.



1. CYLINDER SHELL AND ROD
2. SEAL
3. O-RING
4. RETAINER
5. WIPER

Figure 11. Integral Sideshift Cylinder

Repair

NOTE: Drain the oil from the cylinder before undertaking any repairs.

1. If any of the load rollers must be replaced, make a note of the location and number of the shims. Install the shims, load rollers, and snap rings. See Carriage Adjustment for correct adjustment.

WARNING

Improper welding procedures can damage the structure of the mast or cause incorrect function of the mast. Consult your Yale lift truck dealer for more information before welding on the mast.

2. If the carriage bars have any protruding welds or damaged notches, repair by grinding, filing, or welding.

3. Replace the cylinder rod seals as follows:

a. Clamp one end of the cylinder in a vise between the hydraulic fitting and the retainer on the same end.

b. Unscrew the retainer from the cylinder. Slide the retainer off the cylinder rod.

c. Clamp the other end of the cylinder in a vise between the hydraulic fitting and the retainer on the same end.

d. Unscrew the retainer from the cylinder.

NOTE: If new retainers that are already assembled with seals are being installed, proceed to Step h.

e. Remove and discard the seals and O-ring from each retainer with a brass O-ring tool. **DO NOT** scratch the grooves.

WARNING

Cleaning solvents may be flammable and toxic and can cause severe skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety precautions.

f. Clean the retainers and the cylinder rod with cleaning solvent. Lubricate the new seals and O-rings with hydraulic oil.

g. Install the seals into the retainer grooves. Form the seals into a "kidney" shape to ease placement into the groove. Note the direction of the rod seals. **Pressure seals are installed with the lip toward the pressure side of the cylinder.**

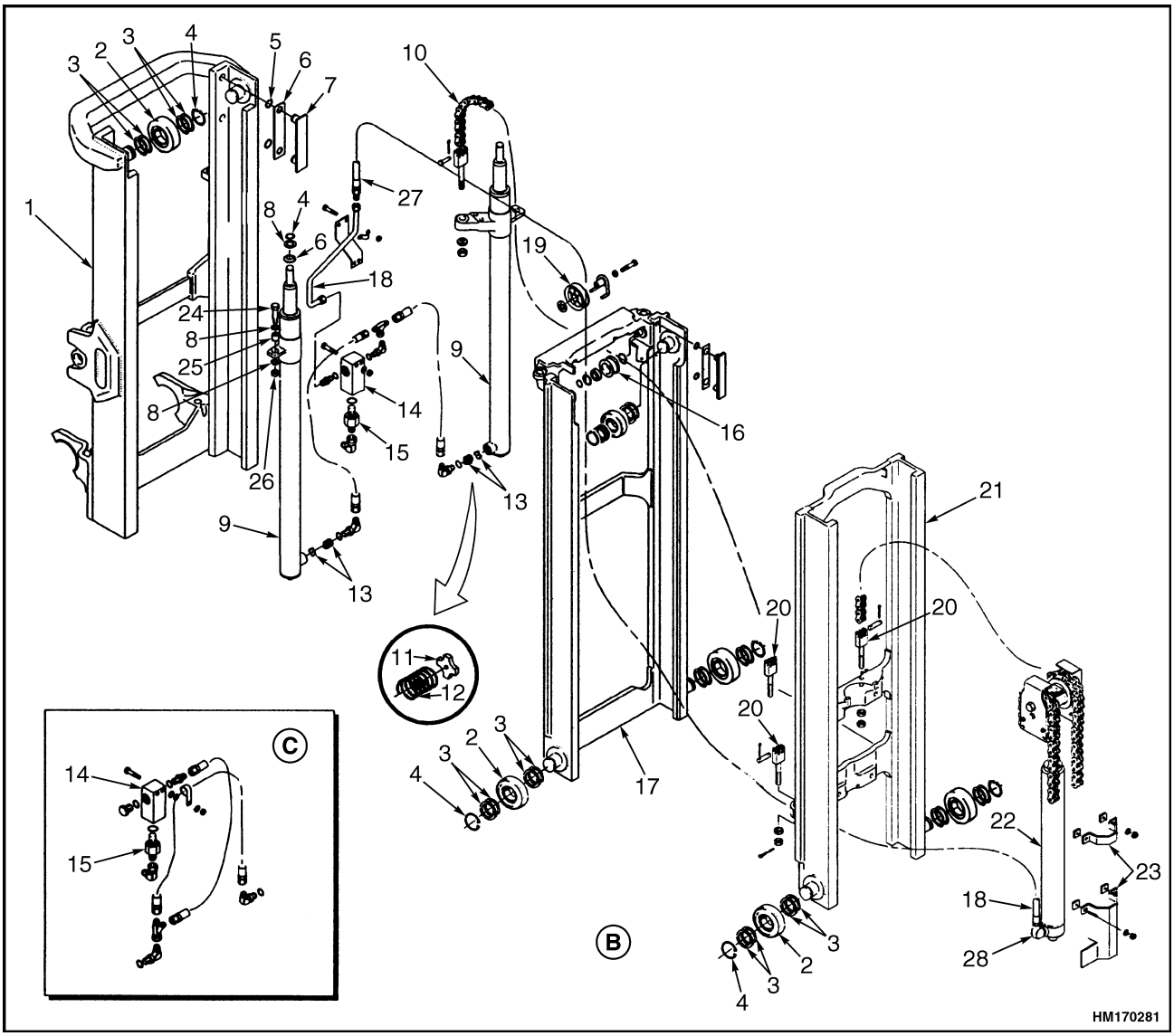
h. Apply a film of hydraulic oil to the inside of the retainers.

i. Clamp one end of the cylinder in a vise between the hydraulic fitting and the end.

j. Screw the retainer into the cylinder. Tighten the retainer to 325 ±30 N•m (240 ±25 lbf ft).

k. Clamp the other end of the cylinder in a vise between the hydraulic fitting and the end.

l. Slide the retainer onto the cylinder rod. Screw the retainer into the cylinder. Tighten the retainer to 325 ±30 N•m (240 ±25 lbf ft).



A. MODELS ERP20-30ALF (B216), ERP20-30ALF (ERP040-060DH) (D216), GC/GLC040-065RG/TG/ZG, ERC20-30AGF (ERC040-065RF/ZF, RG/ZG) (E108), ERC20-32AGF (ERC040-065GH) (A908), AND GP/GLP/GDP2.00-3.00RF/TF (GP/GLP/GDP040-060RG/TG/ZG) SHOWN.
B. MODELS GP/GLP/GDP16-20AF/BF (GP/GLP/GDP030-040AF/BF), GC/GLC030-040AF, GLP/GDP16-20AF (GP/GLP/GDP030-040AF), ERC/P16-20AAF (ERC030-040AF, AG/BG) (A814), AND ERC/P16-20AAF (ERC030-040AH) (B814) SHOWN.
C. OLDER MODELS.

1. OUTER MAST WELDMENT
2. LOAD ROLLER
3. SHIM
4. SNAP RING
5. O-RING
6. SHIM(S)
7. STRIP BEARING
8. WASHER
9. MAIN LIFT CYLINDER
10. LIFT CHAIN
11. STAR WASHER
12. SPRING
13. LOWERING CONTROL VALVE (INTERNAL)
14. HOUSING
15. LOWERING CONTROL VALVE (EXTERNAL)
16. CHAIN SHEAVE
17. INTERMEDIATE MAST WELDMENT
18. FREE-LIFT CYLINDER TUBE
19. HOSE SHEAVE
20. CHAIN ANCHOR
21. INNER MAST WELDMENT
22. FREE-LIFT CYLINDER
23. CYLINDER BRACKET
24. CAPSCREW
25. SPACER
26. NUT
27. HOSE
28. FLOW CONTROL FITTING

Figure 18. Three-Stage, Full Free-Lift Mast (Sheet 2 of 2)

CAUTION

Use caution when installing seals over the threads of the gland. Sharp edges of the thread can damage the seals.

7. Install the backup ring, new O-ring, new wear ring, new rod seal, backup ring, and wiper onto the gland. See Figure 23.

8. Carefully install the gland onto the rod and piston assembly in the shell. See Figure 23.

9. Engage the threads and turn the gland in the shell until it is tight. Use the correct spanner, tighten gland to 340 to 410 N•m (251 to 302 lbf ft). DO NOT hit the gland with a hammer and driver to tighten.

10. Install the lowering control valve. See Figure 15, Figure 16, and Figure 18. Make sure the special washer and the spring are installed correctly. Incorrect installation can cause the load to lower too fast.

Two-Stage Limited Free-Lift Mast and Three-Stage Full Free-Lift Mast, Main Lift Cylinders for Lift Trucks GP/GLP/GDP16-20AF/BF (GP/GLP/GDP030-040AF/BF), GC/GLC030-040AF, GLP/GDP16-20AF (GP/GLP/GDP030-040AF), and ERC/P16-20AAF (ERC030-040AF, AG/BG) (A814), and ERC/P16-20AAF (ERC030-040AH) (B814)

CAUTION

A difficult and important step in assembling lift cylinders is the correct installation of the seals. Most lift cylinder maintenance is caused by seal leaks. Do not damage any parts during assembly.

1. Lubricate all internal parts of the lift cylinder with clean hydraulic oil or packing lubricant, Yale Part No. 504234269. Use **NEW** O-rings, seals, and wear rings.

WARNING

Be careful when removing or installing snap rings. Snap rings can eject with enough force to cause injury. Always use the correct snap ring pliers and wear eye and face protection during removal or installation.

2. Install a new O-ring onto the check valve then install the check valve, washer, and snap ring into the base of the piston. Make sure the arrow on the check valve is toward the base of the piston. See Figure 24.

3. Install the backup ring, new seal, and new wear ring onto the piston. See Figure 24.

4. Install the piston ring onto the piston. See Figure 24.

5. Install the spacer onto the rod. See Figure 24.

6. Carefully install the rod and piston assembly into the shell. See Figure 24.

CAUTION

Use caution when installing seals over the threads of the gland. Sharp edges of the thread can damage the seals.

7. Install a new wear ring, new O-ring, new rod seal, backup ring, and wiper onto the gland. See Figure 24.

8. Carefully install the gland onto the rod and piston assembly in the shell. See Figure 23.

9. Engage the threads and turn the gland in the shell until it is tight. Use the correct spanner, tighten gland to 340 to 410 N•m (251 to 302 lbf ft). DO NOT hit the gland with a hammer and driver to tighten.

10. Install the lowering control valve. See Figure 15, Figure 16, and Figure 18. Make sure the special washer and the spring are installed correctly. Incorrect installation can cause the load to lower too fast.

Two-Stage Limited Free-Lift Mast and Three-Stage Full Free-Lift Mast, Main Lift Cylinders

CAUTION

A difficult and important step in assembling lift cylinders is the correct installation of the seals. Most lift cylinder maintenance is caused by seal leaks. Do not damage any parts during assembly.

1. Lubricate all internal parts of the lift cylinder with clean hydraulic oil or packing lubricant, Yale Part No. 504234269. Use **NEW** O-rings, seals, and wear rings.

Legend for Figure 31

NOTE: FOUR-FUNCTION MAST SHOWN.

A. ALIGN MARK E AT BOTTOM OF THIS CLAMP

1. HOSE CHANNEL
2. COWL HOSES
3. HEADER HOSES
4. STRAP CLAMP
5. CLAMP
6. CLAMP
7. FITTING
8. TUBE
9. FITTING
10. CLAMP
11. BRACKET
12. LOWER BRACKET
13. CAPSCREW
14. CARRIAGE BRACKET
15. BOTTOM CLAMP
16. HOSE GUIDE
17. SNAP RING
18. CAPSCREW (THREE-FUNCTION)
19. CAPSCREW (FOUR-FUNCTION)
20. HOSE GUARD
21. STUBSHAFT
22. SHEAVE
23. WASHER
24. WASHER
25. NUT

Header Hose Arrangement

NOTE: This is the Header Hose Arrangement for GP/GLP/GDP16-20AF/BF (GP/GLP/GDP030-040AF/BF), GC/GLC030-040AF, GLP/GDP16-20AF (GP/GLP/GDP030-040AF), ERC/P16-20AAF (ERC030-040AF, AG/BG) (A814), ERC/P16-20AAF (ERC030-040AH) (B814), and ERP1.60-1.80-2.00ATF (ERP030-040TH) models.

NOTE: Hoses have a service life that is determined by application and time. All hoses must be inspected at the intervals specified in the **Maintenance Schedule** for the hydraulic system. Install a new hose if the hose is worn, damaged, soft or hard, and no longer flexible. If necessary, make a comparison to a new hose that is the correct replacement for the hose you are inspecting.

Some lift trucks have auxiliary hydraulic equipment that is attached to the carriage. Examples of auxiliary equipment are a sideshift carriage or a roll clamp. These auxiliary functions require arrangements of header hoses for their operation.

TWO-STAGE LFL MAST, NEW HOSE INSTALL

WARNING

Before working on or near the mast, see Safety Procedures When Working Near 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 lift chains and carriage height must be correctly adjusted before the header hoses can be adjusted. See the section Lift Chains Adjustment for adjustment procedures.

1. Mark each hose with a single letter: **A**, **B**, **C**, or **D**. See Figure 29, Figure 37, and Figure 38.
2. Use a calculator to calculate dimension **E**. See Figure 37.
3. Clamp the end of the hose (the smaller fitting) that attaches to the carriage in a vise (do NOT clamp on the threads), and pull on the other end until the hose is straight. Do NOT apply enough force to stretch the hose. See Figure 37.
4. Mark all the hoses with dimension **E** (all measurements are made from the carriage end of the hose [the smaller fitting]). See Figure 37.
5. Attach the hoses to the carriage brackets with the clamps. See Figure 38.
6. Place the hoses at the location of the hose sheave. The hose sheave and stub shaft must be assembled on to the hose before they are attached to the mast. Tighten the mounting hardware to 66 N•m (49 lbf ft).

Legend for Figure 42

* Metric Formulas (All Dimensions are in Millimeters)
Class II Mast Type
Dimension E = (0.985 × Y) + (0.985 × Z) − 350**
Example: Dimension E = (0.985 × Y) + (0.985 × Z) − 350 **Step 1.** Dimension E = (0.985 × 3710) + (0.985 × 2095) − 350 **Step 2.** Dimension E = 3654.4 + 2063.6 − 350 **Step 3.** Dimension E = 5718 − 350 **Step 4.** Dimension E = 5368.0
**** For Lift Heights of 3710 mm to 6110 mm. For Lift Heights of 6260 mm to 8510 mm, use 842.**
Dimension G Calculations are similar to Dimension E Dimension G for Lift Heights of 3710 mm to 6110 mm: (1.965 × Y) + (0.985 × Z) − 65 Dimension G for Lift Heights of 6260 mm to 8510 mm: (1.965 × Y) + (0.985 × Z) − 65

* Inch Formulas (All Dimensions are in Inches)
Class II Mast Type
Dimension E = (0.985 × Y) + (0.985 × Z) − 8.781**
Example: Dimension E = (0.985 × Y) + (0.985 × Z) − 8.781 **Step 1.** Dimension E = (0.985 × 146.1) + (0.985 × 82.5) − 8.781 **Step 2.** Dimension E = 143.91 + 81.3 − 8.781 **Step 3.** Dimension E = 225.20 − 8.781 **Step 4.** Dimension E = 216.42
**** For Lift Heights of 146.1 To 240.6. For Lift Heights of 246.5 to 335.0, use 33.156.**
Dimension G Calculations are Similar to Dimension E Dimension G for Lift Heights of 146.1 to 240.6: (1.965 × Y) + (0.985 × Z) − 2.562 Dimension G for Lift Heights of 246.5 to 335.0: (1.965 × Y) + (0.985 × Z) − 2.562
*All measurements are made with mast vertical and fully lowered.

1. DIMENSION G
2. DIMENSION E
3. VISE
4. HOSE
5. TOP OUTER CHANNEL
6. BOTTOM OUTER CHANNEL
7. GROUND LEVEL

Carriage Adjustment

1. Install the load rollers on the carriage. Install the shims for the rollers in the same sequence on the stub shaft as before disassembly. When the carriage has six load rollers, there are no shims under the top load rollers. See Mast and Carriage Adjustments.

WARNING

The mast is heavy. The mast can weigh approximately 681 kg (1501 lb). Make sure all lifting devices (hoists, cables, chains, slings, etc.) are suitable and of adequate capacity to lift the motor.

2. Use a crane to raise the carriage up the inner mast weldment. Find the tightest fit between the load rollers and the inner mast weldment.

3. Remove the carriage from the mast. Adjust the shim arrangement for each load roller for clearance between the load roller and the inner mast weldment. Repeat Step 1 and Step 2 until there is zero clearance at the point of tightest fit.

4. Check lateral movement of carriage:

   a. Fully lower carriage to ground.

   b. Place hand or small pry bar between top of carriage side plate and the inner channel flange. See Figure 51.

   c. Move carriage back and forth and check movement.

   d. Carriage lateral movement must not be greater than 2.5 mm (0.10 in.).

   e. If carriage lateral movement is greater than 2.5 mm (0.10 in.), add or remove shims and repeat Step a through Step d until correct movement is achieved.

5. Keep the shim arrangement between the middle and bottom load rollers on the same side of the carriage approximately equal. Also keep the shim arrangement on each side of the carriage approximately equal. The carriage must be parallel with the inner mast weldment within ±1.50 mm (±0.06 in.).

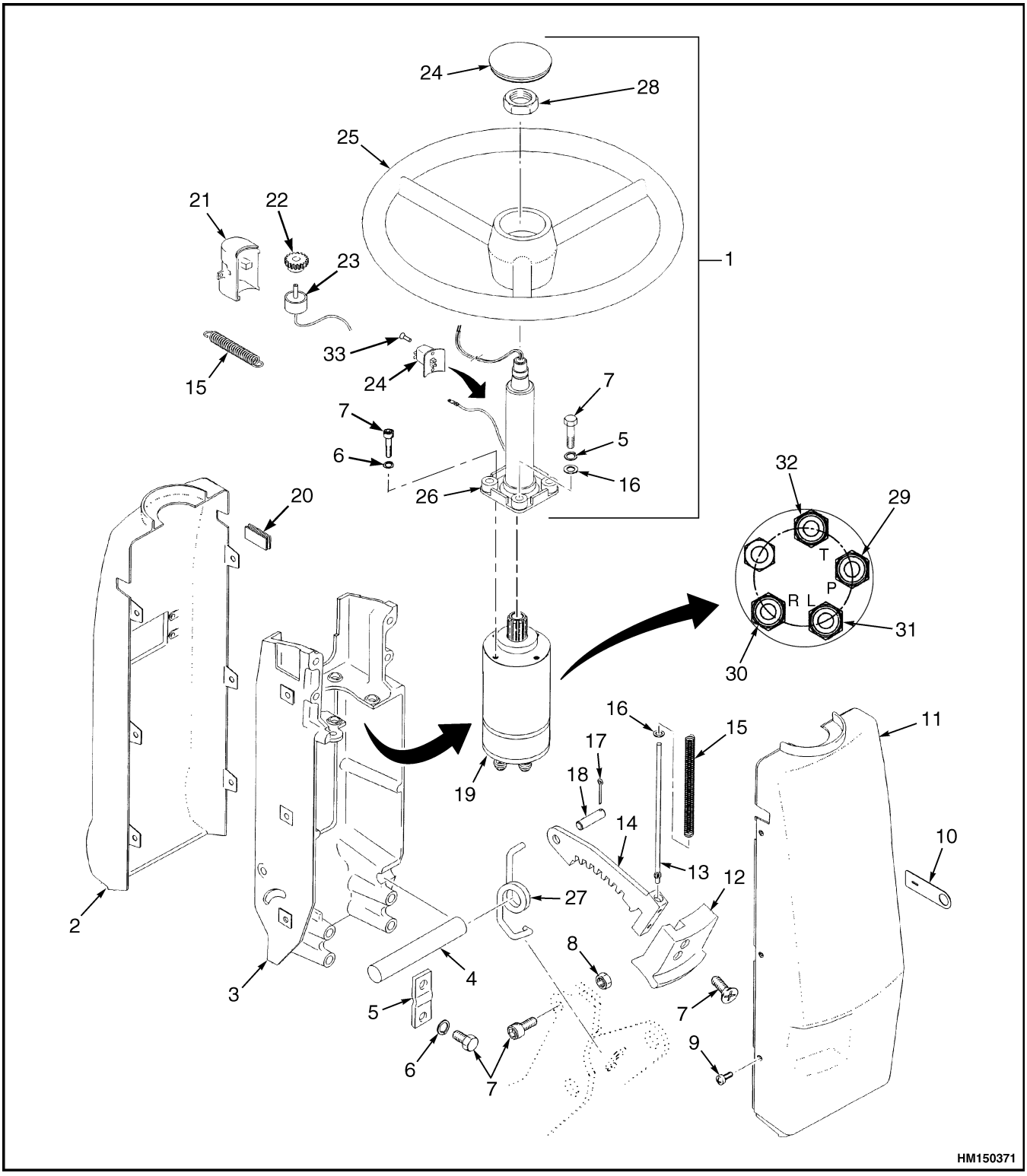
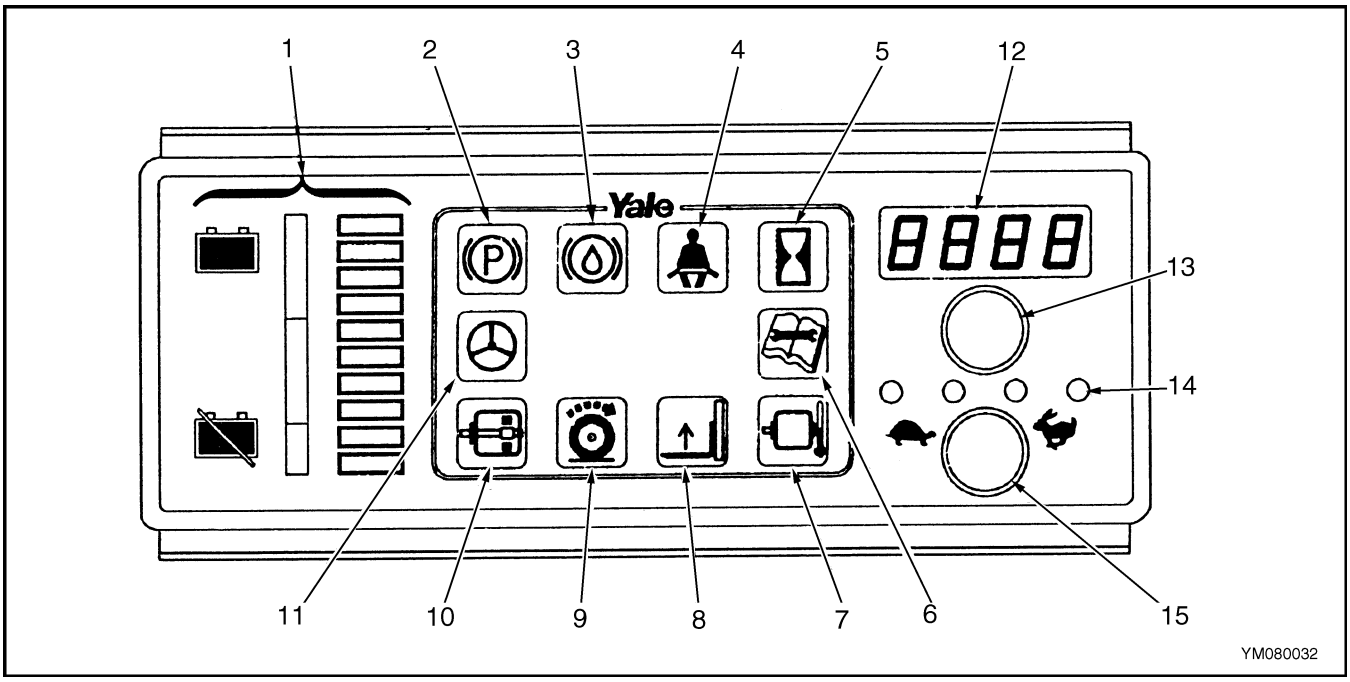


Figure 5. Steering Wheel and Steering Column Assembly - (Later Models)

Troubleshooting

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



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

Figure 3. Premium Display Panel

Description of Features on the Premium Display Panel

Battery Indicator

The battery indicator is a scale with a series of 10 Light Emitting Diodes (LEDs) in three colors (green, orange, and red). As the battery voltage decreases during operation, different LEDs illuminate to indicate a discharged battery. No more than two LEDs are illuminated at one time. When the battery is fully charged, the two green LEDs at the end of the scale are illuminated. When the battery discharges during operation, the LEDs illuminate from top to bottom (green to red). See Figure 3.

All lift trucks with this type of warning indicator display have a lift interrupt. When the battery is discharged to the red section of the battery discharge indicator, the last two LEDs begin to flash just before the lift interrupt is enabled. When the last two LEDs are illuminated continuously, the controller for the battery discharge indicator stops the power to the hydraulic pump motor. This action prevents the lift truck from lifting. Enough battery power is normally available to move the lift truck to a battery charger or to a place where a charged battery can be installed.

Parking Brake Indicator

This red indicator is **ON** for 1 second after the key is moved to the **ON** position. This on-time checks that the indicator is operating. The indicator will also be **ON** when the parking brake is applied and the seat switch is closed. The indicator will go **OFF** when the parking brake is released.

If the parking brake is NOT applied and the operator leaves the seat or turns the key to the **OFF** position, a warning buzzer will make a noise for approximately 10 seconds.

Brake Fluid Low Indicator

This red indicator is **ON** for 1 second after the key is moved to the **ON** position. This on-time checks that the indicator is operating. If the indicator is **ON** during operation, the fluid level in the brake fluid reservoir is low and must be filled. See Figure 3.

Legend for Figure 10

NOTE: SET DIP SWITCHES TO TRUCK VOLTAGE. IF TRUCK VOLTAGE IS NOT KNOWN, SET TO 48 VOLTS.

1. BATTERY CHARGE INDICATOR WITH LIFT INTERRUPT
2. WARNING LIGHT, PARKING BRAKE INDICATOR
3. WARNING LIGHT, BRAKE FLUID RESERVOIR IS LOW
4. WARNING LIGHT, FASTEN SEAT BELT
5. INDICATOR LIGHT, HOURMETER
6. WARNING LIGHT, SERVICE INTERVAL
7. WARNING LIGHT, MOTOR TEMPERATURE OVER LIMIT (TRACTION OR HYDRAULIC)
8. INDICATOR LIGHT, HYDRAULIC MOTOR
9. INDICATOR LIGHT, TRACTION MOTOR
10. WARNING LIGHT, MOTOR BRUSHES ARE WORN (TRACTION, HYDRAULIC, OR STEERING)
11. INDICATOR LIGHT, STEERING PUMP MOTOR
12. DIGITAL DISPLAY
13. PUSH BUTTON, DISPLAY STATUS CODES
14. PERFORMANCE LEVEL INDICATORS (4 LEDS)
15. PUSH BUTTON, SET PERFORMANCE LEVEL
16. DIP SWITCHES ON BACK OF DISPLAY PANEL

CURTIS 1215 DISPLAY PANEL REPLACEMENT

The Curtis 1215 Display Panel is located in the front cover over the battery compartment. The display panel cannot be repaired and must be replaced if it is faulty.

Remove

1. Move lift truck to a safe, level area. Turn key switch to **OFF** and remove key. Put a DO NOT OPERATE tag on the multifunction control handle. Put blocks under drive wheels to keep lift truck from moving. Refer to How to Put Lift Truck on Blocks in the section **Periodic Maintenance**.

WARNING

Disconnect battery and separate connector before opening compartment cover or inspecting or repairing electrical system. If a tool causes a short circuit, the high-current flow from the battery can cause an injury or parts damage.

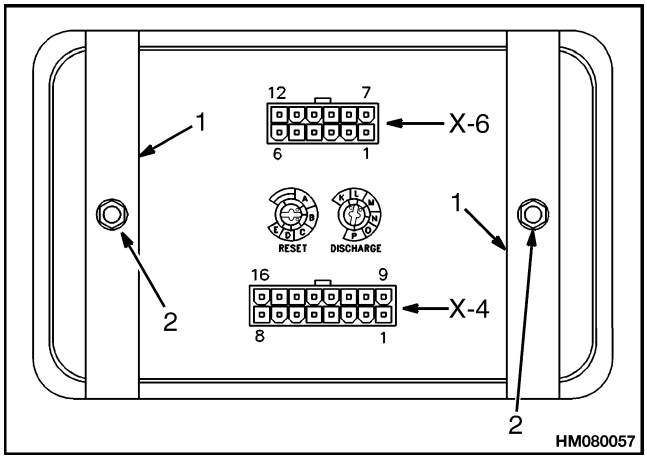
2. Disconnect and separate battery connector.

3. Remove hydraulic tank dipstick.

4. Remove socket head capscrews retaining battery compartment cover. Remove battery compartment cover.

5. Disconnect two plugs X-4 and X-6 from rear of display assembly.

6. Remove two nuts and brackets that fasten display assembly to instrument panel. See Figure 11. Remove display assembly.



1. MOUNT BRACKET 2. MOUNT NUT

Figure 11. Curtis 1215 Mount

Install

1. Adjust pots on rear of dash display assembly.

2. Connect two plugs X-4 and X-6 to rear of dash display.

3. Position display assembly in instrument panel. Install nuts and brackets to rear of display to fasten display assembly to instrument panel.

4. Install battery cover.

5. Reinstall hydraulic tank dipstick.

6. Remove blocks from under drive wheels. Remove DO NOT OPERATE tag. Connect battery and install key.

Legend for Figure 25

1. HORN SWITCH AND COVER
2. ENCODER HOUSING
3. SPRING
4. SHAFT COVER
5. DIRECTION CONTROL LEVER (NOT ON ALL UNITS)
6. OPTICAL ENCODER
7. GEAR
8. IGNITION SWITCH
9. STEERING COLUMN
10. ACTIVATOR
11. COWL COVER
12. WHT/BLK
13. WHT (ENC.)
14. RED (MARKED) (+5V)
15. BLK (BATT. –)
16. WHT (START SW.)
17. YEL (SOLENOID)
18. RED (BATT. +)

3. Remove the eight screws that fasten the cover over the cowl. Move the cover for access to the activator. Fasten the cowl cover to prevent damage to the wires of the rocker switches if installed.

4. Make a note of the location of the wires fastened to the activator for correct connection during installation. Remove the wires.

5. Remove the two screws that fasten the activator and remove the activator. Install the replacement activator in the same alignment as the old activator.

6. Carefully remove the spring that fastens the optical encoder assembly to the cover over the steering shaft. Remove the encoder assembly. Remove the encoder from the encoder housing and remove the gear from the shaft of the encoder.

7. If damaged, replace the gear at this time. Install the gear on the replacement encoder in the same location on the shaft. Put a coating of multipurpose grease on the new gear or a gear without grease. Install the encoder in the housing. Install the housing in the hole of the shaft cover so that the encoder cannot move. Install the spring to hold the encoder assembly in correct alignment.

8. Connect the wires to the activator as removed during removal. Install the cover over the cowl. Install the covers on the steering column. There are no adjustments.

LIGHTS, CONVERTER, RELAY, AND REVERSE ALARM

The lights are all fastened to the overhead guard. The brake, tail, and reverse light assemblies are on the rear legs of the overhead guard and are standard in North America and optional in Europe. These light sets operate on 12, 36, or 48 volts. The flashing light is fastened to the top or rear of the overhead guard and is optional on all units. This 12-volt light operates from the battery of the lift truck and is on when the key is in the **ON** position. The rear driving light (optional) is also fastened to the top or rear of the overhead guard. An optional light for the operator compartment is also fastened to the top of the overhead guard. The optional spot light (not available in North America) and the optional front driving lights are all fastened to the front legs of the overhead guard. All of these lights operate on 12, 36, or 48 volts.

NOTE: It is not necessary to replace the complete light assemblies to replace a bulb. Do only the steps necessary for your replacement needs.

Incandescent Brake, Tail, and Reverse Light Assembly, Replace

1. Disconnect the battery and remove the key.

2. Open the hood for access to the electrical plug of the light assembly. See Figure 26. Disconnect the rectangular six-pin plug for the light assembly.

3. Remove the two screws in the lens of the light assembly. To replace a bulb *only*, remove the lens from the base. Push and turn the bulb 1/4 turn counterclockwise. Make sure you are replacing the correct bulb of the set. Make sure the replacement bulb is the correct voltage and has the correct pin configuration. Install the replacement bulb in the socket using the reverse procedure. Go to Step 7 if the assembly will not be replaced.

4. If the complete light assembly is being replaced, remove the light assembly from the bracket.

5. If necessary, install the grommet on the wires of the replacement light assembly. Install the connector, wire cable, and grommet in the leg of the overhead guard leg.

6. Put the wire and connector in the same position as the old wire and connector. Connect the light assembly and wire harness connectors. Close the hood.

Legend for Figure 33

A. ERC/P16-20AAF (ERC030-040AG/BG) AND ERC20-30AGF (ERC040-65RG/ZG)

1. FUSE 7 (15A)
2. FUSE 6 (15A)
3. FUSE 5 (15A)
4. FUSE 3 (15A)
5. POWER STEERING CONTACTOR
6. FUSE 4 (POWER STEERING) (40A)
7. LINE CONTACTOR
8. TRACTION MOTOR CONTROLLER
9. FUSE 1 (TRACTION MOTOR)

B. ERC35-55HG (ERC070-120HG)

10. FUSE 2 (LIFT PUMP MOTOR)
11. MOTOR CONTROLLER FOR LIFT PUMP MOTOR
12. PUMP FUSE
13. FUSE
14. 1A CONTACTOR
15. LINE CONTACTOR
16. PUMP #2 CONTACTOR
17. PUMP #2 FUSE

letter "F" to open the File menu or the letter "S" for the Setup menu.

Use the mouse, type in the highlighted letter, or use the function keys as described to make selections from the menu you are working with.

MENUS

The following pages have the different menus available for the ITW SWITCHES Program. Descriptions explain the purpose of the items in these menus.

The File menu contains the following menu items shown in Figure 4:

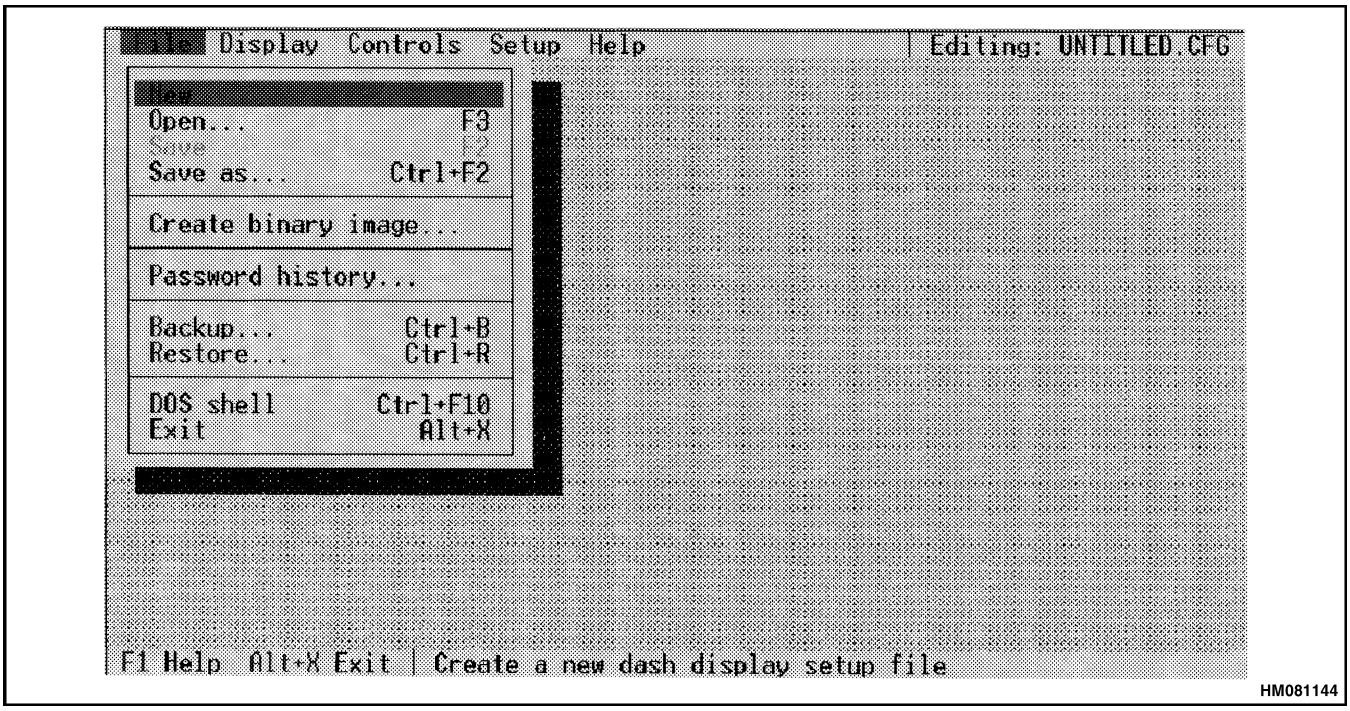


Figure 4. File Menu

File - New
Select this menu item to create a new setup file of the SEM Display Panel for editing. If you have made changes to a previous setup file and have not saved them to a disk, you will be prompted to save these changes before continuing.

By default, the new setup file will be named UNTITLED.CFG.

File - Open
Select this menu item to open an existing setup file for editing. The "Open setup file" file selection dialog will be displayed on the desktop. Highlight a setup file (files with a ".CFG" extension) in the file list and select "Open" in the menu to open the file for editing. The selected file's name will be displayed in the upper right-hand corner of the screen.

If you have made changes to a previously opened setup file and have not saved them to a disk, you will be prompted to save these changes before opening another setup file.

File - Save
Select this menu item to save any changes you have made to the current setup file. Note that this menu item is not available if you have not made any changes to the current setup file.

If the setup file has not been previously saved (i.e., it's name is still "UNTITLED.CFG"), you will be prompted to name the file before saving it. The "Save setup file as" file selection dialog will be displayed on the desktop. Type a valid DOS filename (for example, "NACCO1.CFG") in the "File name" field and select "OK" in the menu to save the setup file to a disk. A file extension of ".CFG" is highly recommended, but not required.

This feature allows an existing setup file to be used as a template for a new setup file.

The Passwords dialog allows you to enter and configure options for passwords of the SEM Display Panel shown in Figure 18.

The dialog consists of 32 pages, each page containing 8 password edit fields (except for the last page, which contains 7 edit fields), allowing up to 255 passwords to be entered. To the right of each password edit field is an "ellipsis" ("...") in the menu, which, when selected, allows the options for that password to be configured.

To move between edit fields on the same dialog page, press the **Tab** (or **Shift+Tab**) keys on the keyboard. Note that when an ellipsis is selected (highlighted), pressing **Enter** causes the "Password options" dialog to be displayed for that password.

To move between dialog pages, click "PgUp" or "PgDn" in the menu, or press the **Page Up** or **Page Down** (**PgUp** or **PgDn**) keys on the keyboard.

To enter a password, select the edit field for that password. Enter the password using the keyboard - the password must contain 4 digits and only the digits 1, 2, 3, 4, and 5 are allowed. Optionally, a name containing from 2 to 8 characters can be associated with the password by entering it in the "Name" edit field.

To delete an existing password, highlight that password's edit field or ellipsis, and then select "Delete" in the menu, or press **Ctrl** + **Delete** on the keyboard. All passwords following the deleted password will be shifted upward in the list; for example, if Password #5 is deleted, Password #6 will become the new Password #5.

To configure a password's options, select the ellipsis in the menu next to that password shown in Figure 19. The Password xxx Options dialog is displayed, where "xxx" is the number of the password entry. Select the mode limit option for the password using the "Limits" radio-button control, and check or uncheck other options for the password using the "Other" check box control. Note that if "Function 14" has been disabled globally using the "Dash control register" dialog, you cannot change this option in the password configuration.

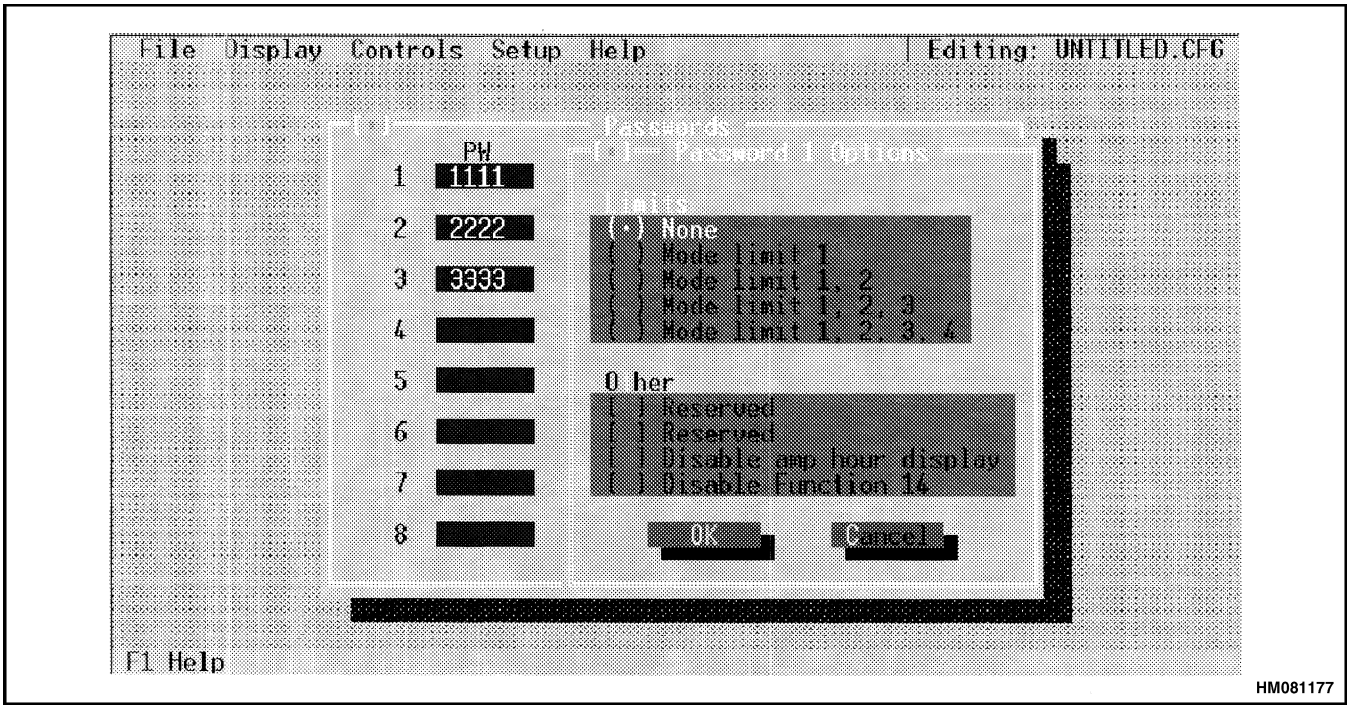
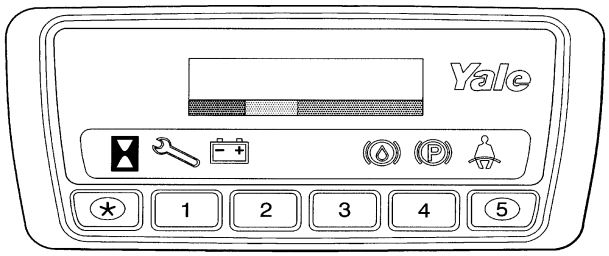


Figure 19. Password Options

DISPLAY PANEL FOR SEM CONTROLS

(WINDOWS VERSION)

ERC/P16-20AAF (ERC030-040AG/BG) [A814]; ERC35-45HG (ERC070-120HG) [A839]; ERP20-30ALF [B216]; ERP16-20ATF [D807]; ERC20-30AGF (ERC040-065RG/ZG) [E108]; ERP030-40TG [E807]



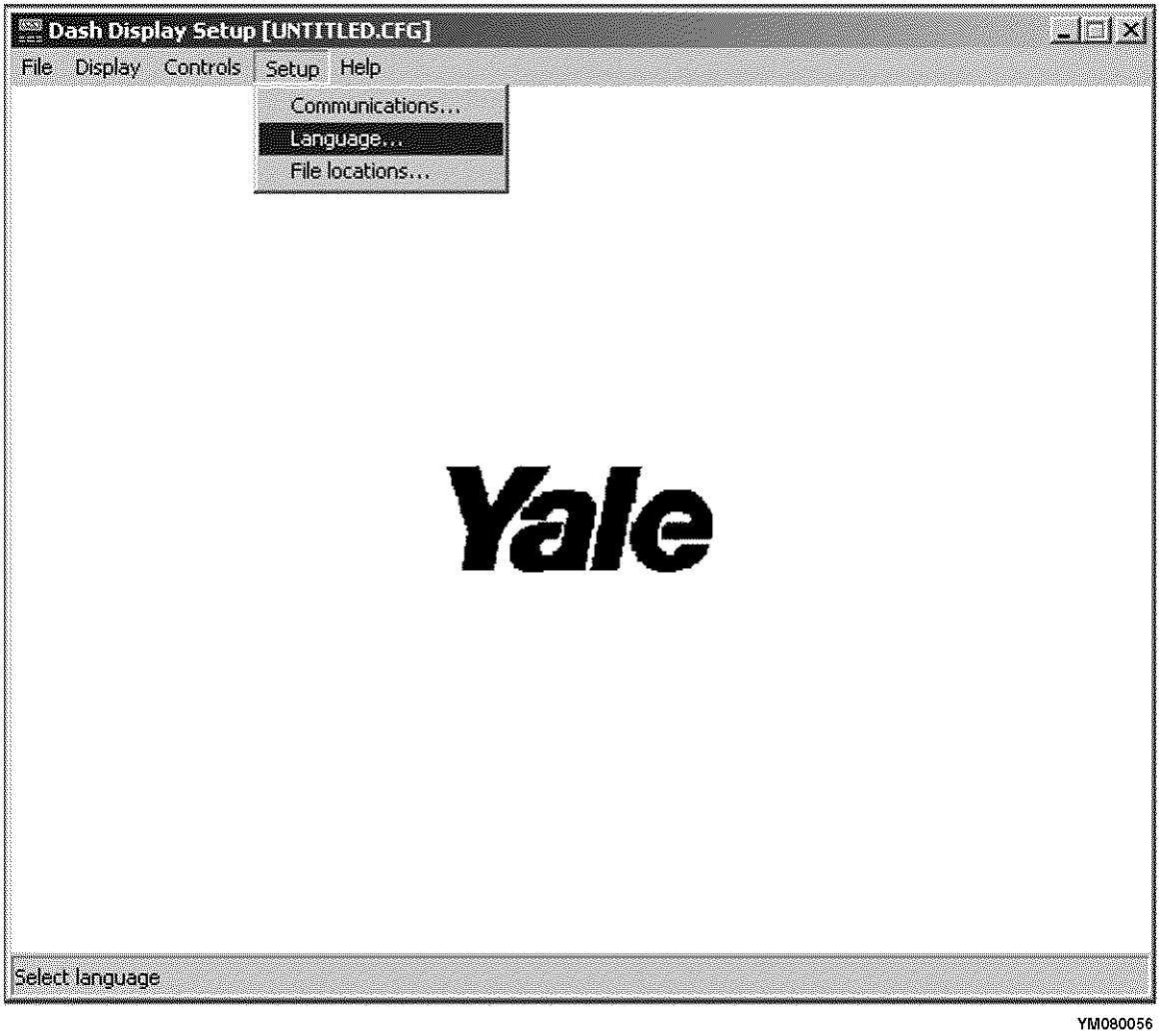


Figure 6. Setup Menu

Step 4

To write to the display, select **Display - Write setup to display** with the truck battery connected, the serial cable connected, and the key in the **OFF** position. Be sure to follow the procedures found in the section **Adjustments with a Computer** in this manual. A screen identical to Figure 17 should appear. The box labeled **Dash Control and Passwords** does not need to be checked unless changes were made to the **Dash control register settings** shown in Figure 15.

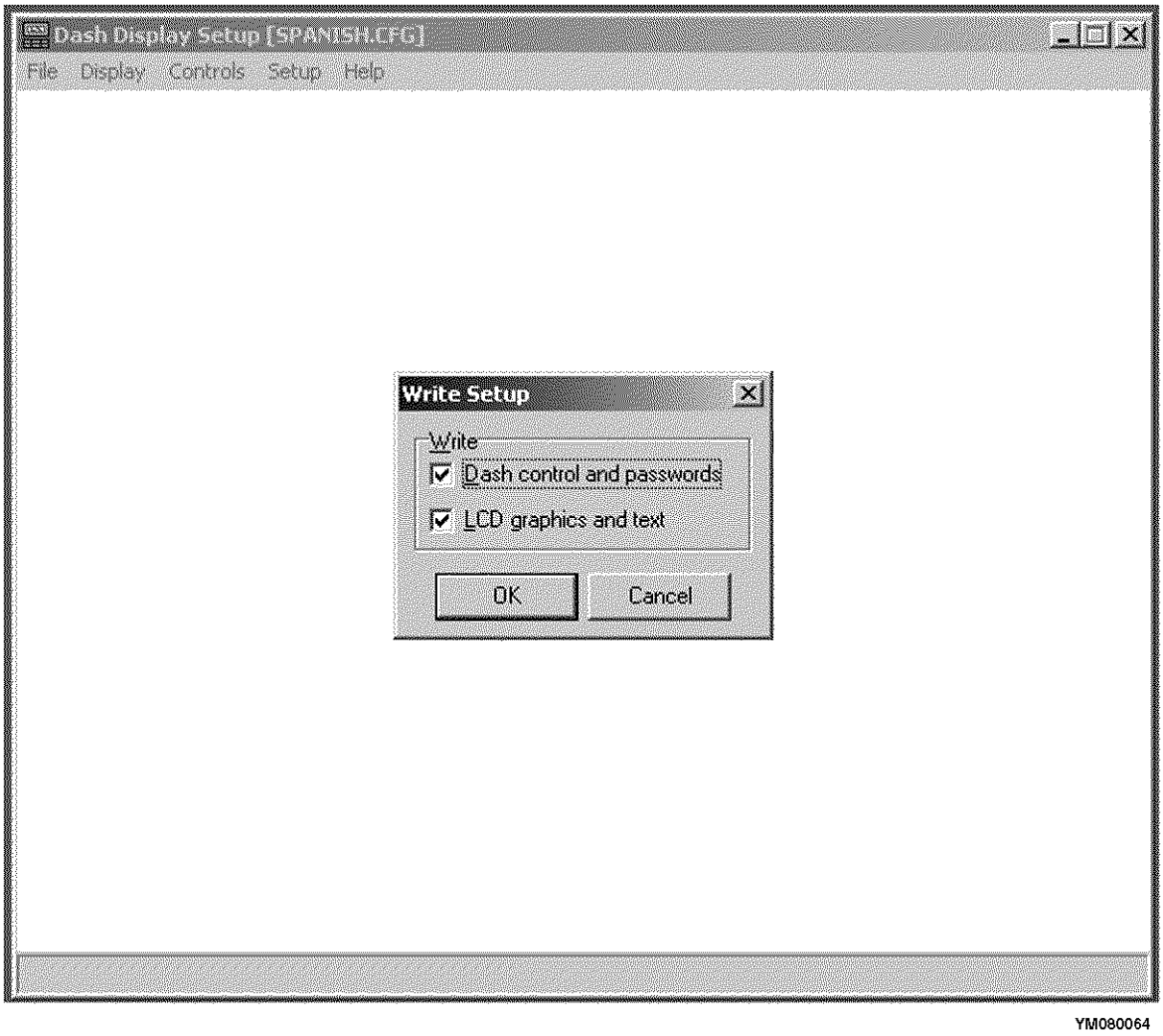


Figure 17. Write Setup

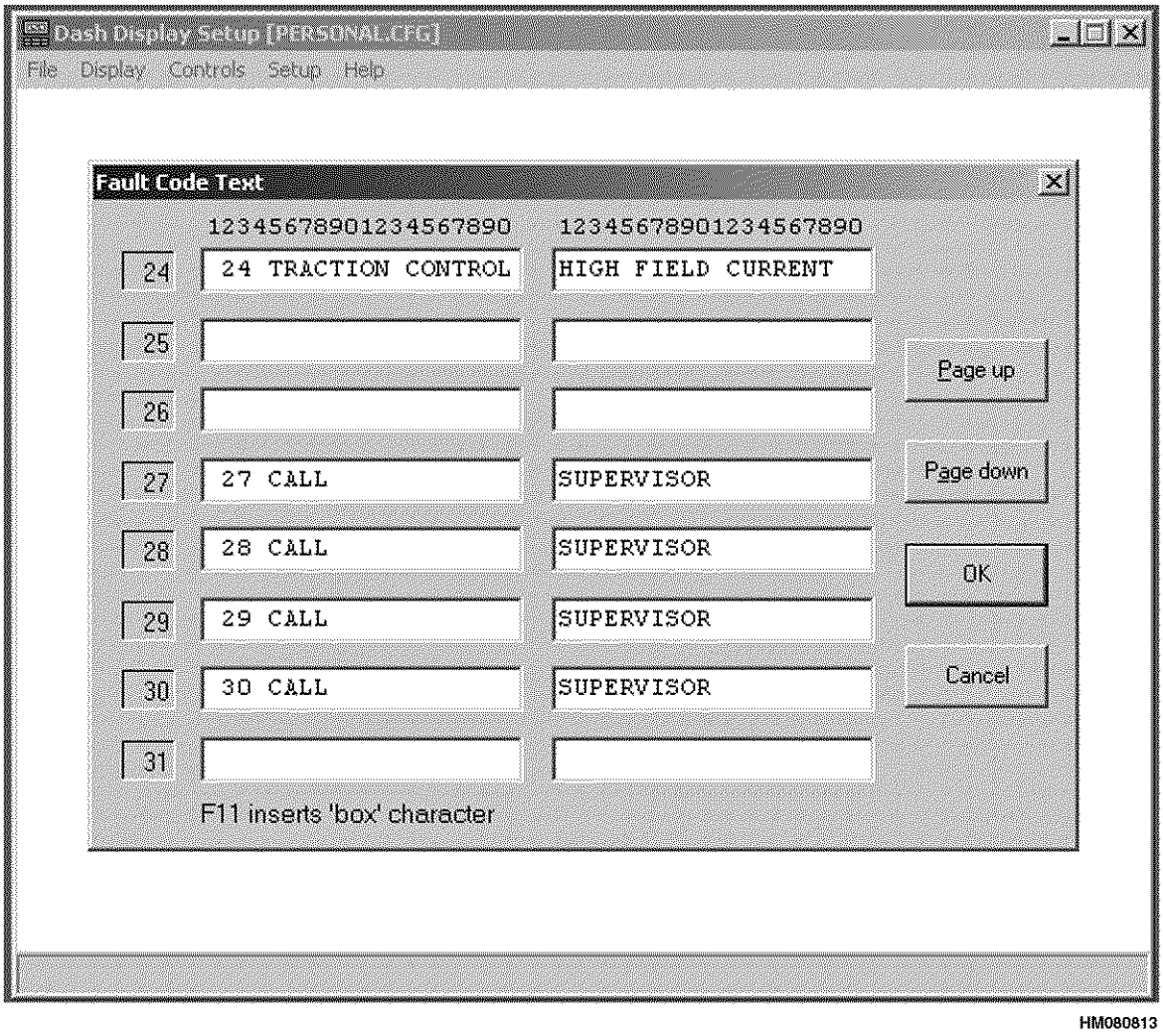


Figure 33. Edited Fault Code Text

Step 2

Write to the display by selecting **Display - Write setup to display**, with the truck battery and the serial cable connected and the key in the **OFF** position. Be sure to follow the procedures shown in the section **Adjustments with a Computer** in this manual. A screen identical to Figure 17 should appear. The box labeled **Dash control and passwords** does not need to be checked unless changes were made to the **Dash Control Register** settings shown in Figure 15.

Step 3

If you wish to save this setup, follow the instructions in **Sample Session 1, Step 5**.

Computer System

A personal computer (PC) can be used to set traction or pump motor functions, indicate status codes (possible faults), and make adjustments to the operating limits set in the control cards. After making control adjustments with a PC, the battery must be disconnected and the capacitors discharged by honking the horn or using a 50Ω, 50-watt resistor from Bat (Pos) to Bat (Neg) at the control before the new settings will take effect. The PC must have the following **minimum** configuration to program motor controllers:

1. Requires Windows 95™ or 98 operating system, a Pentium 133 MHz or larger processor with 32 MB of RAM, 3.5 MB free space on the hard drive, and a CD-ROM drive.

2. One open serial communications port, either COM 1 or COM 2 on the PC.

3. Shielded cable assembly, nine-pin DB-9 serial cable, male-to-female. This cable assembly is a standard computer extension cable with straight-through wiring. Other cable lengths can be used that are within the serial cable limits of personal computers. It is recommended that less than 10 m (30 ft) be used. This cable assembly is normally available from vendors of computer equipment.

4. Adapter cable for ZX controls. This cable has a female D-9 connector on one end and a Y-plug adapter on the other end. The cable can be constructed from individual parts. Cable connector pin assignments are shown in Table 1.

5. Adapter cable for SR controls. This cable has a female DB-25 connector on one end and a 12-pin (Y-plug available for ZX controllers) adapter on the other end. The cable can be constructed from individual parts. Cable connector pin assignments are shown in Table 1.

6. Some computers can require a DB25F (female) to DB9 (male) adapter. Connector-to-connector pin assignments are shown in Table 2.

7. SMARTSET™ software CD-ROM. See the **README.TXT** file on the CD for information about its contents and how to install the software. This CD contains two main programs:

   a. A program to set traction or pump motor functions, indicate status codes (possible malfunctions), and make adjustments to the operating limits set in the control cards.

   b. A communications program that permits a remote computer to connect to a local computer through a telephone and modem connection. This communications program permits a service engineer at a remote location to run the local programs and make checks and adjustments to the lift truck.

Table 1. Cable Connections - Computer to Control

Model EV-100ZX and EV-T100 CONTROLS	
Computer Connector (9-Pin)	**Controller Connector (14-Pin) Y-Plug**
Pin 2 (Receive)	Pin 14
Pin 3 (Transmit)	Pin 13
Pin 5 (Signal ground)	Pin 4
Pin 4 to pin 6 (Jumper)	
Pin 7 to pin 8 (Jumper)	
Model SR and SP CONTROLS	
Computer Connector (9-Pin)	**Controller Connector (12-Pin) Y-Plug**
Pin 2 (Receive)	Pin 12
Pin 3 (Transmit)	Pin 11
Pin 5 (Signal ground)	Pin 4
Pin 4 to pin 6 (Jumper)	
Pin 7 to pin 8 (Jumper)	

HOW TO RETURN TO FACTORY DEFAULT SETTINGS

NOTE: This step only loads the Card column in the program. The changed settings must be saved to the control card. See Figure 15.

Select **Card - Set to factory defaults** and select **OK** on the **Save Factory** dialog box that appears as shown in Figure 14.

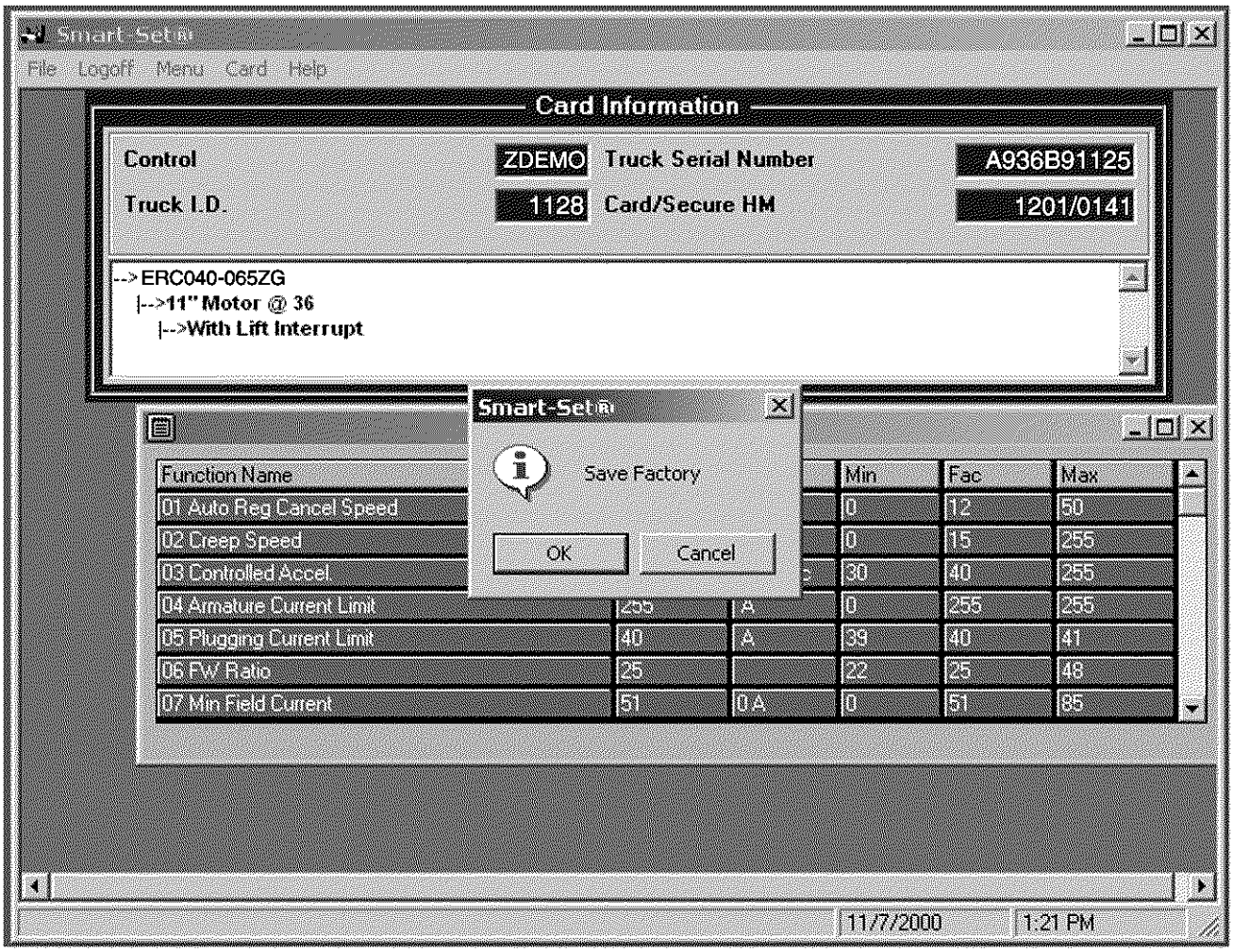


Figure 14. Saving Factory Default Settings

7. The **ZX Control Status Monitor** window will appear as shown in Figure 28, showing six columns of data. The six columns have the following data:

   a. Function description.

   b. Digital value received from the register on the control card.

   c. Current real-time converted analog reading.

   d. Minimum hold reading, lowest reading since the last reset.

   e. Maximum hold reading, highest reading since the last reset.

   f. Units, actual unit measurement reading shown in volts, amps, etc.

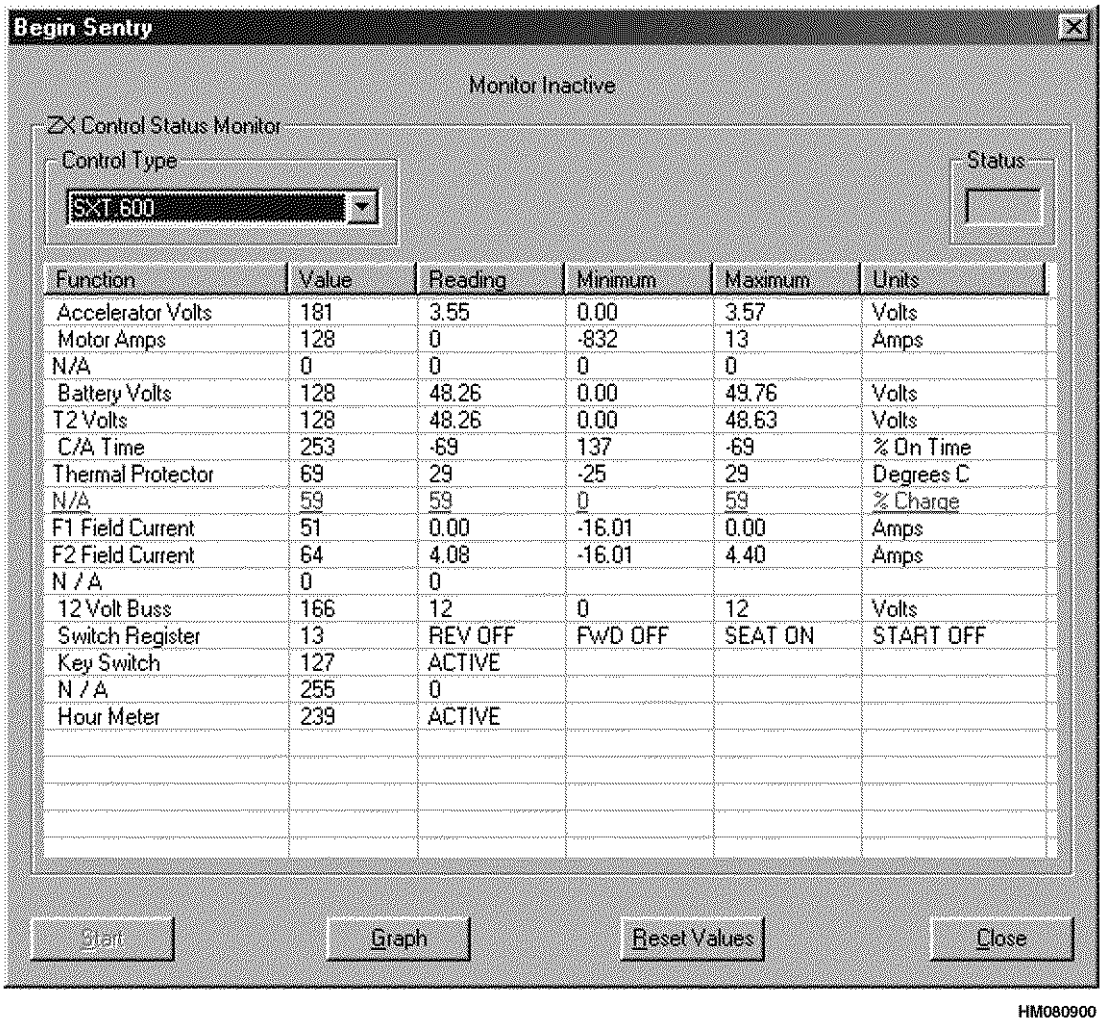


Figure 28. ZX Control Status Monitor

HOW TO RESET MIN AND MAX DISPLAY

When the **ZX Control Status Monitor** screen is shown, select the **Reset Values** button as shown in Figure 28. The Maximum and Minimum columns are reset. New Maximum and Minimum levels are then recorded.

When the **ZX Control Status Monitor** screen is shown, the lift truck can be operated normally. The monitor will continuously show the real-time status of the control and can also record the maximum and minimum values of selected functions.

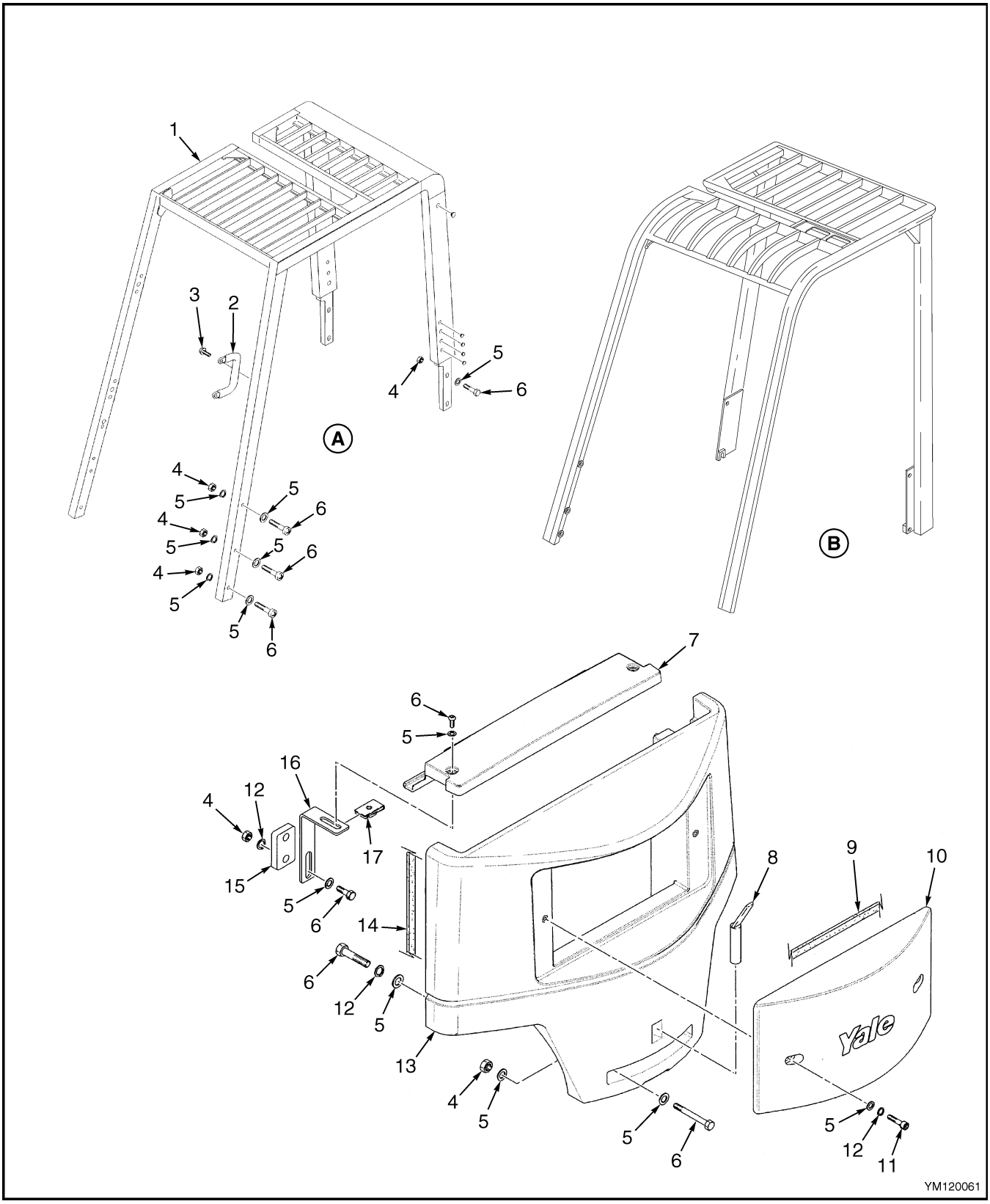
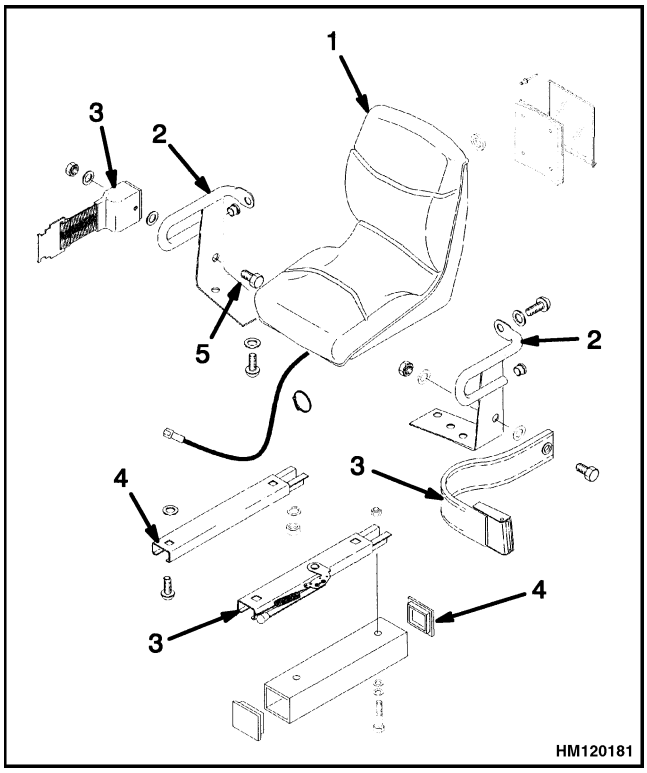


Figure 3. Overhead Guard and Counterweight Later Model ERP20-30ALF (B216) Trucks and ERP20-30ALF (ERP040-060DH) (D216) Trucks

OPERATOR RESTRAINT SYSTEM

The parts of the operator restraint system are as follows: the seat belt, hip restraint brackets, seat and mounting, battery restraint (restraint rod and hood plate), and the assembly for the hydraulic hand levers and latch. See Figure 13 and Figure 15. Each item must be checked to make sure it is attached securely, functions correctly, and is in good condition.

The seat belt must latch securely. Make sure the seat belt extends and retracts smoothly and is not damaged or torn. If the seat belt cannot be pulled from the retractor assembly, the seat belt assembly must be replaced.



1. SEAT
2. HIP RESTRAINT
3. SEAT BELT AND MOUNT
4. SEAT RAILS
5. CAPSCREW

Figure 15. Operator Restraint and Seat Assembly

Counterweight Replacement

If the lift truck must be put on blocks for maintenance and repair, see the section **Periodic Maintenance** 8000 YRM 552 for early and later model ERP20-30ALF (B216) trucks and **Periodic Maintenance** 8000 YRM 1060 for ERP20-30ALF (ERP040-060DH) (D216) models, for the procedures of putting the lift truck on blocks.

WARNING

The counterweight is very heavy. Make sure that the crane and lifting devices have enough lifting capacity to safely lift the counterweight. The weights of the counterweights are shown in Table 1.

The counterweight normally is not removed for most repairs. The counterweight is fastened to the frame with four capscrews. The weights for the counterweights are shown in Table 1.

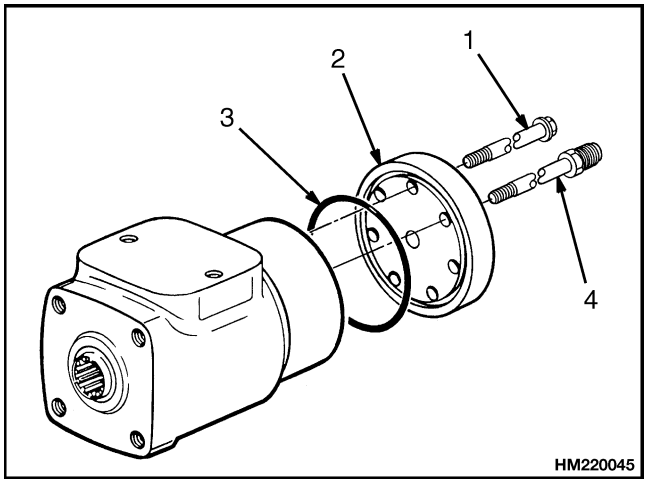
REMOVE

NOTE: For early model ERP20-30ALF (B216) lift trucks, do Step 1 through Step 4 and Step 6 and Step 7. For later model ERP20-30ALF (B216) lift trucks and for ERP20-30ALF (ERP040-060DH) (D216) lift trucks, do Step 1 and Step 5 through Step 7.

1. Remove the battery. See the section **Periodic Maintenance** 8000 YRM 552 for ERP20-30ALF (B216) models and **Periodic Maintenance** 8000 YRM 1060 for ERP20-30ALF (ERP040-060DH) (D216) models, for the procedures to remove the battery.

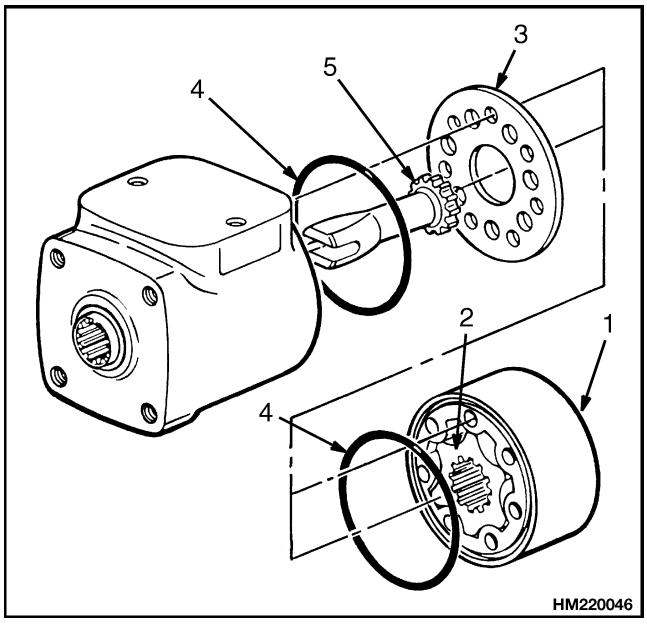
2. Remove the top cover of the counterweight (cover over electronics compartment). See Figure 11.

STEP 2.
Remove the cover on the bottom of the steering control unit. Remove the check ball.



1. CAPSCREW
2. COVER
3. O-RING
4. SPECIAL FITTING

STEP 3.
Remove the stator, rotor, and port plate. Put a mark on the stator so that the same side will be toward the body of the control unit at assembly. Remove the O-rings. Remove the center shaft.



1. STATOR
2. ROTOR
3. PORT PLATE
4. O-RING
5. CENTER SHAFT

PROBLEM	POSSIBLE CAUSE	PROCEDURE OR ACTION
Slow or difficult steering.	Relief valve for the steering system is not adjusted correctly.	Adjust or install new relief valve.
	Low oil pressure from the hydraulic pump.	Check for restrictions. See Troubleshooting Hydraulic System.
	Seal in the steering cylinder has a leak.	Repair cylinder. Install new seal or new cylinder.
	Hydraulic lines are too small or have restrictions.	Remove restrictions. Install larger or new hydraulic lines.
	Steering control unit is worn, not assembled correctly, or has damage.	Repair or install new control unit.
Steering wheel turns the tires in the wrong direction.	The hydraulic lines are not connected correctly at the steering cylinder or at the steering control unit.	Connect lines correctly. Remove air from the system.
Steering function continues after the steering wheel stops.	The steering control unit is assembled wrong or has damage.	Repair or install new control unit.
The steering operation is not smooth.	The oil level in the tank is low.	Fill tank. Check for leaks.
	Air was not removed after repair to the hydraulic system.	Remove air from the system.
	The steering control unit is assembled wrong or has damage.	Repair or install new control unit.
	The hydraulic pump has a leak at the inlet.	Fix leaks. Remove air from the system.

WARNING

The threads of the adjuster wheel are not the same for each brake assembly. If the adjuster wheel assemblies are installed on the wrong brake, the brake shoe clearance will increase each time the brakes are applied. The adjuster wheel for the right brake has left-hand threads. The adjuster wheel for the left brake has right-hand threads.

8. Put an antiseize compound on threads of adjuster wheel. Install adjuster wheel assembly between two brake shoes. Make sure adjuster wheel is toward rear of lift truck.

Turn adjuster wheel into adjuster nut so adjuster assembly is in its shortest position. This action permits brake drum to be easily installed over brake shoes.

9. Install link in adjuster wheel actuator. Put adjuster wheel actuator in the hole in brake shoe. Fasten spring to adjuster wheel actuator and brake shoe. The spring must be installed in the position shown in Figure 6. Install return springs for brake shoes. Make sure return springs are installed in correct positions. See Figure 6. A gray spring is always installed on right brake shoe.

10. Make sure bottom edge of adjuster wheel actuator is just above center of teeth of adjuster wheel. Bend lower link to align adjuster wheel actuator.

NOTE: To prevent damage to the inner oil seal when installing the hub, the hub and drum assembly can be temporarily fastened to the wheel. Align the height of the axle housing with hub bearings. Put grease under wheel and slide wheel toward axle housing. Install outer bearing and nut. Remove wheel from hub so the clearance of the brake shoes can be adjusted.

11. Clean hub bearings and lubricate them with wheel bearing grease. Install hub bearings and seals in hub. Install brake drum and hub on axle housing. See Figure 7 and Figure 8.

12. Adjust hub bearings by tightening nut to 205 N•m (151 lbf ft) while rotating hub. Loosen nut until hub turns freely. The torque must be less than 27 N•m (20 lbf ft). Tighten nut to 34 N•m (25 lbf ft) or until first alignment position after 34 N•m (25 lbf ft). Bend lock plate over nut.

CAUTION

If there is too much clearance, the automatic adjusters will not operate. If the clearance is too small, the automatic adjuster cannot turn the adjuster wheel to increase the clearance and the adjuster wheel will not turn until the brake shoes wear. If the adjuster wheel does not move for a long operating period, the adjuster link can wear a spot on the adjuster wheel so that it will not turn correctly.

NOTE: If the brake shoes were not replaced, loosen adjuster wheel approximately 25 teeth.

13. Adjust the clearance of the brake shoes. Put a brake adjustment tool or a screwdriver through hole in drum. Turn adjuster wheel so teeth of adjuster wheel nearest back plate move upward. Turn adjuster wheel until hub will not turn. Pull actuator away from adjuster wheel and turn adjuster wheel approximately 15 teeth in opposite direction. The brakes will adjust to correct clearance when they are applied while lift truck is traveling in **REVERSE** direction.

14. Put sealant on flange of axle shaft. Install axle shaft and capscrews. Tighten capscrews to 98 N•m (72 lbf ft).

ADJUST

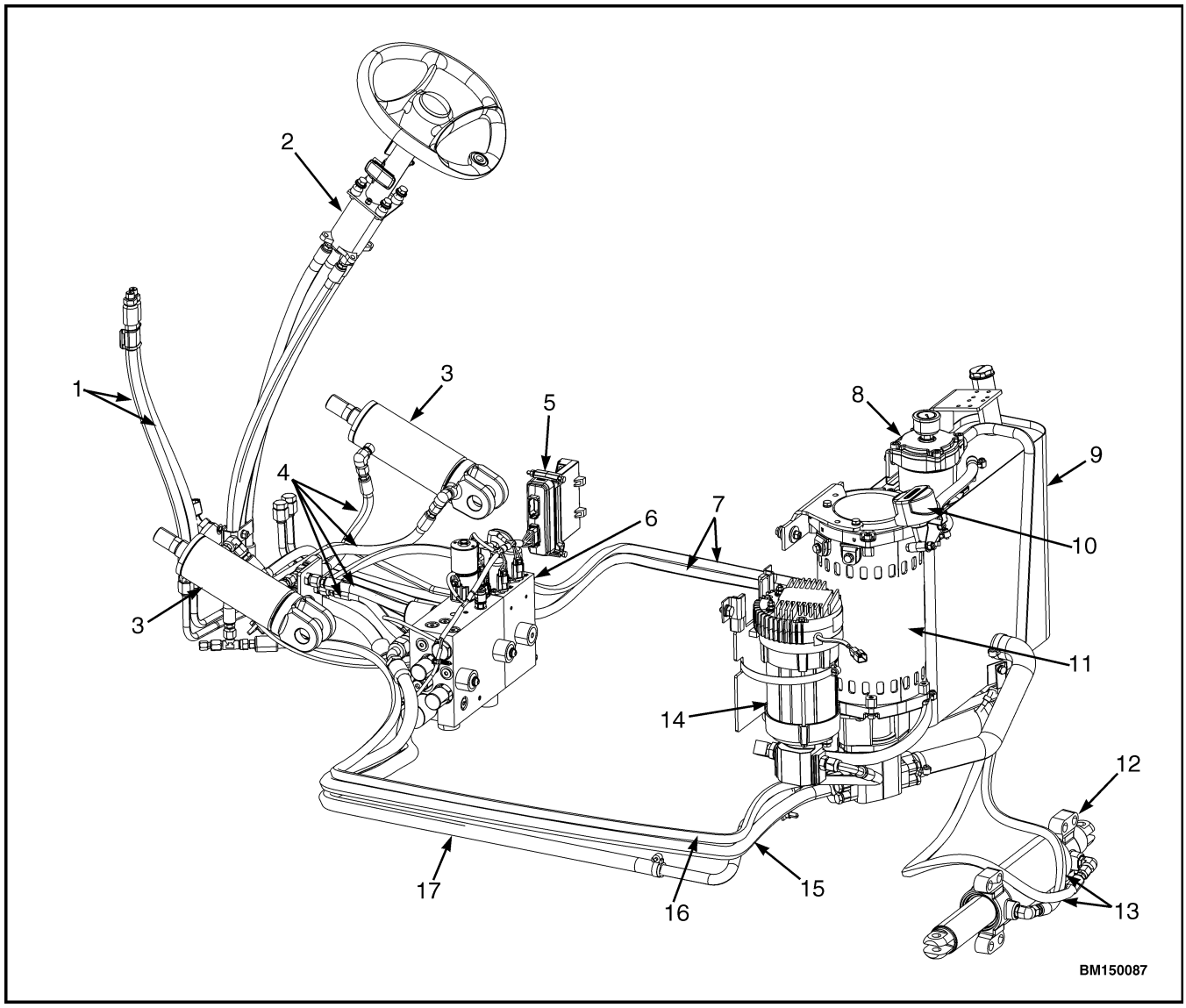
1. Remove air from brake hydraulic system. See the procedure Brake System Air Removal.

2. Install wheel on hub. Tighten nuts to 237 to 305 N•m (175 to 225 lbf ft).

3. Tilt mast backward or lift the truck to remove blocks. Push on brake pedal. The pedal must not touch floor plate. Move lift truck in REVERSE and push on brake pedal to permit adjusting mechanism to operate. Repeat this operation several times.

4. The service brakes must be adjusted before the parking brake can be adjusted. See Figure 9 and Figure 10 and the following paragraphs in this section for the correct adjustment of the parking brake.

PROBLEM	POSSIBLE CAUSE	PROCEDURE OR ACTION
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.



1. AUXILIARY HYDRAULIC HOSES
2. STEERING CONTROL UNIT
3. TILT CYLINDERS
4. TILT CYLINDER HOSES
5. VALVE DRIVER MODULE
6. MAIN CONTROL VALVE
7. HOSES TO STEERING CONTROL UNIT
8. HYDRAULIC FILTER
9. HYDRAULIC TANK
10. HYDRAULIC TANK BREATHER
11. HYDRAULIC PUMP AND MOTOR
12. STEER CYLINDER
13. STEER CYLINDER HOSES
14. STEERING PUMP AND MOTOR
15. HYDRAULIC PUMP AND MOTOR HOSES
16. HOSES TO STEER PUMP AND MOTOR
17. HOSES TO HYDRAULIC TANK

Figure 6. Hydraulic System for ERP20-32ALF (ERP040-065DH) (E216) Lift Trucks With E-Hydraulic Controls

Legend for Figure 14

1. TO STEERING CONTROL UNIT
2. METAL BAND (HOLDS PUMP MOTOR TO MOUNTING WELDMENT)
3. FROM HYDRAULIC TANK
4. PUMP MOTOR
5. STEERING PUMP
6. STEERING CYLINDER
7. RETURN TO HYDRAULIC TANK
8. PRESSURE CHECK FITTING
9. RUBBER CHANNELS
10. MOUNTING BRACKETS
11. CAPSCREW
12. WASHER
13. MOUNTING WELDMENT

LIFT TRUCK MODELS [ERP20-32ALF (ERP040-065DH) (E216)]

Remove

WARNING

The hydraulic oil is HOT at operating temperature. Do not permit the hot oil to contact the skin and cause a burn.

CAUTION

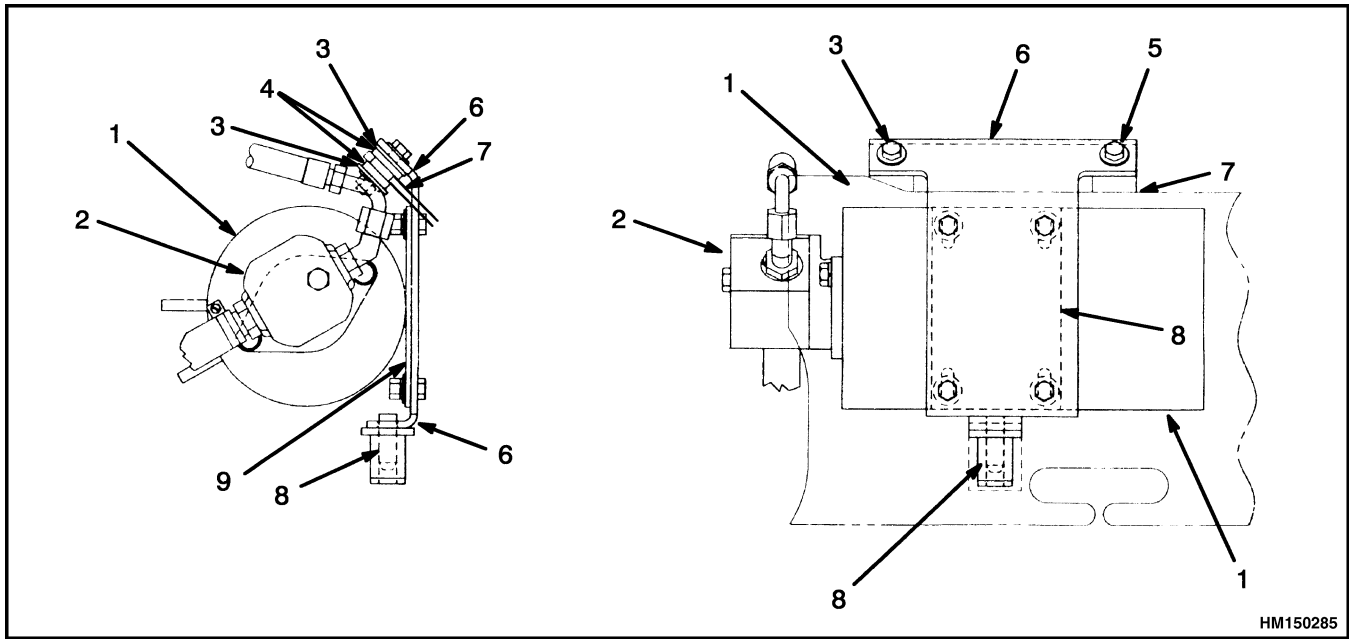
Do not permit dirt to enter the hydraulic system when the oil level is checked or the filter is changed. Dirt can cause damage to components of the hydraulic system.

Never operate the pump without oil in the hydraulic system. The operation of the hydraulic pump without oil will damage the pump.

1. Turn key to the **OFF** position and remove key.
2. Remove top counterweight cover and open hood for access to hydraulic filter assembly. See Figure 26.
3. Remove the four socket head screws from filter cover. See Figure 26. Remove O-ring seal from filter cover and discard O-ring. See Figure 27.
4. Remove filter element from filter housing and discard filter element. If debris cap was removed with filter element, remove cap from filter element. See Figure 27.

Install

1. Lubricate oil seal on new filter element. If debris cap was removed from filter element, install cap onto new filter element and install filter element into filter housing. See Figure 27.
2. Lubricate new O-ring and install new O-ring into filter cover. See Figure 27.
3. Place filter cover onto housing, making sure the pin on the cover lines up with the notch on the housing, and secure cover to housing with four socket head screws. See Figure 26.
4. Close hood and install counterweight cover.
5. Turn key to the **ON** position and operate hydraulic system, check for leaks and check oil level.



1. MOTOR
2. HYDRAULIC PUMP - STEERING
3. WASHER (4)
4. RUBBER BUSHINGS (4)
5. CAPSCREW AND NUT (2)
6. MOUNT BRACKET
7. FRAME BRACKET
8. MOUNT PIN
9. MOTOR BASE

Figure 34. Steering Pump and Motor for ERC/P16-20AAF (ERC030-040AF, AG/BG) (A814) and ERC/P16-20AAF (ERC030-040AH) (B814)

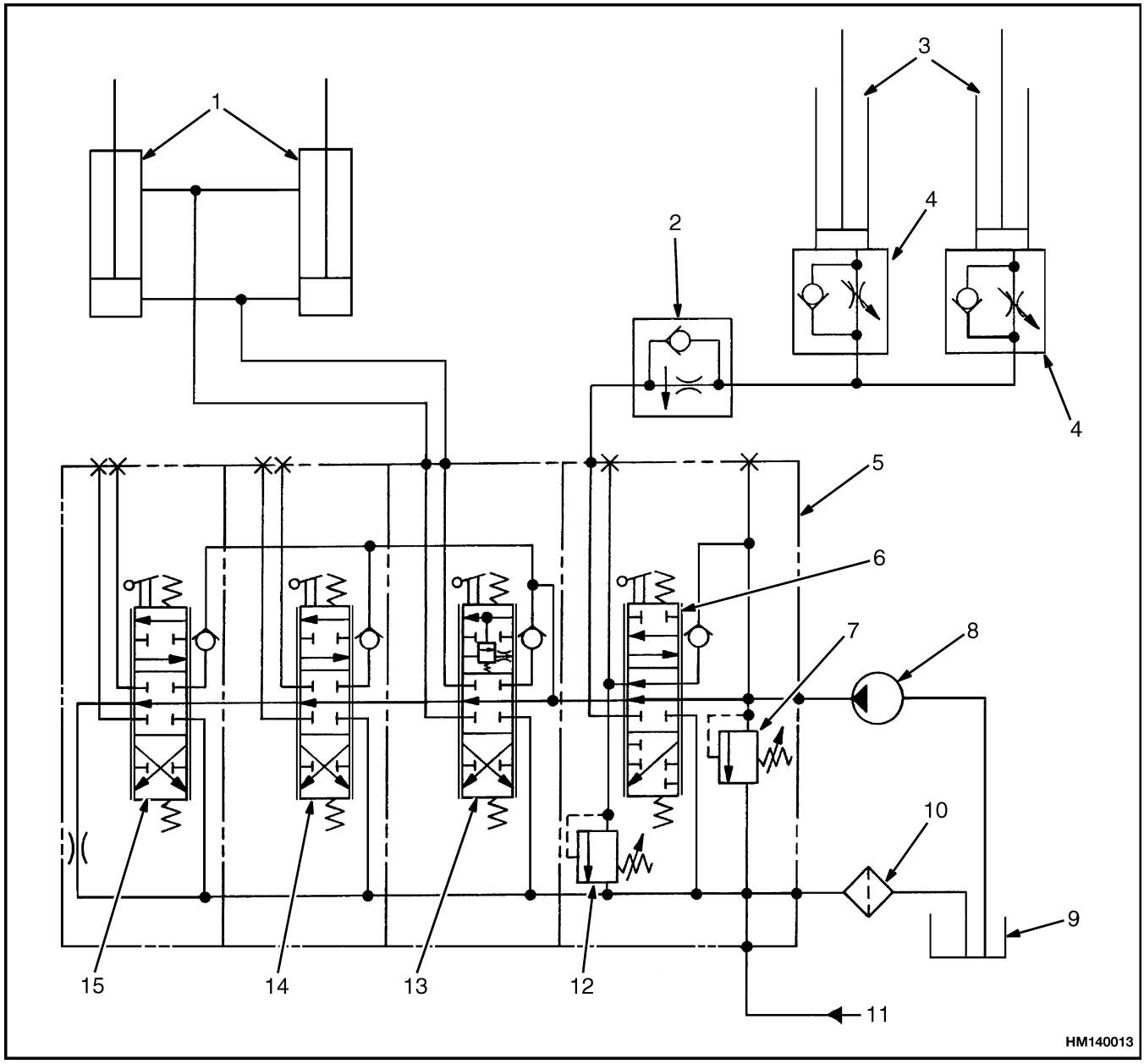
6. Make a note of the positions of the rubber bushings at the mount brackets and remove capscrews that fasten brackets. See Figure 35.

7. Carefully lift steering pump and motor assembly up out of frame. Do not damage pressure switch on bottom of pump.

NOTE: Do not remove mount brackets from motor base unless motor will be replaced. These brackets must be correctly aligned on motor base.

8. Make a note of the position of the inlet and outlet ports of the pump for correct alignment to the motor during assembly. Remove two capscrews that fasten pump to motor and carefully remove pump. Remove O-ring at pump shaft.

PROBLEM	POSSIBLE CAUSE	PROCEDURE OR ACTION
Steering wheel turns the tires in the wrong direction.	The hydraulic lines are not connected correctly at the steering cylinder or at the steering control unit.	Connect lines correctly. Remove air from system.
Steering function continues after the steering wheel stops.	The steering control unit is assembled wrong or has damage.	Repair or install new control unit.
The steering operation is not smooth.	The oil level in the tank is low.	Fill tank. Check for leaks.
	Air was not removed after repair to the hydraulic system.	Remove air from system.
	The steering control unit is assembled wrong or has damage.	Repair or install new control unit.
	The steering pump has a leak at the inlet.	Fix leaks. Remove air from system.
	HYDRAULIC SYSTEM	
The pump makes more noise than normal.	The oil level is not correct or there is no oil in the tank (cavitation).	Check oil level and fill as required. Check for leaks.
	Wrong type or grade of hydraulic oil for the temperature or operation (cavitation).	Check, drain tank, and fill with correct specified oil.
	The suction screen has a restriction (cavitation).	Clean or install new screen.
	The inlet fitting is loose or hoses are allowing air to enter the system (aeration).	Tighten fitting. Install new hoses. Remove air from system.
	The pump bearings or gears have damage.	Repair or install new pump.
	The capscrews that hold the pump together are loose.	Tighten capscrews to specified torque.
	The pump is loose at the motor mounting.	Tighten fasteners to specified torque.
	The pump drive mechanism is loose, is worn, or has damage.	Check, repair, or install new parts as required.



1. TILT CYLINDER
2. LOWERING CONTROL VALVE (EXTERNAL)
3. LIFT CYLINDER
4. LOWERING CONTROL VALVE (INTERNAL)
5. MAIN CONTROL VALVE
6. LIFT/LOWER SPOOL
7. RELIEF VALVE (LIFT CIRCUIT)
8. HYDRAULIC PUMP
9. HYDRAULIC TANK
10. FILTER
11. FROM STEERING CIRCUIT
12. RELIEF VALVE (TILT AND AUXILIARY CIRCUITS)
13. TILT SPOOL
14. AUXILIARY SPOOL
15. AUXILIARY SPOOL

Figure 3. Control Valve Schematic, Main Control Valve Without OPS

Legend for Figure 12

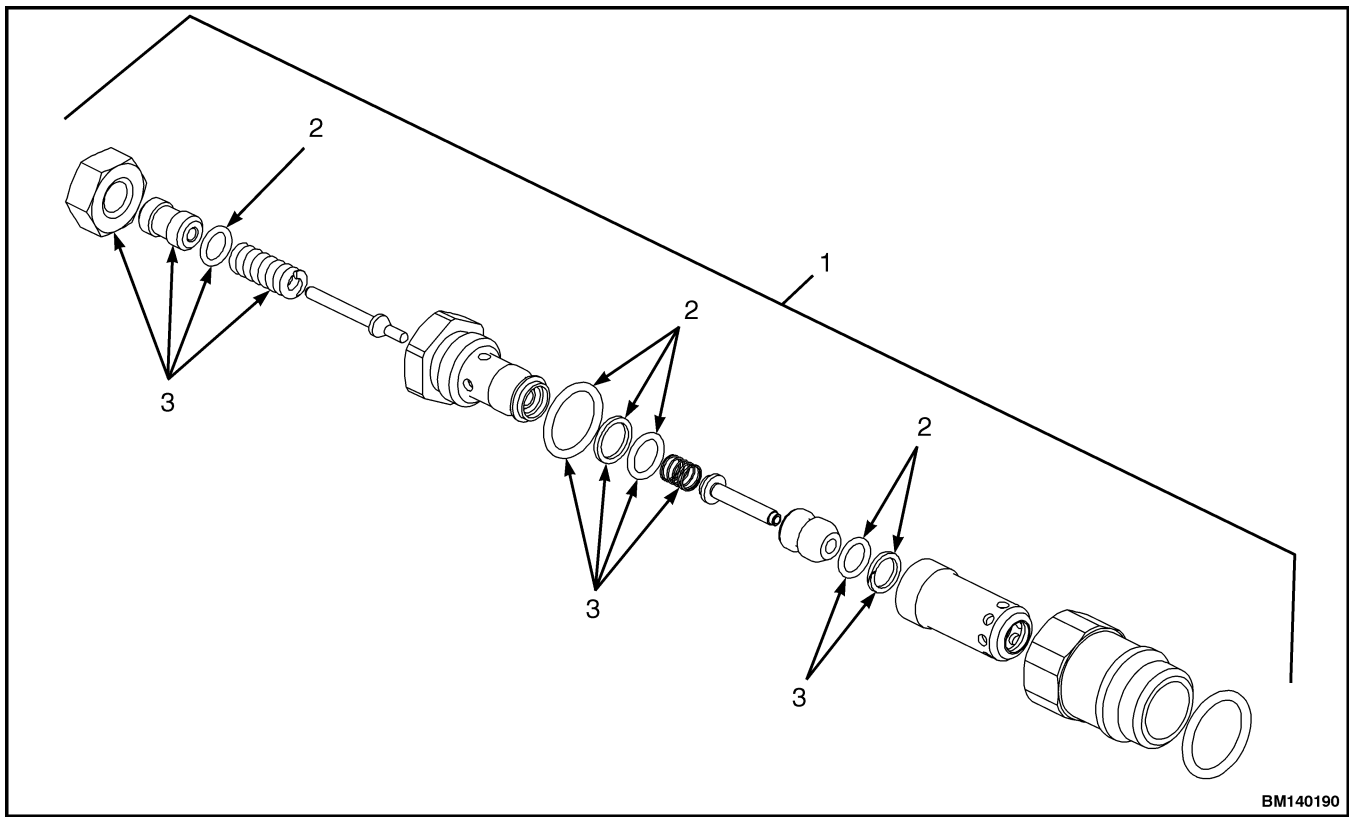
1. THROUGH BOLT
2. AUXILIARY SECTION
3. O-RING
4. SEAL
5. RETAINER
6. AUXILIARY SPOOL
7. SPRING
8. POPPET
9. TILT SPOOL
10. TILT SECTION
11. LIFT/LOWER SECTION
12. LIFT/LOWER SPOOL
13. SECONDARY RELIEF VALVE
14. PRIMARY RELIEF VALVE
15. INLET SECTION
16. PLUG
17. SPRING CUP
18. TILT CONTROL SPOOL (OPS)
19. OPS SOLENOID END CAP
20. SOCKET HEAD CAPSCREW
21. OPS SOLENOID (TILT SECTION)
22. LIFT CONTROL SPOOL (OPS)
23. OPS SOLENOID (LIFT SECTION)
24. SCREW
25. END CAP
26. NUTS
27. PISTON
28. PISTON SPRING

Relief Valve Repair

Repair of the relief valves is limited to the replacement of items in the seal kits on both relief valve assemblies. Seal kit items are shown in Figure 13 and Figure 14.

NOTE: Before disassembling the relief valves, match mark the adjuster cap and the relief valve body and count the number of turns used to remove the adjuster cap.

1. Loosen the lock nut and disassemble the relief valve as shown in Figure 13 and Figure 14.



1. PRIMARY RELIEF VALVE 2. SEAL KIT 3. SEAL KIT WITH SPRING

Figure 13. Primary Relief Valve

Yale

Maintenance

EV-100ZX™ SCR MOTOR CONTROLLER

DESCRIPTION, ADJUSTMENTS, TROUBLESHOOTING, REPAIRS, AND THEORY

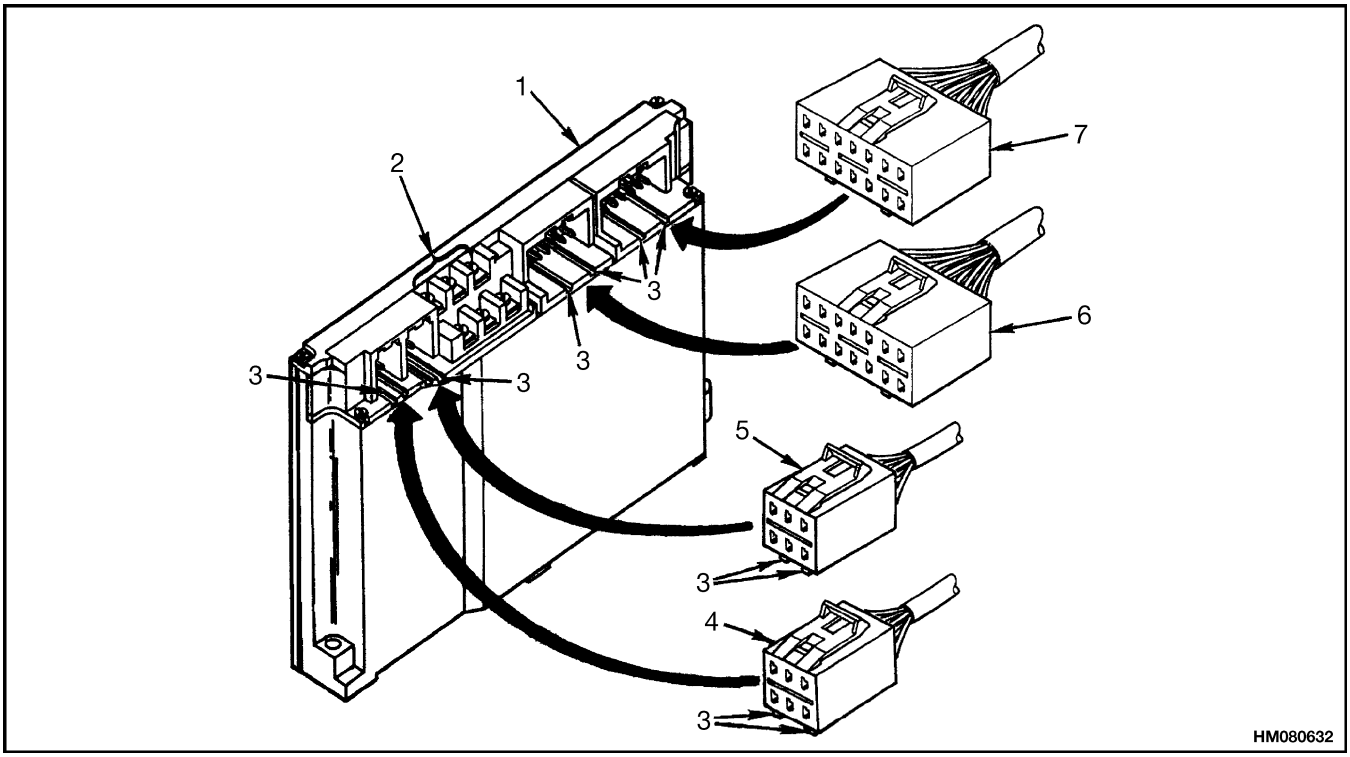
ERC/P16-20AAF (ERC030-040AF) [A814]; ERC070-120HD [A839]; ERP20-30ALF [B216]; ERC20-30AGF (ERC040-065RF/ZF) [E108]

Legend for Figure 3

NOTE: LABELS THAT HAVE A COMBINATION OF NUMBERS AND LETTERS ARE FOR POWER CABLES. LABELS THAT HAVE ONLY NUMBERS ARE FOR CONTROL WIRES.

A. EV-200ZX TRACTION AND SCR HYDRAULIC CONTROLLERS
B. EV-100ZX OR EV-200ZX TRACTION AND DUAL CONTACTOR HYDRAULIC CONTROLLERS
C. EV-100ZX TRACTION AND SCR HYDRAULIC CONTROLLERS
D. EV-100ZX OR EV-200ZX TRACTION AND ONE CONTACTOR HYDRAULIC CONTROLLER

1. TRACTION MOTOR CONTROLLER
2. MOTOR CONTROLLER(S) FOR LIFT PUMP MOTOR
3. POWER STEERING CONTACTOR



1. CONTROL CARD (TRACTION OR HYDRAULIC PUMP)
2. TB SCREW TERMINALS (6)
3. PLUG GUIDES
4. PLUG PA (6-PIN) (WIDE GUIDES)
5. PLUG PB (6-PIN) (CLOSE GUIDES)
6. PLUG PY (14-PIN)
7. PLUG PZ (14-PIN)

Figure 4. Control Card Connections

6. Push and hold the **ESC** key for 1 second. The display shows 8888. To check or set another register, do Step 1 through Step 3. To return to normal operation (run mode), push and hold **ESC** again for 1 second or longer.

Control Cards

FUNCTION NUMBER DESCRIPTIONS

The following pages have descriptions for the different Function Numbers. The setting for each function is specific for each control card. To identify the control card, check the label at the top edge of each card case. There are some painted letters and numbers followed by letters on the lower part of the label. The last two letters identify the type of card installed. The following types of control cards are used:

ZH = Traction Controller with three-wire potentiometer and **with** Battery Discharge Indicator (BDI).

ZY = Traction Controller with three-wire potentiometer and **without** Battery Discharge Indicator (BDI)

ZP = Pump Motor Controller **with** Truck Management Module (TMM1)

These same letters are also shown in the **Parameter Tables** and in the section headings for the control cards for the traction motor and hydraulic pump motor.

TRACTION CONTROL CARDS (LABEL LETTERS - ZH AND ZY)

NOTE: These control cards are used with the motor controllers that control the speed of the traction motor.

Function Number 1 STORED STATUS CODE

(Push 1)

WARNING

If any of the parameters are changed, the operators must be told that the lift truck will operate differently.

Do not adjust the parameters outside of the range of numbers shown in the Tables. Parameters set outside of the ranges can cause damage to the components of the traction system and can cause the lift truck to operate differently than normal. This different operation of the lift truck can result in personal injury.

This register contains the last status code of a possible PMT fault that caused the lift truck to stop operation. These codes can be removed from the display by turning the key to the **OFF** position. The code is stored in registers in the control card. This status code will be replaced with the same status code if another possible PMT fault occurs. The status code can be cleared from memory by adjusting the setting number to zero. The number must be stored by pushing the **STORE** key for 1 second. Adjustment of the values in this register does not change the operation of the lift truck. This register is cleared when the battery is disconnected.

Function Number 2 CREEP SPEED

(Push 2)

This register adjusts the creep speed of the lift truck. The range of adjustment is from 0 (5%) to 255 (15%). The percentage values are the SCR 1 **ON Time**. A constant creep speed frequency is maintained when the accelerator input voltage is between 3.7 and 3.5 volts (a potentiometer resistance value between 6K and 4.7K ohms).

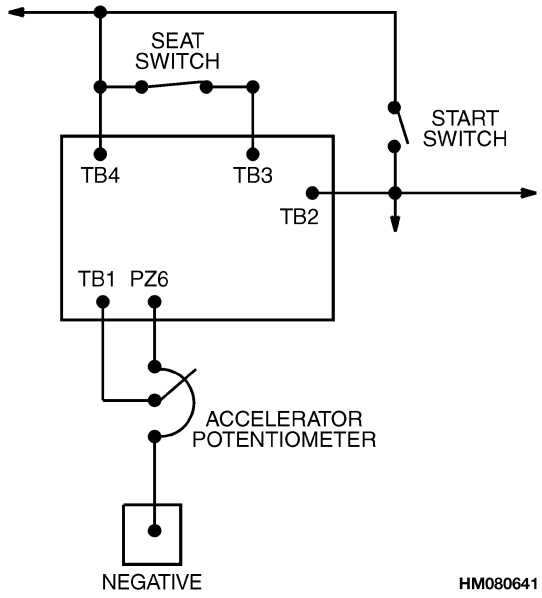
Function Number 3 CONTROLLED ACCELERATION AND 1A TIME

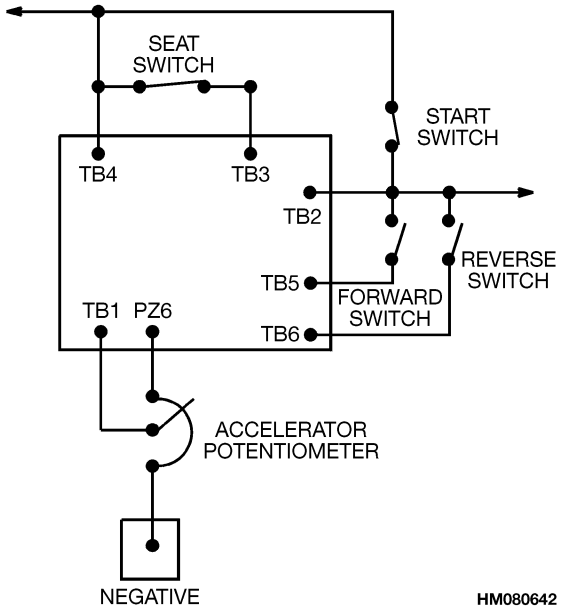
(Push 3)

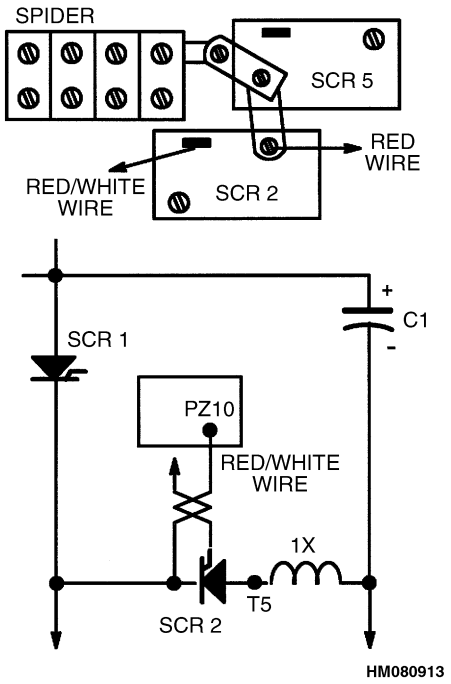
This register adjusts the maximum rate of acceleration. The setting determines the time allowed to reach maximum SCR speed after the accelerator is set for maximum speed from stop. The control stays in SCR acceleration for between 0.77 second (setting 8) and 21.5 seconds (setting 255) before the 1A contactor closes. The numbers in parenthesis are the parameters for the times shown. The 1A contactor automatically closes 0.2 second after the controlled acceleration stops. The speed control input is less than 0.5 volt (accelerator potentiometer set at less than 50 ohms). Do not adjust the number in the register to less than the minimum setting of 8.

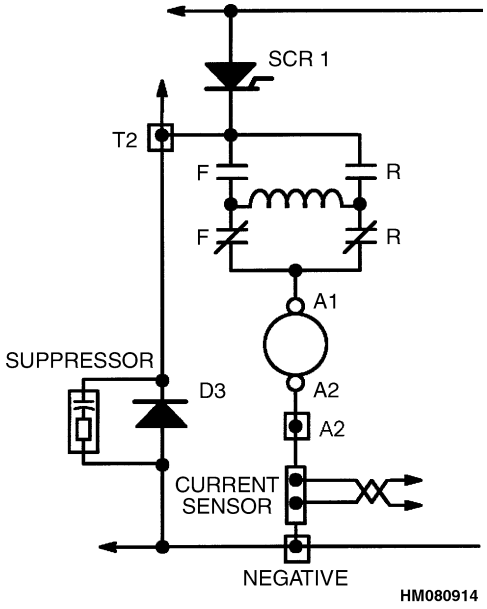
Table 6. Register Map for Control Cards ZH and ZY (Traction)

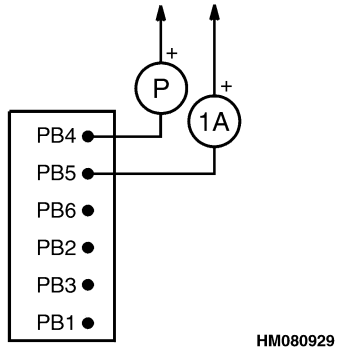
EEPROM Register Number	PC Register Number	Handset (HS) Number	Description	Access By:	Restrictions
0	1	1	Fault Code	HS or PC	Erases when battery is disconnected
1	2	2	Creep	HS or PC	None
2	3	3	Controlled Acceleration	HS or PC	None
3	4	4	Current Limit	HS or PC	None
4	5	5	Current Limit (Plugging)	HS or PC	None
5	6	6	1A Dropout	HS or PC	None
6	7	7	FW Pickup	HS or PC	None
7	8	8	FW Dropout	HS or PC	None
8	9	9	Regenerative Braking Current Limit	HS or PC	None
9	10	10	Regenerative Start	HS or PC	None
10	11	11	Speed Limit 1	HS or PC	None
11	12	12	Speed Limit 2	HS or PC	None
12	13	13	Speed Limit 3	HS or PC	None
13	14	14	Battery Voltage Compensation	HS or PC	None
14	15	15	Battery Voltage Selection	HS or PC	None
15	16	16	Pedal Position Plugging	HS or PC	None
16	17	17	Type of Control Card Selection	HS or PC	None
17	18	18	Steering Pump Time Delay	HS or PC	None
18	19	19	Maintenance Alert (Tens/Units)	HS or PC	None
19	20	20	Maintenance Alert (Thousands/Hundreds)	HS or PC	None
20	21	21	Maintenance Speed Limit	HS or PC	None
21	22	22	Mode Reference	HS or PC	
22	23	23	Hourmeter (minutes)	HS or PC	None
23	24	24	Hourmeter (seconds)	HS or PC	None
24	25	25	Fault Register Data	HS or PC	GE Temporary Storage
25	26	26	Battery Charge Data	HS or PC	GE Temporary Storage
26	27	27	Battery Voltage Data	HS or PC	GE Temporary Storage

Status Code **-05**	Description START switch or brake switch does not close	Cause of Status Indication This Status Code is indicated when TB1 is less than 2.5 volts and TB2 is less than 60% of battery voltage.
Memory Recall No **Circuit** Traction	**Indication of Fault** Forward or Reverse contactor does not close. **Possible Cause** Malfunction of the brake switch circuit. Check the brake switch to make sure it closed when the brake pedal is released. Check for an open circuit loose connections in the wires from the brake switch to the seat switch, to TB3, and from the brake switch to the START switch. Malfunction of the START switch circuit. Check the START switch to make sure it closed when the accelerator is actuated. Check for an open circuit or loose connections in the wires from the brake switch to the START switch and from TB2 to the START switch.	

Status Code **-06**	Description Accelerator actuated and no direction switch is selected.	Cause of Status Indication This Status Code is indicated when TB5 and TB6 are less than 60% of battery voltage and TB1 is less than 2.5 volts.
Memory Recall No **Circuit** Traction	**Indication of Fault** Forward or Reverse contactor does not close. **Possible Cause** Accelerator pedal is actuated before a direction switch is closed. The Status Code is cleared when a direction switch is closed or the accelerator pedal is released. Malfunction of the circuit for the FORWARD or REVERSE switches. Check the direction switches to make sure they close when the direction control lever is moved to that position. Open circuit between the direction switches and TB5 or TB6. Check for an open circuit or loose connections in the wires for the direction control circuits to TB5 or TB6.	

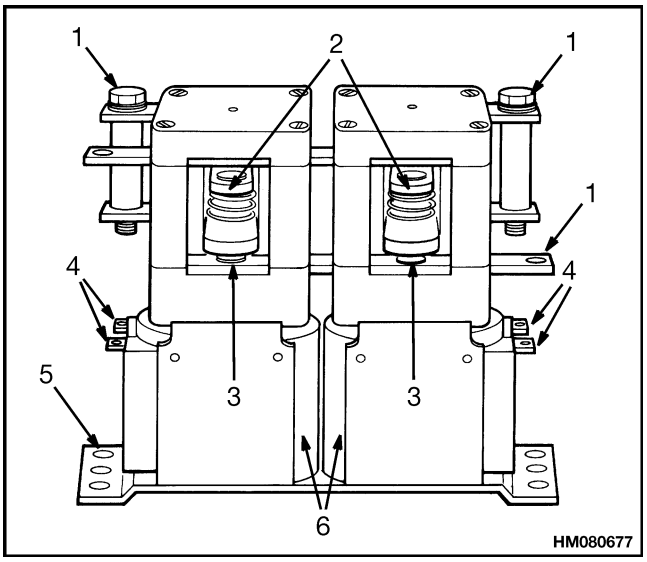
Status Code **-47**	**Description** SCR 2 does not go to **ON** correctly. (Also see Status Code -25).	**Cause of Status Indication** This Status Code is indicated when SCR 2 has a failure and does not go **ON**.
Memory Recall Yes **Circuit** Traction	**Indication of Fault** Forward or Reverse contactors open and close, then close only when the key switch is opened and closed. **Possible Cause** Malfunction of SCR 2 circuit. Check that SCR 2 goes **ON** with a gate signal. Check for an open circuit or loose connection between SCR 2 gate and PZ10 (white/red wire). Check for an open circuit or loose connection between SCR 1 and C1 and through the SCR 2 circuit. Malfunction of Forward or Reverse contactors. Check for Forward or Reverse contactors momentarily opening and closing during operation when traveling over bumps and dock plates.	

Status Code **-48**	**Description** Voltage check at T2 is less than 12% of battery voltage.	**Cause of Status Indication** This Status Code is indicated when a voltage check at T2 is less than 12% of battery voltage.
Memory Recall Yes **Circuit** Traction	**Indication of Fault** Forward or Reverse contactors do not close. **Possible Cause** Malfunction of Forward or Reverse contactors. Check for welded contacts that hold a Forward or Reverse contactor closed. Check for slow operation of a Forward or Reverse contactor. Malfunction of diode D3 circuit. Check for a short circuit across D3. Check for a short circuit across the suppressor for D3.	

Status Code **-123**	Description Low voltage to hydraulic pump contactor coil.	Cause of Status Indication This Status Code is indicated when the current to the coil circuit of the hydraulic pump contactor is less than 100 milliamps.
Memory Recall No **Circuit** Hydraulic Pump	**Indication of Fault** The contactor for the hydraulic pump does not close. Status code can change between code -123 and code -124. Do the checks for Status Code -123 first. If the problem not found, do the checks for Status Code -124. **Possible Cause** Malfunction in coil circuit of hydraulic pump contactor. Check for open circuit or loose connections between PB4 and the battery positive side of contactor coil. Disconnect Plug A and check the resistance between PB4 and the battery positive side of contactor coil. Coil for contactor 1A is damaged. Disconnect Plug A and check the resistance between the battery positive side of the contactor coil and its Plug A connection. The normal resistance is 10 to 14 ohms.	

CONTACTORS

The **FORWARD** and **REVERSE** (direction) contactor assemblies control the direction of current flow through the traction motor. See Figure 13. The contactor is a heavy-duty switch that opens and closes the power circuit. The traction circuit has a **FORWARD** and **REVERSE** contactor assembly. Each contactor assembly has the following parts: two sets of normally open (NO) contacts, two sets of normally closed (NC) contacts, and a coil. The coil is an electromagnet that moves the NO contacts to the closed position against spring pressure. The coil is in the control circuit. The contactor tips are in the traction circuit.

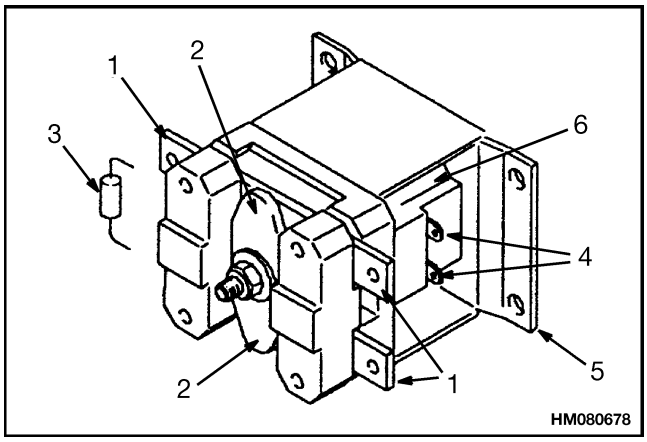


1. POWER TERMINALS
2. NC CONTACTS
3. NO CONTACTS
4. COIL TERMINALS
5. MOUNT BRACKET
6. COIL

Figure 13. Direction Contactor

When a contactor coil is energized, the normally open (NO) contacts close and the normally closed (NC) contacts open. This action gives direction control to the traction motor. The contacts normally have a long service life because the current flow through the contacts is stopped before the contacts open. The SCR 1 is **OFF** before the contactor coil is de-energized. The only condition where the contacts open during a large current flow is a Pulse Monitor Trip (PMT).

The other contactors used in the motor controller have one set of NO contacts. These contactors are not the same, but their operation is similar. A typical contactor of this kind is shown in Figure 14.



1. POWER TERMINALS
2. CONTACTS
3. SUPPRESSOR
4. COIL TERMINALS
5. MOUNT BRACKET
6. COIL

Figure 14. Typical Contactor Assembly (Regenerative Braking Shown)

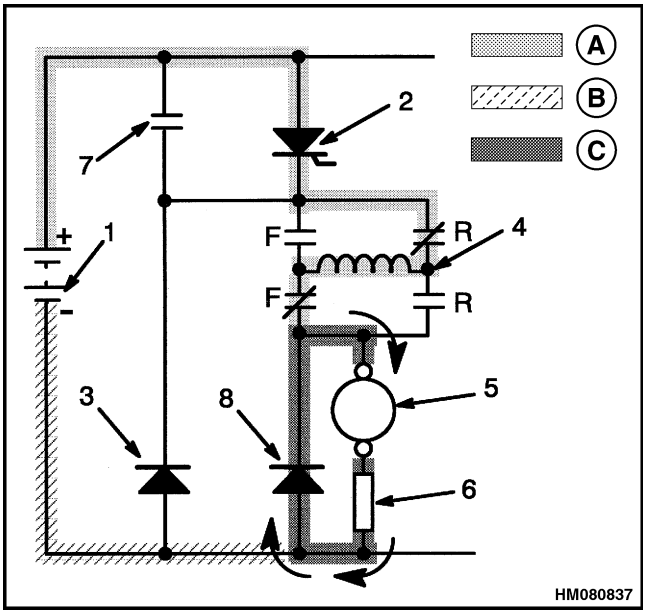
Contactor, Repair

Make an identification and disconnect the wires and cables from the contactor assembly. Remove the mounting screws and remove the contactor assembly. See Figure 15.

CAUTION

ALWAYS replace all of the contacts in a contactor at the same time. Replace the contacts in the contactor for the hydraulic pump after 1000 hours of operation. Replace the contacts in the other contactors when the thickness of any area of a contact is less than 30 percent of the thickness of a new contact or if there is any transfer of contact material. DO NOT USE A FILE ON THE CONTACTS. DO NOT LUBRICATE THE CONTACTS.

Contactor Contacts. The contacts in a contactor are made of special silver alloy. The contacts look black and rough from normal operation. This condition does not cause problems with the operation of the lift truck. Cleaning is not necessary.



1. BATTERY
2. SCR 1 (**OFF**)
3. DIODE D3
4. MOTOR FIELD
5. MOTOR ARMATURE
6. MOTOR CURRENT SENSOR
7. CONTACTOR 1A
8. DIODE D4

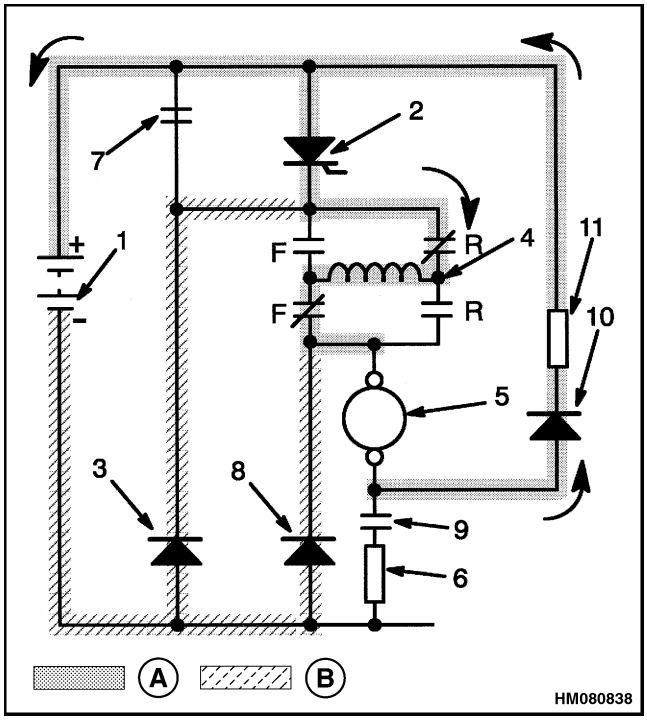
Figure 27. Plugging Circuit

Plugging is energized when the direction switches in the direction control lever are moved to the opposite direction from which the lift truck is traveling. The direction contactors change to their opposite positions and reverse the current flow through the motor field. The induction current generated in the traction motor now flows opposite to the current flow from the battery. The lift truck stops very quickly if the induction current is not controlled. A diode D4 permits part of the induction current from the armature to flow with the battery current through the armature again. This reduction of the opposite induction current permits the lift truck to stop more smoothly.

The control card for the traction circuit has a **PLUG** adjustment. This adjustment controls the maximum application of the plugging current. The position of the accelerator pedal controls the plugging distance up to the maximum application. This adjustment can be changed as needed for an operator. The shorter the plugging distance, the faster is the wear on the traction motor brushes.

Regenerative Braking. When a lift truck is being stopped, energy is generated by the traction motor. The lift truck causes the traction motor to rotate and operate like a generator. Plugging uses battery energy in opposition to the energy generated by the traction motor. This energy generates heat in the traction motor. Lift trucks used in heavy duty operations can generate enough heat to damage the traction motors and cause the motor brushes to wear rapidly.

Regenerative braking returns the energy generated by the traction motor to the battery. See Figure 28. The regenerative braking contactor opens during regenerative braking. When the voltage generated by the traction motor is less than the battery voltage, the lift truck moves slowly. The contactor for regenerative braking then closes and plugging is used to stop the slowly moving lift truck. Regenerative braking generates less heat in the traction motor and reduces brush wear. Another electric circuit must be added to the motor controller to control this operation. The energy generated during regenerative braking must be controlled within limits so that the parts of the electric circuit are not damaged. The adjustments used to control regenerative braking are:



1. BATTERY
2. SCR 1 (**OFF**)
3. DIODE D3
4. MOTOR FIELD
5. MOTOR ARMATURE
6. MOTOR CURRENT SENSOR
7. CONTACTOR 1A
8. DIODE D4
9. REGENERATIVE BRAKING (RB) CONTACTOR
10. DIODE D7
11. REGENERATIVE BRAKING CURRENT SENSOR

Figure 28. Regenerative Braking

Table 2. EV-100ZX Parameters - ERC040-065RF/ZF (36 to 48V) (Traction Card Type ZY NO Regenerative Braking and NO Field Weakening) (Continued)

		Default		Permitted Range	
Fcn. No.	**Description**	**Factory Parameter**	**Factory Value**	**Minimum Parameter**	**Maximum Parameter**
Function Numbers 31 through 47 can be read and cleared with a Handset. These registers store the fault codes and other data that the controller senses during the operation of the lift truck. These registers can only be reset to zero. The PC software program automatically resets these registers to zero.					
Function Numbers 48 through 62 enable the lift truck to be set to four performance levels by the operator. (If the customer does not want this function available to the operator, a service person can set all four levels to the same setting.) Each time the operator pushes the button on the instrument panel, the performance level will increase by one step. At the maximum (rabbit) level, the performance levels will begin at the lowest (turtle) level again.					
	MODE 1				
48	Controlled Acceleration	40	3.5 sec	Fcn. No. 52	255
49	FW Pickup Current	0	N/A	0	N/A
50	Speed Limit 1	85	80%	Fcn. No. 54	180
51	Not Used				
	MODE 2				
52	Controlled Acceleration	30	2.6 sec	Fcn. No. 56	Fcn. No. 48
53	FW Pickup 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 Pickup Current	0		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 Pickup Current	0		Fcn. No. 57	110
62	Speed Limit 1	0	None	0	Fcn. No. 58

Table 6. EV-100ZX Parameters - ERC70-120HD, ERC040-065RF/ZF, and ERP20-30ALF Lift Trucks (36 to 48V) (Hydraulic Pump Card Type ZP)

U.S. Lift Truck Models					
		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	-
2	Internal Resistance Compensation Start	10	65 amp	0/255	
3	Controlled Acceleration	50	1.04 sec	25/150	0.52 sec/3.1 sec
4	Current Limit (C/L)	255	max. amp	0/255	max. amperes
5	Not Used				
6	Not Used				
7	Controlled Acceleration Compensation	15			
8	Not Used				
9	Not Used				
10	Not Used				
11	Speed Limit 1	35	13 volts	30/70	11 to 26 volts
12	Speed Limit 2	55	21 volts	30/70	11 to 26 volts
13	Speed Limit 3	255	maximum volts	30/255	11 to maximum volts
14	Speed Limit 4	255	maximum volts	30/255	11 to maximum volts
15	Not Used				
16	Internal Resistance Compensation	10	2.28 volts		
17	Card Type Selection <u>with</u> BDI Low Function	63 High Current Limit with lockout function 65 High Current Limit with lockout function 71 High Current Limit with lockout function			
17	Card Type Selection <u>without</u> BDI Function	45 High Current Limit without lockout function 50 High Current Limit without lockout function 53 High Current Limit without lockout function			

[1] Any number other than zero can be read as a possible fault.

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3. To change the register value number, check for the correct value for that function register in the Parameter Tables. See the section **Transistor Motor Controllers (SR and SP) Parameter Tables for Four-Wheel Electric Rider Lift Trucks Transistor Motor Controllers**, **(SR and SP) Parameter Tables for Four-Wheel Electric Rider Lift Trucks** 2200 YRM 739. Change the register value by turning the Adjustment Knob on the Handset. The display continues to blink as the number value changes.

4. Push and hold the **STORE** key for 1 second. When the new value is set (stored), the display stops blinking.

NOTE: Make sure the motor controller is in the run mode before disconnecting the Handset. If the motor controller is not in the run mode, the battery must be disconnected and connected again to reset the system. It may also be necessary to discharge the capacitors by operating the horn for several seconds with the battery disconnected.

5. Push and hold the **ESC** key for 1 second. The display shows 8888. To check or set another register value number, do Step 1 through Step 3. To return to normal operation (run mode), push and hold **ESC** again for 1 second or longer. The display returns to the status code mode or displays the state of battery charge if the operator is in the seat. The display can also be blank (if there are no status codes or there is no BDI signal).

⚠ CAUTION

The plug cover on the small connector of the motor controller must be installed for correct operation. Make sure to disconnect the power and replace the plug cover each time the Handset is disconnected.

The vehicle can now be operated with the Handset connected or disconnected. Disconnect the Handset cable at the small connector on the motor controller when the battery is disconnected. This disconnects the Handset. Make sure to install the plug cover on the connector of the motor controller each time the Handset cable is removed.

Function Numbers 48 through 63

The key switch must be turn to the **OFF** position. The password must also be entered - if enabled.

NOTE: These functions (48 through 63) are the functions that are enabled when a Performance Mode (1, 2, 3, or 4) is selected at the Premium Display Panel. Each function must be set within the register parameters shown in the **Parameter Tables**. See the section **Transistor Motor Controllers (SR and SP) Parameter Tables for Four-Wheel Electric Rider Lift Trucks Transistor Motor Controllers**, **(SR and SP) Parameter Tables for Four-Wheel Electric Rider Lift Trucks** 2200 YRM 739.

1. Turn the key to the **ON** position after the Handset is connected to the display panel.

2. Push the Handset keypad numbers for the desired function. **Think of the CONT key equaling 47. Push and hold the CONT key plus the additional key number above 47 to total the required Handset number.** Close the seat switch and the key switch.

   Example: for Function Number 48, push the **CONT** and key **1** (47+1=48, 47+2=49, 47+3=50, 47+5=52, etc.). The display shows the selected function. After 1 second, the display shows the register value for this function.

3. Push and hold the **CONT** key for 1 second. The register value number on the display will blink.

4. To change the register value number, **check for the correct value for that function register in the Parameter Tables.** See the section **Transistor Motor Controllers (SR and SP) Parameter Tables for Four-Wheel Electric Rider Lift Trucks Transistor Motor Controllers**, **(SR and SP) Parameter Tables for Four-Wheel Electric Rider Lift Trucks** 2200 YRM 739. Change the register value by turning the Adjustment Knob on the Handset. The display continues to blink as the number value changes.

5. Push and hold the **STORE** key for 1 second. When the new value is set (stored), the display stops blinking.

6. Push and hold the **ESC** key for 1 second. The display shows 8888. To check or set another register, do Step 1 through Step 3. To return to normal operation (run mode), do Step 5 of the previous procedure.

Table 3. Function Map for Motor Controllers SR (Traction) (Continued)

EEPROM Register Number	PC Function Number	Handset (HS) Number	Description	Access By	Restrictions
50	51		Mode 1 Maximum Armature % On Time	PC Only	Reset to Zero Only
51	52		Mode 2 Controlled Acceleration	PC Only	Reset to Zero Only
52	53		Mode 2 Field Weakening (FW) Start	PC Only	Reset to Zero Only
53	54		Mode 2 Field Weakening (FW) Ratio	PC Only	Reset to Zero Only
54	55		Mode 2 Maximum Armature % On Time	PC Only	Reset to Zero Only
55	56		Mode 3 Controlled Acceleration	PC Only	Reset to Zero Only
56	57		Mode 3 Field Weakening (FW) Start	PC Only	Reset to Zero Only
57	58		Mode 3 Maximum (FW) Ratio	PC Only	Reset to Zero Only
58	59		Mode 3 Maximum Armature % On Time	PC Only	Reset to Zero Only
59	60		Mode 4 Controlled Acceleration	PC Only	Reset to Zero Only
60	61		Mode 4 Field Weakening (FW) Start	PC Only	Reset to Zero Only
61	62		Mode 4 Field Weakening (FW) Ratio	PC Only	Reset to Zero Only
62	63		Mode 4 Maximum Armature % On Time	PC Only	Reset to Zero Only
63-127	64-128		NOT USED	PC Only	Reset to Zero Only

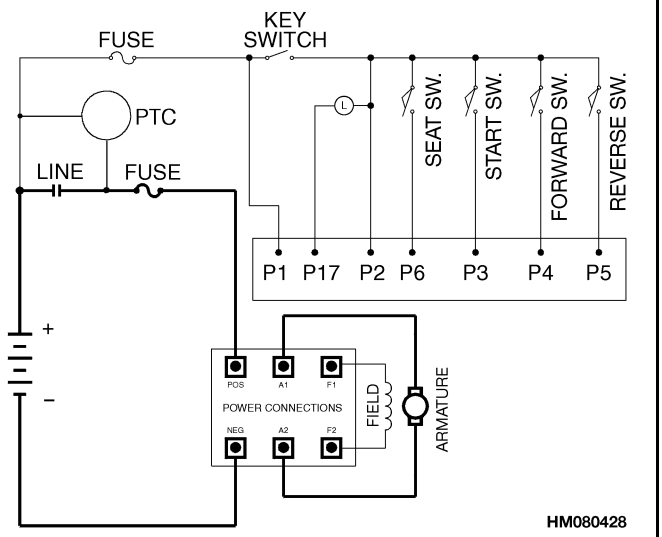
Status Code	Description	Memory Recall	Circuit
23	Motor field current is high at start of reverse travel.	No	Traction

Symptom

Maximum travel speed is reduced or lift truck does not move.

Possible Causes and Test Procedures

- Confirm that the motor field stud is not shorted to the hydraulic pump.
- Malfunction of motor controller.
  Replace the traction motor controller.



Cause of Status Indication

This status code is displayed when the current in the motor field is too high at start of reverse travel.

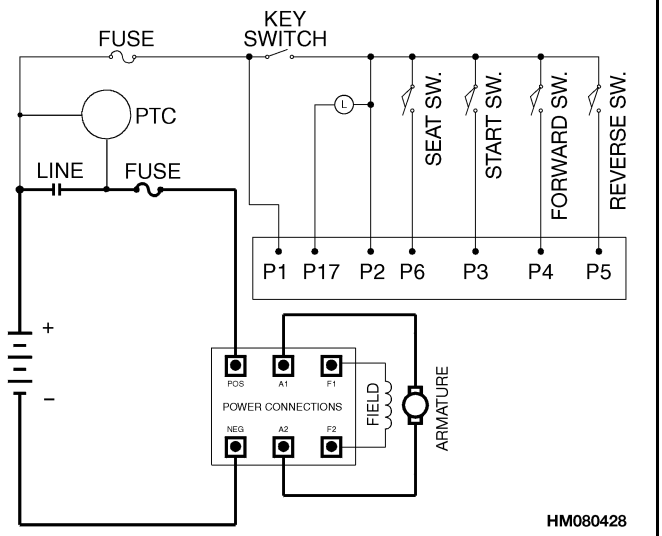
Status Code	Description	Memory Recall	Circuit
24	Motor field current is high at start of forward travel.	No	Traction

Symptom

Maximum travel speed is reduced or lift truck does not move.

Possible Causes and Test Procedures

- Confirm that the motor field stud is not shorted to the hydraulic pump.
- Malfunction of motor controller.
  Replace the traction motor controller.



Cause of Status Indication

This status code is displayed when the current draw in the motor field is too high at start of forward travel.

Status Code	Description	Memory Recall	Circuit
91	Temperature of lift pump motor is too high.	No	Traction and Pump

Symptom

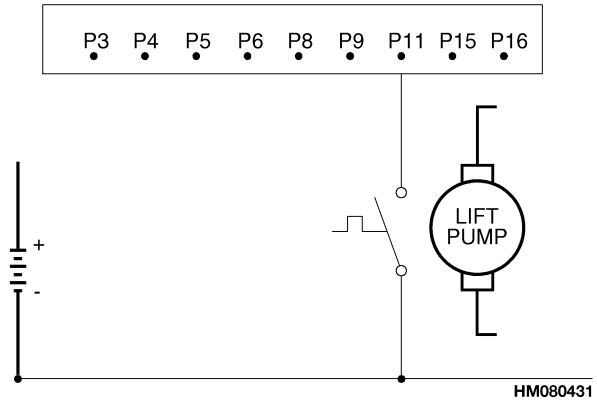
Status code flashes on and off.
Maximum travel speed is reduced.

Possible Causes and Test Procedures

- Lift pump motor is too hot.
  Allow lift pump motor to cool.
  If problem occurs several times, find reason lift pump motor is too hot and correct.
- P11 of pump motor controller or contactor module is shorted to battery negative.
  Locate and repair short.
- Temperature sensor of lift pump motor is shorted or damaged.
  Replace temperature sensor.
- Malfunction of pump motor controller (transistor controlled lift pump only).
  Replace the pump motor controller.
- Malfunction of contactor module (contactor controlled lift pump only).
  Replace the contactor module.

NOTE: Function Number 13, speed limit 3 is enabled by this status code.

PUMP MOTOR CONTROLLER OR
CONTACTOR MODULE (CONTACTOR PUMP CONTROL)



Cause of Status Indication

This status code is displayed when the voltage at terminal P11 of the pump motor controller or the contactor module is at zero volts.

Special Precautions

WARNING

To avoid injury and prevent electrical shock, perform the following steps before troubleshooting, adjustments, or repair:

- **Turn the key to the OFF position and disconnect the battery connector.**
- **Discharge the capacitors in the controllers using the horn. Move the key to the OFF position, disconnect the battery connector, and hold the horn button until the horn stops making a sound.**

CAUTION

To help prevent controller damage:

- **ALWAYS disconnect the battery when servicing the controllers.**
- **ALWAYS discharge the capacitors using the horn before performing any service.**
- **NEVER connect power to the motor controllers when any power cable is disconnected.**
- **NEVER make a short circuit at any motor controller terminal to battery (+), battery (—) or the frame.**

Check with the dealer for your lift truck before operating in an area with normal temperatures over 40°C (100°F). The lift truck motor controllers can be damaged.

CAUTION

Never add any electrical component to the lift truck without approval from the dealer for your lift truck. Other electrical components can prevent operation and/or damage the motor controller.

NEVER USE STEAM TO CLEAN ELECTRONIC COMPONENTS.

In dusty areas, blow low pressure air over the controller to remove dust. In oily or greasy areas, a mild solution of detergent or denatured alcohol can be used to wash off the controller, and then low pressure air should be used to completely dry the controller.

For the controller to be most effective, it must be mounted against the frame of the lift truck. The metal frame, acting as an additional heat sink, gives improved lift truck performance by keeping the controller package cooler. Apply a thin layer of silicone (heat transfer) grease Yale Part Number 504223239 between the controller heat sink and the lift truck frame prior to controller installation.

Controller wire plugs and other exposed transistor controller parts should be kept free of dirt and paint that might change the effective resistance between points.

CAUTION

Do NOT operate the traction system at high speed or rapidly change direction of operation with the wheels raised. Motor controller damage can occur.

Do not subject the controller to any high voltage (hipot or megger) testing.

Use a lead acid battery with the voltage and ampere hour rating specified for the lift truck. Follow normal battery maintenance procedures, recharging before 80% discharged, with periodic equalizing charges.

Other parts of these assemblies also cannot be repaired, and must be replaced if they malfunction. The contactors do have parts that can be replaced.

WARNING

Some checks in this section must be done with the battery connected and power applied to the controller. When making these checks, make sure the drive wheels are raised from the floor.

Make sure you disconnect the battery and separate the connector before you remove any power cables from the power terminals of the motor controller. The capacitor stores electrical energy and can cause injury if a person discharges a capacitor through parts of the body. AFTER the battery is disconnected and the key in the OFF position, make sure you also discharge the capacitor C1. Discharge the capacitor C1 by pushing and holding the horn button until the horn stops making a sound. The capacitor C1 discharges through the horn.

NOTE: The bolts and screws connected to the electronic components are normally metric sizes.

Make sure that you use the correct fastener for the part that is disassembled or removed.

FUSES

The fuses are found on the motor controller assembly or contactor panels. See Figure 8 or Figure 9. The condition of the fuses can normally be checked by looking at them or can be checked with an ohmmeter.

Accelerator Volts Hold Off

This feature checks the voltage level at the accelerator input whenever the key switch or seat switch is activated. If at start up, the voltage is less than 3.0 volts, the controller does not operate. This feature assures that the controller is calling for low speed operation at start up.

Pulse Monitor Trip (PMT)

The PMT design disables controller operation if a fault occurs that would cause a disruption of normal lift truck operation.

The PMT circuit checks for faults three ways:
- Look ahead
- Look again
- Automatic look again and reset

Field or armature FET (field effect transistor) failure, which would cause uncontrolled truck movement, is considered a PMT type fault. The controller monitors both field and armature FETs at start up and during operation. A PMT fault does not allow the line contactor to close at start up, or PMT opens it during operation.

Thermal Protector (TP)

This temperature sensitive device is internal to the power transistor (Q1) module. If the transistor's temperature begins to exceed the design limits, the thermal protector lowers the maximum current limit and maintain the transistors within their temperature limits. As the controller cools, the thermal protector automatically resets, returning the controller to full power.

Low Voltage

Batteries under load, particularly if undersized or more than 80 percent discharged, produce low voltages at the controller terminals. The SR and SP controllers are designed for use down to 50 percent of a nominal battery voltage of 36 to 84 volts and 75 percent of a nominal battery voltage of 24 volts. Lower battery voltage can cause the controller to operate improperly and the resulting PMT should open the line contactor, in the event of a failure.

SP PUMP MOTOR CONTROLLERS

The SP controllers are sealed units with no serviceable components. User adjustable features allow the controllers to be customized for different applications. Self diagnostics are provided to monitor internal components as well as detect problems with certain inputs and outputs. Adjustable registers and status codes are accessed using a Handset or a personal computer.

The SR controller is a transistorized lift pump controller capable of providing multiple lift pump speeds. Many of the features of the SR traction controller are incorporated into the lift pump controller.

This lift pump motor controller features:
- Three speeds, adjustable from 0 to 100 percent of motor voltage. The speeds are actuated by connecting the appropriate P terminal to battery negative
- Adjustable current limit and controlled acceleration
- Lift interrupt capability
- Handset and PC programmability
- Thermal protection
- Low voltage protection
- System diagnostics
- Premium instrument panel mode select capability

The three speed limits are activated by the hydraulic valve PC board connecting P12, P19, and/or P20 independently to battery negative.

The first speed (Speed Limit 1) is activated by connecting P12 to battery negative. SLl is set by Function Number 11. The specified motor voltage is regulated, however, motor current varies depending on the loading of the lift truck.

Tilt and auxiliary 1 provide the Speed Limit 1 input.

The second speed (Speed Limit 2) is activated by connecting P19 to battery negative. SL2 is set by Function Number 12. Operation of SL2 is similar to SL1.

The third speed (Speed Limit 3) is activated by connecting P20 to battery negative. SL3 is set by Function Number 13. Operation of SL3 is similar to SL1.

Fast lift provides the Speed Limit 3 input.

If more than one speed limit is activated, the selected speed with the highest motor volts overrides the lower motor voltage speed.

The lift pump controller current limit circuit and controlled acceleration circuit are adjustable and operate the same as the traction controller circuits.

The lift interrupt feature disables the lift pump controller when the connection at P10 loses the 12 volt signal from the traction controller. The battery discharge feature of the traction controller provides the 12-volt signal to the lift pump controller until the battery is discharged to 10 percent. Lift interrupt can be disabled by adjusting Function Number 17 of the traction motor controller.

Table 2. SR (SEM) Register Parameters for Traction Motor Controller - ERC/P16-20AAF (ERC030-040AG/BG) (36 to 48V) (High Speed Motor With E or ES Rating) (Continued)

U.S. and European Lift Truck Models					
		Default		Permitted Range	
Fcn. No.	Description	Factory Register Value	Factory Amount	Parameter Values (Min/Max)	Amount (Min/Max)
19	Maintenance Code (Tens and Units)	255	—	0/255	—
20	Maintenance Code (Thousands and Hundreds)	255	—	0/255	—
21	Auto Regen Braking Current Limit (With Auto Regen)	51	—	51/143	—
21	Auto Regen Braking Current Limit (Without Auto Regen)	255	—	144/255	—
22	Mode	184	184	184	184
23	For Special Programs	0	—	0/255	—
24	Field Weakening Start	100[1]	—	88/1151	—
25	Monitor	0[1]	—	0	—
26	Base Ratio	65[1]	—	62/68[1]	—
27	NOT USED		—	—	—
Set the register value for Function Numbers 28 to 0 (zero) whenever the status codes are cleared (erased from memory). Status codes will then be stored in the correct order of occurrence. The PC software program will automatically "ask" the technician if a 0 (zero) setting is wanted.					
29-47	NOT USED	—	—	—	—
Function Numbers 48 through 63 are **ONLY** used with lift trucks that have the **PREMIUM** display panel.					
48	Mode 1 Controlled Acceleration	52	1.30 sec	30/255	1.0 to 6.3 Seconds
49	Mode 1 Field Weakening (FW) Start	100[1]	—	88/115[1]	—
50	Mode 1 Field Weakening (FW) Ratio	35[1]	—	32/58[1]	—
51	Mode 1 Maximum Armature % On Time	95	—	50/115	—
52	Mode 2 Controlled Acceleration	52	1.30 sec	30/255	1.0 to 6.3 Seconds

[1]This function is not normally adjusted. Register values that are within the minimum/maximum parameter values will not change lift truck performance.
[2]Adjusting this register value to the wrong number can cause battery damage.
[3]Adjusting this register value to the wrong number can cause a status code of 15 or 16 and the lift truck will not operate.
[4]This register value sets electrical limits to protect the motor if a stall occurs. **NEVER** set a register value to a number above the maximum value or there can be motor damage if a stall does occur.
[5]A register value setting outside the parameter values can cause the traction system to operate differently than normal or cause damage to the motor controller or motor. **Personal injury** can also occur.

Table 6. SR (SEM) Register Parameters for Traction Motor Controller - ERC040-065RG/ZG (36 to 48V) (11 Inch-Traction Motor) (Continued)

U.S. Lift Truck Models					
		Default		Permitted Range	
Fcn. No.	Description	Factory Register Value	Factory Amount	Parameter Values (Min/Max)	Amount (Min/Max)
48	Mode 1 Controlled Acceleration - 48V	42	1.05 sec	30/255	1.0 to 6.3 Seconds
49	Mode 1 Field Weakening (FW) Start	130[1]	—	118/145[1]	—
50	Mode 1 Field Weakening (FW) Ratio	35[1]	—	32/58[1]	—
51	Mode 1 Maximum Armature % On Time	97	—	50/115	—
52	Mode 2 Controlled Acceleration - 36V	40	1.05 sec	30/255	1.0 to 6.3 Seconds
52	Mode 2 Controlled Acceleration - 48V	42	1.05 sec	30/255	1.0 to 6.3 Seconds
53	Mode 2 Field Weakening (FW) Start	130[1]	—	118/145[1]	—
54	Mode 2 Field Weakening (FW) Ratio	35[1]	—	32/38[1]	—
55	Mode 2 Maximum Armature % On Time	78	—	50/115	—
56	Mode 3 Controlled Acceleration	82	2.05 sec	30/255	1.0 to 6.3 Seconds
57	Mode 3 Field Weakening (FW) Start	130[1]	—	118/145[1]	—
58	Mode 3 Field Weakening (FW) Ratio	35[1]	—	32/58[1]	—
59	Mode 3 Maximum Armature % On Time	51	—	50/115	—
60	Mode 4 Controlled Acceleration - 36V	40	1.05 sec	30/255	1.0 to 6.3 Seconds
60	Mode 4 Controlled Acceleration - 48V	42	1.05 sec	30/255	1.0 to 6.3 Seconds
61	Mode 4 Field Weakening (FW) Start - 36V	140[1]	—	128/155[1]	—

[1]This function is not normally adjusted. Register values that are within the minimum/maximum parameter values will not change lift truck performance.
[2]Adjusting this register value to the wrong number can cause battery damage.
[3]Adjusting this register value to the wrong number can cause a status code of 15 or 16 and the lift truck will not operate.
[4]This register value sets electrical limits to protect the motor if a stall occurs. **NEVER** set a register value to a number above the maximum value or there can be motor damage if a stall does occur.
[5]A register value setting outside the parameter values can cause the traction system to operate differently than normal or cause damage to the motor controller or motor. **Personal injury** can also occur.

Table 10. SR (SEM) Register Parameters for Traction Motor Controller - ERP20-30ALF (36 to 48V) (E or ES Rated) (Continued)

U.S. Lift Truck Models					
		Default		Permitted Range	
Fcn. No.	Description	Factory Register Value	Factory Amount	Parameter Values (Min/Max)	Amount (Min/Max)
53	Mode 2 Field Weakening (FW) Start	130[1]	—	118/145[1]	—
54	Mode 2 Field Weakening (FW) Ratio	35[1]	—	32/58[1]	—
55	Mode 2 Maximum Armature % On Time	78	—	50/115	—
56	Mode 3 Controlled Acceleration	82	2.05 sec	30/255	1.0 to 6.3 Seconds
57	Mode 3 Field Weakening (FW) Start	130[1]	—	118/145[1]	—
58	Mode 3 Field Weakening (FW) Ratio	35[1]	—	32/58[1]	—
59	Mode 3 Maximum Armature % On Time	51	—	50/115	—
60	Mode 4 Controlled Acceleration	42	1.05 sec	30/255	1.0 to 6.3 Seconds
61	Mode 4 Field Weakening (FW) Start	130[1]	—	118/145[1]	—
62	Mode 4 Field Weakening (FW) Ratio	35[1]	—	32/58[1]	—
63	Mode 4 Maximum Armature % On Time	51	—	50/115	—
64-128	NOT USED	—	—	—	—

[1]This function is not normally adjusted. Register values that are within the minimum/maximum parameter values will not change lift truck performance.
[2]Adjusting this register value to the wrong number can cause battery damage.
[3]Adjusting this register value to the wrong number can cause a status code of 15 or 16 and the lift truck will not operate.
[4]This register value sets electrical limits to protect the motor if a stall occurs. **NEVER** set a register value to a number above the maximum value or there can be motor damage if a stall does occur.
[5]A register value setting outside the parameter values can cause the traction system to operate differently than normal or cause damage to the motor controller or motor. **Personal injury** can also occur.

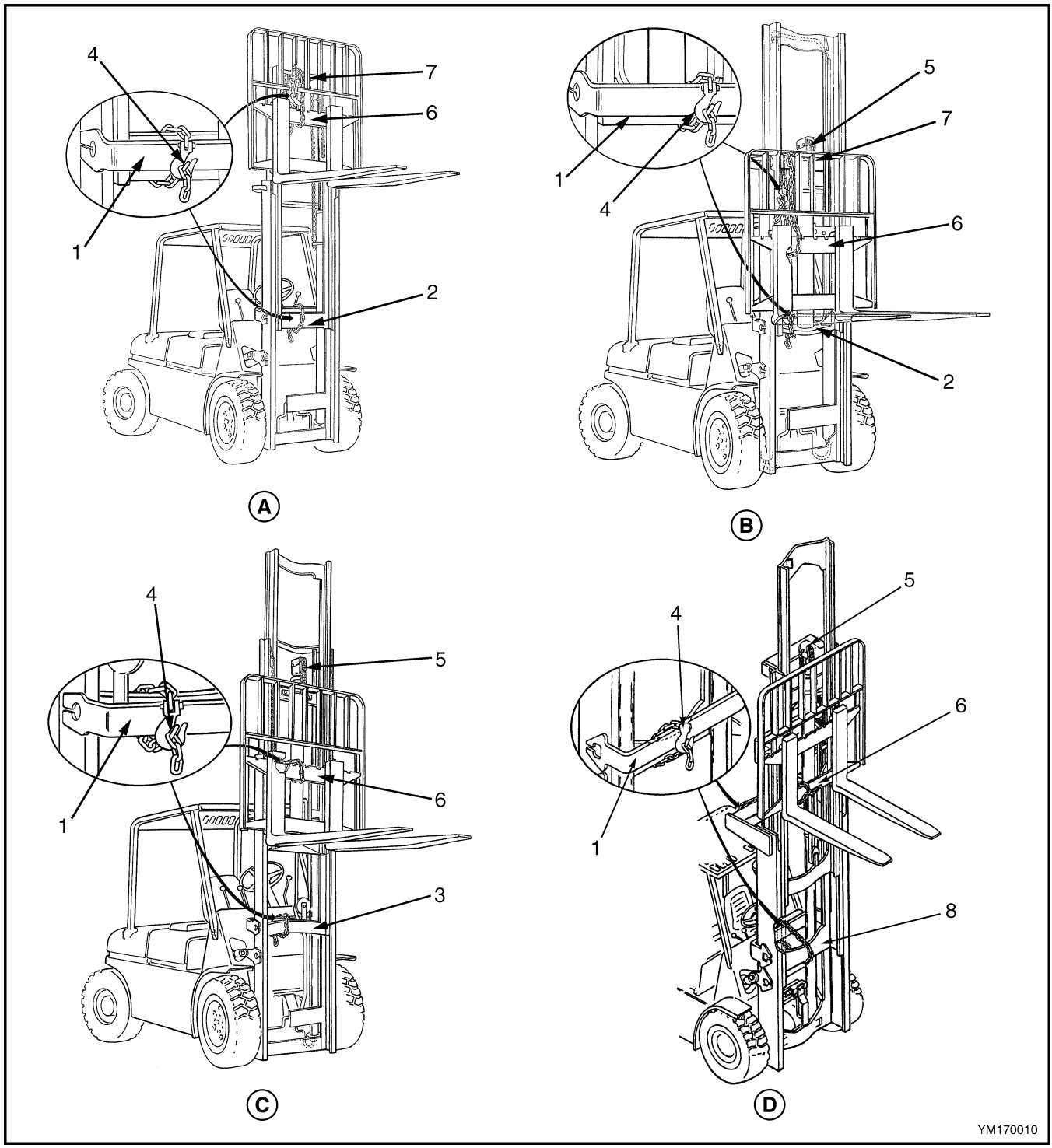
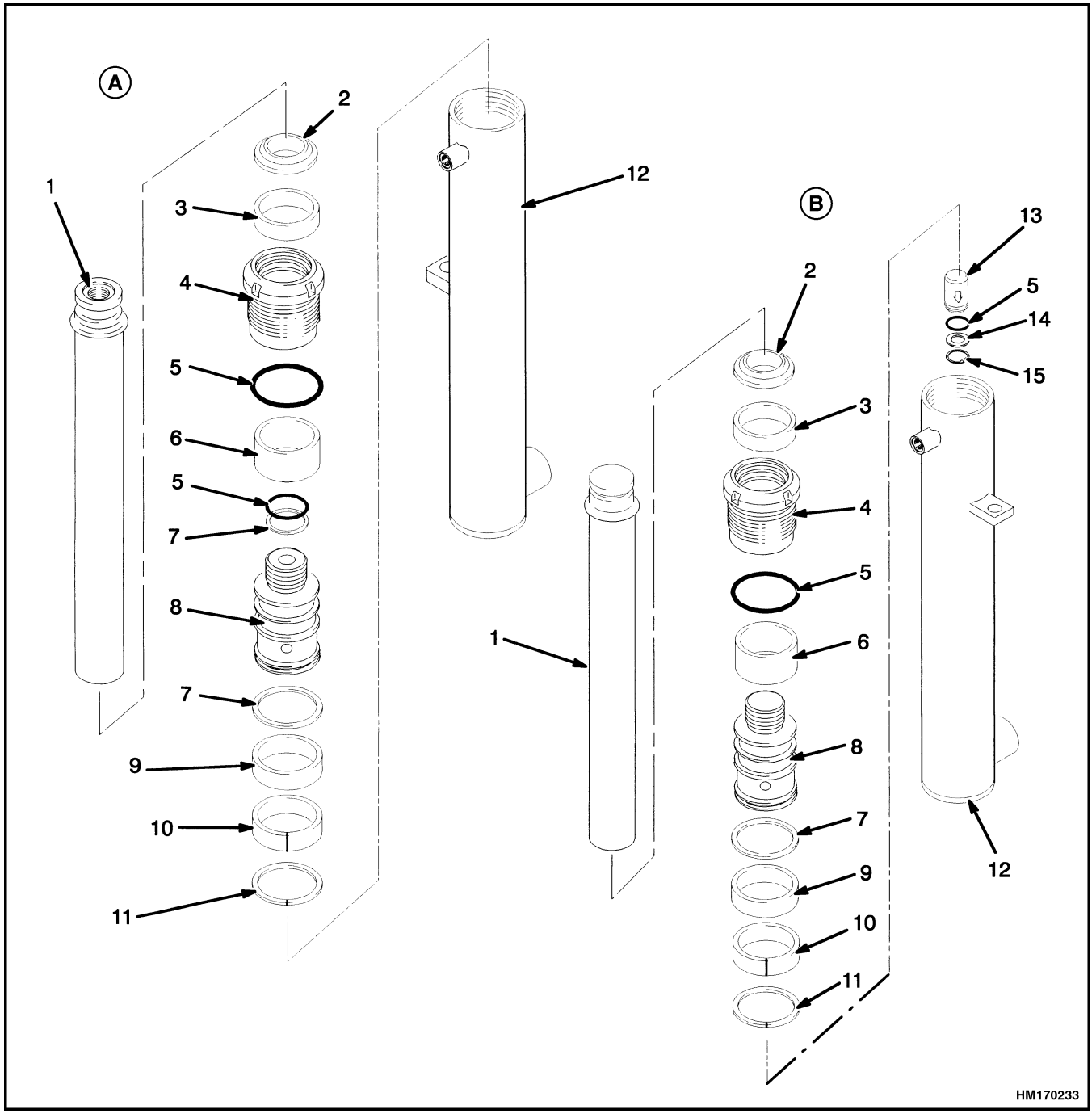


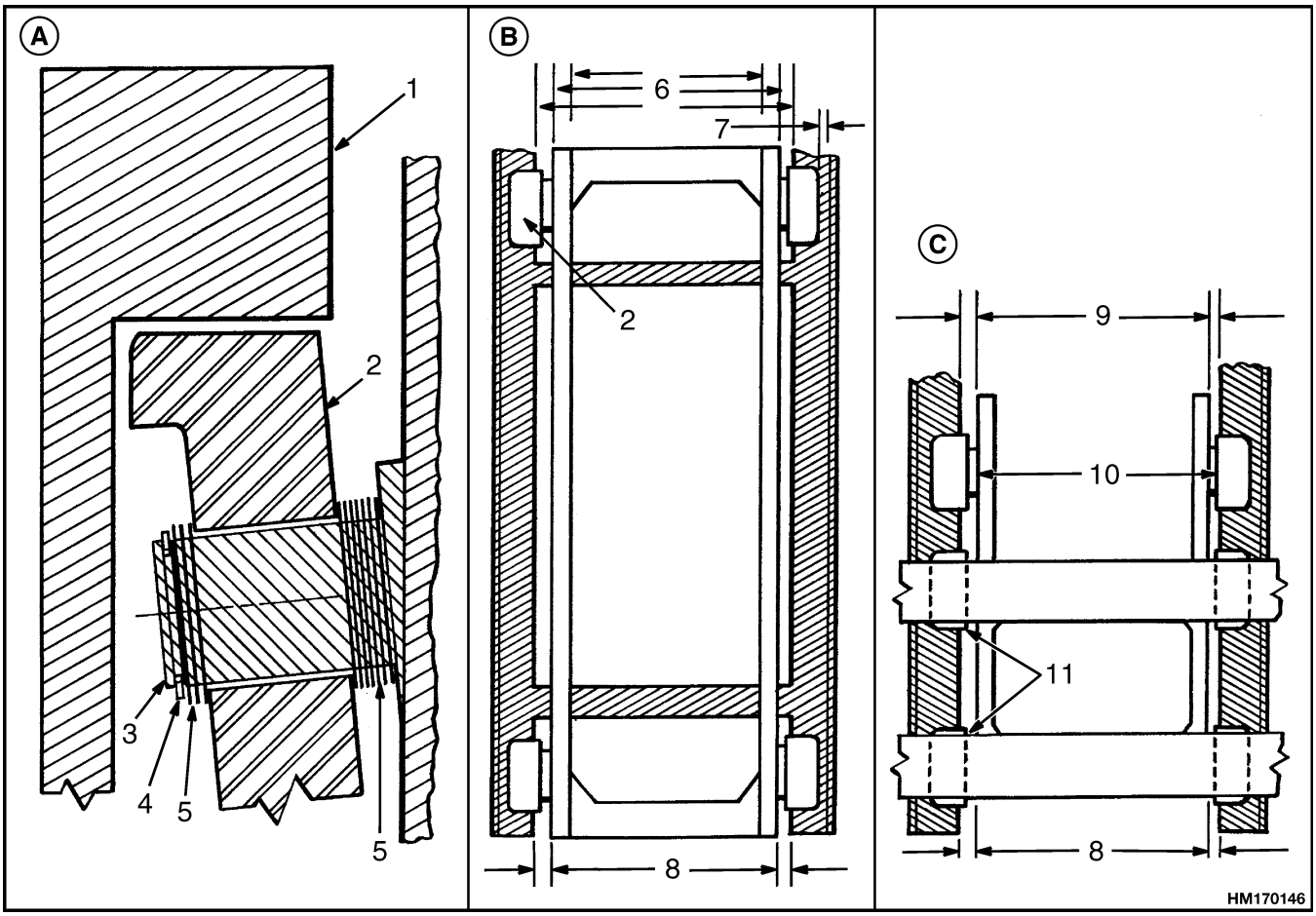
Figure 10. Two-Stage LFL, Two-Stage FFL, Three-Stage FFL, and Four-Stage FFL Masts



A. RIGHT-HAND LIFT CYLINDER **B.** LEFT-HAND LIFT CYLINDER

1. ROD
2. WIPER
3. ROD SEAL
4. RETAINER
5. O-RING
6. SPACER
7. BACKUP RING
8. PISTON
9. PISTON SEAL
10. WEAR RING
11. SEAL RING
12. SHELL
13. CHECK VALVE
14. WASHER
15. SNAP RING

Figure 22. Main Lift Cylinders



NOTE: USE SHIMS TO KEEP CARRIAGE AND MAST WELDMENTS PARALLEL, TO GIVE APPROXIMATELY EQUAL SPACE BETWEEN BOTH SIDES OF CARRIAGE AND WELDMENTS, AND TO GIVE ZERO CLEARANCE AT POINT OF TIGHTEST FIT.

A. TOP VIEW
B. MAST FRONT VIEW
C. CARRIAGE FRONT VIEW

1. CHANNEL
2. LOAD ROLLER
3. STUB SHAFT
4. SNAP RING
5. SHIMS
6. PARALLEL
7. ZERO CLEARANCE AT POINT OF TIGHTEST FIT
8. EQUAL SPACE ±1.5 mm (0.060 in.)
9. PARALLEL
10. PUT SPACER ON OUTSIDE OF TOP LOAD ROLLER, UNDER SNAP RING
11. SHIM FOR ZERO CLEARANCE AT POINT OF TIGHTEST FIT

Figure 32. Mast Adjustments

b. Use shims to adjust load rollers so there is zero clearance between load roller and channel at point of tightest fit.

c. The number of shims under a load roller must be approximately the same as the stub shaft in the opposite side of the weldment. The weldments will be approximately in the center.

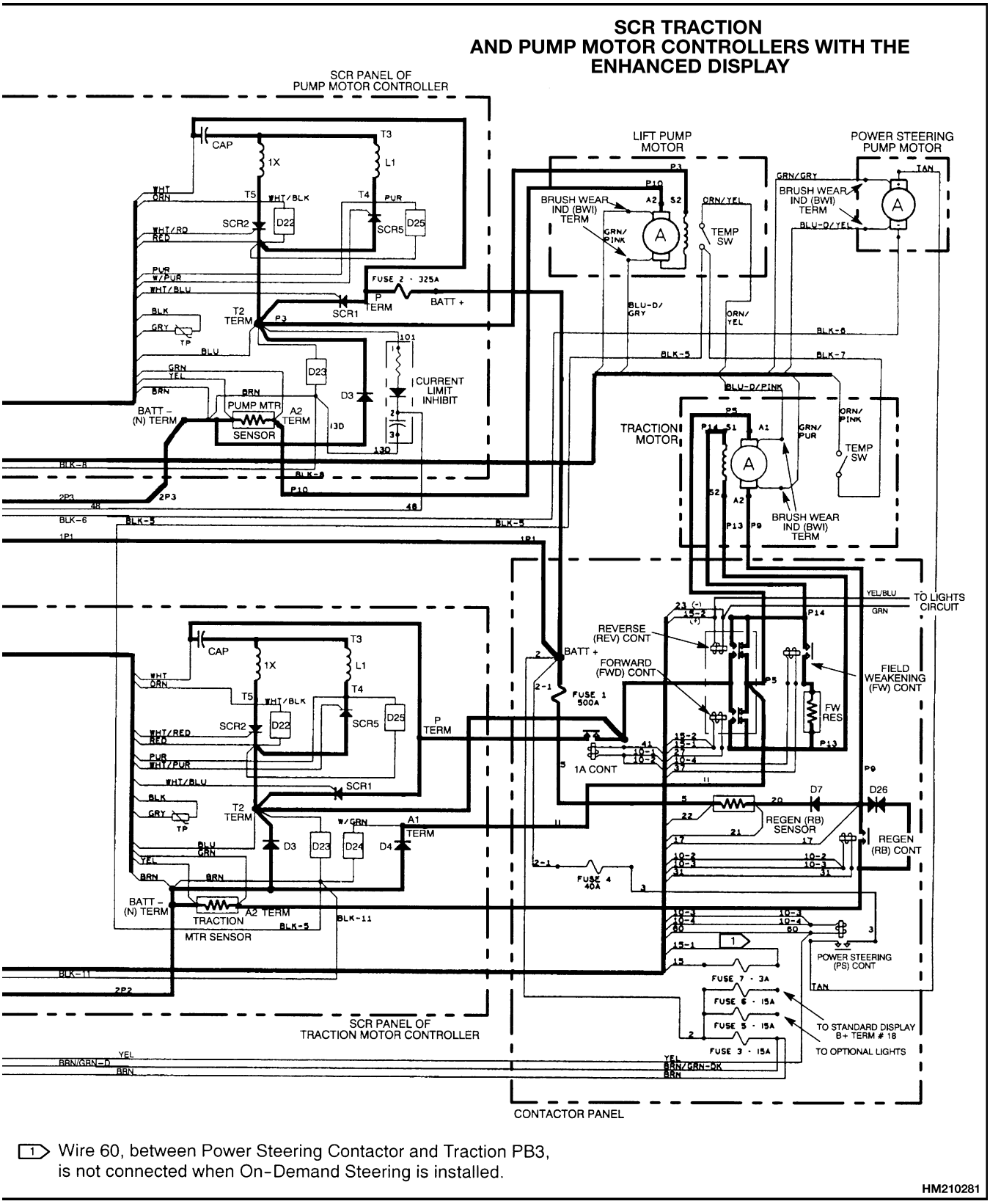


Figure 4. Wiring Diagram ERC20-30AGF (ERC040-065RF/ZF)

Legend for Figure 12

1. TRACTION MOTOR
2. LIFT PUMP MOTOR
3. STEERING PUMP MOTOR
4. HORN
5. FOOT DIRECTIONAL CONTROL PEDAL
6. CONTROL LEVER SWITCHES
7. MOTOR CONTROLLERS COMPARTMENT
8. BATTERY COMPARTMENT

Legend for Figure 20

1. TRACTION MOTOR
2. LIFT PUMP MOTOR
3. STEERING PUMP MOTOR
4. HARNESS FOR TEMP. AND BWI SENSORS
5. MAIN CHASSIS HARNESS
6. DISPLAY PANEL HARNESS
7. TO INSTRUMENT PANEL
8. TO ON-DEMAND STEERING
9. BATTERY+ CONTROL WIRES

Legend for Figure 28

NOTE: SET DIP SWITCHES TO TRUCK VOLTAGE. IF TRUCK VOLTAGE IS NOT KNOWN, SET 36/48V (U.S.) TRUCKS TO 48V AND 72/80V (EUROPEAN) TRUCKS TO 80V.

1. STEERING COLUMN
2. ON-DEMAND POWER STEERING ENCODER
3. ON-DEMAND POWER STEERING ACTIVATOR
4. INSTRUMENT PANEL
5. DISPLAY PANEL
6. DIP SWITCHES
7. WIRING HARNESS
8. BLK (BATT. −)
9. WHT (START SWITCH)
10. YEL (PS CONTACTOR COIL)
11. RED (BATT. +)
12. WHT/BLK (NEGATIVE)
13. WHT (ENCODER)
14. WHT (ENCODER)
15. RED (+5 VOLTS)
16. RED MARK ON WIRE
17. RIBBON CABLE FROM ENCODER

NOTES

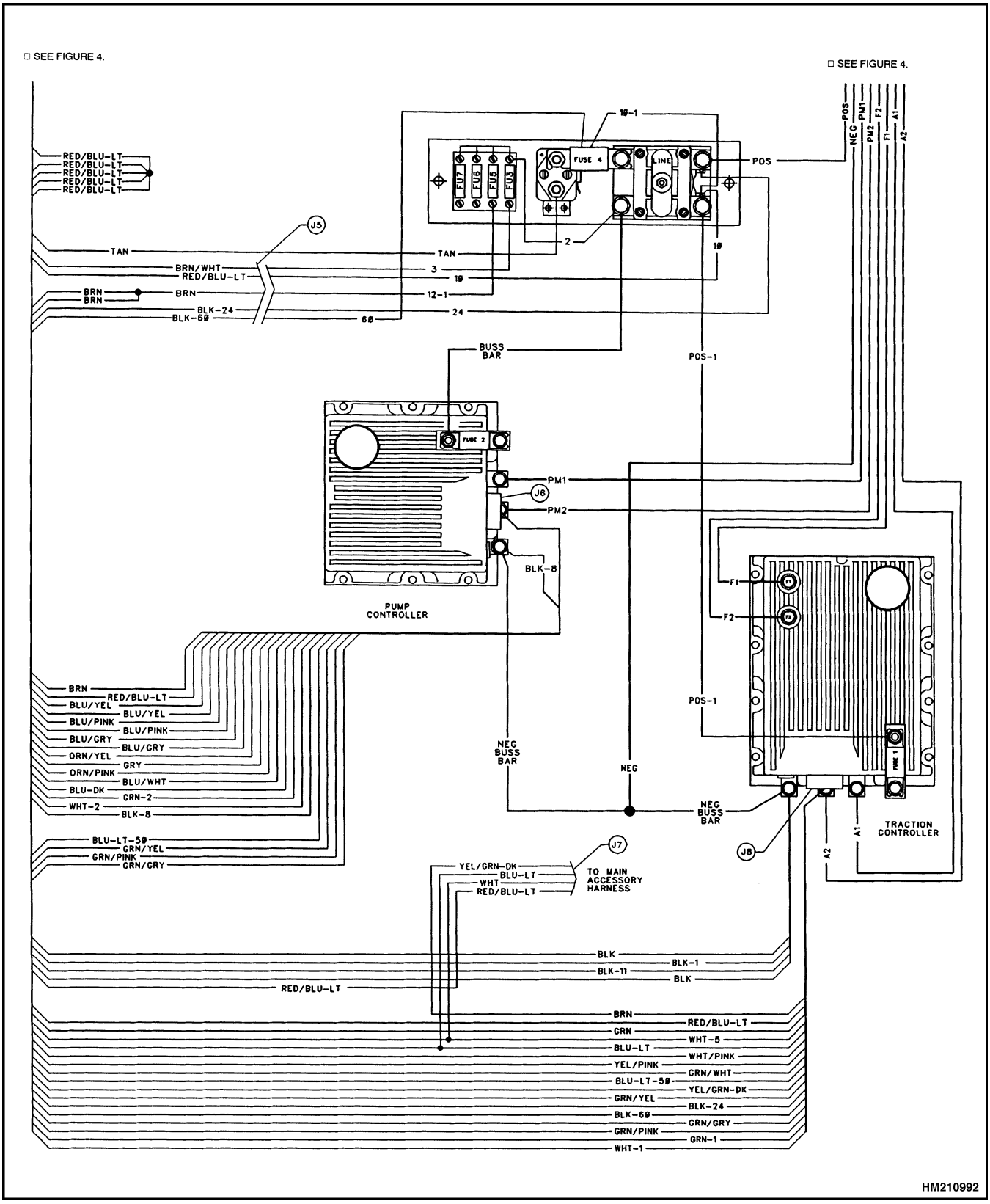


Figure 5. SR (SEM) and SP Motor Controllers ERC/P16-20AAF (ERC030-040AG/BG), ERC20-30AGF (ERC040-065RG/ZG) Wiring Diagram (Early Models)

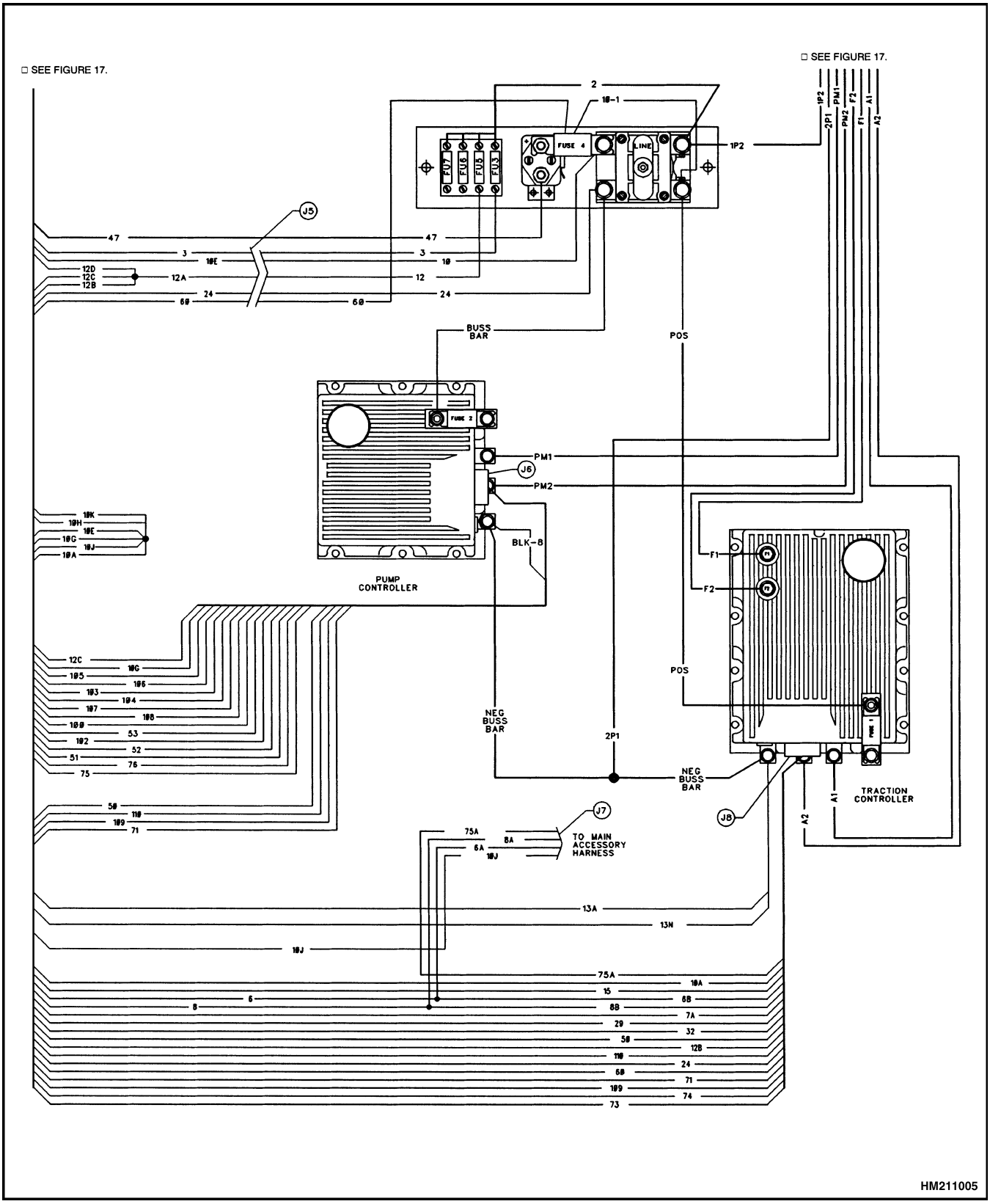


Figure 19. SR (SEM) and SP Motor Controllers ERP20-30ALF Wiring Diagram

Legend for Figure 27

1. CABLE CONNECTOR
2. RED/BRN
3. BLK/YEL
4. RED/BLUE-LIGHT
5. BLACK
6. BLACK AND BLUE
7. BLACK AND BLUE/WHITE
8. BLACK AND GRAY

Legend for Figure 35

18-Pin Connector			
Pin	**Function**	**Pin**	**Function**
1	No Connection	9	Battery Negative (−)
2	Battery Shunt	10-12	No Connection
3	No Connection	13	Parking Brake Switch
4	Traction Control TRX	14	Brake Fluid Switch
5	Traction Control RCV	15	Seat Switch Output
6	Pump Control TRX	16	Seat Switch B+ Input
7	Pump Control RCV	17	Key Switch (IGN)
8	No Connection	18	Battery Positive (+)

1. SEM DISPLAY PANEL
2. INSTRUMENT PANEL
3. MOUNT BRACKET
4. MOUNT NUT
5. CONNECTOR FOR PERSONAL COMPUTER CONNECTION
6. 18-PIN CONNECTOR

PERIODIC MAINTENANCE

ERC/P16-20AAF
(ERC030-040AF, ERC030-040AG/BG) [A814];
ERP20-30ALF [B216];
ERC20-30AGF
(ERC040-065RF/ZF, ERC040-65RG/ZG) [E108]

Table 1. Maintenance Schedule (Continued)

Item No.	Item	8 hr/ 1 day	250 hr/ 6 wks	500 hr/ 3 mo	1000 hr/ 6 mo	2000 hr/ 1 yr	Procedure or Quantity	Specification
16	Wheel Nut Torque ERC20-30AGF (ERC040-065RF/ZF - RG/ZG) Steer Wheel Castle Nuts (Cushion)			X			Check grease and tighten to correct torque	Multipurpose Grease See NOTE 2 68 N•m (50 lbf ft) Initial 3 N•m (2 lbf ft) Final
16	Wheel Nut Torque ERC20-30AGF (ERC040-065RF/ZF - RG/ZG) And ERP20-30ALF Drive Wheel (Wheel Nuts)			X			Check torque	237 to 305 N•m (175 to 225 lbf ft)
16	Wheel Nut Torque ERP20-30ALF Steer Wheels			X			Check torque	237 to 305 N•m (175 to 225 lbf ft)
19	Steering Axle Rod Ends (Steering Cyl.)					L	Check operation 2 Fittings	Lubricate as required Multipurpose grease See NOTE 2
19	Steering Axle King Pins					L	Check operation 2 Fittings See NOTE 3	Lubricate as required Multipurpose grease See NOTE 2
19	Steering Axle Tie Rods ERC/P16-20AAF (ERC030-040AF - AG/BG)		L				Check operation 6 Fittings	Lubricate as required Multipurpose grease See NOTE 2

X=Check C=Change L=Lubricate CIL=Check Indicator Light during operation

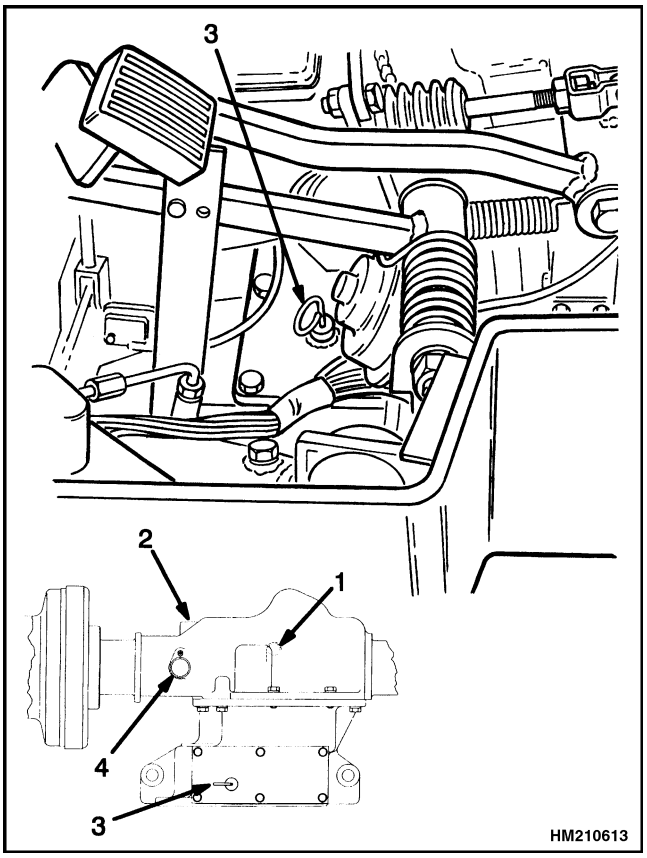
NOTE 1: Equalization charge is required approximately each month.

NOTE 2: Multipurpose grease with 2 to 4% Molybdenum Disulfide.

NOTE 3: Lubricate lower spindle bearings at 250 hours and upper bearings during assembly.

NOTE 4: Replace the contacts in the hydraulic pump contactor every 1000 hours of operation. Replace the other contacts in the contactors when the thickness is 30% of a new contact. See the Service Manual for detailed information.

NOTE: Never use steam to clean electrical parts.



1. DRAIN PLUG (ON BOTTOM)
2. FILL PLUG
3. DIPSTICK
4. BREATHER

Figure 20. Differential and Speed Reducer ERC/P16-20AAF (ERC030-040AF - AG/BG)

WHEEL NUT TORQUES

WARNING

Check all wheel nuts after 2 to 5 hours of operation: when new lift trucks begin operation and on all lift trucks when the wheels have been removed and installed. Tighten the nuts in a cross pattern to the correct torque value shown in the Maintenance Schedule. When the nuts stay tight for 8 hours, the interval for checking the torque can be extended to 500 hours.

Make sure the wheel bolts or nuts are tight. Tighten the wheel bolts or nuts in a cross pattern to the correct torque value shown in the Maintenance Schedule.

STEERING AXLE SPINDLES

Use multipurpose grease to lubricate the king pins in the steering axle. See the **Steering Axle** of your lift truck to disassemble and lubricate the king pin bearings.

STEERING TIE RODS

NOTE: Lubricate the steering tie rods at 500 hours for model ERP20-30ALF only.

Lubricate the steering tie rods with multipurpose grease. More frequent lubrication may be required if the lift truck operates in dirty or difficult conditions. See Figure 18.

MAST

WARNING

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

When working on or near the mast, see Safety Procedures When Working Near Mast in this section.

Metal particles can fall into the eyes during the operation of the mast. Failure to remove these particles can cause eye injury. Remove metal particles that are attached to the edges of mast parts with a grinder if necessary. Always wear eye protection when using a grinder.

CAUTION

Do NOT use steam or high-pressure water to clean the load rollers or the lift chains. Steam and high-pressure water can remove the lubrication from the bearings in the load rollers. Water in the bearings of the sheaves and the link pins of chains can also shorten the service life of these parts.

1. Clean the mast assembly. Inspect the mast channels in the areas where the rollers travel. If there are loose particles or metal particles that are attached to the edges of mast parts, remove these particles.

2. Lubricate the sliding surfaces and the load roller surfaces along the *full length* of the channels as shown in Figure 21. Only apply lubricant to surfaces that are clean and dry. Only apply lubricant to the darker areas as indicated by (1) and (2) in Figure 21.

Legend for Figure 30

NOTE: CONTACTOR CONTROLLED HYDRAULIC PUMP MOTOR AND TRANSISTOR MOTOR CONTROLLER FOR TRACTION MOTOR WITH REGENERATIVE BRAKING, 1A BYPASS, AND FIELD WEAKENING.

1. CONTACTOR FOR HYDRAULIC PUMP MOTOR
2. POWER STEERING PUMP CONTACTOR
3. 1A CONTACTOR
4. L CONTACTOR
5. REGENERATIVE BRAKING CONTACTOR
6. REVERSE CONTACTOR
7. FORWARD CONTACTOR
8. FIELD WEAKENING CONTACTOR
9. TRANSISTOR CONTROL FOR TRACTION MOTOR CONTROL CARD

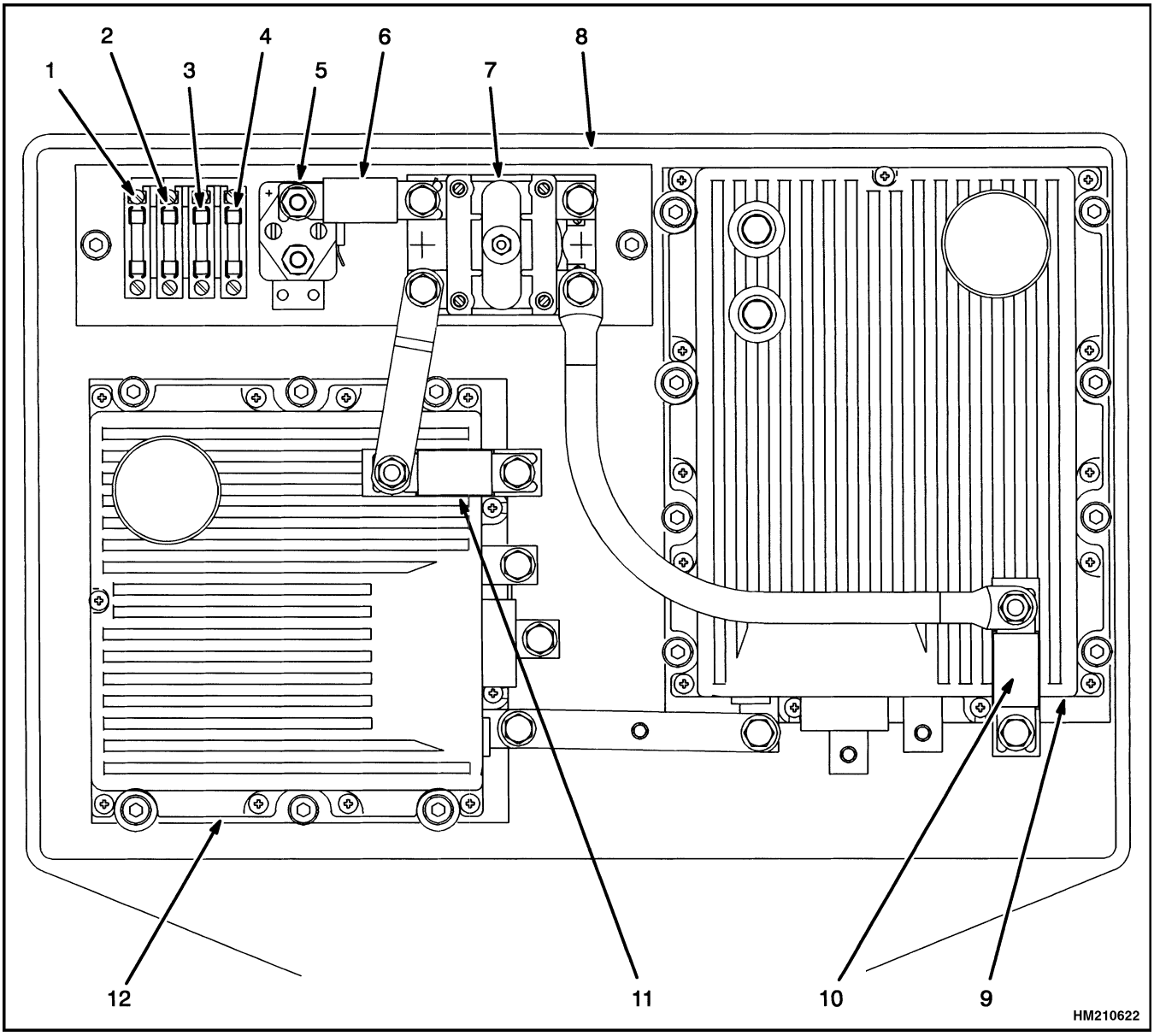


Figure 31. SR (SEM) Transistor Traction and SP Pump Motor Controllers for ERC/P16-20AAF (ERC030-040AG/BG), ERP20-30ALF and ERC20-30AGF (ERC040-065RG/ZG)

Safety Procedures When Working Near Mast

The following procedures must be used when inspecting or working near the mast. Additional precautions and procedures can be required when repairing or removing the mast. See the correct Service Manual section for the specific mast being repaired.

⚠ 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 and the key is removed. 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 section for the mast.**

WHEN WORKING NEAR THE MAST ALWAYS:

1. Lower the mast and carriage completely. Push the lift/lower control lever forward and make sure there is no movement in the mast. Make sure that all parts of the mast that move are fully lowered.

OR

2. If parts of the mast must be in raised position, install a safety chain to restrain the moving parts of the mast. Connect moving parts to a part that does not move. Follow these procedures:

a. Put the mast in a vertical position.

b. Raise the mast to align the bottom crossmember of the weldment that moves in the outer weldment with a crossmember on the outer weldment. On the two-stage and free-lift mast, the moving part is the inner weldment. On the three-stage mast, it is the intermediate weldment. On the four-stage mast, it is the first intermediate weldment. See Figure 45.

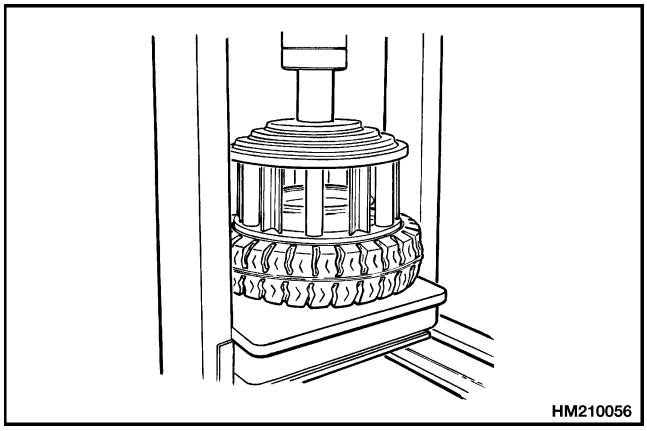
c. Use a 9.4 mm (3/8 in.) minimum safety chain with a hook to fasten the crossmembers together so the movable member cannot lower. Put the hook on the back side of the mast. Make sure the hook is completely engaged with a link in the chain. Make sure the safety chain does not touch lift chains or chain sheaves, tubes, hoses, fittings, or other parts on the mast.

d. Lower the mast until there is tension in the safety chain and the free-lift cylinder (free-lift and three-stage masts only) is completely retracted. If running, stop the engine. Apply the parking brake. Install a **DO NOT REMOVE** tag on the safety chain(s).

e. Install another safety chain [9.4 mm (3/8 in.) minimum] between the top or bottom crossmember of the carriage and a crossmember on the outer weldment.

3. Apply the parking brake. After lowering or restraining the mast, shut off the power and remove the key. Put a **DO NOT OPERATE** tag in the operator's compartment.

STEP 3.
Remove the cage and put the flange seat (if used), the side flange, and the lock ring in position on the wheel rim. Install the cage on the tire. Use the press to push the tire onto the wheel rim so the side flange and lock ring can be installed.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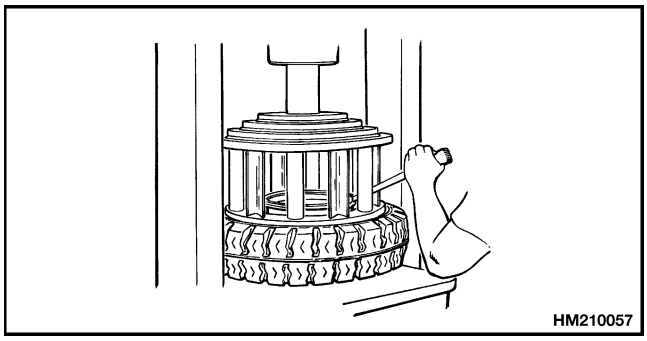
STEP 4.
While the cage is holding the tire on the wheel rim, install the lock ring. Use a tire tool to make sure the lock ring is in the correct position.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Wheels, Install

WARNING

Check all wheel nuts after 2 to 5 hours of operation: when new lift trucks begin operation and on all lift trucks when the wheels have been removed and installed. Tighten the nuts in a cross pattern to the correct torque value shown in the Maintenance Schedule. When the nuts stay tight for 8 hours, the interval for checking the torque can be extended to 500 hours.

Install the wheel on the hub. Tighten the nuts as shown in the Maintenance Schedule.

SIT TIRE, CHANGE

WARNING

Wheels must be changed and tires repaired by trained personnel only.

Always wear safety glasses.

1. Put lift truck on blocks as described in How to Put Lift Truck on Blocks at the beginning of this section.
2. Remove wheel nuts and remove wheel and tire from lift truck. Lift truck tires and wheels are heavy.

NOTE: When you disassemble the wheels, see Figure 52. There are several types of wheels used on these series of lift trucks.

Capacities

Item	Specification
Hydraulic System (Full Mark on Dipstick)*	
ERC20-30ALF	23.0 liter (6.1 gal)
ERC20-30AGF (ERC040-065RG/ZG, RF/ZF)	27.4 liter (7.23 gal)
Differential/Speed Reducer	
ERC20-30ALF	4.2 liter (8.8 pt)
ERC20-30AGF (ERC040-065RG/ZG, RF/ZF)	3.7 liter (7.8 pt)
Brake Fluid	0.24 liter (0.5 pt)
Hydraulic Pump Capacities**	
Large Lift Pump	19 cc/rev. (1.16 $in.^3$/rev.)
Small Lift Pumps	12 cc/rev. (0.73 $in.^3$/rev.)
Steering Pump	4.23 cc/rev. (0.26 $in.^3$/rev.)

*Check after all air is removed from the system and with the mast fully lowered.
**Oil temperature at 54 to 66°C (130 to 150°F)

Movement Rates (Maximum) for Tilt Cylinders

Lift Truck Model	Hydraulic Oil Temperature/Mast Tilt Rate			
	20°C (68°F)		60°C (140°F)	
	mm/min	in/min	mm/min	in/min
All Models	0.8	0.03	5.0	0.20

190 mm (7.5 in.) Motor and 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
ERC050 RG/ZG, RF/ZF	Two-Stage LFL	36 48	0.285 0.376	56 74	0.513 0.625	101 123	0.574	113	0.508	100
	Two-Stage FFL	36 48	0.295 0.391	58 77	0.472 0.625	93 123	0.538	106	0.457	90
	Three-Stage FFL	36 48	0.290 0.381	57 75	0.462 0.610	91 120	0.549	108	0.467	92
ERC060 RG/ZG, RF/ZF	Two-Stage LFL	36 48	0.249 0.310	49 61	0.472 0.590	93 116	0.569	112	0.457	90
	Two-Stage FFL	36 48	0.249 0.330	49 65	0.417 0.554	82 109	0.538	106	0.366	72
	Three-Stage FFL	36 48	0.249 0.330	49 65	0.411 0.533	81 105	0.544	107	0.396	78
ERC065 RG/ZG, RF/ZF	Two-Stage LFL	36 48	0.259 0.320	51 63	0.472 0.590	93 116	0.559	110	0.457	90
	Two-Stage FFL	36 48	0.244 0.320	48 63	0.417 0.554	82 109	0.523	103	0.366	72
	Three-Stage FFL	36 48	0.244 0.320	48 63	0.411 0.533	81 105	0.533	105	0.396	78

LFL = Limited Free Lift FFL = Full Free Lift
*Standard 19 cc (1.16 $in.^3$) displacement pump, 190 mm (7.5 in.) standard pump motor and 610 mm (24 in.) load center.
Oil temperature 54 to 66°C (130 to 150°F). Lifting speeds (valve fully open) ±10% acceptable. No Load lowering speeds are minimum values. Rated Load lowering speeds are maximum values. N/A = Not Available

Table 1. Terminal and Plug Wire Connections for Control Card JH (Continued)

With: Transistor Control of Hydraulic Pump, Regenerative Braking, Power Steering On Demand, Premium Display or Full GE Display Option, GE Battery Discharge Indicator (BDI) with Lift Interrupt, Brush Wear and Temperature Indicators NOTE: Table 1 and Table 2 are components of the same controller option.		
Plug or Terminal No.	**Wire Color or Wire Number**	**Function**
PY1	—	Not used.
PY2	—	Not used.
PY3	—	Not used.
PY4	BLK-1	To instrument panel display number 9 (TGND) input (ground).
PY5	WHT-1	To instrument panel display number 1 (T5) input.
PY6	—	Not used.
PY7	—	Not used.
PY8	BRN/WHT	Signal wire from PY12 on hydraulic pump control card.
PY9	BRN/PNK	Signal wire from PY11 on hydraulic pump control card.
PY10	BRN/ORN	Signal wire from PY10 on hydraulic pump control card.
PY11	YEL/GRN	
PY12	—	Not used.
PY13	WHT-2	To instrument panel display number 5 (PY13) input.
PY14	BLK-2	To instrument panel display number 4 (PY14) input.
PZ1	WHT/BRN	Battery negative.
PZ2	VIO	Signal wire from TR1 thermal protector.
PZ3	BRN	Signal wire for voltage check across TR1.
PZ4	RED	Signal wire to gate for TR1.
PZ5	WHT/VIO	Signal wire from TR1 thermal protector.
PZ6	32 to GRN/	Voltage supply to accelerator potentiometer.
PZ7	WHT	
PZ8	17	Battery positive. (Voltage check across Regenerative Braking Diode D7.)
PZ9	31	Regenerative braking contactor negative.
PZ10	BLU	Signal wire for voltage check across TR1.
PZ11	GRN to 22	Signal wire from current sensor for Regenerative Braking.
PZ12	YEL to 21	Signal wire from current sensor for Regenerative Braking.
PZ13	GRN	Signal wire from motor current sensor.
PZ14	YEL	Signal wire from motor current sensor.
	WHT	Signal wire for battery voltage check.

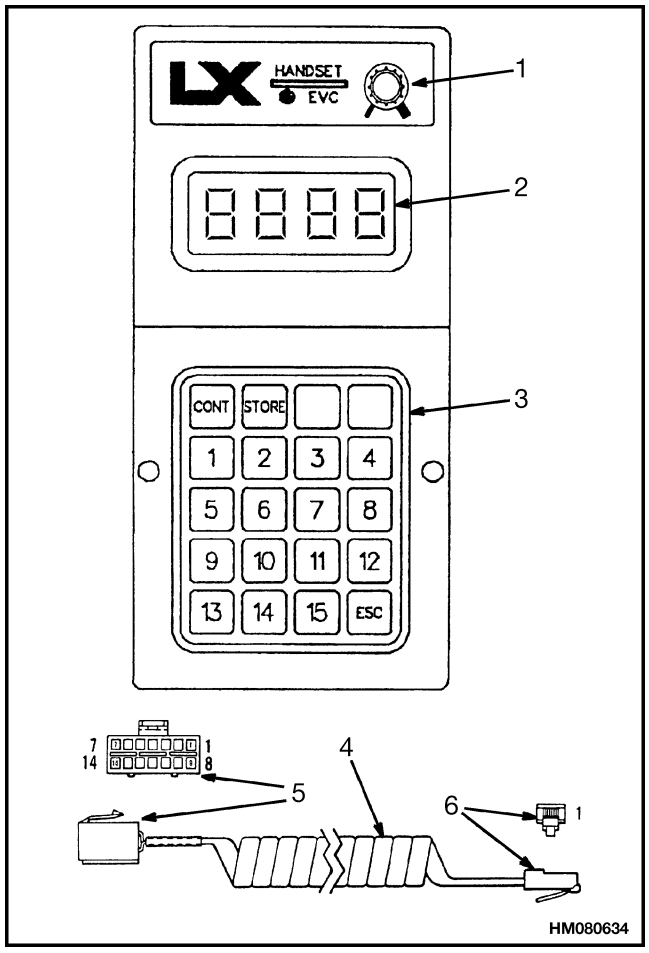


Figure 5. Handset

Legend for Figure 5

Plug Wiring			
Mod Plug	**Plug PY**	**Mod Plug**	**Plug PY**
1	9	5	5
2	6	6	8
3	3	7	1
4	4	8	2

1. ADJUSTMENT KNOB
2. LED DISPLAY
3. KEYPAD
4. COIL CORD
5. PLUG PY (14-PIN)
6. MODULAR PLUG (8-PIN HANDSET)

Function Number 29

HOURMETER (Tens/Units) (Push CONT and 14)

This register has the data for the accumulated operating hours of the hydraulic system. 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 hydraulic system 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

CONTROLLED ACCELERATION (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 from stop. Do not set the number in the register to less than the parameter in the register for Function Number 52.

Function Number 49

SPEED LIMIT 2 (Push CONT and 2 while the key switch and seat switch are closed)

This register permits the adjustment of the speed limit for the hydraulic pump in MODE 1. The minimum parameter is zero. Do not set the number in the register greater than the number in the register for Function Number 53.

Function Number 50

SPEED LIMIT 3 (Push CONT and 3 while the key switch and seat switch are closed)

This parameter permits adjustment of the speed limit (maximum battery volts to the motor). The range is 0% to 96%. There is no speed limit switch for this function. This function will be disabled if the parameter in the register is set to zero. Do not set the number in the register to less than the parameter for Function Number 54. The maximum number in the register is 255.

Function Number 52

CONTROLLED ACCELERATION (Push CONT and 5 while the key switch and seat switch are closed)

This register permits the adjustment of the maximum rate of acceleration in MODE 2. The parameter determines the time allowed to reach maximum SCR speed from stop. Do not set the number in the register to less than the parameter for Function Number 56. Do not set the number in the register greater than the number in the register for Function Number 48.

Function Number 53

SPEED LIMIT 2 (Push CONT and 6 while the key switch and seat switch are closed)

This register permits the adjustment of the speed limit for the hydraulic pump in MODE 2. Do not set the number in the register to less than the parameter for Function Number 49. Do not set the number in the register greater than the number in the register for Function Number 57.

Function Number 54

SPEED LIMIT 3 (Push CONT and 7 while the key switch and seat switch are closed)

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

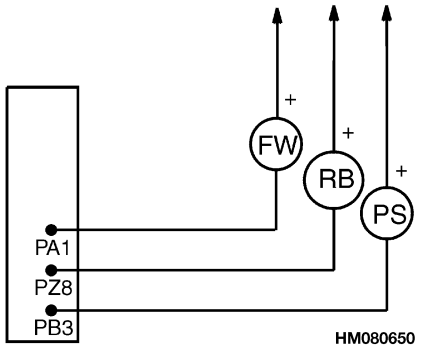
Function Number 56

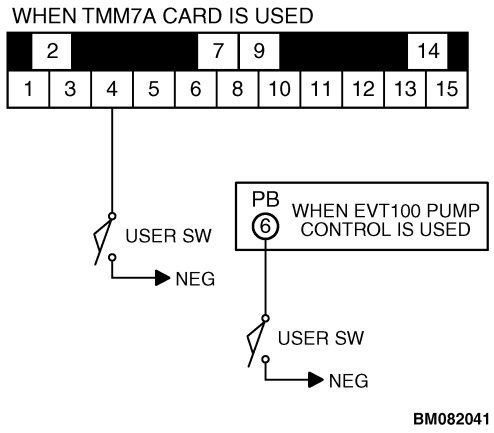
CONTROLLED ACCELERATION (Push CONT and 9 while the key switch and seat switch are closed)

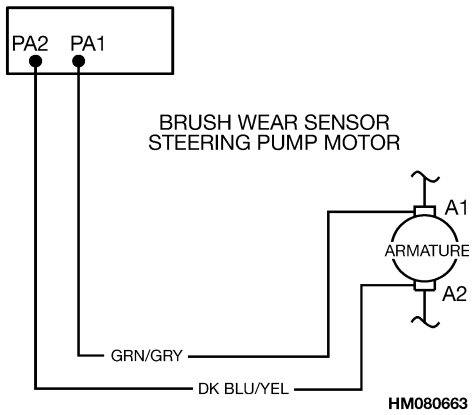
This register permits the adjustment of the maximum rate of acceleration in MODE 3. The parameter determines the time allowed to reach maximum SCR speed from stop. Do not set the number in the register to less than the parameter for Function Number 60. Do not set the number in the register greater than the number in the register for Function Number 52.

Table 10. Register Map for Control Card ZP (Hydraulic Pump) (Continued)

EEPROM Register Number	PC Function Number	Handset (HS) Function Number	Function	Access By:	Restrictions
87	88		Hours (Thousands/ Hundreds) 14	PC Only	Reset to Zero only
88	89		Fault 15	PC Only	Reset to Zero only
89	90		NOT USED	—	—
90	91		Hours (Tens/Units) 15	PC Only	Reset to Zero only
91	92		Hours (Thousands/ Hundreds) 15	PC Only	Reset to Zero only
92	93		Fault 16	PC Only	Reset to Zero only
93	94		NOT USED	—	—
94	95		Hours (Tens/Units) 16	PC Only	Reset to Zero only
95	96		Hours (Thousands/ Hundreds) 16	PC Only	Reset to Zero only
96	97	48	Instrument Panel Display CA-1	HS or PC	None
97	98	49	Instrument Panel Display SL2-1	HS or PC	None
98	99	50	Instrument Panel Display SL4-1	HS or PC	None
99	100	51	NOT USED	—	—
100	101	52	Instrument Panel Display CA-2	HS or PC	None
101	102	53	Instrument Panel Display SL2-2	HS or PC	None
102	103	54	Instrument Panel Display SL4-2	HS or PC	None
103	104	55	NOT USED	—	—
104	105	56	Instrument Panel Display CA-3	HS or PC	None
105	106	57	Instrument Panel Display SL2-3	HS or PC	None
106	107	58	Instrument Panel Display SL4-3	HS or PC	None
107	108	59	NOT USED	—	—
108	109	60	Instrument Panel Display CA-4	HS or PC	None

Status Code **-26**	Description Electronic driver in control card for the RB, PS, or FW contactor has a short circuit.	Cause of Status Indication This Status Code will be indicated when there is a short circuit in the electronic driver for the FW, RB, or PS contactor coil.
Memory Recall No **Circuit** Traction	**Indication of Fault** The FW, RB, or PS contactor closed immediately when the key switch is closed. **Possible Cause** Malfunction of an electronic driver in the control card. Replace the control card.	

Status Code **-92**	Description USER DEFINED STATUS CODE See Instructions for Truck Management Module for details.	Cause of Status Indication This status code will be displayed when the voltage at the respective terminal of the TMM or Pump Logic Card is at zero volts.
Memory Recall No **Circuits Valid for Traction Controller & Pump Controller**	**CORRECTIVE ACTIONS** **Possible Cause** Hydraulic pump motor is too hot. Temperature sensor has closed to battery negative. Permit the hydraulic pump motor to cool. Symptom Statuc Code flashes "on and off" POSSIBLE CAUSE User defined status code is displayed by switch closure or motor brush sensor closure to Negative. • See GEH-TMM7A Truck Management Module Instructions for OEM Defined Status Codes for complete corrective action required. Other causes for status code: • Terminal 4 (TMM7A) is shorted to Negative. • Plug PB6 (Pump) is shorted to Negative. • Defective input switch (shorted). • Defective TMM card. • Defective Pump card.	

Status Code **-93**	Description Steering pump motor brushes are worn and must be replaced.	Cause of Status Indication This Status Code will be indicated when the voltage at terminal PA1 or PA2 of the hydraulic pump control card [or between TMM1 (TB5 and TB6)] is at zero volts.
Memory Recall No **Circuit** Steering Pump	**Indication of Fault** Status Code is indicated as a flashing number on the instrument panel display. **Possible Cause** Steering pump motor brushes are worn. The sensor has closed to battery negative. Replace the brushes. Other causes. PA1 or PA2 [or TMM1 (TB5 or TB6)] has a short circuit to battery negative. There is a short circuit in the sensor wires. There is a short circuit or other malfunction in the sensor.	

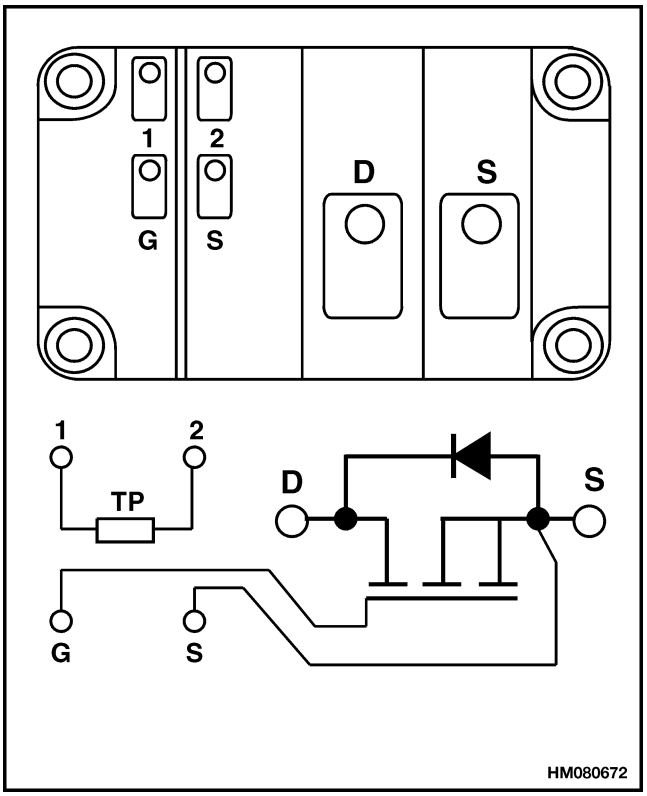
TR1 Assembly, Remove

1. Make notes of the positions of the suppressors and remove the suppressors from the mount over TR1. Disconnect the electric connections to the TR1 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 TR1 assembly to the base plate.

TR1 Assembly, Check

Use an Ohmmeter to check between the source **S** and the drain **D**. See Figure 11 and Figure 12. A good TR1 will indicate infinity (∞) on any scale between the *** and ***. An indication of 5 K ohms to 20 K ohms on the 10,000 scale is correct for the opposite direction.



NOTE: D = DRAIN, S = SOURCE, G = GATE, AND TP = THERMAL PROTECTOR.

Figure 11. MOSFET Arrangement

Check between the gate **G** and the drain **D** with the ohmmeter on the 10,000 scale. The correct reading is infinity (∞) in both directions.

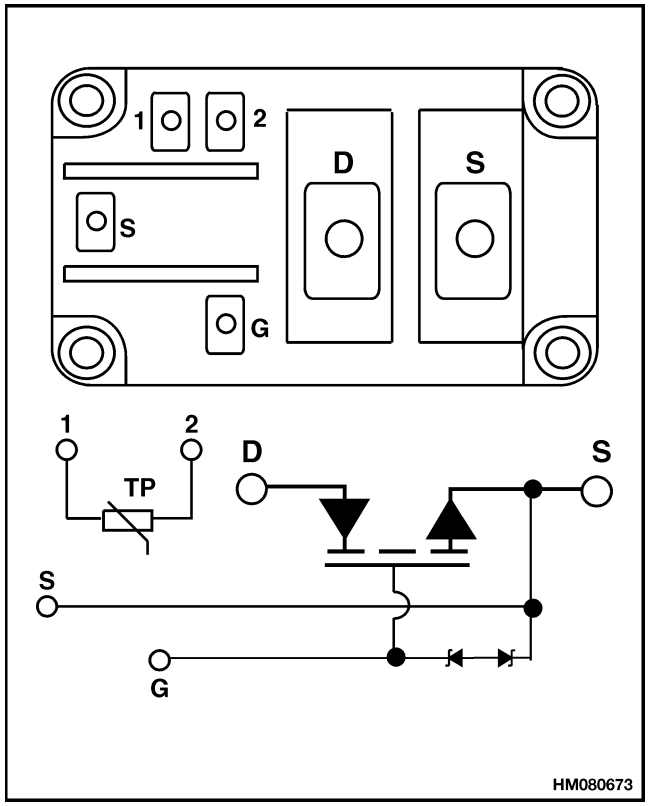
Check between the gate **G** and the source **S** with the ohmmeter on the 10,000 scale. The correct reading is infinity (∞) in both directions.

TR1 Assembly, Install

1. Install the new TR1 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.

2. Install the electrical connections to the TR1 assembly. Install the thermal protector on the heat sink.

3. Install the mount and the suppressors over the TR1 assembly. Make sure the connections are made correctly.



NOTE: D = DRAIN, S = SOURCE, G = GATE, AND TP = THERMAL PROTECTOR.

Figure 12. IGBT Arrangement