# INTRODUCTION

## GENERAL

This section has a description and the repair and adjustment procedures for the different battery indicators used on electric lift trucks.

**⚠ CAUTION**

**Do not operate an electric lift truck with a discharged battery. Continued operation can damage contactors, motors and the battery.**

**⚠ WARNING**

**If the lift truck has been operated using a low battery, check all contactors for welded contacts BEFORE connecting a charged battery. Lift truck operation cannot be controlled if the contacts are welded.**

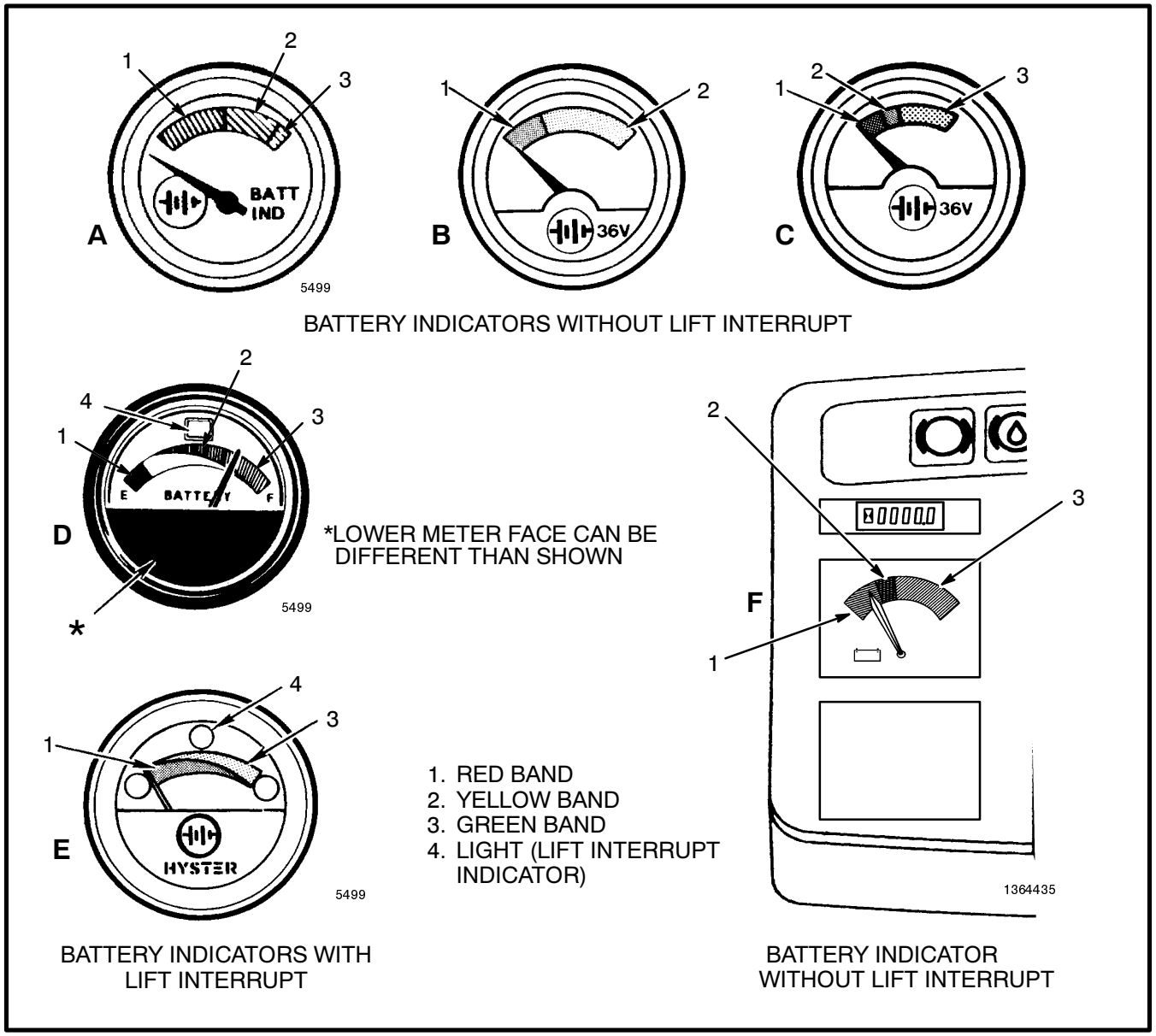



FIGURE 1. BATTERY INDICATORS WITH METER MOVEMENTS

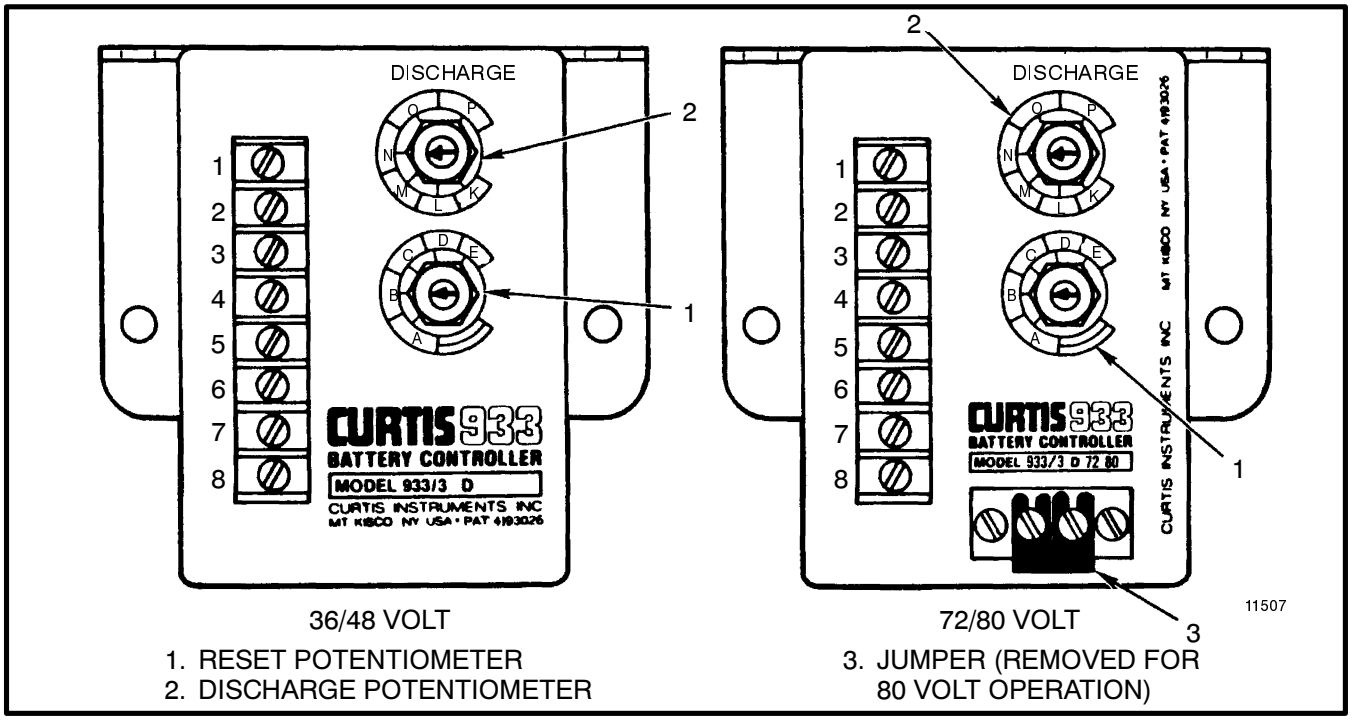
## BATTERY INDICATORS WITHOUT LIFT INTERRUPT, LATER MODELS (See FIGURE 8.)

There is no adjustment for these indicators. The voltage range, however, can be checked. Check the voltage settings as shown in FIGURE 8. When the hydraulic system is at the relief setting, the indicator is set to indicate a specific gravity of 1.150. At this time the needle is in the middle of the red band. Replace the indicator if it does not operate correctly.

## BATTERY INDICATORS WITH LIFT INTERRUPT, LATER MODELS (See FIGURE 9.)

The following procedures for the battery indicator apply to both the gauge type LED indicator and the LED display indicator shown as **E** and **F** in FIGURE 4.

The controller for the battery indicators has two factory set adjustments. The adjustments are made with the RESET potentiometer and the DISCHARGE potentiometer.




36/48 VOLT

1. RESET POTENTIOMETER
2. DISCHARGE POTENTIOMETER

72/80 VOLT

3. JUMPER (REMOVED FOR 80 VOLT OPERATION)

FIGURE 9. BATTERY INDICATOR CONTROLLER, LATER MODELS

### Reset Potentiometer

The RESET potentiometer determines the level to which the battery must be charged before the indicator indicates fully charged. The RESET potentiometer is set at the factory to C. The RESET function operates only when a battery has been disconnected for at least 15 seconds and another battery connected. The replacement battery must be charged to at least 90% of its capacity.

The RESET potentiometer increases the voltage at which the battery is accepted when turned from C toward G (clockwise). The specific gravity of the battery must be more than 1.245.

The RESET potentiometer decreases the voltage at which the battery is accepted when turned from C toward A . The specific gravity of the battery is less than 1.245.

If a battery that is connected does not have the correct specific gravity, the indicator will remain in its original position.

### Discharge Potentiometer

The DISCHARGE potentiometer determines the level at which the LIFT interrupt function occurs. The potentiometer is set at the factory to N. The N setting is equal to 1.73 volts per cell.

Turning the DISCHARGE potentiometer from N toward K lets the battery discharge MORE before LIFT interrupt occurs.

# BRAKE SYSTEM

## GENERAL

This section has a description and the repair procedures for the parts of the hydraulic brake system. These parts include the brake booster, master cylinder and brake shoe assemblies.

## DESCRIPTION AND OPERATION

The master cylinder is actuated by a brake booster on the S3.50-5.50XL (S70-120XL) and H3.50-5.00XL (H70-110XL) lift trucks. The brake booster is a hydraulic valve actuated by the brake pedal. The brake booster uses the oil that flows from the steering control unit to multiply the force of the brake pedal. The system allows braking without hydraulic pressure at the brake booster.

Lift trucks of the E3.50-5.50XL (E70-120XL, E70-120$XL_3$) series have a different master cylinder that is not actuated by a brake booster.

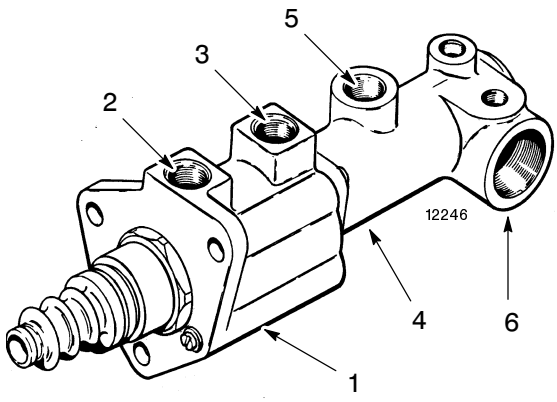
## BRAKE BOOSTER AND MASTER CYLINDER (See FIGURE 1. and FIGURE 2.)

These parts are for the S3.50-5.50XL (S70-120XL) and H3.50-5.00XL (H70-110XL) models. The operation of the parts is described in FIGURE 2.

## MASTER CYLINDER (See FIGURE 3.)

This master cylinder is for the E3.50-5.50XL (E70-120XL, E70-120$XL_3$) models. The master cylinder has a housing and a piston assembly. The housing (3) has two ports between the bore for the piston and the reservoir for the fluid. The compensator port (7) in front of the piston is open when the piston is fully retracted. The compensator port lets fluid move to or from the brake system when the temperature changes. Another port (6) keeps fluid in the cavity around the piston. The piston (10) moves in the housing when the operator pushes the brake pedal. A small movement of the piston closes the compensator port (7). Hydraulic pressure actuates the wheel cylinders as the piston pushes fluid through the check valve (13). A return spring pushes the piston (10) back to the stop plate (9) when the pedal is released. Fluid can flow through passages in the piston and past the primary cup (11) as the piston returns. Fluid flows across the piston to prevent a vacuum while fluid returns through the check valve (13). When the piston passes the compensator port (7), excess fluid from the system can return to the reservoir. The check valve keeps a very small amount of pressure in the brake system. The pressure helps to keep the system effectively sealed.

**S3.50-5.50XL (S70-120XL)**
**H3.50-5.00XL (H70-110XL)**




1. BRAKE BOOSTER
2. INLET FROM STEERING CONTROL UNIT
3. OUTLET TO HYDRAULIC TANK
4. MASTER CYLINDER
5. INLET FROM RESERVOIR
6. OUTLET TO WHEEL CYLINDERS

FIGURE 1. BRAKE BOOSTER AND MASTER CYLINDER

**⚠ WARNING**

**The piston has a compressed spring behind it. Remove the piston carefully.**

### Assembly (See FIGURE 11.)

**NOTE:** Lubricate the parts of the master cylinder with clean brake fluid.

1. Install the seal support washer (7) on the piston (4). Install the seals (3) on the piston. Make sure that the cup washer (6) is installed as shown in FIGURE 11. Carefully install the spring and piston assembly in the master cylinder. Do not damage the seals.

2. Install the retaining ring for the piston.

### Installation (See FIGURE 1.)

1. Put the master cylinder in position on the brake booster and install the capscrews for the master cylinder.

2. Connect the brake lines and wires. Connect the hose to the brake fluid reservoir. Fill the reservoir and remove the air from the brake system as described in CHECKS AND ADJUSTMENTS in this section.

## MASTER CYLINDER, E3.50-5.50XL (E70-120XL, E70-120XL$_3$) (See FIGURE 12.)

### Removal and Disassembly

1. Remove the floor plate. Disconnect the brake line at the master cylinder. Put caps on the brake line and the port in the cylinder.

2. Remove the return spring for the pedal. Disconnect the rod end at the pedal.

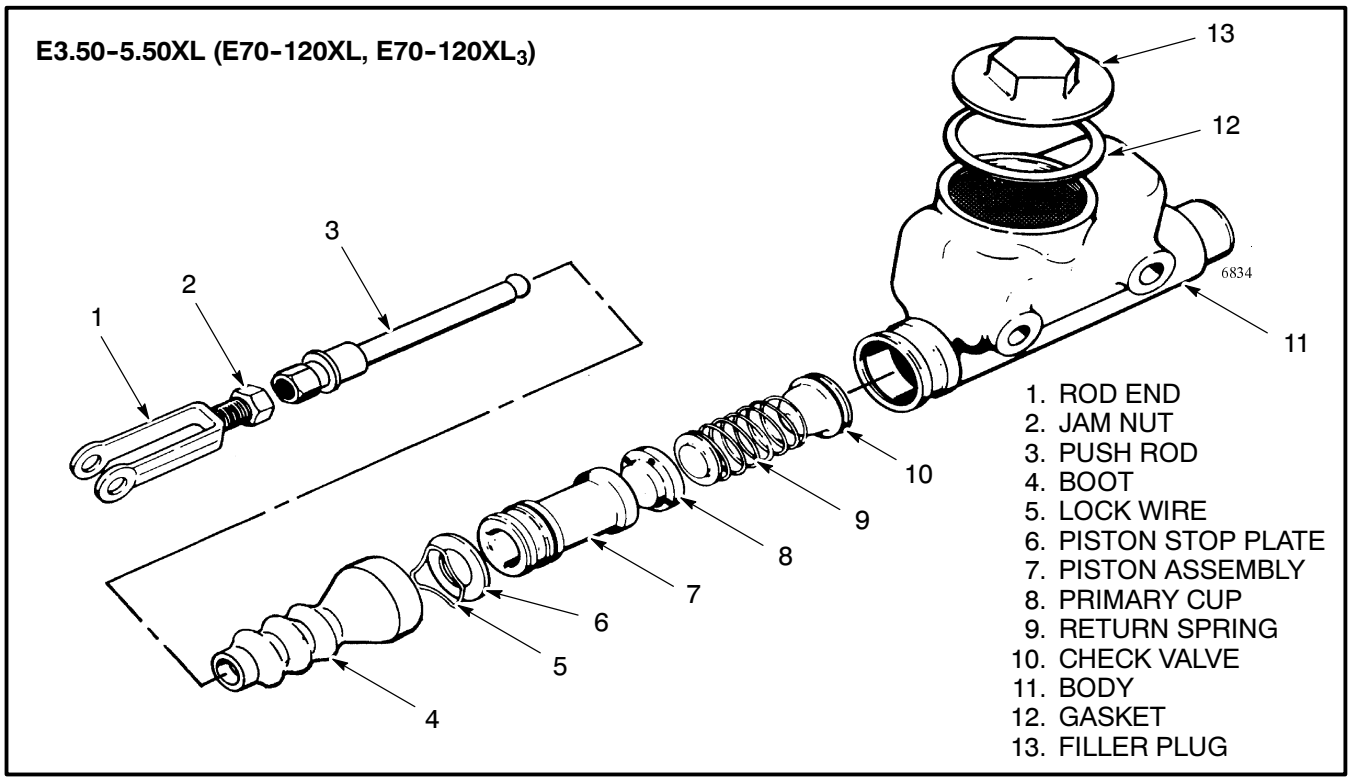



FIGURE 12. MASTER CYLINDER

3. Remove the capscrews that hold the master cylinder to the frame. Remove the master cylinder.

4. Remove the boot and push rod as an assembly. Drain the fluid in the reservoir.

**⚠ WARNING**

**The piston has a compressed spring behind it. Carefully remove the piston so that you can control the spring and prevent an injury.**

## MAST WEIGHTS

| MODEL | TYPE OF MAST | MAXIMUM FORK HEIGHT | | APPROXIMATE WEIGHT | |
|---|---|---|---|---|---|
| | | millimeters | inches | kilograms | pounds |
| E3.50–4.00XL (E70–80XL) | 2–Stage VISTA | 3073<br>3696<br>4305 | 121<br>145.5<br>169.5 | 645<br>713<br>781 | 1420<br>1570<br>1720 |
| | Full Free–Lift VISTA | 3073<br>3696 | 121<br>145.5 | 661<br>726 | 1455<br>1600 |
| | 3–Stage VISTA | 4369<br>4928<br>5550 | 172<br>194<br>218.5 | 888<br>972<br>1022 | 1955<br>2140<br>2250 |
| E4.50–5.50XL (E100–120XL) | 2–Stage VISTA | 2819<br>3454<br>4051 | 111<br>136<br>159.5 | 636<br>706<br>776 | 1400<br>1555<br>1710 |
| | Full Free–Lift VISTA | 2819 | 111 | 679 | 1495 |
| | 3–Stage VISTA | 4125<br>4674<br>5309 | 162.5<br>184<br>209 | 888<br>987<br>1022 | 1955<br>2175<br>2250 |

## MAST SPEEDS

**PERFORMANCE WITH SINGLE HYDRAULIC PUMP MOTOR**

| MODEL | | LIFTING | | | | LOWERING | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | NO LOAD | | RATED LOAD | | NO LOAD | | RATED LOAD | |
| | | m/sec | ft/min | m/sec | ft/min | m/sec | ft/min | m/sec | ft/min |
| **TWO–STAGE MAST** | | | | | | | | | |
| E3.50XL (E70XL) | (36 V) | 0.35 | 68 | 0.20 | 39 | 0.48 | 95 | 0.53 | 104 |
| | (48 V) | 0.44 | 86 | 0.29 | 54 | 0.48 | 95 | 0.53 | 104 |
| E4.00XL (E80XL) | (36 V) | 0.35 | 68 | 0.19 | 37 | 0.48 | 95 | 0.53 | 104 |
| | (48 V) | 0.44 | 86 | 0.28 | 53 | 0.48 | 95 | 0.53 | 104 |
| **FULL FREE–LIFT MAST** | | | | | | | | | |
| E3.50XL (E70XL) | (36 V) | 0.30 | 59 | 0.17 | 34 | 0.38 | 74 | 0.46 | 90 |
| | (48 V) | 0.38 | 75 | 0.25 | 48 | 0.38 | 74 | 0.46 | 90 |
| E4.00XL (E80XL) | (36 V) | 0.30 | 59 | 0.17 | 33 | 0.38 | 74 | 0.46 | 90 |
| | (48 V) | 0.38 | 75 | 0.25 | 47 | 0.38 | 74 | 0.46 | 90 |
| **THREE–STAGE MAST** | | | | | | | | | |
| E3.50XL (E70XL) | (36 V) | 0.33 | 64 | 0.19 | 37 | 0.39 | 77 | 0.50 | 98 |
| | (48 V) | 0.41 | 81 | 0.27 | 51 | 0.39 | 77 | 0.50 | 98 |
| E4.00XL (E80XL) | (36 V) | 0.33 | 64 | 0.18 | 35 | 0.39 | 77 | 0.50 | 98 |
| | (48 V) | 0.41 | 81 | 0.27 | 50 | 0.39 | 77 | 0.50 | 98 |

the new brushes so that the brush commutator surface fully touches the commutator. Make sure that the springs are pushing on each brush. Install and tighten the screws for the brush wires and bus connectors.

8. Carefully install the brush covers so that sparks are kept inside the motor housing. Install the battery as described in the **OPERATING MANUAL** or the **PERIODIC MAINTENANCE MANUAL** for your lift truck.

### Steering Pump Motor

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

1. Disconnect the battery connector. Remove the floorplate from the lift truck for access to the steering pump motor. Open the hood for access to the motor on J2.00-3.20XM (J40-65XM) trucks. Remove the screws that hold the two brush cover plates to the motor housing.

2. Inspect the brushes and commutator as described in the previous paragraphs for the traction and hydraulic pump motors. The brush replacement procedure is also the same, although there are only two brushes for the steering pump motor.

3. Install the brush covers and screws. Install the floorplate or close the hood and connect the battery connector.

## BRUSH WEAR REPLACEMENT GUIDE

| BRUSH WEAR REPLACEMENT GUIDE | | | | | | | |
|---|---|---|---|---|---|---|---|
| BRUSH HEIGHT (mm) | 17 | 22 | 28 | 30 | 31 | 32 | 40 |
| WEAR (mm) | 8 | 12 | 14 | 15 | 16 | 16 | 20 |
| WORN BRUSH HEIGHT (mm) | 9 | 10 | 14 | 15 | 15 | 16 | 20 |

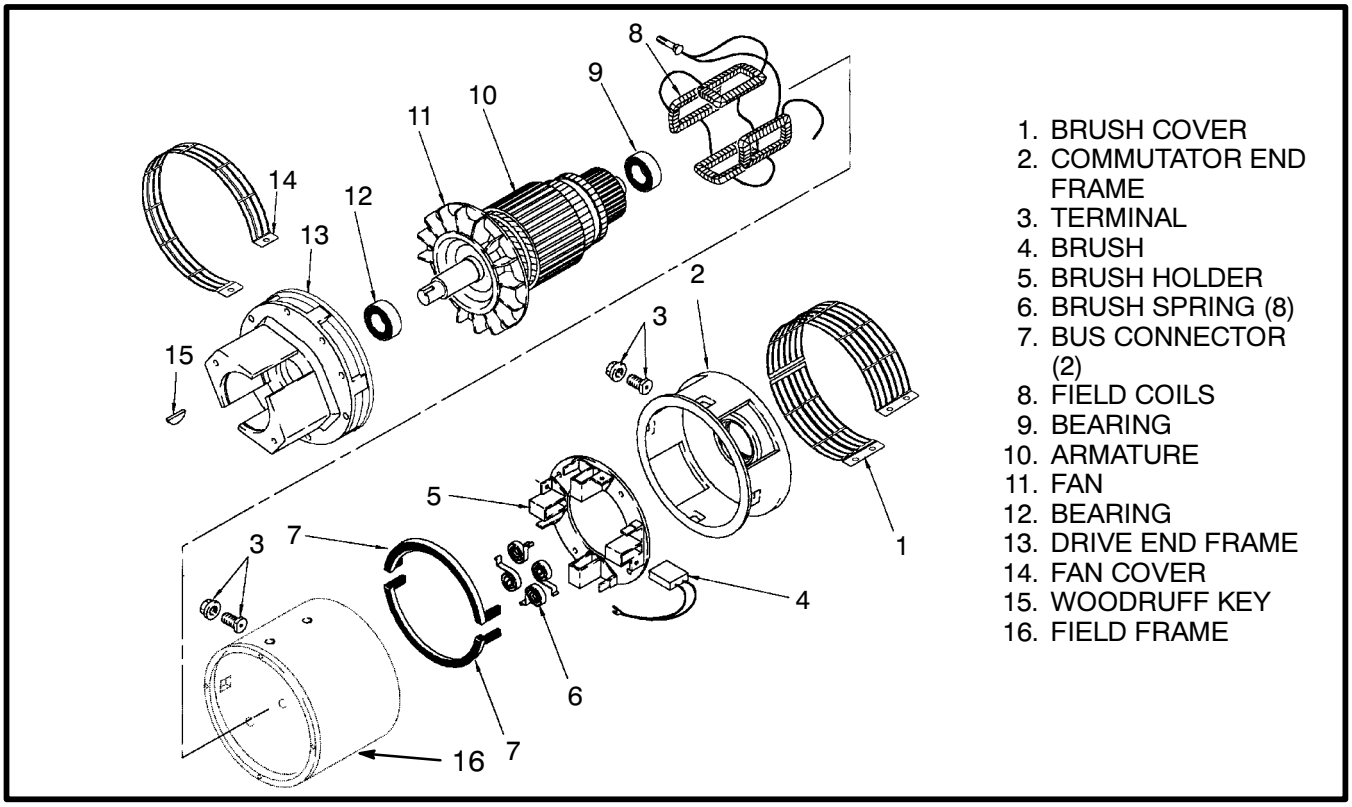



FIGURE 19. TYPICAL HYDRAULIC PUMP MOTOR

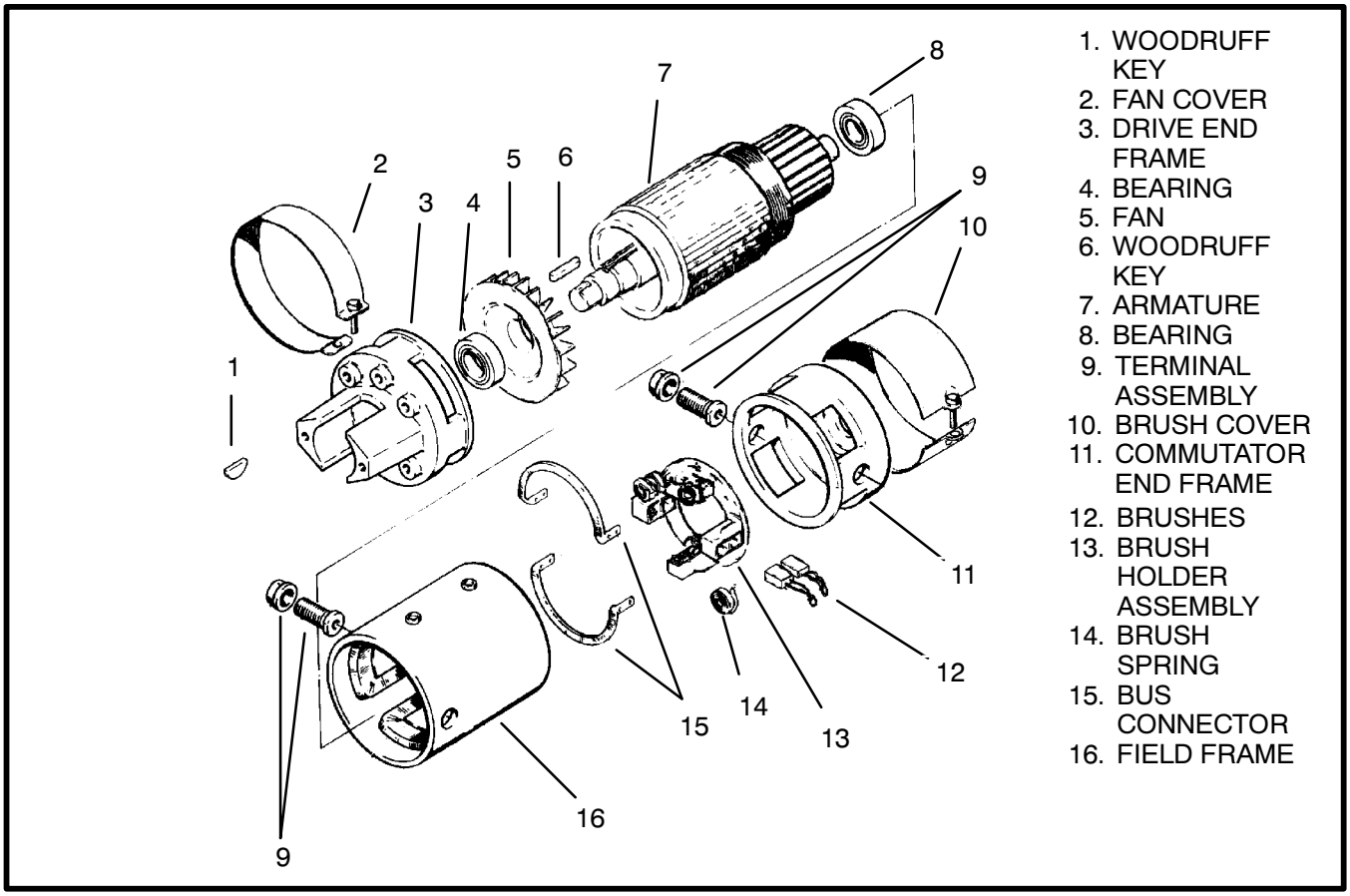
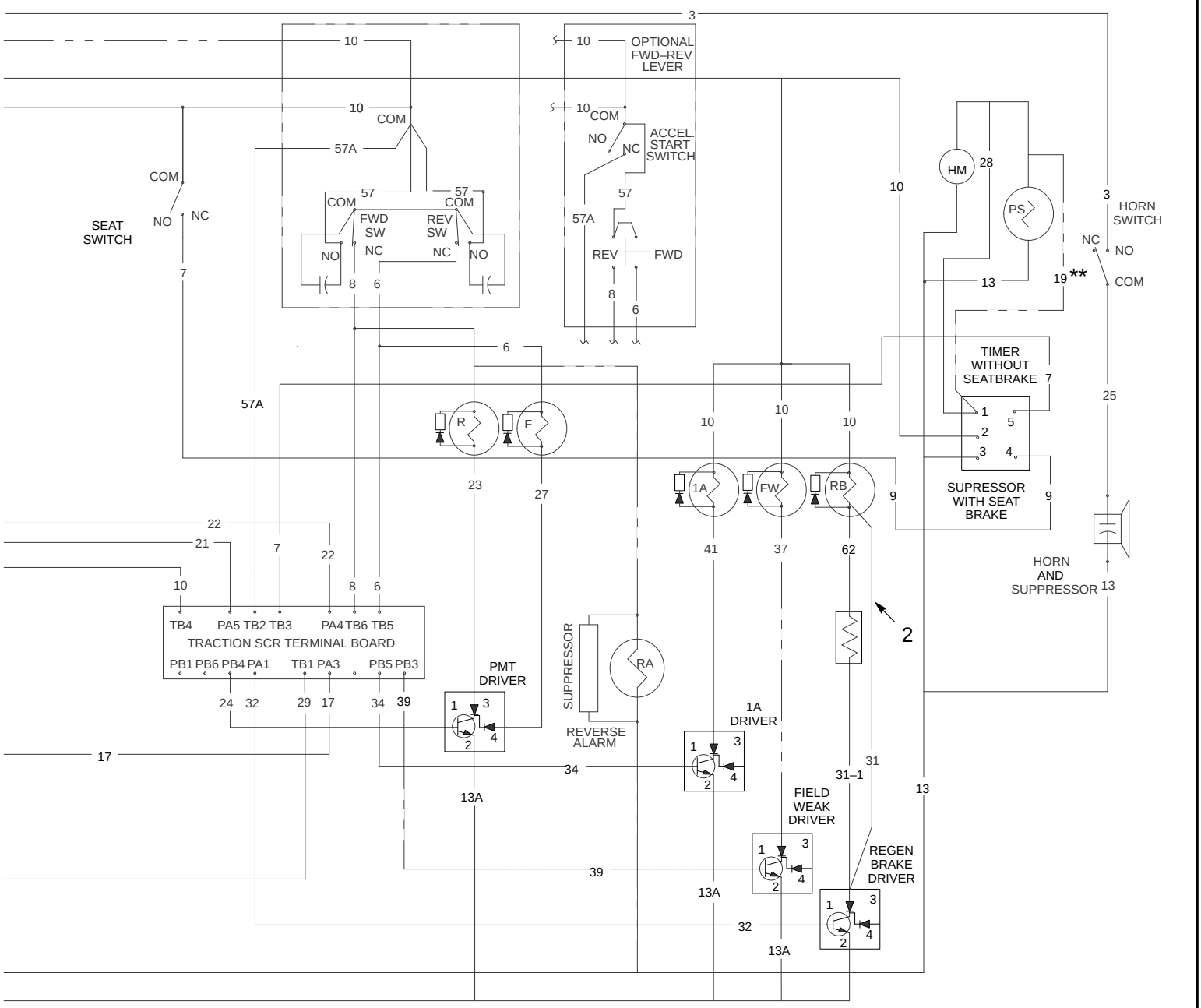



FIGURE 20. ANOTHER HYDRAULIC PUMP MOTOR



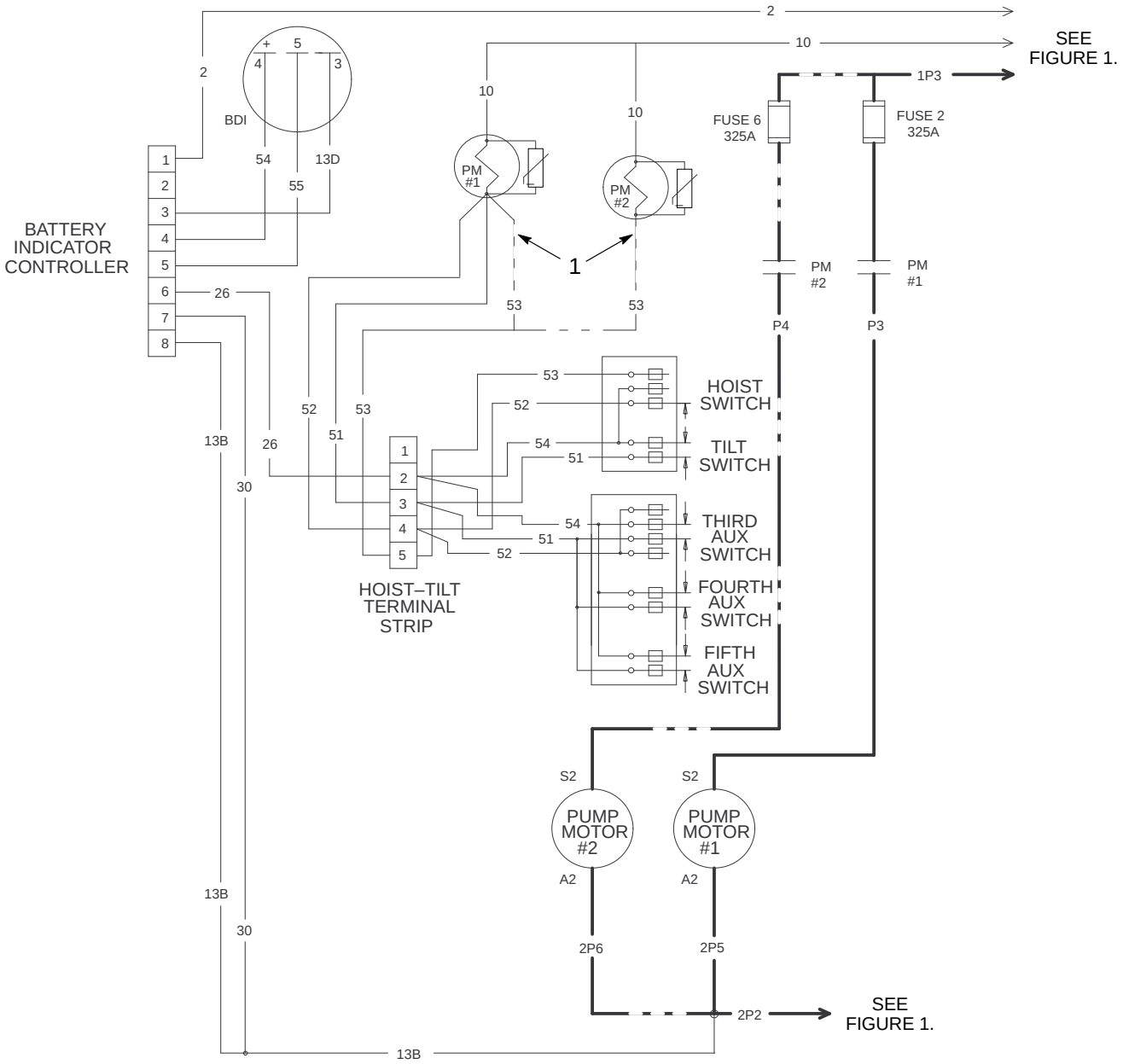

1. ITEMS FOR FIELD WEAKENING ARE OPTIONAL
2. JUMPER WIRE #31 IS DISCONNECTED ON LIFT TRUCKS WITH 48 VOLT SYSTEMS
3. ALL SWITCHES ARE SHOWN IN THE STATIC POSITION
4. OPTIONAL CIRCUITS ARE SHOWN BY DASHED LINE ——— – – ———

* CAPACITOR C2 IS PART OF THE EV–200 CIRCUIT ONLY

** LATER UNITS ONLY

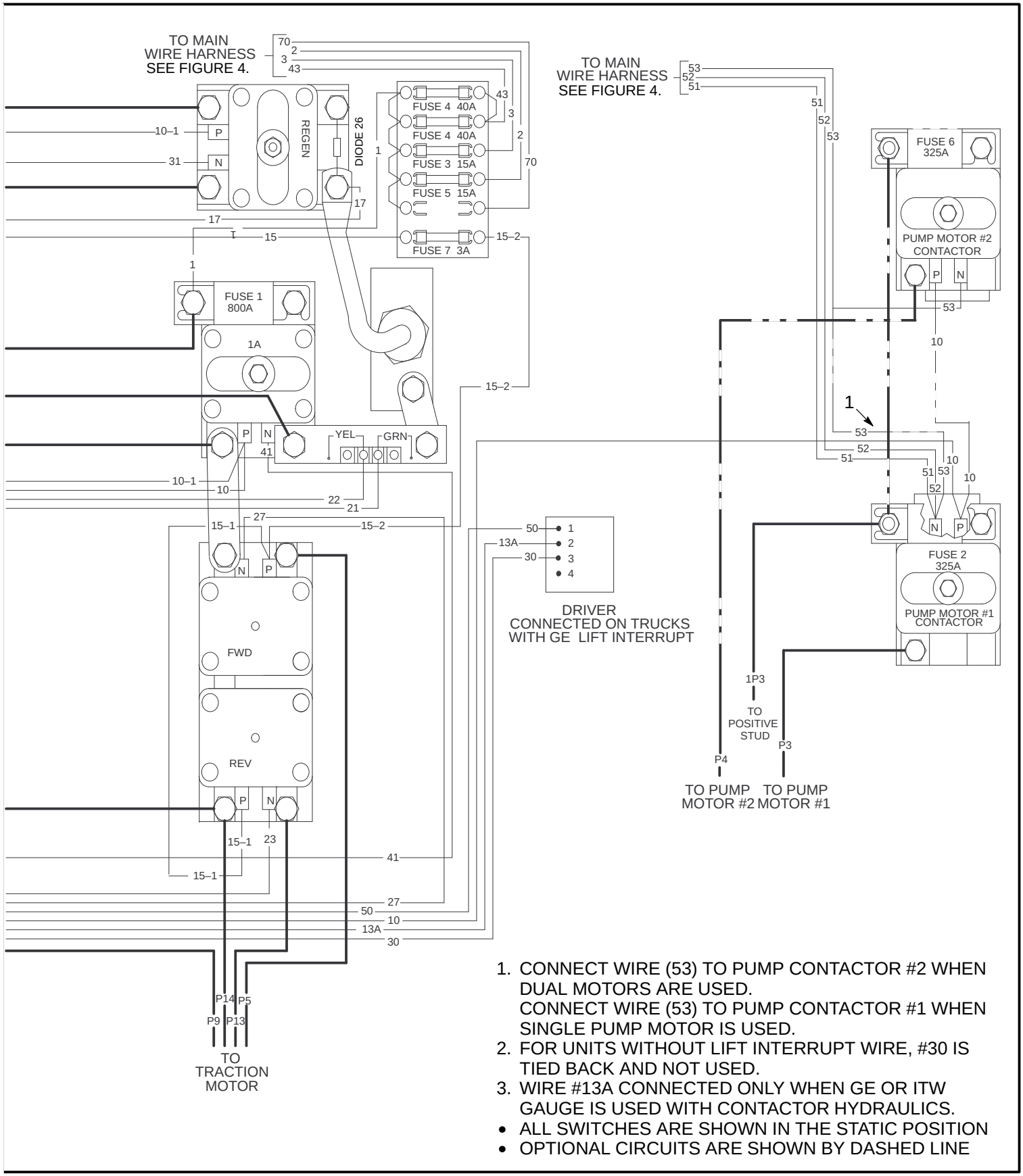
FIGURE 1. SCHEMATIC DIAGRAM, EV–100 OR EV–200 SCR TRACTION MOTOR CONTROL, 36–48 VOLTS

## BATTERY INDICATOR – WITH LIFT INTERRUPT WITH PUMP MOTOR CONTACTOR CONTROL (ONE OR TWO PUMP MOTORS)




1. CONNECT WIRE 53 TO PUMP CONTACTOR #2 WHEN TWO PUMP MOTORS ARE USED. CONNECT WIRE 53 TO PUMP CONTACTOR #1 WHEN ONE PUMP MOTOR IS USED.
2. ALL SWITCHES ARE SHOWN IN THE STATIC POSITION
3. OPTIONAL CIRCUITS ARE SHOWN BY DASHED LINE

FIGURE 5. HYDRAULIC PUMP MOTOR CONTROLS (2 OF 3)

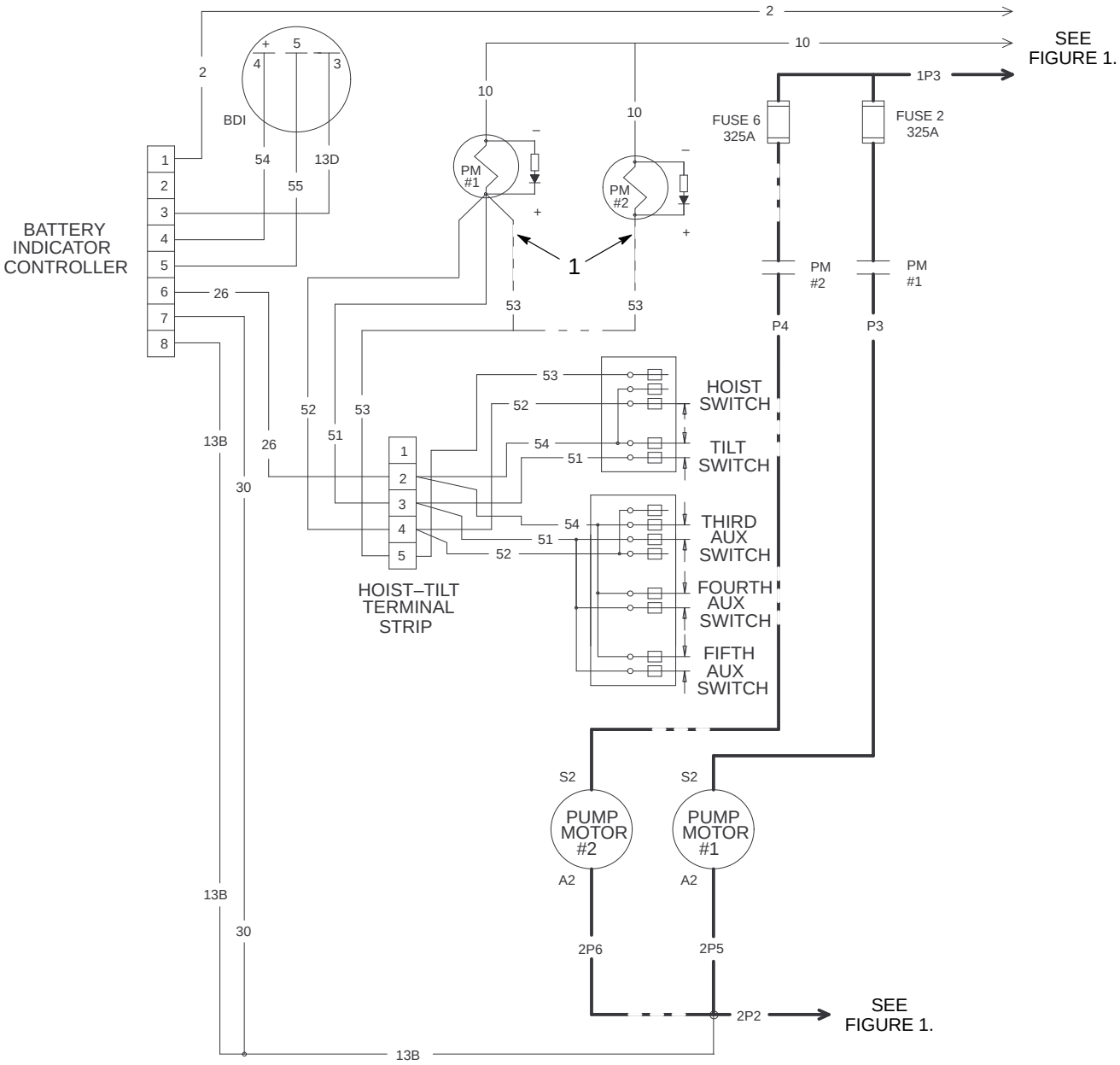



1. CONNECT WIRE (53) TO PUMP CONTACTOR #2 WHEN DUAL MOTORS ARE USED.
   CONNECT WIRE (53) TO PUMP CONTACTOR #1 WHEN SINGLE PUMP MOTOR IS USED.
2. FOR UNITS WITHOUT LIFT INTERRUPT WIRE, #30 IS TIED BACK AND NOT USED.
3. WIRE #13A CONNECTED ONLY WHEN GE OR ITW GAUGE IS USED WITH CONTACTOR HYDRAULICS.

- ALL SWITCHES ARE SHOWN IN THE STATIC POSITION
- OPTIONAL CIRCUITS ARE SHOWN BY DASHED LINE

FIGURE 2. WIRING DIAGRAM, EV–100 SCR TRACTION MOTOR CONTROL WITH SINGLE OR DUAL HYDRAULIC PUMP MOTOR CONTACTOR CONTROL

## BATTERY INDICATOR – WITH LIFT INTERRUPT WITHOUT PUMP MOTOR SCR CONTROL (ONE OR TWO PUMP MOTORS)

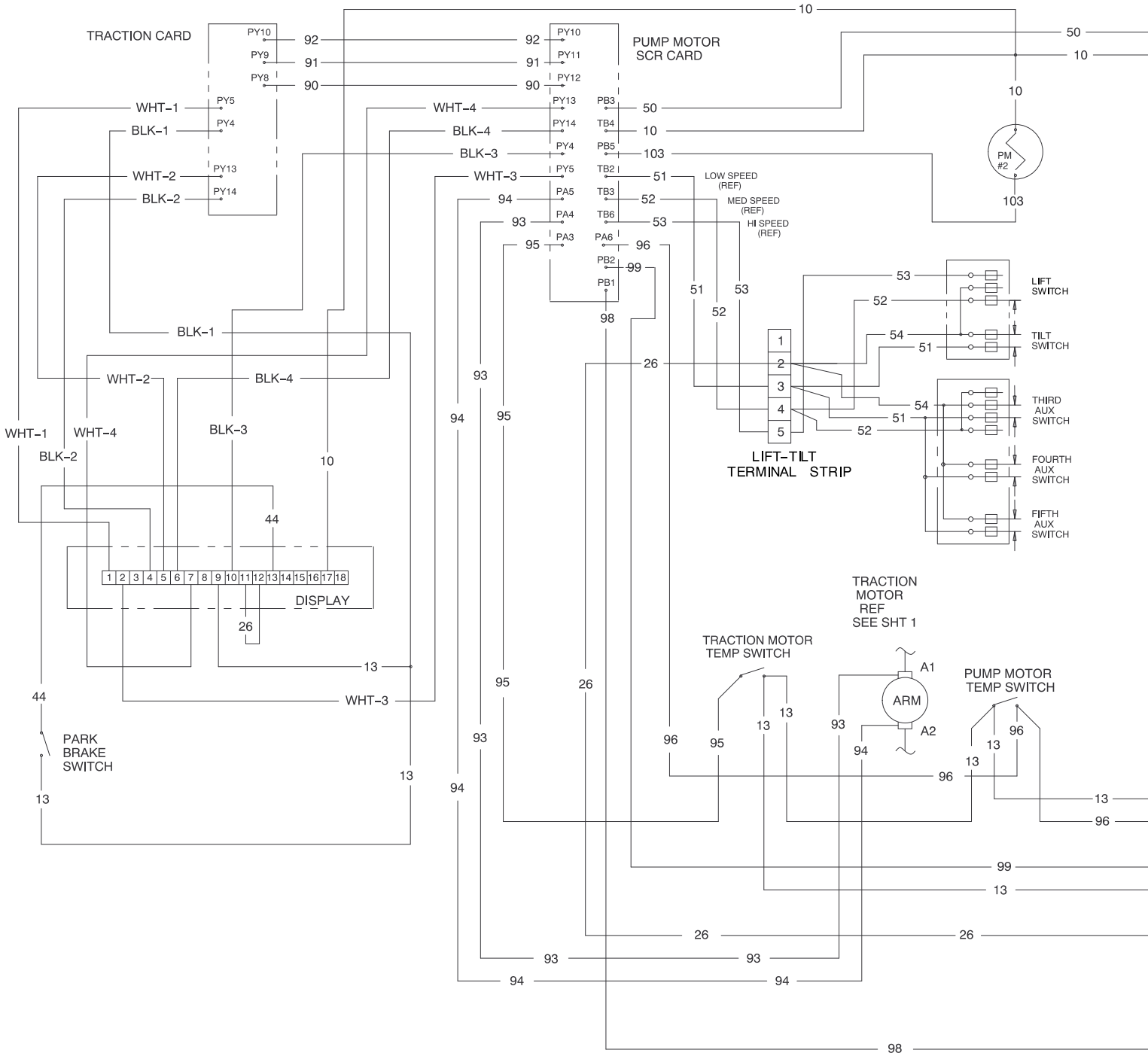



1. CONNECT WIRE 53 TO PUMP CONTACTOR #2 WHEN TWO PUMP MOTORS ARE USED. CONNECT WIRE 53 TO PUMP CONTACTOR #1 WHEN ONE PUMP MOTOR IS USED.

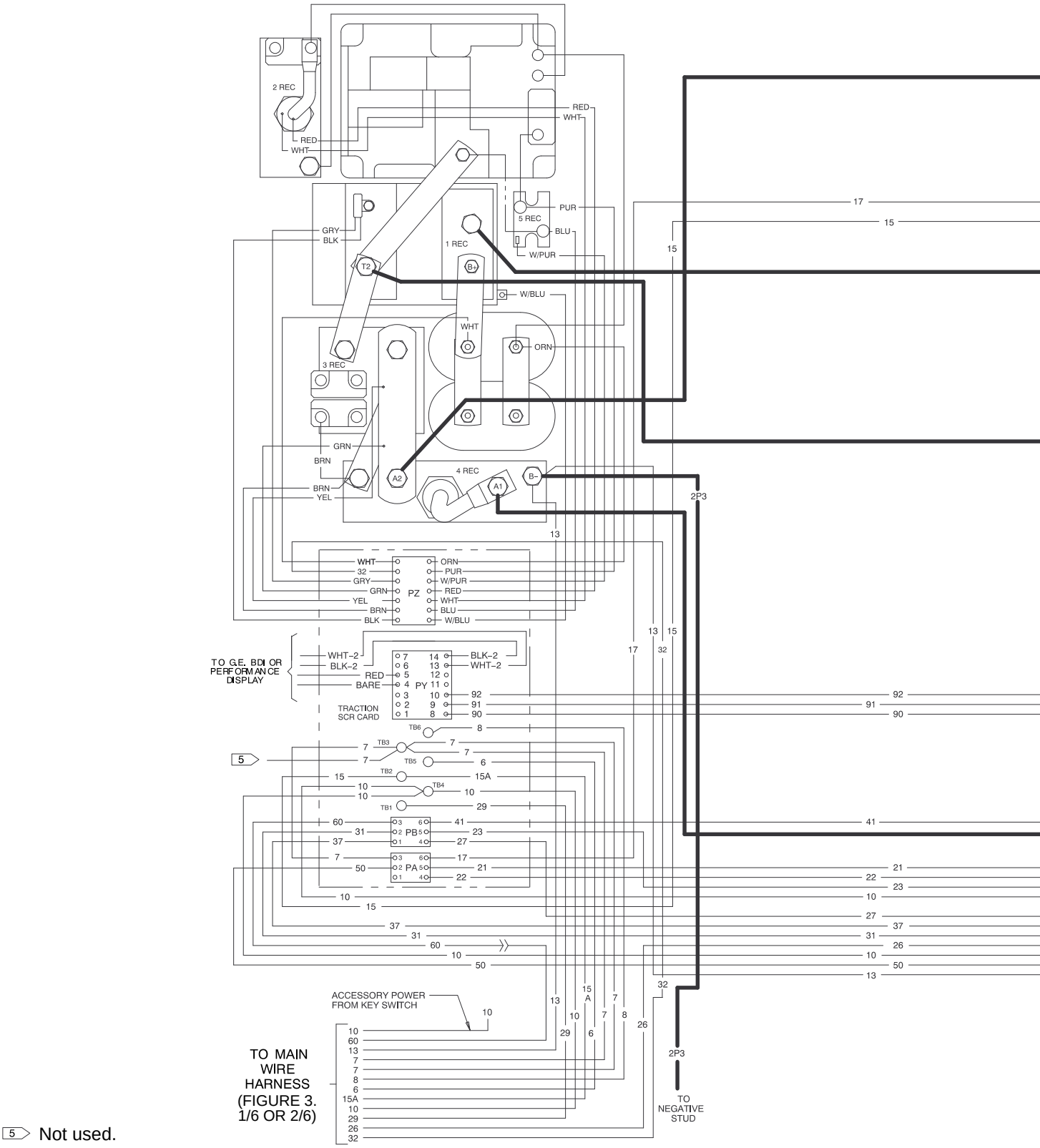
- ALL SWITCHES ARE SHOWN IN THE STATIC POSITION
- OPTIONAL CIRCUITS ARE SHOWN BY DASHED LINE

FIGURE 5. HYDRAULIC PUMP MOTOR CONTROLS (2 OF 4)

# LIFT PUMP MOTOR




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


2 REC
RED
WHT
RED
WHT
PUR
5 REC
BLU
W/PUR
GRY
BLK
1 REC
T2
B+
W/BLU
WHT
ORN
3 REC
GRN
BRN
A2
4 REC
B-
A1
BRN
YEL
2P3
13
WHT
32
GRY
GRN
YEL
BRN
BLK
PZ
ORN
PUR
W/PUR
RED
WHT
BLU
W/BLU
13
15
17
32
TO G.E. BDI OR PERFORMANCE DISPLAY
WHT-2
BLK-2
RED
BARE
PY
BLK-2
WHT-2
TRACTION SCR CARD
92
91
90
TB6
8
TB3
7
7
5
TB5
6
TB2
15A
TB4
10
TB1
29
60
31
37
PB
41
23
27
7
50
PA
17
21
22
10
15
37
31
60
10
50
ACCESSORY POWER FROM KEY SWITCH
10
TO MAIN WIRE HARNESS (FIGURE 3. 1/6 OR 2/6)
10
60
13
7
7
8
6
15A
10
29
26
32
13
10
29
6
15
A
7
7
8
26
32
2P3
TO NEGATIVE STUD

5 Not used.

# DRIVE AXLE

## GENERAL

This section has the description and repair procedures for the differential, speed reducer, drive axle, wheel bearings, and the mounts for the axle housing.

## DESCRIPTION (See FIGURE 1.)

The drive axle assembly is fastened to the frame of the lift truck by separate mounts. The drive axle assembly can rotate in the mounts. The outer ends of the axle housings are the spindles for the wheel bearings. The wheel bearings are tapered roller bearings with the cups pressed into the hubs. The nut on the end of the axle housing adjusts and holds the wheel bearings. The axle shafts are fastened to the hubs by capscrews and two dowel pins. The back plate and brake assembly are fastened to the axle mounts. The axle housing also has bearing journals for the mast.

The outer wheel bearing is lubricated by gear oil from the differential housing. The inner wheel bearing is lubricated by wheel bearing grease.

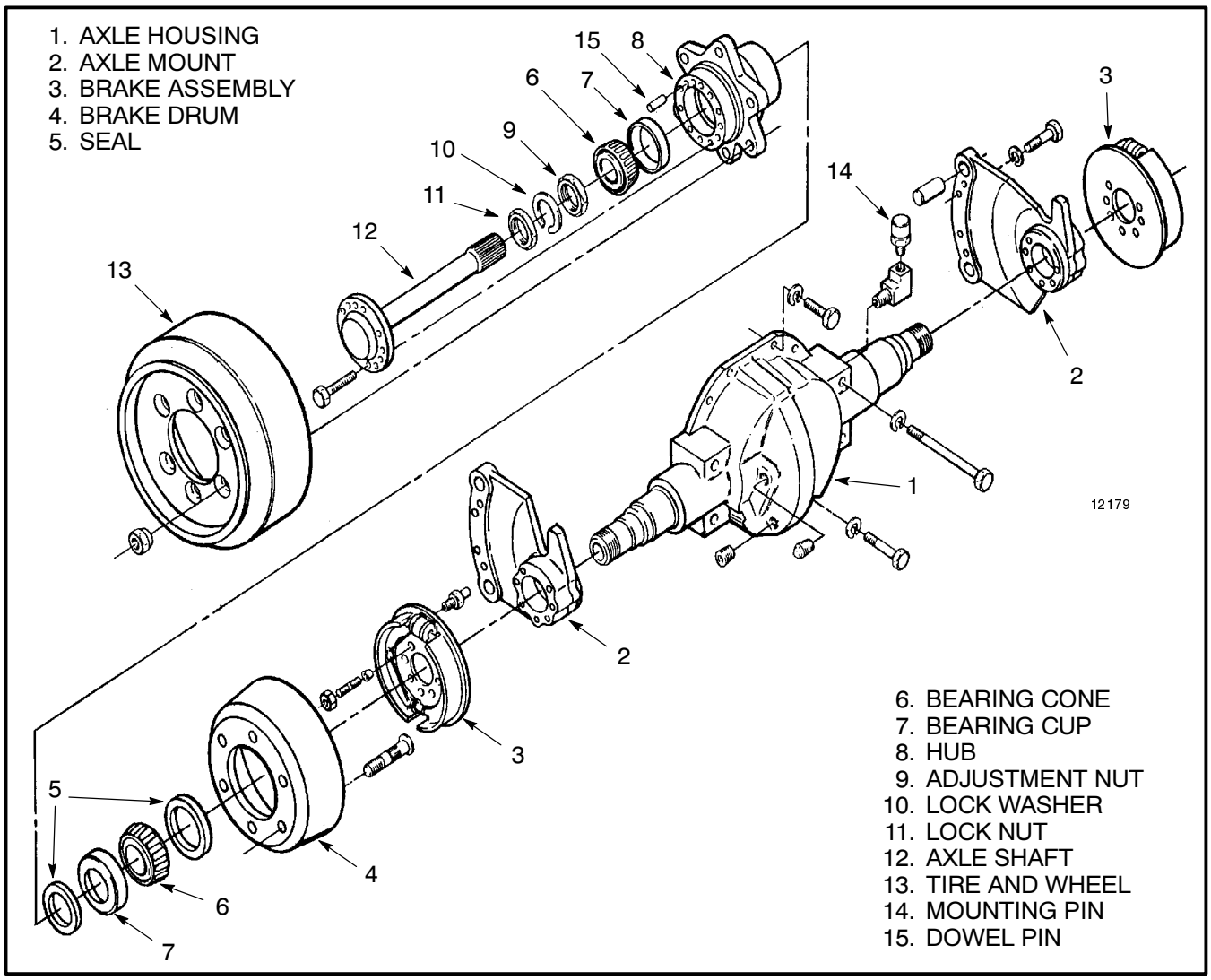



FIGURE 1. DRIVE AXLE ASSEMBLY

**NOTE:** If a mounting pin cannot be removed, soak it in penetrating oil or use a hacksaw blade to saw a slot in the pin. Use the procedure shown in FIGURE 12. to remove the pin.

### Cleaning

1. Do not release brake lining dust from the brake linings into the air when the brake drum is removed.

2. Use a solvent approved for cleaning of brake parts to wet the brake lining dust. Follow the instructions and cautions of the manufacturer for the use of the solvent. If a solvent spray is used, do not create dust with the spray.

3. When the dust is wet, clean the parts. Put any cloth or towels in a plastic bag or an airtight container while they are still wet. Put a "DANGEROUS FIBERS" warning label on the plastic bag or airtight container.

**⚠ CAUTION**

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

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

5. Clean all parts of the drive axle with solvent. Dry with compressed air.

### Inspection

Inspect the bearings and seals for defects. The axle housings must rotate freely in the mounts. The splines for the axle shafts must not be damaged.

### Assembly (See FIGURE 1. FIGURE 11. and FIGURE 12.)

1. Use a lifting device to hold the axle housing. Apply sealant Hyster Part No. 264159 on the flange of the axle housing.

2. Lubricate the surface for the axle mounts on the axle housing with an anti-seize compound. Slide the axle mounts onto the axle housing. Align the axle mounts with the frame and install the axle housing onto the speed reducer housing. Install the capscrews and washers. Tighten the capscrews to 65 Nm (50 lbf ft).

3. Install the capscrews for the axle mounts, but do not tighten them. Lubricate the mounting pins with an anti-seize compound. Use the procedure shown in FIGURE 12. to install the mounting pins in the axle mounts and the frame. After the mounting pins are installed, tighten the capscrews for the axle mounts to 320 Nm (235 lbf ft).

4. Assemble the brake assembly to the mount for the axle housing as described in the section **THE BRAKE SYSTEM, 1800 SRM 338.**

5. Install the seal in the center of the hub. Lubricate the inner bearing with grease. Install the inner seal in the hub. Install the brake drum on the hub. Install the hub and brake drum on the axle. Use care not to damage the seals when installing the hub. Lubricate the outer bearing cone with grease and install the outer bearing cone.

6. Install the adjustment nut. Tighten the nut to 205 Nm (150 lbf ft) while rotating the hub. Loosen the nut until the hub rotates freely. The torque must be less than 25 Nm (20 lbf ft). Tighten the nut to 35 Nm (25 lbf ft) or to the first alignment position after 35 Nm (25 lbf ft). Install the lock washer to hold the nut. Install the lock nut and tighten it to 135 Nm (100 lbf ft).

| TABLE 1. FUSES | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| LIFT TRUCKS | POWER FUSES | | CONTROL CIRCUIT FUSES | | | | | |
| | Traction | Hyd. pump | Steering | Control | Battery Ind. | Hour Meter | LED Display | Accel. Card |
| E20–30B/BS/BH | 225A | 175A | 30A | 15A | N/A | N/A | N/A | 10A |
| E30–60B/BS<br>36–48 Volts<br>72–80 Volts | <br>250A<br>175A | <br>200A<br>150A | 30A | 10A | N/A | N/A | N/A | 10A |
| E60–120B<br>36–48 Volts<br>72–80 Volts | <br>200A (2)<br>175A | <br>200A (2)<br>150A | 30A | 10A | N/A | N/A | N/A | 10A |
| E/J1.25—3.00XL (E/J25–60XL) | 500A | 325A | 40A | 15A | 15A | 10A* | 10A | N/A |
| E3.5–5.5XL (E70–120XL) | 800A | 325A (2) | 40A (2) | 15A | 15A | 10A* | 10A | N/A |
| J25–35A, J25–35B | 500A | 325A | 40A (2) | 15A | N/A | N/A | N/A | 10A |
| J40–60A, J50–60AS<br>36–48 Volts<br>72–80 Volts | <br>250A<br>175A | <br>200A<br>150A | 30A | 15A | N/A | N/A | N/A | N/A |

*Later production lift trucks only. Earlier production lift trucks do not have a separate fuse.

N/A = Not Applicable

## CONTROL CARD

The control card is a printed circuit board with electronic parts in a plastic case. The control card has two 6 pin plugs (PA and PB) that connect the signal wires between the parts of the controller and the control card. A 14 pin plug (PC) connects the control card to the functions for SCR 1, SCR 2, and SCR 5. Two machine screws at the bottom of the plastic case fasten the control card to the mounting plate. The control card for each function and the position of each control card is the same in both configurations of the controller.

Different control cards are used in the electric lift trucks made by Hyster Company. A replacement control card must be the same part number as the control card that was removed. Lift trucks that are equipped with the regenerative braking function use a different control card than lift trucks that only use a plugging function. These two control cards for the traction circuit have a different shape and must not be used as a replacement for the other control card. The control card used in lift trucks equipped with an SCR control for the hydraulic pump can not be used for one of the control cards for the traction circuit. A bad control card must be replaced because it cannot be repaired by service persons.

The control card for the traction circuit has an ”Static Return to OFF” (SRO) circuit. The key switch and seat switch must be closed before the accelerator is moved to operate the lift truck. A service person must understand the SRO sequence when troubleshooting. The SRO is a safety circuit that normally prevents the FORWARD or REVERSE travel of the lift truck unless the operator is in the correct position at the controls. If a service person must operate the lift truck with a by–pass on the SRO circuit, raise the drive wheels so that the lift truck can not move and cause an accident.

The control card for the traction circuit has a ”Pulse Monitor Trip” (PMT) circuit that checks for a malfunction of SCR 1. If SCR 1 does not operate with pulses, but stays ”ON” continuously, the controller will open the direction contactor and stop the lift truck.

## CONTROL CARD ADJUSTMENTS

### ⚠ WARNING

**Never operate a lift truck using a control card that has not been adjusted. The lift truck will not operate as expected and can cause personal injury or damage. Adjust the control cards according to the following procedures.**

**NOTE:** To check and replace the control card or other parts of the motor controller, see the correct section for the controller as shown on page 1.

## PROPORTIONAL CONTROL (J25–35A Only) (See FIGURE 9.)

This adjustment calibrates the proportional control of the logic circuit with the position of the steering potentiometer on J25–35A units. The signal voltage from the steering potentiometer indicates the angle position of the steering trunnion. The logic circuit uses this voltage signal to control the energy applied to the traction motors. This adjustment is not normally necessary unless the steering potentiometer or the logic circuit is replaced.

**NOTE:** You will see other adjustments on the proportional control module. Special equipment is needed to make these adjustments. Make changes only to the adjustments described in this section.

Before making this adjustment, make sure the steering potentiometer is calibrated with the steering trunnion. See the section of the steering potentiometer on page 19. Make sure the steering chain is correctly adjusted.

1. Make sure the battery is charged and has a specific gravity of at least 1.260.

2. Raise the drive wheels from the floor.

**NOTE:** Do not push on the accelerator (MONOTROL) pedal during Steps 3, 4 and 5.

3. Connect the battery and turn the key switch to the "ON" position. Close the seat switch. If there is a direction switch on the steering column, put the switch in the neutral position. Put the steering trunnion in the straight forward position (see page 19). Adjust the steering potentiometer until the LED 1 is illuminated.

4. Rotate the steering wheel for turning with a minimum radius towards the right (85 degrees from the straight forward position).

**NOTE:** The 85 degree point for turning in a minimum radius must occur as you steer into the turn. This point is where you will adjust to 100% reverse power of the inner drive wheel. The clearance in the steering assembly will give a wrong 85 degree indication if you go past 85 degrees and return. Make the adjustment when steering into the turn.

The maximum turning angle of the trunnion is approximately 90 degrees when the lift truck is moving. The trunnion will only turn approximately 85 degrees when the lift truck is stopped because of the increased friction between the floor and the tire.

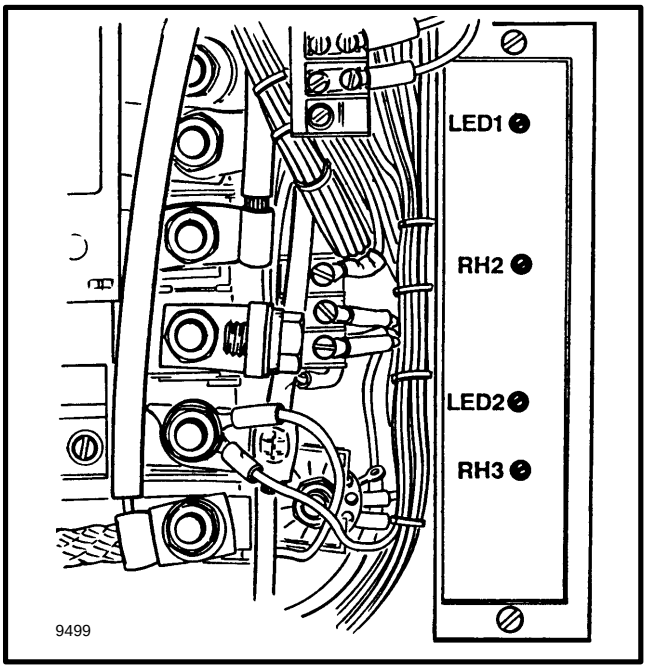



FIGURE 9. PROPORTIONAL CONTROL ADJUSTMENTS

Adjust RH 2 until LED 2 illuminates. If LED 2 is already illuminated, turn RH 2 counterclockwise until LED 2 is not illuminated. Then turn RH 2 clockwise until LED 2 just illuminates.

5. Rotate the steering wheel for turning with a minimum radius towards the left (85 degrees). Check that LED 2 just illuminates at the same degree as when the steering was turned towards the right. If the adjustment is not correct, check again the calibration of the steering trunnion with the steering potentiometer. Also, check Step 3 again.

6. Check the "CREEP" speed adjustment. Put the steering trunnion in the straight ahead position. Check that both drive wheels rotate at equal "CREEP" speeds. Adjust the "CREEP" speeds so that they are equal.

7. When turning the lift truck, the proportional control has a "CREEP" speed that overrides the logic card "CREEP" speed. This adjustment is RH 3 on the proportional control module. This adjustment is set at the factory and is not normally adjusted by service technicians. If this adjustment is not correct, the controller can have a PMT when turning the lift truck.

If RH 3 must be adjusted, do the following:

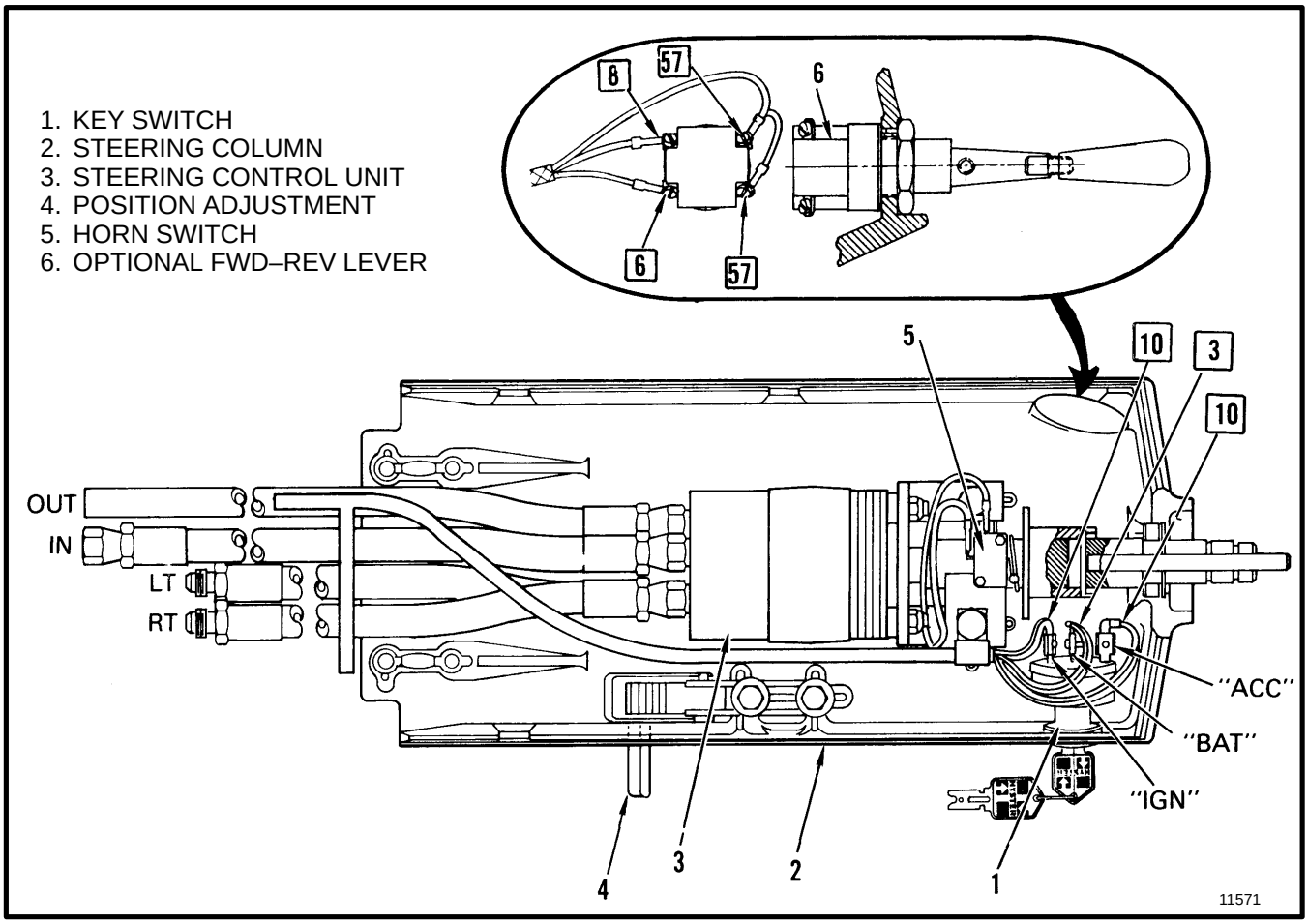



FIGURE 19. STEERING COLUMN ASSEMBLY FOR SitDrive® LIFT TRUCKS

**Direction Switches (MONOTROL)**
**(Later Production Lift Trucks)**
**(See FIGURE 20.)**

There is a small direction switch under each pad of the MONOTROL pedal. See FIGURE 20. Each switch controls one direction. A capacitor is in parallel with each direction switch to decrease arcs at the switch contacts. If both sides of the MONOTROL pedal are pushed at the same time, the direction circuit is deenergized and the lift truck will not move. The contacts of the two direction switches are in a series and parallel arrangement so that both direction contactors can not be energized at the same time.

Each direction switch must be adjusted so that one set of switch contacts are closed when the pedal pad is at each position of its travel. The pedal pad must be removed from the pedal assembly to make adjustments. Each switch is normally adjusted so that the body of the switch is even with the stop on the pedal pad.

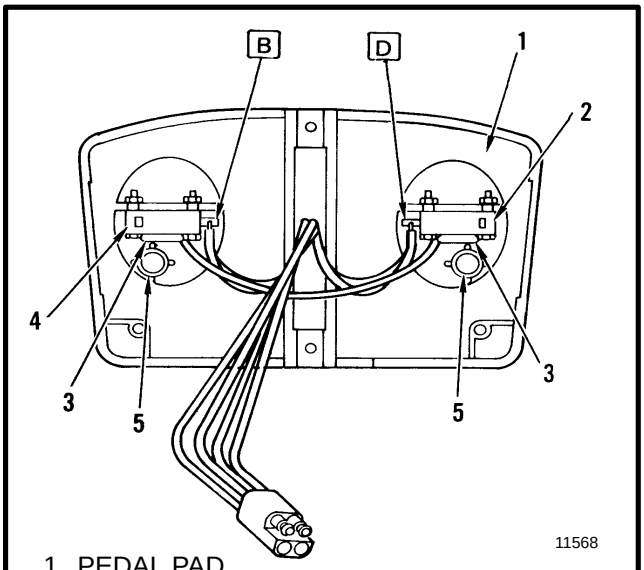



FIGURE 20. MONOTROL PEDAL

The controller also checks the battery voltage each time a battery is connected. The traction control will prevent lift truck operation if the battery voltage is not correct as set by traction function 15. A status code of -16 (voltage too high) or -15 (voltage too low) will indicate on the display panel. The battery can have a voltage that is too high or too low. A battery with the correct voltage can also be deeply discharged from use or other reasons and have a voltage that is less than the minimum of the voltage range.

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

(2) **Warning light, parking brake indicator.** The red light is **ON** when the parking brake is applied and the seat switch is closed. and goes **OFF** when the parking brake is released.

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

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

When it is time for periodic maintenance, the warning light, Service Interval (11) will be illuminated and a status code -99 will be indicated. The register in the controller card must be reset by the service person before this warning light will go **OFF**.

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

### Performance Display (See FIGURE 4.)

When the key switch is turned to the **ON** position, a start program will cause each warning and indicator light to illuminate to show that the function is operating. The functions and operation of the indicators for these early and later display panels is the same. These display panels have the following functions:

(1) **Battery Charge Indicator With Lift Interrupt.** This battery charge indicator shows the battery charge with an LED bar graph. There are four green bars, four orange bars, and two red bars. When the battery is discharged during operation, the LED bar that is illuminated decreases sequentially from the top green bar through the orange bars to the red bars. When the battery is discharged to the red LED bars, the battery is 73% discharged and the lift interrupt function will not permit operation of the hydraulic motor. The battery must be charged or a charged battery must be installed before lift truck operation can continue. The top green bar will be illuminated when the battery is more than 90% charged.

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

The controller also checks the battery voltage each time a battery is connected. The traction control will prevent lift truck operation if the battery voltage is not correct as set by traction function 15. A status code of -16 (voltage too high) or -15 (voltage too low) will indicate on the display panel. The battery can have a voltage that is too high or too low. A battery with the correct voltage can also be deeply discharged from use or other reasons and have a voltage that is less than the minimum of the voltage range.

Install the connectors and the key switch wires. On the Basic panel, set the DIP switches near the connector for the panel to the voltage of the lift truck. See FIGURE 7. Move the DIP switch for the correct voltage to the up position and all others to the down position. Install the column cover on the steering column.

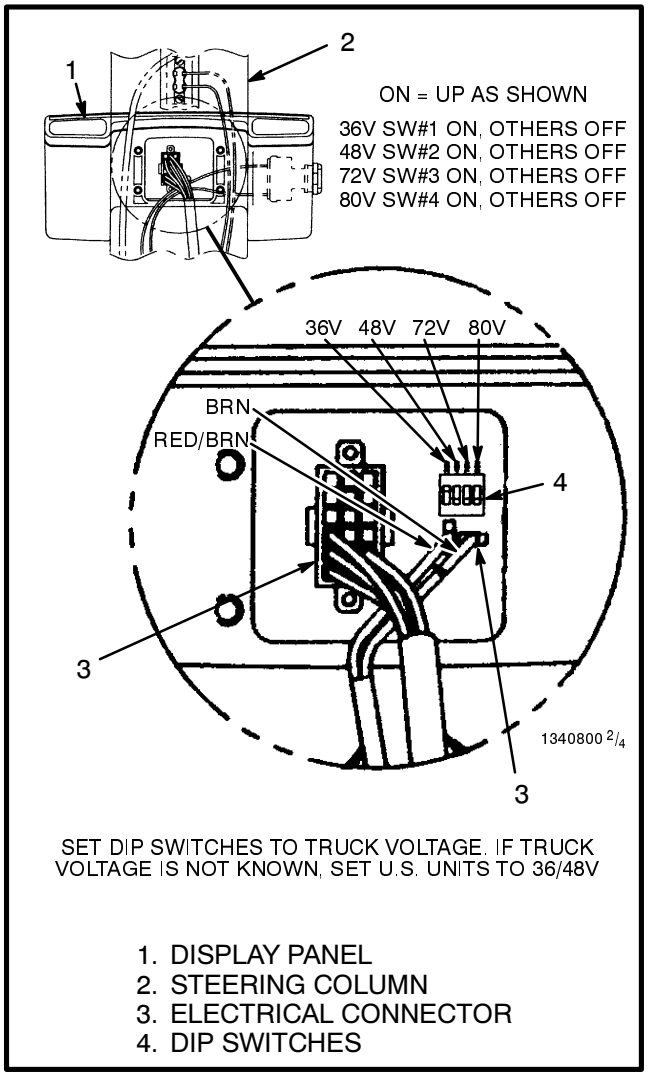



FIGURE 7. DIP SWITCHES - "LX" AND "ZX"

### Replace The Key Switch (See FIGURE 8.)

**NOTE:** The key switch is replaced as one of the components of the display panel. See procedure under Replacing Parts Of The Basic Display Panel to replace the key switch of either display panel assembly.

### Indicator LEDs

**NOTE:** The indicator LEDs of the Basic display panel are part of the circuit board and must be replaced as an assembly. See Replacing Parts Of The Basic Display Panel of this section. The LED indicators of the Performance display panel cannot be replaced. If these LED indicators are bad, replace the display panel. See Replacing Display Panel Assembly of this section.

### Battery Indicators

There are two types of battery indicators for these trucks. One type is a meter movement with colored bands showing the battery charge (Basic display panel). The other type is a Light Emitting Diode (LED) display with LEDs of different colors showing battery charge (Performance display panel).

**NOTE:** The battery indicator is replaced as one of the components of the display panel. See procedure under Replacing Parts Of The Basic Display Panel of this section. The battery indicator of the Performance display panel cannot be replaced as a separate component. The indicator must be replaced as part of the Performance display panel. See Replacing Display Panel Assembly of this section.

See the section **BATTERY INDICATORS, 2200 SRM 138** to adjust these battery indicators.

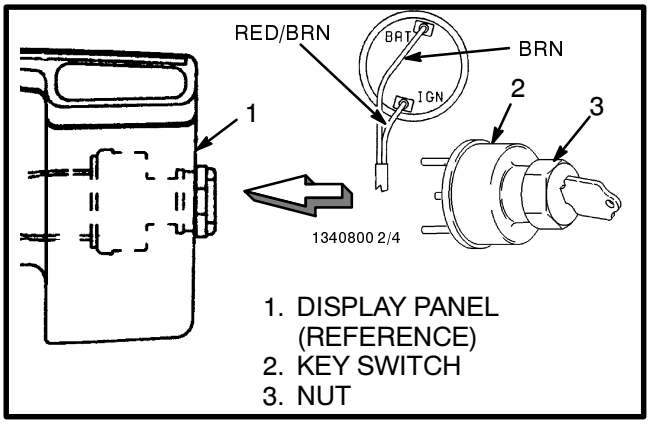



FIGURE 8. KEY SWITCH - "LX" AND "ZX"

### Digital Display (Performance Display Panel Only)

**NOTE:** The digital display of the Performance display panel cannot be replaced as a separate component. The display must be replaced as part of the Performance display panel. See Replacing Display Panel Assembly of this section.

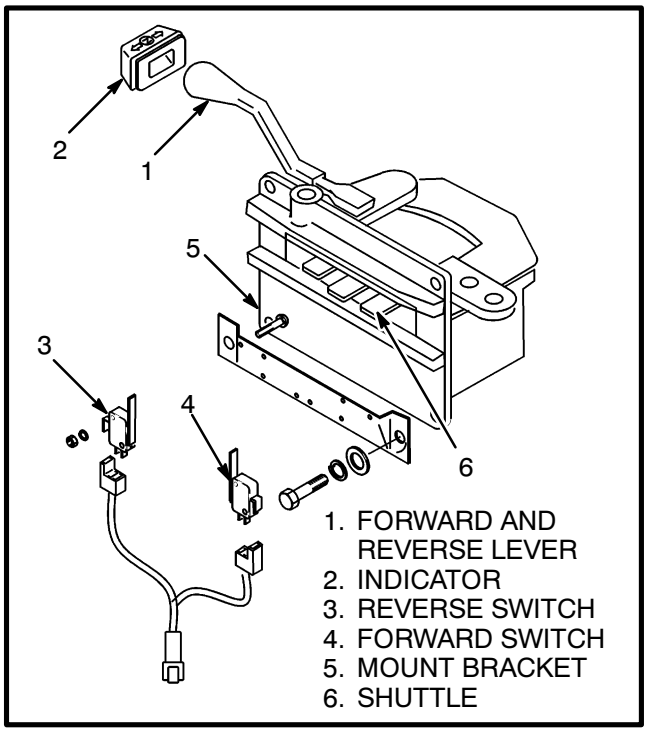



FIGURE 19. DIRECTION CONTROL LEVER AND SWITCHES

3. Make a note of the location of the wires for correct connection during installation and disconnect the three wires from the switch. Replace the switch and connect the wires to the replacement switch.

4. There is no adjustment for these switches. Install the cover for the steering column.

### Direction Control Switches, E70-120XL$_3$ (Steering Column) (See FIGURE 20.)

The direction control switches send battery voltage to close the Forward or Reverse contactors. This control has a pair of microswitches in the steering column. See FIGURE 20. Each microswitch controls one direction. Remove the cover of the steering column so that you can disconnect the three wires from the switch. Replace the switch and reconnect the wires. Adjust the switch in its mount bracket so that the switch opens and closes correctly when that direction is selected. Install the cover for the steering column.

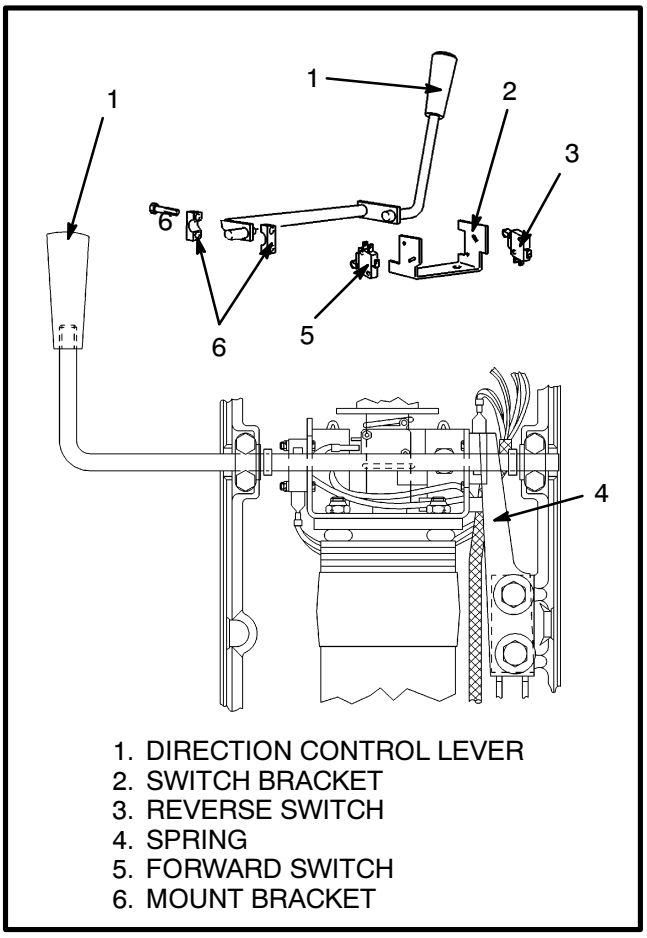


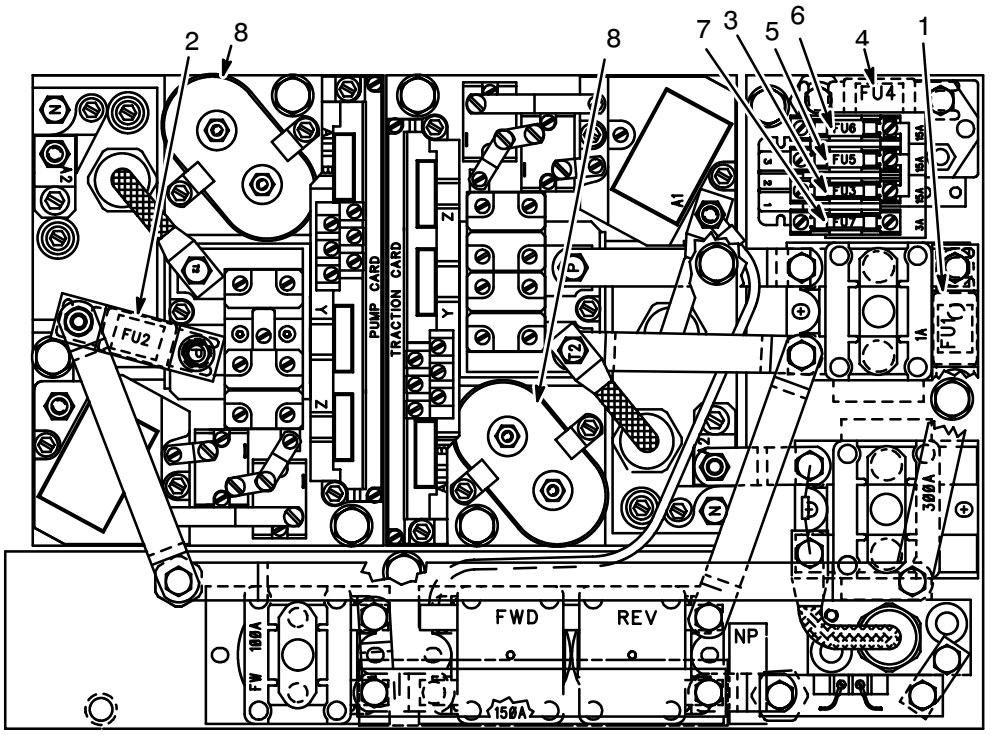

FIGURE 20. DIRECTION CONTROL LEVER AND SWITCHES

### Brake Fluid Switch

This switch is a magnetic switch on the reservoir of the master cylinder for the service brakes. It sends a signal to the control card of the display panel to illuminate the indicator for low fluid level. The switch is part of the reservoir. To replace the reservoir, see **THE BRAKE SYSTEM** for your unit.

### Brush Wear And Over Temperature Sensors

The Brush Wear Indicators illuminate when the motor brushes must be replaced. The sensor wires for the brush wear indicators are an insert in the brush material when it is made. The sensor wires are insulated from the brush material. When the brush wears within approximately 1.5 mm (0.060 in) of the brush lead, the insulation between the sensor wire and the brush material is destroyed. The connection between the brush and the sensor wire causes the warning indicator to illuminate if the circuit is operating correctly. Motor indicators on the




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

FIGURE 26. FUSE LOCATIONS FOR THE EV-100ZX SCR MOTOR CONTROLLER OF THE E25-65XM AND N30XMH

## ADJUST THE ACCELERATOR POSITION SENSOR (See FIGURE 22. and FIGURE 36.)

### ⚠ CAUTION

**The Monotrol pedal or accelerator pedal movement and start switch MUST be adjusted before adjusting the accelerator position sensor. See Monotrol Pedal Or Accelerator Pedal Adjustment of this section to adjust the pedal movement. See Adjusting Start Switch of this section to adjust the start switch.**

**NOTE:** The floorplates must be installed to check the maximum speed adjustment of the accelerator position sensor.

When the position of the Monotrol pedal or accelerator pedal and the start switch adjustments are correctly adjusted, adjust the accelerator position sensor as follows:

1. Raise the drive tires as described in the **OPERATING MANUAL** or the **PERIODIC MAINTENANCE** section.

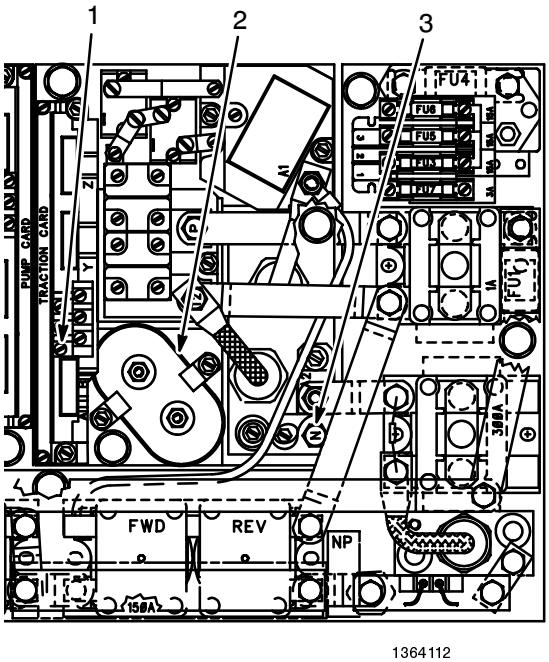
### ⚠ WARNING

**On SCR units, do not touch the terminals of capacitor C1 of the traction or lift motor controllers. The charge on the capacitors can cause electrical shock and personal injury. Disconnect the battery and use an insulated screwdriver or jumper wire to discharge the capacitors before connecting the volt meter leads. Make a short-circuit across the capacitor terminals to discharge each capacitor and prevent electrical shocks.**

2. Remove the cover from the counterweight for access to the traction control card.

3. Connect a volt meter between the TB1 terminal (+) of the traction control card and a battery negative (-). See FIGURE 36. Connect the battery after the volt meter is connected.

4. Sit in the seat or put a weight in the seat to close the seat switch or the switch of the seat brake. Turn the key to the **START** and **ON** position. Do NOT depress the Monotrol pedal or accelerator pedal.




1. TERMINAL TB1 OF TRACTION CONTROL CARD (METER +)
2. TRACTION CAPACITOR C1 (LIFT CAPACITOR NOT SHOWN)
3. BATTERY NEGATIVE (METER -)

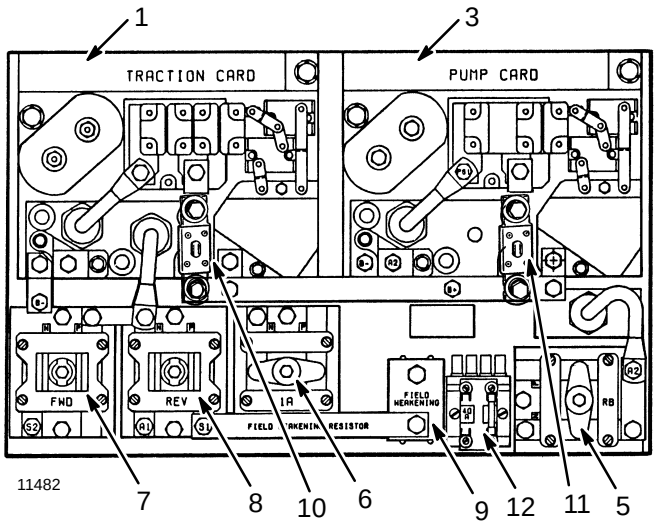
FIGURE 36. VOLT METER CONNECTION POINTS ON SCR MOTOR CONTROLLERS

5. The correct volt meter reading is 3.7 volts or more. If the voltage reading is too low, remove the top floor plate and adjust the mount plate for the position sensor. Move the plate to a position for the correct voltage. Repeat Step 4 and Step 5 until the voltage is correct after the screws have been tightened with the mount plate in the correct position.

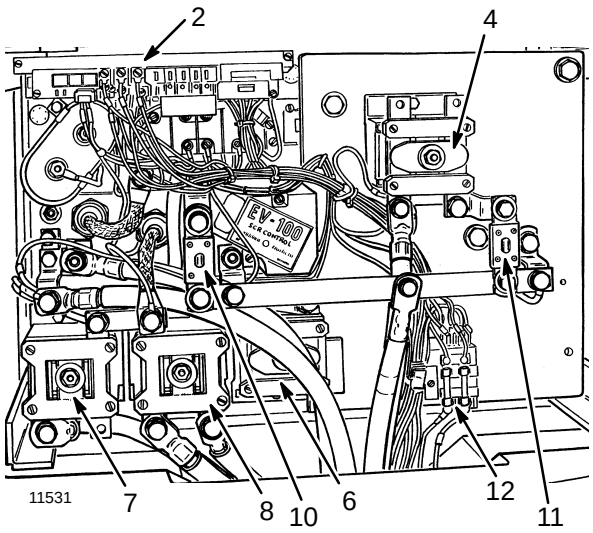
6. Install the floor plate and sit in the seat or put a weight in the seat to close the seat switch or the switch of the seat brake. Turn the key to the **START** and **ON** position. Depress the Monotrol pedal or accelerator pedal to the floor plate. The correct volt meter reading is 0.4 volt or more. If the voltage reading is too low, remove the top floor plate and adjust the position sensor on the mount plate for 0.4 volt. Check that the voltage of Step 5 is correct. Repeat Steps 4 through 6 until both voltages (Step 5 and 6) are correct.

7. Install the floor plate, remove the volt meter and lower the lift truck off the blocks.

## BEFORE NOVEMBER 1987



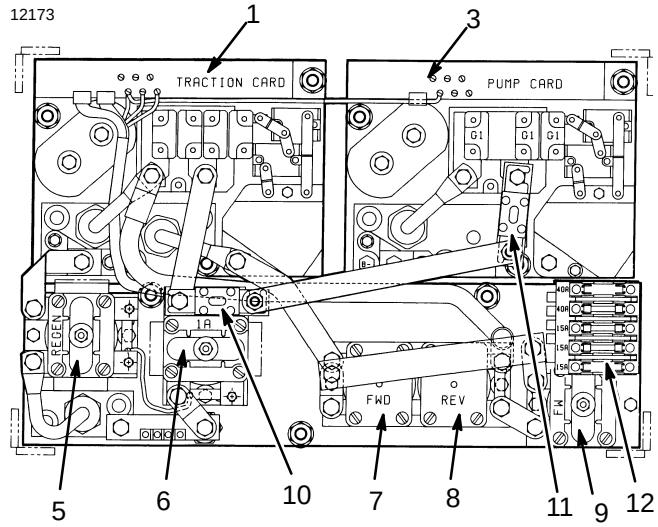

MOTOR CONTROLLER WITH REGENERATIVE BRAKING, 1A BY–PASS, AND SCR CONTROLLER FOR HYDRAULIC PUMP



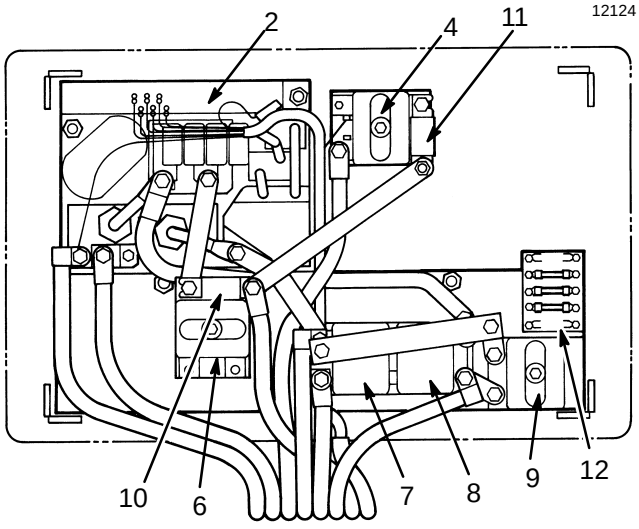

MOTOR CONTROLLER WITH 1A BY–PASS, AND CONTACTOR CONTROL FOR HYDRAULIC PUMP

1. TRACTION CARD REGENERATIVE BRAKING
2. TRACTION CARD WITHOUT REGENERATIVE BRAKING
3. EV–100 CONTROL, HYDRAULIC PUMP MOTOR
4. CONTACTOR, HYDRAULIC PUMP MOTOR
5. CONTACTOR, REGENERATIVE BRAKING
6. CONTACTOR, 1A
7. CONTACTOR, FORWARD DIRECTION
8. CONTACTOR, REVERSE DIRECTION
9. CONTACTOR, FIELD WEAKENING
10. FUSE, TRACTION CIRCUIT
11. FUSE, HYDRAULIC PUMP
12. FUSES, CONTROL CIRCUIT AND STEERING

## AFTER NOVEMBER 1987

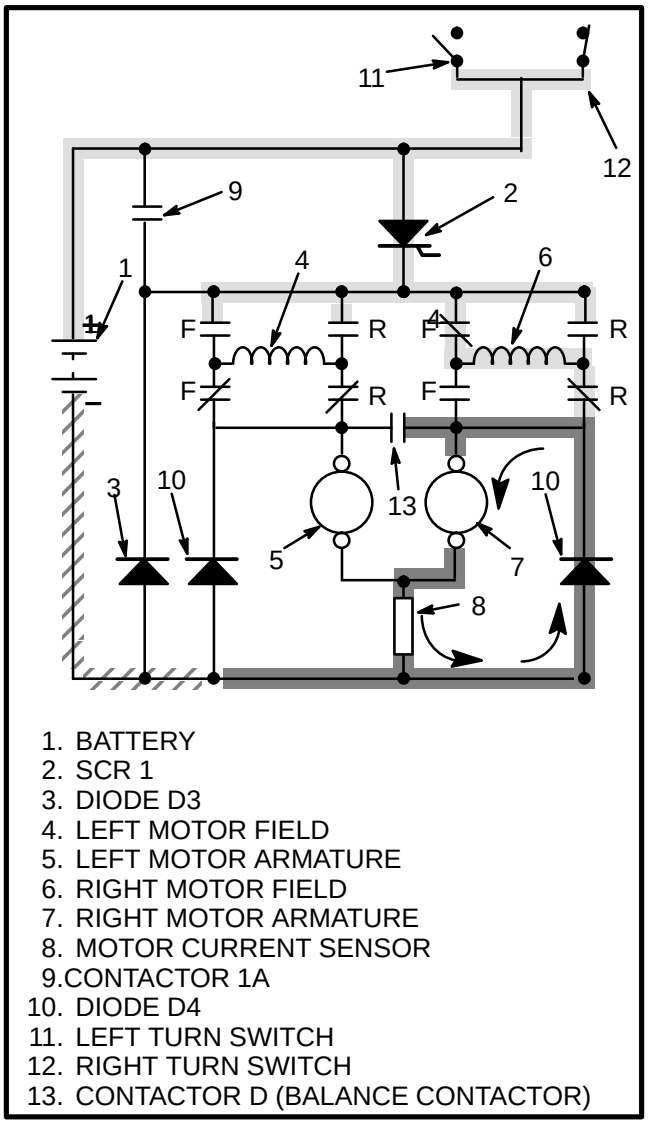



MOTOR CONTROLLER WITH REGENERATIVE BRAKING, 1A BY–PASS, AND SCR CONTROLLER FOR HYDRAULIC PUMP




MOTOR CONTROLLER WITH 1A BY–PASS, AND CONTACTOR CONTROL FOR HYDRAULIC PUMP

FIGURE 9. TYPICAL COMPONENT LOCATIONS OF THE EV–100 CONTROLLER, SitDrive® LIFT TRUCKS




1. BATTERY
2. SCR 1
3. DIODE D3
4. LEFT MOTOR FIELD
5. LEFT MOTOR ARMATURE
6. RIGHT MOTOR FIELD
7. RIGHT MOTOR ARMATURE
8. MOTOR CURRENT SENSOR
9. CONTACTOR 1A
10. DIODE D4
11. LEFT TURN SWITCH
12. RIGHT TURN SWITCH
13. CONTACTOR D (BALANCE CONTACTOR)

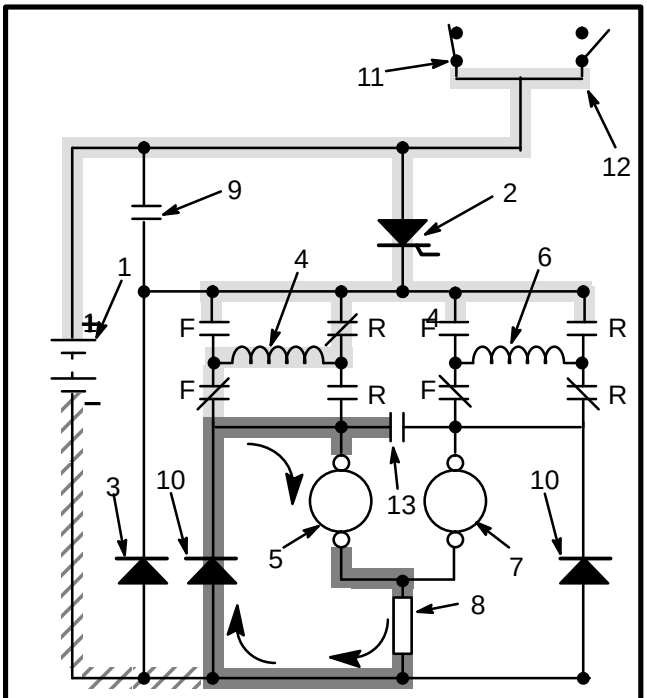
FIGURE 20. DUAL MOTOR PLUGGING CIRCUIT (LEFT TURN)

If a turn switch is open, only the traction motor that is operating will use the plugging function. The contactor D will not close. See FIGURE 20. and FIGURE 21.

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. Turning the adjustment clockwise will decrease the plugging distance. Turning the adjustment counterclockwise will increase the plugging distance. The shorter the plugging distance, the faster is the wear on the traction motor brushes.

## SCR CONTROL (HYDRAULIC PUMP MOTOR)

The control card for the hydraulic pump is not the same as the control card for the traction circuit. This control card has a different (OSC ASM) label. The SCR function of a speed control is the same, but the many functions necessary for control of a traction circuit are not needed for the hydraulic pump. A contactor is not used in the power circuit. The 325 ampere fuse for the hydraulic pump circuit is found between the (+) bus bar and the SCR 1 anode of the controller.




1. BATTERY
2. SCR 1
3. DIODE D3
4. LEFT MOTOR FIELD
5. LEFT MOTOR ARMATURE
6. RIGHT MOTOR FIELD
7. RIGHT MOTOR ARMATURE
8. MOTOR CURRENT SENSOR
9. CONTACTOR 1A
10. DIODE D4
11. LEFT TURN SWITCH
12. RIGHT TURN SWITCH
13. CONTACTOR D (BALANCE CONTACTOR)

FIGURE 21. DUAL MOTOR PLUGGING CIRCUIT (RIGHT TURN)

This control card does not have an SRO check nor a PMT check. If SCR 1 has a short–circuit, the pump motor will run until the battery is disconnected. The main control valve is an open center valve and the hydraulic

**FORWARD** contactor is closed. No voltage is applied to the traction circuit because SCR 1 is not **ON**.

The control card sends a gate signal to SCR 2. This action gives a current path to both sides of C1. C1 charges to battery voltage. SCR 2 goes **OFF** when C1 is charged because there is no current flow.

The control card senses the voltage on C1 through PC14 of the control card plug. If the capacitor is charged, the control card will send a gate signal to SCR 1.

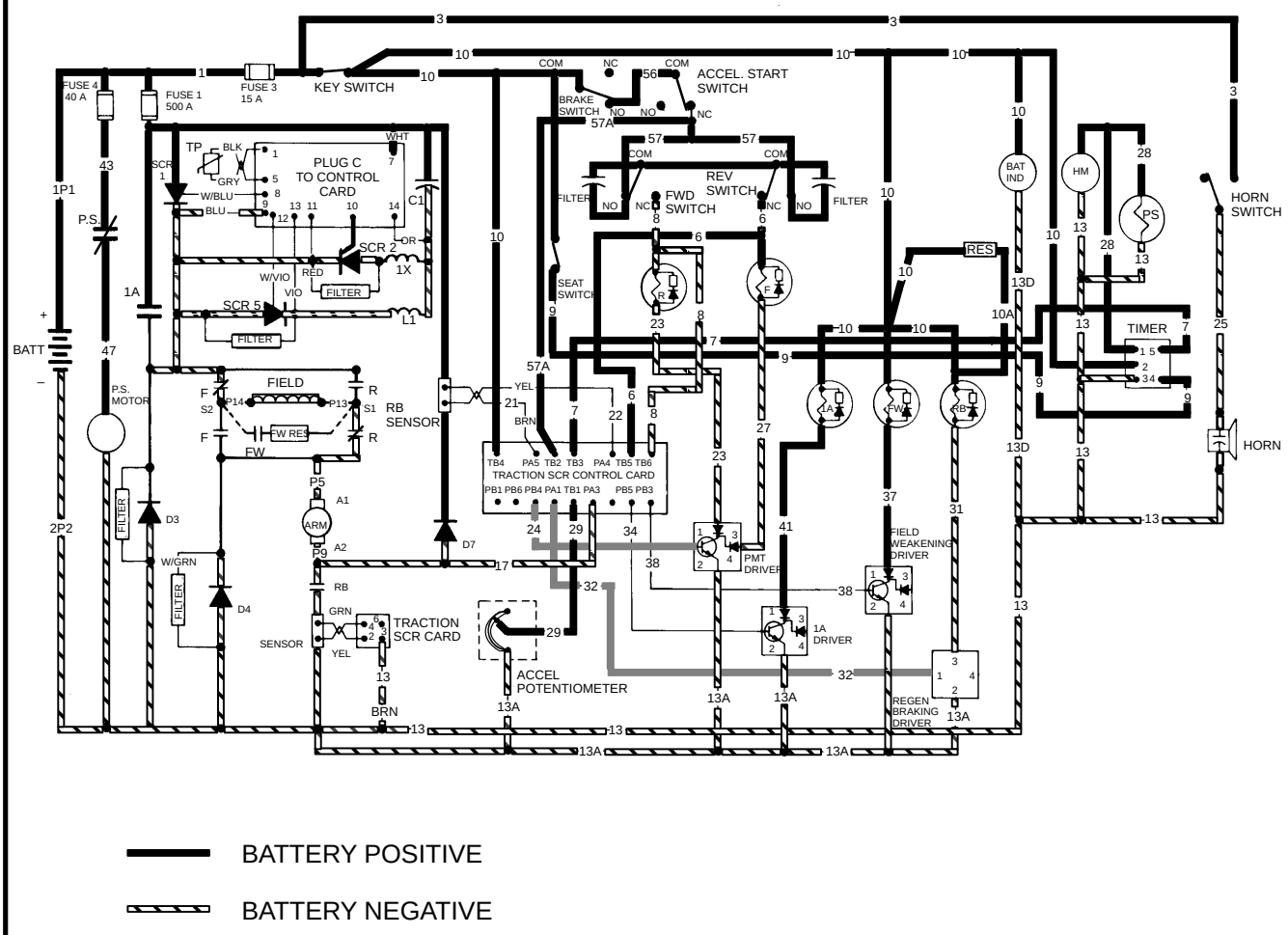
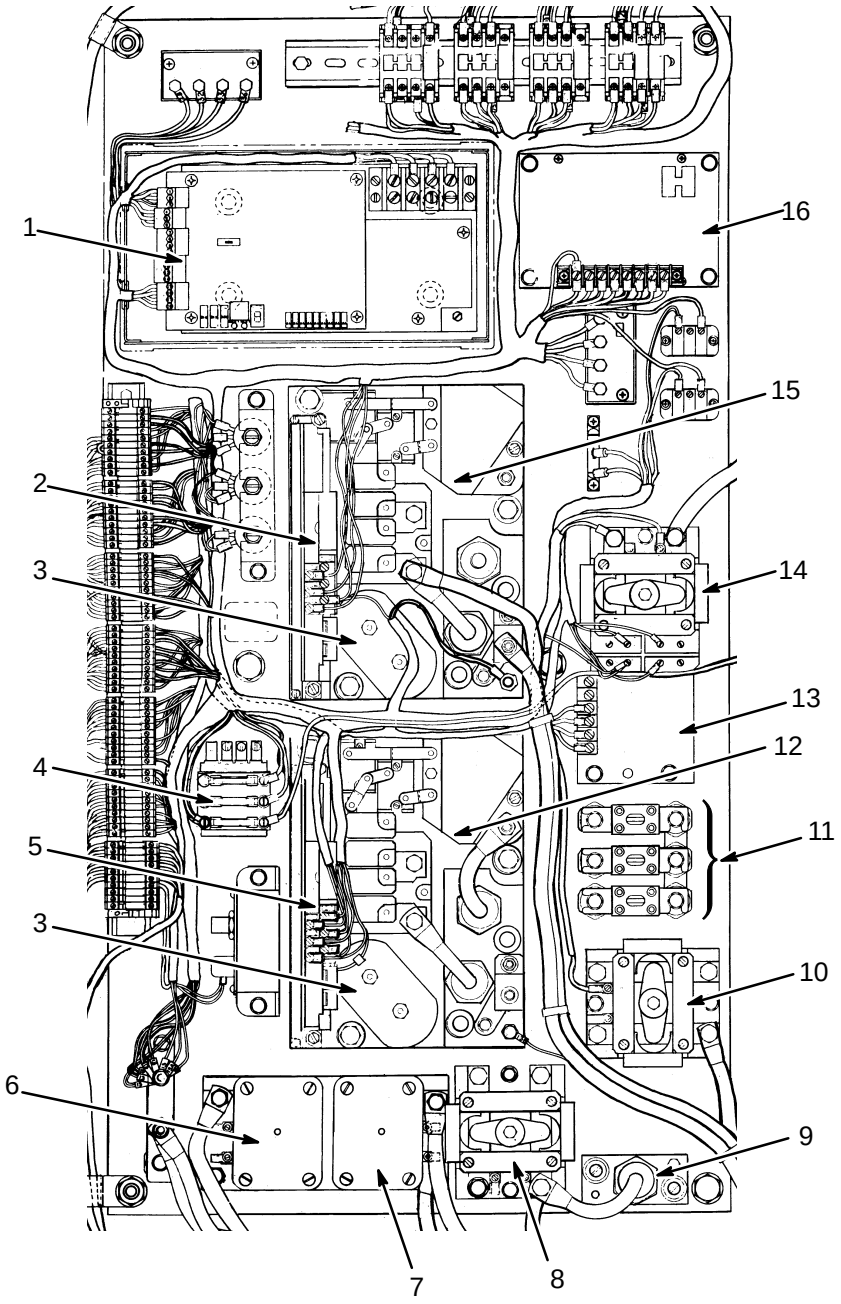



FIGURE 32. SEQUENCE OF OPERATION, GATE SIGNAL TO SCR 2




1. ELECTRONIC CONTROL MODULE
2. CONTROL CARD, HYDRAULIC PUMP
3. CONTACTOR C1
4. FUSES, CONTROL CIRCUIT
5. CONTROL CARD, TRACTION CIRCUIT
6. CONTACTOR, REVERSE DIRECTION
7. CONTACTOR, FORWARD DIRECTION
8. CONTACTOR, REGENERATIVE BRAKING
9. DIODE D7 (REGENERATIVE BRAKING),
10. CONTACTOR, STEERING PUMP
11. FUSES, TRACTION CIRCUIT HYDRAULIC PUMP. AND STEERING
12. MOTOR CONTROL MODULE, TRACTION
13. POWER DISCONNECT MODULE
14. CONTACTOR, BATTERY DISCONNECT
15. MOTOR CONTROL MODULE, HYDRAULIC PUMP
16. AUTOMATIC SHUT–OFF MODULE

FIGURE 3. COMPONENT LOCATIONS, R30EH LIFT TRUCKS

erative braking contactor. The regenerative braking contactor has a special constant duty coil rated at 24 volts and must be used with the special electronic driver. This special electronic driver looks like the other electronic drivers used in this controller. The special electronic driver has the following part number: 1C3645CPM1UDA9. This special electronic driver has an internal circuit that reduces the battery voltage to an average 17 volts applied to the coil of the regenerative braking contactor. The coil of the regenerative braking contactor will be damaged unless the special electronic driver is used with it.

When the configuration of the controller was changed during 1987, the special electronic driver for the regenerative braking function was removed. The coil on the regenerative braking contactor was changed to a 36–48 volt rating. The coil is not rated for constant operation, so a resistor is added in series with the coil on 48–volt lift trucks to reduce the voltage. The same electronic driver used for the other contactors is now used with the regenerative braking contactor.

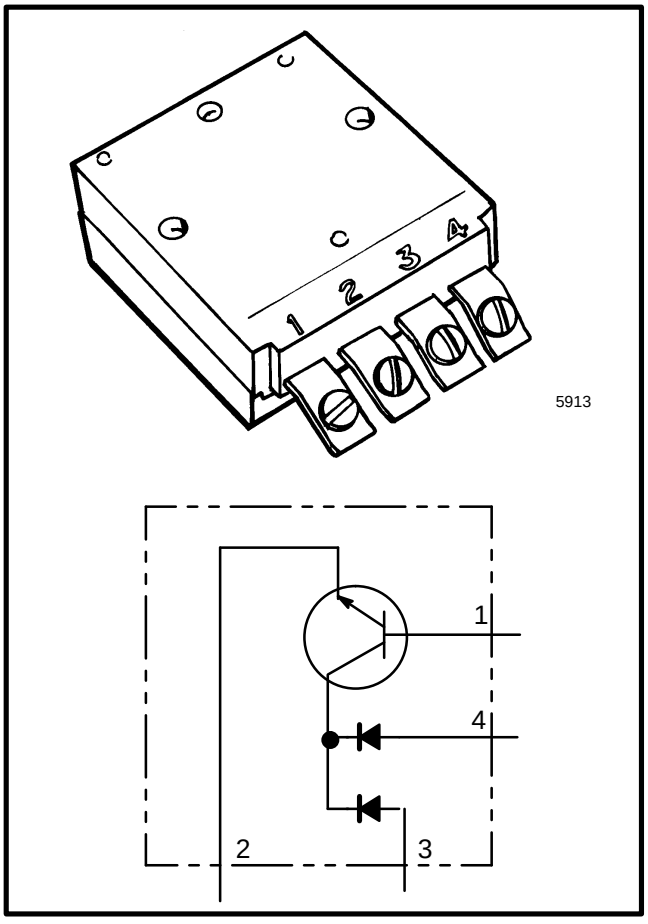


FIGURE 14. ELECTRONIC DRIVER MODULE

The resistor in series with the coil is installed in all 36–48 volt controllers. Two wires are connected to the coil when the controller is received from the manufacturer. One wire is from the resistor and the second wire is a by–pass around the resistor. If the controller is installed in a lift truck with a 48 volt battery, the by–pass wire is disconnected. If the controller is installed in a lift truck with a 36 volt battery, both wires stay connected and the resistor does not function.

The electronic drivers used for the **FORWARD, REVERSE,** and **1A** contactors have the following part numbers:
1C3645CPM1RDA2 (for 36–48 volt service)

The access to the electronic drivers on the bottom of the stack is difficult. Remove the two mounting screws and separate the drivers as necessary for access to the terminals. Make sure you disconnect the battery when you separate or connect the electronic drivers. Do not cause a short–circuit.

The electronic driver modules are most easily checked in the lift truck. Raise the drive wheels from the floor. Connect the battery. Set the controls of the lift truck so that the electronic driver you are checking will operate. Check that there is an input signal on terminal 1 of 1.0–2.0 volts.

If there is 1.0–2.0 volts at terminal 1 of the electronic driver, check for approximately battery voltage between battery negative and terminal 3 or terminal 4. If there is approximately battery voltage, the electronic driver is damaged. A good electronic driver will indicate less than 10 volts when measured between terminals 2 and 3 when the contactor is closed during operation.

## CONTACTORS

The **FORWARD** and **REVERSE** contactor assemblies control the direction of current flow through each traction motor. 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. A suppressor is part of each coil. The contactors in your lift truck can look different than the contactors shown in

# INTRODUCTION

## GENERAL

**NOTE:** This section does **NOT** include the EV–100/200 ‘‘**LX**’’ Series of motor controllers. However, the basic operation and most components are the same. See the section **EV–100/200 LX SERIES DIAGNOSTIC MOTOR CONTROLLER AND HAND SET, 2200 SRM 460** for the ‘‘**LX**’’ Series controllers.

This section describes the procedures for troubleshooting the EV–100 motor controller. The EV–100 motor controller is used, with modifications, in several series of lift trucks. Other information can be found in the following sections:

**EV–100 MOTOR CONTROLLER, REPAIRS AND ADJUSTMENTS, 2200 SRM 288** describes the repairs and adjustments of the EV100 controller and the control switches.

**EV–100 MOTOR CONTROLLER, DESCRIPTION AND OPERATION, 2200 SRM 287** describes the circuits and operation of the EV–100 controller.

**DIAGRAMS**. Circuit diagrams and details for the electrical system. There is a separate **DIAGRAMS** section printed for each series of electric lift truck.

This section is separated into the following parts:

- SRO And PMT Circuits (traction circuit). A short description of the SRO and PMT circuits and the sequence of operation of the controller is used as an introduction to Troubleshooting. The functions and operations of the SRO and PMT circuits must be understood before doing the troubleshooting procedures.
- Troubleshooting (traction circuit without regenerative braking). General procedures and fault analysis.
- Troubleshooting (traction circuit with regenerative braking). General procedures and fault analysis.
- Troubleshooting for lift trucks with an SCR controller for the hydraulic pump motor. General procedures and fault analysis.

Some lift trucks have a second EV–100 controller to control the speed of the hydraulic pump motor. Both controllers are found on the same control panel and use the same principles of operation. The controller for the hydraulic pump motor only controls the motor speed and does not have the other functions necessary for controlling the traction motor. A Troubleshooting guide is included in this section for this controller. Lift trucks that do not have an EV–100 controller for the hydraulic pump motor, have a contactor for motor control.

WHEN YOU NEED HELP. Call a Hyster lift truck dealer if you have correctly followed a fault procedure and have not found the fault. This section describes the most common faults that sometimes occur in the EV–100 controller. Hyster dealers can call Service Engineers who can help you check and repair a fault that is not common.

**NOTE:** The configuration of the controller was changed during November 1987. The operation of the controller is still the same, but some power connections and the location of some contactors were changed. All of the components are on a base plate mount in the earlier configuration. The later configuration divides the base plate into three groups:

- traction controller group
- contactor group
- controller group for the hydraulic pump.

(If the SCR controller for the hydraulic pump is not used, a single contactor for the hydraulic pump is installed in that position.)

The three groups of components are fastened to the rear plate of the battery compartment. FIGURE 1. shows a typical controller in the newer configuration. FIGURE 2. shows the configuration of the earlier manufacture.

# LIFT TRUCKS WITHOUT REGENERATIVE BRAKING

From 1.12

1.14 Turn the key switch to OFF and connect wire 57A at terminal TB2. Check the SRO circuit. Turn the key switch to ON and close the seat switch. Do not step on the accelerator (Monotrol) pedal. Check for battery voltage at TB5 and TB6. (If there is battery voltage at TB5 or TB6 before TB3, the SRO circuit will not permit the operation of the lift truck.)

1.15 Battery voltage at TB5 or TB6 when the pedal is up. Adjust or repair the direction switches.

1.16 No voltage at TB5 or TB6. SRO circuit operates correctly. Check the forward direction switch. Set the controls to operate in the Forward direction, and close the start switch. Check for battery voltage at TB5.

1.17 No voltage at TB5. Repair or adjust the direction switches.

1.18 Check the PMT electronic driver. Check for 1.0 to 2.0 volts at terminal 1 (wire 24) of the PMT electronic driver.

1.19 No signal voltage to the PMT electronic driver. Check the wire and plug connections. If the wire and plug connections are good, replace the control card.

1.20 Signal voltage (1.0 to 2.0 volts) is correct at terminal 1 of the PMT electronic driver. Check for battery voltage at terminal 4 of the PMT electronic driver.

1.21 No voltage at terminal 4. Check the coil and wires for the forward contactor. Do necessary repairs.

1.22 Battery voltage is correct at terminal 4. Check that wire 13A is connected to terminal 2 of the PMT electronic driver. If the wires are correct, replace the PMT electronic driver.

1.23 If the lift truck still has a fault at this step, check that you are using the correct fault description. Check that you have made the tests described in the troubleshooting steps. Call your Hyster lift truck dealer for other recommendations.

## LIFT TRUCKS EQUIPPED WITH REGENERATIVE BRAKING

# RAISE DRIVE WHEELS

**FAULT NUMBER 2R. Lift Truck Will Not Move In Either Direction. The Direction Contactors Never Close. The Regenerative Braking Contactor Closes.**

Possible Causes:

- Short–circuit across SCR 1
- Short–circuit or open circuit in the control circuit
- Faulty switch in the control circuit (possible SRO function)
- Control card is faulty
- Faulty timer module
- 1A contacts welded closed
- PMT electronic driver is faulty
- Brown wire to PC2 is open

2.0R Check for a short–circuit across SCR 1. Turn the key switch to ON. Check for a short–circuit across SCR 1. Measure the voltage between the anode and cathode of SCR 1. (Put the (+) probe on the anode and the (–) probe on the cathode.) The correct voltage is approximately battery voltage.

2.1R No voltage across SCR 1. Disconnect the battery and discharge the capacitor C1. Check that the 1A contacts are not welded together. Repair or replace a faulty contactor 1A.

2.2R Check SCR 1 and D3 for a short–circuit.

2.3R Replace a faulty SCR 1 or D3. If SCR 1 is faulty, make sure you check D3. A faulty D3 can damage SCR 1.

**NOTE:** The operation of the regenerative braking contactor indicates that the control card is receiving battery power and the circuit for the regenerative braking contactor is operating.

2.4R Disconnect the battery. Disconnect wire 57A at TB2. Connect the battery, turn the key switch to ON, close the seat switch and set the controls to operate in the Forward direction, and close the start switch. Check for battery voltage on wire 57A.

**NOTE:** Wire 57A must be disconnected from TB2 or the check for battery voltage will not correctly indicate if the circuit through the brake switch and the start switch has a problem. TB2 and TB3 are connected through a 7.3k ohm resistor in the control card.

2.5R No voltage on wire 57A. Check the start switch, brake switch, and the wire to the key switch. Repair or adjust as necessary.

To 2.6R

# RAISE DRIVE WHEELS

**FAULT NUMBER 8R. Contactor 1a Will Not Energize. The Other Operations Of The Lift Truck Are Normal.**

Possible Causes:

- Control card is faulty or needs adjustment
- Contactor 1A is faulty
- 1A electronic driver is faulty
- Accelerator potentiometer is faulty or needs adjustment

8.0R Disconnect the battery and separate the connector. Check the adjustments on the control card.

8.1R Set the adjustments according the specifications for the lift truck for which you are making repairs. The operation of the lift truck will not be correct if any of the sensor wires are disconnected.

8.2R Connect the battery and turn the key switch to the ON position. Set the controls so that the lift truck will normally operate. Check the adjustment of the accelerator potentiometer. Measure the voltage between TB1 and battery negative. The correct voltage is 3.50 to 3.68 volts at creep and decreases smoothly to 0.0 to 0.2 volts when the accelerator is moved to maximum speed. The 1A contactor is normally energized at less than 0.5 volts.

8.3R The voltage at TB1 is wrong. Check the linkage and the adjustment o f the accelerator potentiometer. If the voltage does not decrease smoothly between creep and maximum speed, replace the accelerator potentiometer. This signal voltage must decrease to less than 0.5 volts before the control card will permit the contactor 1A to close.

8.4R The voltage at TB1 decreases correctly. Check the voltage at terminal 1 of the 1A electronic driver when the voltage at TB1 has decreased to less than 0.5 volts.

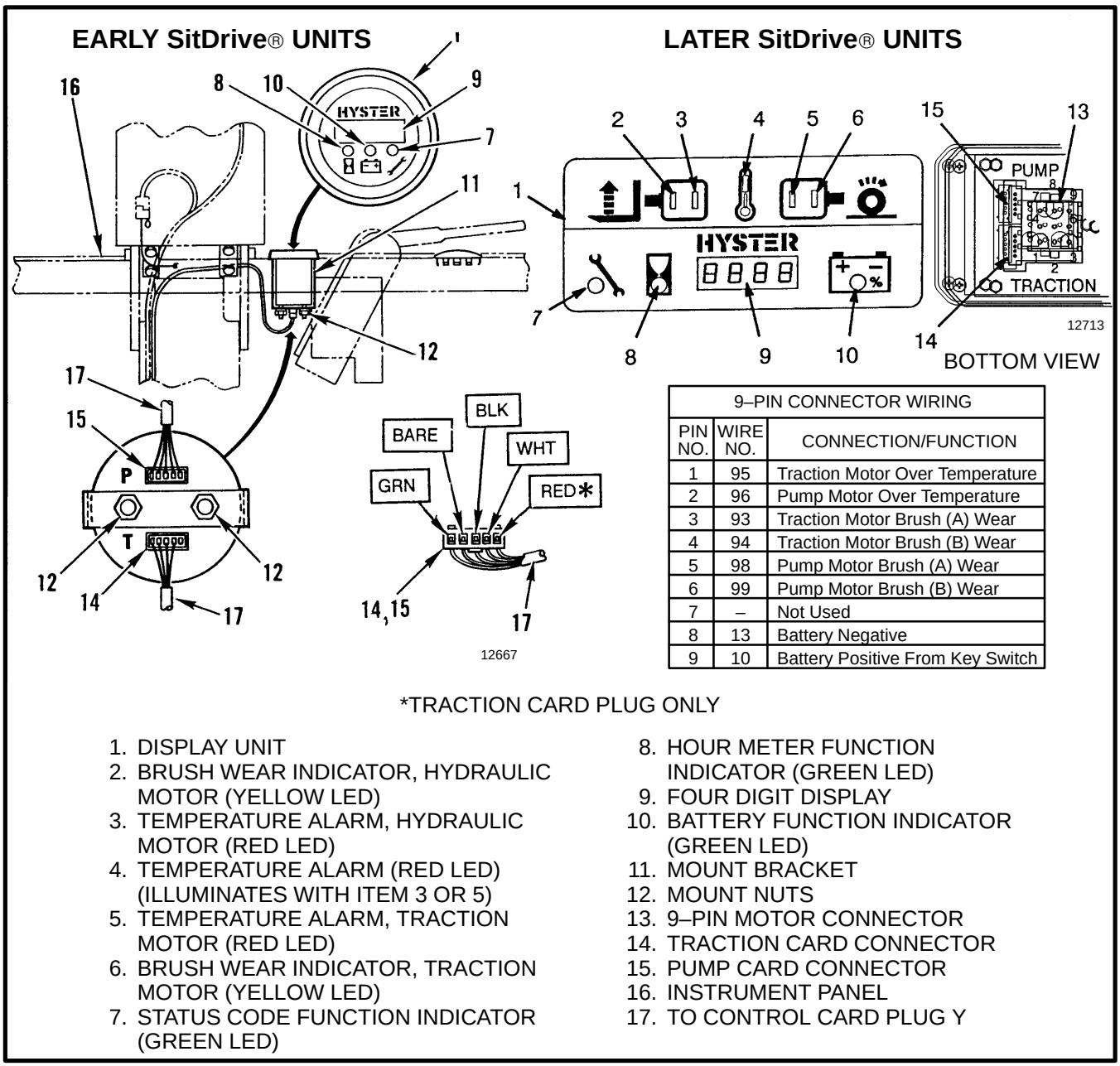
8.5R The voltage at terminal 1 of the 1A electronic driver is less than 1.0 to 2.0 volts. The control card is faulty, replace the control card.

8.6R 1.0 to 2.0 volts at terminal 1 of the 1A electronic driver. Check for battery voltage between terminal 3 of the 1A electronic driver and battery negative.

8.7R There is battery voltage across the electronic driver. Disconnect the battery and replace the 1A electronic driver.

8.8R No battery voltage across the 1A electronic driver. Check for battery voltage at the positive terminal of the coil for the 1A contactor.

8.9R Battery voltage at the positive terminal of the coil for the contactor 1A. Replace the coil or repair any bad connections.




| 9–PIN CONNECTOR WIRING | | |
|---|---|---|
| PIN NO. | WIRE NO. | CONNECTION/FUNCTION |
| 1 | 95 | Traction Motor Over Temperature |
| 2 | 96 | Pump Motor Over Temperature |
| 3 | 93 | Traction Motor Brush (A) Wear |
| 4 | 94 | Traction Motor Brush (B) Wear |
| 5 | 98 | Pump Motor Brush (A) Wear |
| 6 | 99 | Pump Motor Brush (B) Wear |
| 7 | – | Not Used |
| 8 | 13 | Battery Negative |
| 9 | 10 | Battery Positive From Key Switch |

*TRACTION CARD PLUG ONLY

1. DISPLAY UNIT
2. BRUSH WEAR INDICATOR, HYDRAULIC MOTOR (YELLOW LED)
3. TEMPERATURE ALARM, HYDRAULIC MOTOR (RED LED)
4. TEMPERATURE ALARM (RED LED) (ILLUMINATES WITH ITEM 3 OR 5)
5. TEMPERATURE ALARM, TRACTION MOTOR (RED LED)
6. BRUSH WEAR INDICATOR, TRACTION MOTOR (YELLOW LED)
7. STATUS CODE FUNCTION INDICATOR (GREEN LED)
8. HOUR METER FUNCTION INDICATOR (GREEN LED)
9. FOUR DIGIT DISPLAY
10. BATTERY FUNCTION INDICATOR (GREEN LED)
11. MOUNT BRACKET
12. MOUNT NUTS
13. 9–PIN MOTOR CONNECTOR
14. TRACTION CARD CONNECTOR
15. PUMP CARD CONNECTOR
16. INSTRUMENT PANEL
17. TO CONTROL CARD PLUG Y

FIGURE 2. INSTRUMENT PANEL DISPLAY

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

## CONTROL CARD CONNECTIONS

All connections between the control card or control cards and any other electrical component are made at the edge of the card. See FIGURE 3. These connections are made at the four connector plugs: Plug A (PA 1 through 6), Plug B (PB 1 through 6), Plug Y (PY 1 through 14) or Plug Z (PZ 1 through 14). There are also six screw terminals for connections (TB 1 through 6).

Plugs A and B and the screw terminals have some of the same function as on the earlier EV–100 and EV–200 control cards. The Plug Z has basically the same connections as the Plug C on the earlier (before “LX”) control

**FUNCTION 2 CREEP SPEED (Push 2)**

This function permits the adjustment of the creep speed of the lift truck. The range of adjustment is from 0 (5%) to 255 (15%). The percent values are the SCR 1 ON TIME. A constant creep speed frequency will be maintained when the accelerator input voltage is between 3.7 and 3.5 volts (an ohm value between 6K and 4.7K ohms).

**FUNCTION 3 CONTROLLED ACCELER–ATION AND 1A TIME (Push 3)**

This function permits the adjustment of 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 will stay in SCR acceleration for between 0.77 second (8) and 21.5 seconds (255) before the 1A contactor will close. The numbers in () are the setting numbers for the times shown. The 1A contactor will automatically close 0.2 second after the controlled acceleration stops. The speed control input is less than 0.5 volt (accelerator potentiometer set at less than 50 ohms). Do not adjust the function for a setting less than the minimum setting of 8.

**FUNCTION 4 CURRENT LIMIT (Push 4)**

This function permits the adjustment of the current limit of the control. The rating of the control will determine the range of adjustment for this function. See Table 7, 8, 10, 11, 12, 14, 15, 18 or 19. Do not adjust the setting to any number other than the factory setting.

**FUNCTION 5 PLUGGING DISTANCE (CURRENT) (Push 5)**

This function permits the adjustment of the distance it takes to stop the lift truck when plugging by controlling the current. Settings of higher numbers makes the lift truck stop faster. Lower numbers decreases the stopping rate for a longer stopping distance.

## ⚠ CAUTION

**Traction motor or controller damage will occur if the setting is above the maximum setting of Table 7, 8, 10, 11, 12, 14, 15, 18 or 19.**

The number for the setting for the current value of this function must be found if the Pedal Position Plug (Function 16) will not be used. To find the number for the current value, use the following information:

| | |
|---|---|
| Range | 200 to 1000 amps (EV–100)<br>300 to 1500 amps (EV–200) |
| Setting Range | 0 to 255 |
| Resolution | 3.14 amps per set unit (EV–100)<br>4.7 amps per set unit (EV–200) |

Example: Setting of 20=263A (EV–100)
20 x 3.14A = 62.8A or 63A
63A + 200A (range min) = 263A

**FUNCTION 6 1A DROP OUT CURRENT (Push 6)**

This function permits the adjustment of the setting for the current value at which the 1A contactor will deenergize (open). The 1A contactor will open and the motor torque will be limited to SCR current to prevent motor currents that are too high. A setting of 255 will disable the 1A Drop Out.

**FUNCTION 7 FIELD WEAKENING PICK UP (Push 7)**

## ⚠ CAUTION

**A setting HIGHER than the setting shown in Table 10, 14 or 15 will make the Field Weakening Contactor energize too soon. This operation can damage the traction motor.**

This function permits the adjustment of the setting for the current value at which the FW contactor will energize (close). This setting permits the FW contactor to close when the lift truck has returned to approximately 150% of its running current with a full load on a level surface.

**Do NOT set this function to a setting greater than the setting of Function 8.**

**FUNCTION 8 FIELD WEAKENING DROP OUT (Push 8)**

## ⚠ CAUTION

**A setting HIGHER than the setting shown in Table 10, 14 or 15 will make the Field Weakening Contactor remain energized at high currents. This opera-**

TABLE 9. EV–1**00 LXP** FUNCTION VALUE SETTINGS – **E/J1.25–1.75XL (E25–35XL) 36/48V**
(Pump Card)

| FUNCTION | | RECOMMENDATION | | ALLOWED RANGE | |
|---|---|---|---|---|---|
| No. | Description | Factory Setting | Factory Value | Setting Min/Max | Value Min/Max |
| 1 | Stored Status Code | 000[1] | – | 000[1]/255 | – |
| 2 | Internal Resistance Comp. Start | 010 | 65 Amp | 000/255 | 84.5 Amp/1320 Amp |
| 3 | Controlled Acceleration & 1A Time | 010 | 0.31 Sec | 000/050 | 0.1 Sec/1.1 Sec |
| 4 | Current Limit C/L (Lift Relief)<br>Current Limit C/L (Tilt Relief) | 255<br>255 | 375 Amp<br>190 Amp | 255<br>255 | 375 Amp<br>190 Amp |
| 7 | Controlled Acceleration Compensation | 015 | – | 015 | 39 Amp[7]/249 Amp[8] |
| 11 | Speed Limit 1 (Max mtr, V w/NO sw cl) | 035 | 13%Batt V | 035/064 | 13%/24% Batt Volts |
| 12 | Speed Limit 2 (Max mtr, V w/NO sw cl) | 055 | 21%Batt V | 035/064 | 13%/24% Batt Volts |
| 13 | Speed Limit 3 (Max mtr, V w/NO sw cl) | 255 | 100%Batt V | 305/255 | 13%/100% Batt Volts |
| 14 | Speed Limit 4 (Max mtr, V w/NO sw cl) | 180 | 100%Batt V | 305/255 | 13%/100% Batt Volts |
| 16 | Internal Resistance Compensation | 010[3] | 2.28V | 010/025 | – |
| 17 | Card Type Selection | 065 | – | 063/071 | HI with BDI |

[1] Any number other than “zero” can be read as a possible fault.
[3] Average value for most batteries. See procedure for a more accurate value.
[7] Open center current (newer card only). Older card value is 44 Amp.
[8] Current at relief (newer card only). Older card value is 226 Amp..

**NOTE:** There are no functions 5, 6, 8 through 10, 15 or 18 for the Pump Card. Settings for these functions have no effect on operation.

TABLE 19. EV–100 **LX** FUNCTION VALUE SETTINGS – **R30E/EA/EF**
(Traction Card)

| FUNCTION | | RECOMMENDATION | | ALLOWED RANGE | |
|---|---|---|---|---|---|
| No. | Description | Factory Setting | Factory Value | Setting Min/Max | Value Min/Max |
| 1 | Stored Status Code | 000[1] | – | 000[1]/255 | – |
| 2 | Creep Speed | 000 | 5% | 000/255 | 5%/15% |
| 3 | Controlled Acceleration & 1A Time 24V | 025 | 2.2 Sec | 010/255 | 0.94 Sec/21.5 Sec |
| 4 | Current Limit C/L | 255 | 330 Amp | 255 | 330 Amp |
| 5 | Plugging Distance (Current) | 105 | 530 Amp | 000/125 | 200 Amp/592 Amp |
| 6 | 1A Drop Out Current | 000[2] | – | 000[2] | – |
| 7 | Field Weakening Pick Up (Current) | 000[9] | – | 000[9] | – |
| 8 | Field Weakening Drop Out (Current) | 000[9] | – | 000[9] | – |
| 9 | Regen. Braking C/L | 000[9] | – | 000[9] | – |
| 10 | Regen. Start (% ON Time) | 000[9] | – | 000[9] | – |
| 11 | Speed Limit 1 (Max mtr, V w/NC sw open) | 000[9] | – | 000[9] | – |
| 12 | Speed Limit 2 (Max mtr, V w/NC sw open) | 000[9] | – | 000[9] | – |
| 13 | Speed Limit 3 (Max mtr, V w/NC sw open) | 000[9] | – | 000[9] | – |
| 14 | Internal Resistance Compensation | 000[9] | – | 000[9] | – |
| 15 | Battery Volts 24V | 015 | 24 Volts | 000/031 | 24 Volt Operation |
| | Battery Volts 36V | 038 | 36 Volts | 032/044 | 36 Volt Operation |
| 16 | Pedal Position Plug | 040 | 260 Amp | 000/134 | 100Amp/529 Amp |
| 17 | Card Type Selection | 002 | – | 002 | – |
| 18 | Steer Pump Time Delay | 000[7] | – | 000[7] | – |

[1] Any number other than “zero” can be read as a possible fault.
[2] Settings greater than 250 will disable the 1A Drop Out function.
[9] Not used, set to 000 (zero).

# REPAIRS

## GENERAL

**NOTE:** Do **NOT** remove the circuit board from the case when replacing a control card. There are no internal repairs that can be made by service personnel. The control card and case must be replaced as a unit and sent to be repaired.

## ⚠ CAUTION

**ALWAYS replace all of the contactor contacts of a contactor at the same time. Replace the Pump contactor contacts after 1000 hours of operation. Replace other contactor contacts when the thickness of any area of a contact is 30% of the thickness when new or there is any transfer of contact material.**

See the section **EV–100 Repair, 2200 SRM 288** to repair the components of the EV–100 Motor Controllers. See the section **EV–200 MOTOR CONTROLLER, 2200 SRM 414** to repair the components of the EV–200 Motor Controllers.

## CONTROL CARD PLUGS (See FIGURE 5.)

All control card connections are made at plugs A, B, Y or Z or at the six screws of TB terminals. If a wire

| STATUS CODE –25 | DESCRIPTION | MEMORY RECALL | Yes |
|---|---|---|---|
| | 1A contactor does not open or opens slowly. | CIRCUIT | Traction |

## INDICATION OF FAULT

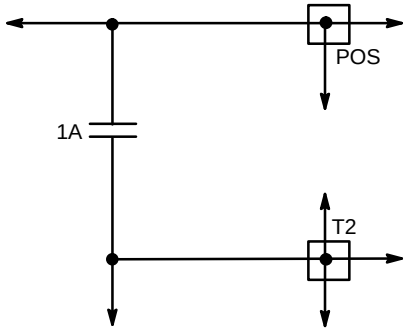
Tips of 1A or Forward and Reverse contactor wear rapidly. Status Code 46 can be on the display, but no fault can be found.

## POSSIBLE CAUSE

**NOTE:** This status code can only be found when the Hand Set is connected. This status code is shown as an additional information for Status Code 46.

Malfunction of 1A contactor

- Check 1A contactor for slow operation as it opens.




## REASON FOR STATUS CODE DISPLAY

This status code is displayed when the 1A contactor takes more than 0.060 second to open.

| STATUS CODE –26 | DESCRIPTION | MEMORY RECALL | Yes |
|---|---|---|---|
| | Electronic driver (in control card) for the 1A, PS, RB or FW contactor has a short–circuit. | CIRCUIT | Traction |

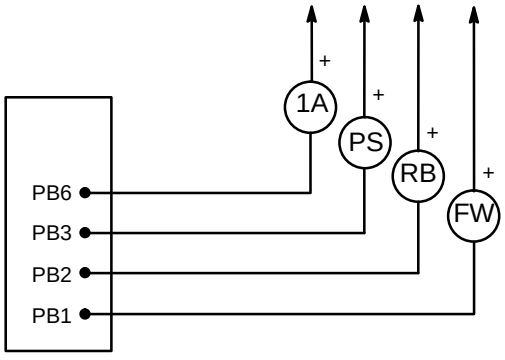
## INDICATION OF FAULT

1A, PS, RB or FW contactor energizes as soon as the key is moved to the ON position.

## POSSIBLE CAUSE

Malfunction of coil driver in control card

- Replace control card.




## REASON FOR STATUS CODE DISPLAY

This status code is displayed when there is a short–circuit in the electronic driver for the 1A, PS, RB or FW contactor.

| STATUS CODE –73 | DESCRIPTION | MEMORY RECALL | Yes |
|---|---|---|---|
| | Regenerative braking contactor does not open or opens slowly. | CIRCUIT | Traction |

## INDICATION OF FAULT

Forward or Reverse contactors deenergize and energize, then will only energize when the key is moved to the Off then ON position.

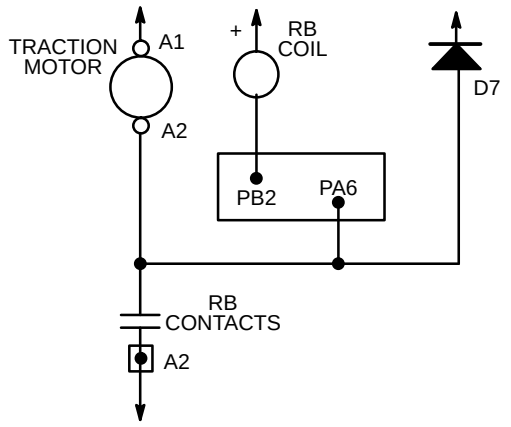
## POSSIBLE CAUSE

RB contactor malfunction.

- Check the RB contactor for smooth operation and wear on the moving parts.

Input signal to PA6 is not regular.

- Check for an open–circuit or loose connections in the PA6 circuit from PA6 to the A2 connection (positive connection) of the RB contactor.




## REASON FOR STATUS CODE DISPLAY

This status code is displayed when the RB contactor does not open within 100 milliseconds after power is removed from the coil.

| STATUS CODE –74 | DESCRIPTION | MEMORY RECALL | Yes |
|---|---|---|---|
| | Regenerative braking contactor closes too slowly. | CIRCUIT | Traction |

## INDICATION OF FAULT

Forward or Reverse contactors deenergize and energize, then will only energize when the key is moved to the Off then ON position.

## POSSIBLE CAUSE

RB contactor malfunction.

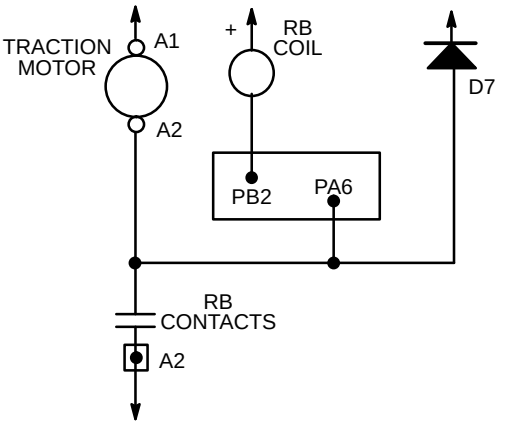
- Check the RB contactor for smooth operation and wear on the moving parts.

Input signal to PA6 is not regular.

- Check for an open–circuit or loose connections in the PA6 circuit from PA6 to the A2 connection (positive connection) of the RB contactor.

RB contactor coil circuit malfunction.

- Check the resistance of the coil for the RB contactor. The correct resistance is 10–14 ohms.
- Check for loose connections from PB2 to the negative side of the RB contactor coil.
- Check for loose connections from battery positive to the positive side of the RB contactor coil.




## REASON FOR STATUS CODE DISPLAY

This status code is displayed when the RB contactor does not close within 100 milliseconds after power is applied to the coil.

| STATUS CODE –150 | DESCRIPTION | MEMORY RECALL | No |
|---|---|---|---|
| | Capacitor C1 (Pump) volts too low. | CIRCUIT | Pump |

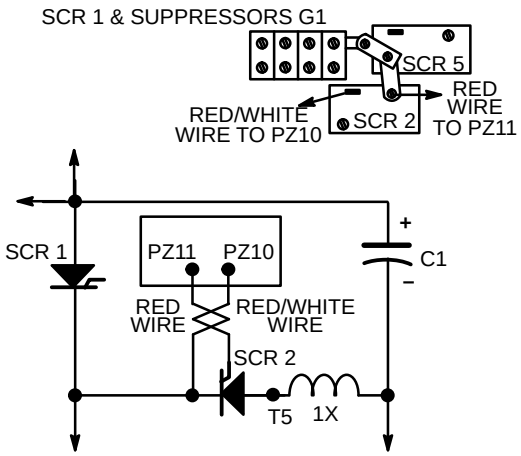
## INDICATION OF FAULT

Hydraulic pump motor will not operate or continues to operate until the battery is disconnected.

## POSSIBLE CAUSE

Malfunction of SCR 2 (Pump) circuit.

- Open circuit or loose connection between suppressor/SCR 1 assembly and SCR 5 (BUS).
- Open circuit or loose connection between SCR 5 and SCR 2 (BUS).
- Open circuit or loose connection between SCR 2 and PZ11 (red wire) or between SCR 2 gate and PZ10 (white/red wire).
- Check SCR 2 to make sure that it will go **ON** with a gate signal.




## REASON FOR STATUS CODE DISPLAY

This status code is displayed when SCR 2 (Pump) does not go **ON** at the beginning of the capacitor charge cycle.

| STATUS CODE –151 | DESCRIPTION | MEMORY RECALL | Yes |
|---|---|---|---|
| | Capacitor C1 (Pump) voltage is too high when motor current is high. | CIRCUIT | Pump |

## INDICATION OF FAULT

Hydraulic pump motor will not operate or continues to operate until the battery is disconnected.

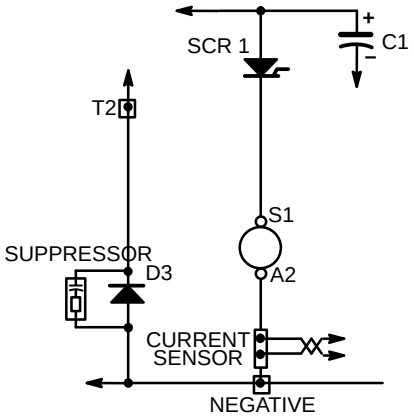
## POSSIBLE CAUSE

Too much inductance from power cables.

- Check for battery cables that are too long.
- Check for attachments that add too many cables or cables that are too long.

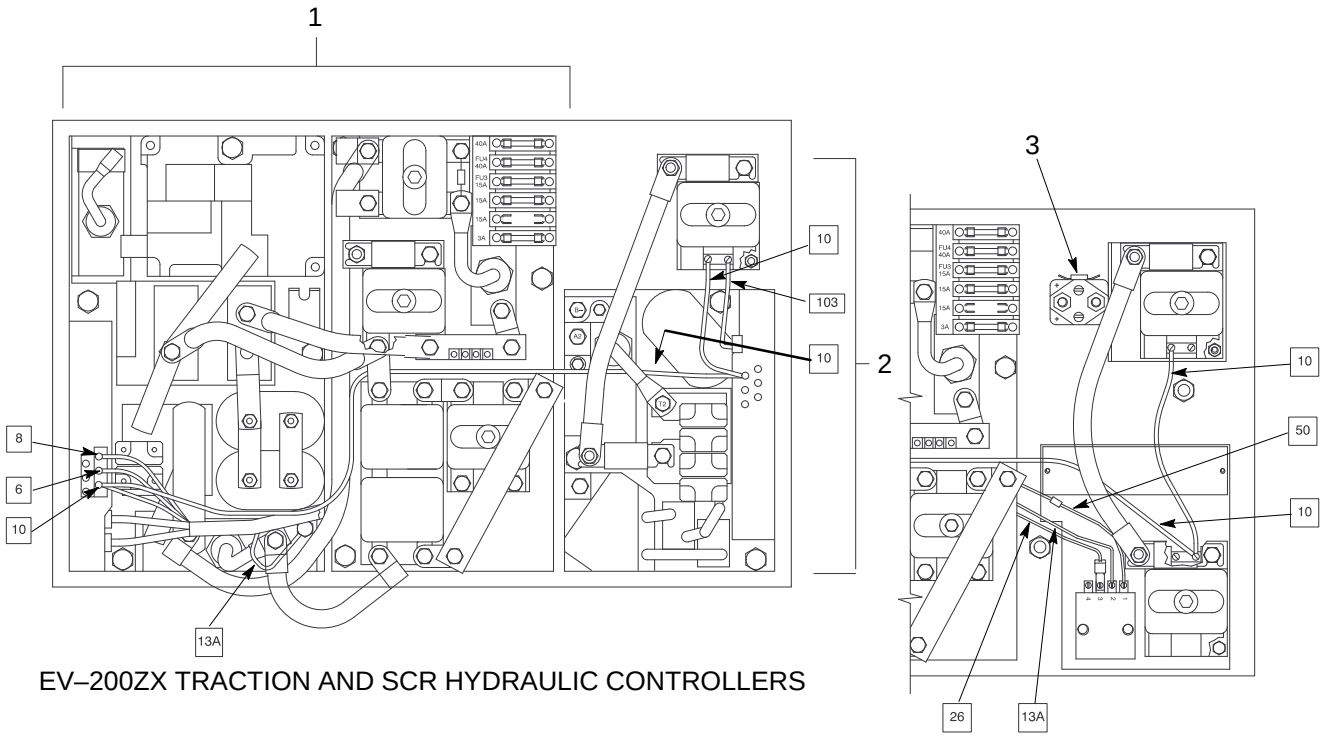
Pump motor current is too high.

- Check for a short–circuit in the field winding.
- Check for a short–circuit in the armature winding.



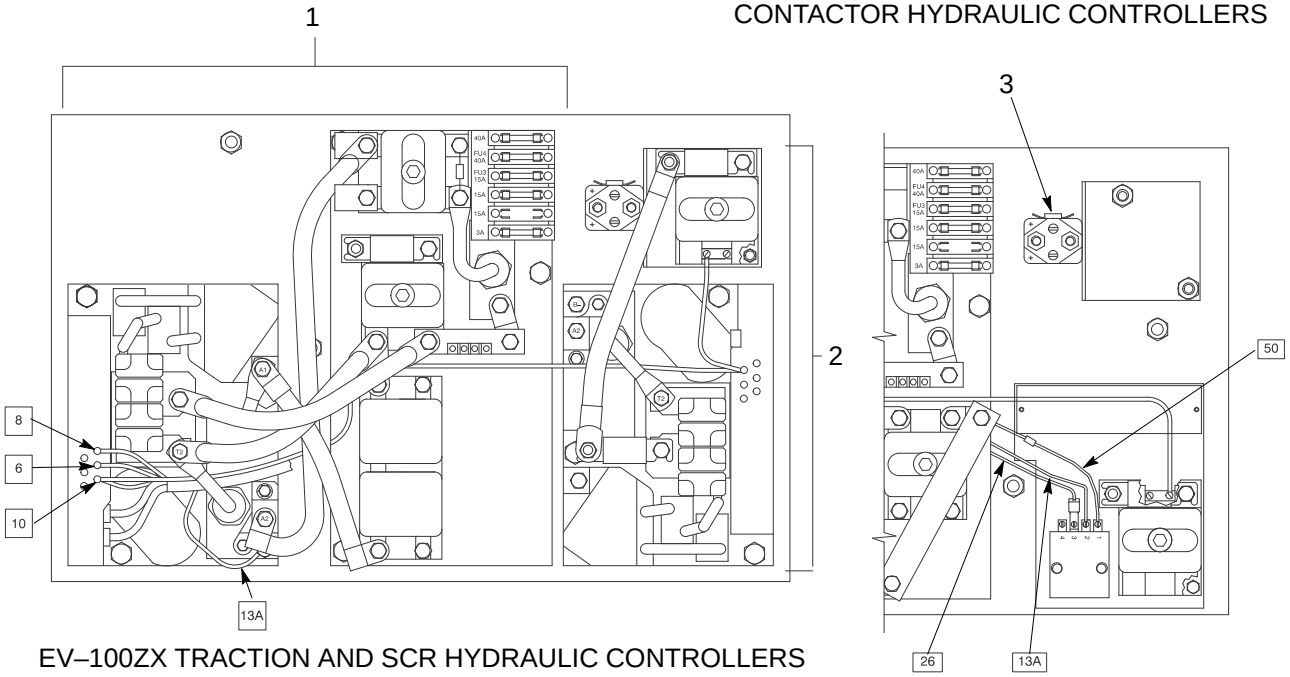

## REASON FOR STATUS CODE DISPLAY

This status code is displayed when the voltage on capacitor C1 (Pump) is more than 225 volts and the motor current is more than 300 amps.




EV–200ZX TRACTION AND SCR HYDRAULIC CONTROLLERS

EV–100 OR EV–200ZX TRACTION AND DUAL CONTACTOR HYDRAULIC CONTROLLERS




EV–100ZX TRACTION AND SCR HYDRAULIC CONTROLLERS

EV–100 OR EV–200ZX TRACTION AND ONE CONTACTOR HYDRAULIC CONTROLLERS

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

Labels that have a combination of numbers and letters are for power cables. Labels that have only numbers are for control wires.

1324927 1/2 R11
Modified

FIGURE 3. CONFIGURATIONS OF THE EV–100ZX OR EV–200ZX SCR MOTOR CONTROLLERS IN THE E3.50–5.50XL (E70–120XL) LIFT TRUCKS

**Function Numbers 1 through 15.**

Push the keypad numbers for the desired register. The register and Hand Set numbers are shown in the **Parameter Tables**.

**Function Numbers 16 through 30.**
**(The seat switch must be open.)**

1. Push the keypad numbers for the desired register. **Think of the CONT key equaling 15. Push and hold the CONT key plus the additional key number above 15 to total the required Hand Set number.**
Example: for Function Number 18, push the **CONT** and key **3** (15+3=18). The display will show the selected register. After one second, the display will show the parameter that has been set in that register.

2. Push and hold the **CONT** key for one second. The display number will blink.

3. To change the parameter, **check for the correct parameter for that register in the Parameter Tables.** Change the parameter by turning the Adjustment Knob on the Hand Set. The display will continue to blink as the number changes.

4. Push and hold the **STORE** key for one second. When the new parameter is set (stored), the display will stop blinking.

5. Push and hold the **ESC** key for one second. The display will show "8888". To check or set another register, do Steps 1 through 3. To return to normal operation (run mode), push and hold **ESC** again for one second or longer. The display will return to the status code mode or display the state of battery charge if the operator is in the seat. The display can also be blank (if there are no status codes and the battery indicator is not installed).

**NOTE:** Make sure the motor controller control is in the run mode before disconnecting the Hand Set. If the motor controller control is not in the run mode, the battery must be disconnected and connected again to reset the system.

The vehicle can now be operated with the Hand Set connected or the Hand Set can be disconnected.

**NOTE:** If the vehicle is operated with the Hand Set connected, **make sure** to set the Adjustment Knob **fully clockwise** to make sure the control can operate at top speed.

Disconnect the plug at connection Y on the control card to disconnect the Hand Set. Connect the plug for the instrument panel display at connection Y.

**Function Numbers 48 through 62. (The seat switch must be closed.)**

1. Turn the key to the **ON** position after the Hand Set is connected to the traction card. Turn the key to the **OFF** position after the Hand Set is connected to the hydraulic pump card.

2. Push the keypad numbers for the desired register. **Think of the CONT key equaling 47. Push and hold the CONT key plus the additional key number above 47 to total the required Hand Set 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 will show the selected register. After one second, the display will show the parameter that has been set in that register.

**NOTE:** HS Numbers 47, 51, 55 and 59 are the registers for the MODE numbers and are not used. Do not try to set these numbers with the Hand Set.

3. Push and hold the **CONT** key for one second. The display number will blink.

4. To change the parameter, **check for the correct parameter for that register in the Parameter Tables.** Change the parameter by turning the Adjustment Knob on the Hand Set. The display will continue to blink as the setting changes.

5. Push and hold the **STORE** key for one second. When the new parameter is set (stored), the display will stop blinking.

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

## 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,

**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.

**Function Number 57**
**SPEED LIMIT 2**
**(Push CONT and 10 while the key switch and seat switch are closed)**

This register permits the adjustment of the speed limit for the hydraulic pump in MODE 3. Do not set the number in the register to less than the parameter for Function Number 53. Do not set the number in the register greater than the number in the register for Function Number 61.

**Function Number 58**
**SPEED LIMIT 3**
**(Push CONT and 11 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. The maximum number in the register is 255.

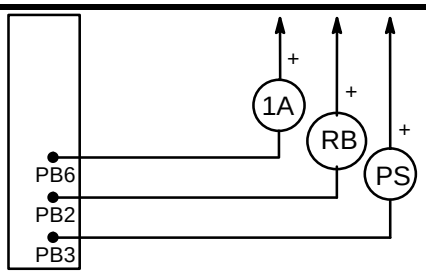
**Function Number 60**
**CONTROLLED ACCELERATION**
**(Push CONT and 13 while the key switch and seat switch are closed)**

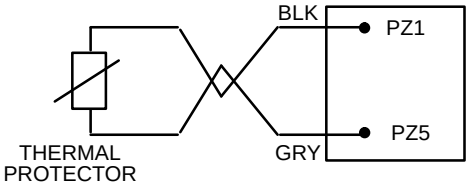
This register permits the adjustment of the maximum rate of acceleration in MODE 4 (Rabbit). The parameter determines the time allowed to reach maximum SCR speed from stop. Do not set the number in the register to less than 8. Do not set the number in the register greater than the number in the register for Function Number 56.

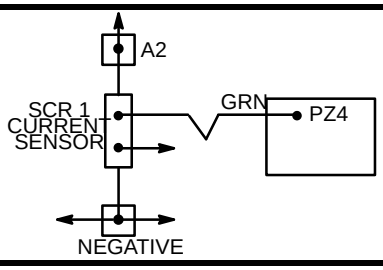
**TABLE 7. REGISTER MAP FOR CONTROL CARD ZP (HYDRAULIC PUMP) (Continued)**

| EEPROM Register Number | PC Function Number | Hand Set (HS) Function Number | Function | Access By: | Restrictions |
|---|---|---|---|---|---|
| 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 | HS or PC | None |
| 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 | HS or PC | None |
| 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 | HS or PC | None |
| 108 | 109 | 60 | Instrument Panel Display CA–4 | HS or PC | None |
| 109 | 110 | 61 | Instrument Panel Display SL2–4 | HS or PC | None |
| 110 | 111 | 62 | Instrument Panel Display SL4–4 | HS or PC | None |
| 111 | 112 | | NOT USED | PC Only | |
| 112 | 113 | | Secure Hourmeter (Tens/Units) | PC Only | Read Only |
| 113 | 114 | | Secure Hourmeter (Thousands/Hundreds) | PC Only | Read Only |
| 114 | 115 | | Secure Auxiliary Hourmeter (Thousands/Hundreds) | PC Only | Read Only |
| 115 | 116 | | Secure Auxiliary Hourmeter (Thousands/Hundreds) | PC Only | Read Only |
| 116 | 117 | | | PC Only | GE Use Only |
| 117 | 118 | | | PC Only | GE Use Only |
| 118 | 119 | | | PC Only | GE Use Only |
| 119 | 120 | | | PC Only | GE Use Only |
| 120 | 121 | | | PC Only | None |
| 121 | 122 | | | PC Only | None |
| 122 | 123 | | | PC Only | None |
| 123 | 124 | | | PC Only | None |
| 124 | 125 | | | PC Only | None |
| 125 | 126 | | | PC Only | None |
| 126 | 127 | | | PC Only | None |
| 127 | 128 | | | PC Only | None |

## Status Code Charts

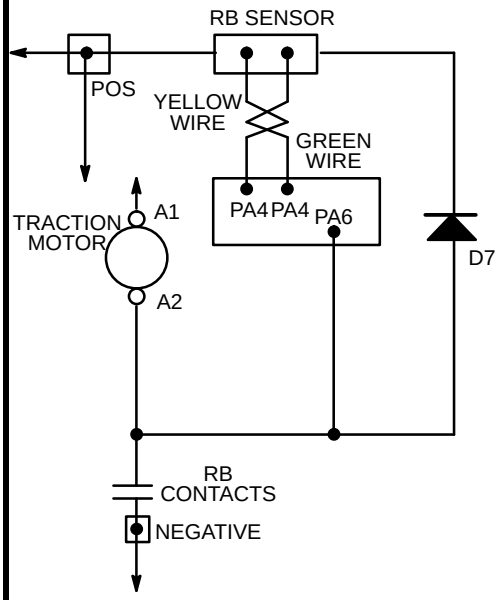
| Status Code | Description | Cause Of Status Indication |
|---|---|---|
| **–26** | Electronic driver in control card for the RB, PS, or FW contactor has a short–circuit. | This Status Code will be indicated when there is a short–circuit in the electronic driver for the 1A, RB, or PS contactor coil. |
| **Memory Recall**<br>Yes<br><br>**Circuit**<br>Traction | **Indication of Fault**<br>The 1A, RB, or PS contactor closes immediately when the key switch is closed.<br>**Possible Cause**<br>Malfunction of an electronic driver in the control card.<br>Replace the control card. |  |

| Status Code | Description | Cause Of Status Indication |
|---|---|---|
| **–41** | Open thermal protector or motor controller is too hot. | This Status Code will be indicated when the voltage between PZ1 and PZ5 is greater 1.8 volts. |
| **Memory Recall**<br>No<br><br>**Circuit**<br>Traction | **Indication of Fault**<br>The traction motor has reduced power on no power in the SCR range.<br>**Possible Cause**<br>Open circuit, thermal protector.<br>Check for a loose or broken wire between the following points:<br>Black wire between thermal protector and PZ1<br>Gray wire between thermal protector and PZ5.<br>Malfunction of thermal protector.<br>Disconnect the wires from PZ1 and PZ5. When the temperature is approximately 25°C (75°F), measure the resistance between the black and gray wire. The correct resistance is approximately 300 ohms.<br>Thermal protector is operating because motor controller is too hot.<br>Permit the motor controller to cool. |  |

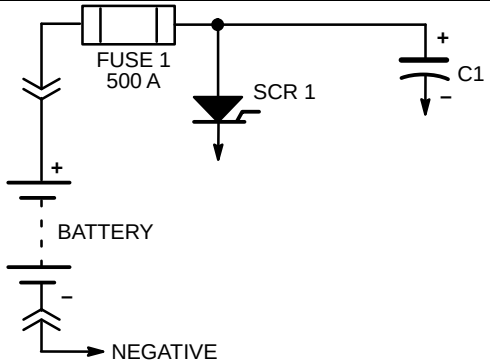
| Status Code | Description | Cause Of Status Indication |
|---|---|---|
| **–42** | Input missing from motor current sensor. | This Status Code will be indicated when the voltage between PY7 and battery negative is greater than 1.6 volts and no current is flowing through the traction motor circuit. |
| **Memory Recall**<br>No<br><br>**Circuit**<br>Traction | **Indication of Fault**<br>No power to the traction motor in the SCR range.<br>**Possible Cause**<br>Open sensor wire circuit to PZ4.<br>Check for a loose or broken wire (green wire) between the current sensor and PZ4 on the control card. |  |

## Status Code Charts

| Status Code | Description | Cause Of Status Indication |
|---|---|---|
| **–75** | SCR 1 does not go **OFF** during regenerative braking. | This Status Code will be indicated when there is any failure of SCR 1 to go **OFF** during regenerative braking. |

| Memory Recall | Indication of Fault | |
|---|---|---|
| Yes | Forward or Reverse contactors open and close, then will only close when the key switch is opened and closed.<br>**Possible Cause**<br>To find if SCR 1 fault is caused by regenerative braking.<br>Cause the traction motor to stall in both directions and check for a new status code that will also indicate the failure. Do Troubleshooting for the new or additional Status Code.<br>If Status Code 75 continues:<br>Check for loose connections on all power circuits for regenerative braking.<br>Check for an open circuit or loose connection in the following input circuits for regenerative braking:<br>Yellow wire from RB sensor to PA4.<br>Green wire from RB Sensor to PA5.<br>Wire 17 from the RB contactor to PA6.<br>Malfunction in motor circuit.<br>Check motor circuit for open or loose connections.<br>Check motor brushes for wear and installed correctly.<br>Check for Forward or Reverse contactors momentarily opening and closing.<br>Check for Forward or Reverse contactors momentarily opening and closing during operation when traveling over bumps and dock plates. |  |
| **Circuit**<br>Traction | | |

| Status Code | Description | Cause Of Status Indication |
|---|---|---|
| **–76** | Voltage on C1 too high during regenerative braking. | This Status Code will be indicated when the voltage on C1 is greater than 225 volts during regenerative braking. |

| Memory Recall | Indication of Fault | |
|---|---|---|
| Yes | Forward or Reverse contactors open and close, then will only close when the key switch is opened and closed.<br>**Possible Cause**<br>Bad connection or not regular connection in battery power circuit.<br>Check battery power circuit for loose connections.<br>Check the power fuse and battery connections that can open during regenerative braking.<br>Too much inductance from cables.<br>Check that the battery cables are too long. |  |
| **Circuit**<br>Traction | | |

## Status Code Charts

| Status Code | Description | Cause Of Status Indication |
|---|---|---|
| **–149** | SCR 5 in the hydraulic pump controller does not go **ON** correctly. | This Status Code will be indicated when SCR 5 does not go **ON** correctly. |

**Memory Recall**

Yes

**Circuit**

Hydraulic Pump

**Indication of Fault**

Hydraulic pump motor will not operate or continues to operate until the battery is disconnected.

**Possible Cause**

Malfunction of SCR 5 circuit.

Check for a short–circuit across SCR 5.

Check for a short–circuit across the suppressor for SCR 5.

Check for a open circuit across SCR 2 or an open gate lead to SCR 5.

Check for an open circuit or a loose connection between SCR 5 and PZ12 (white/purple wire).

Malfunction of SCR 2 circuit.

Check for a short–circuit across SCR 2.

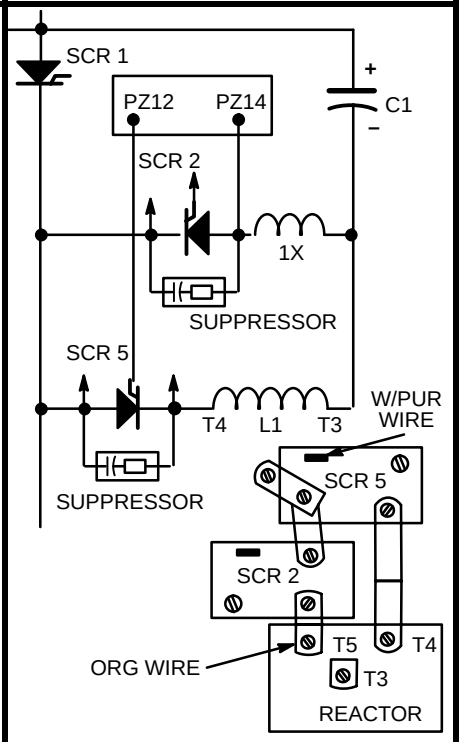
Check for a short–circuit across the suppressor for SCR 2.

Check for a open circuit across SCR 5 or an open gate lead to SCR 2.

Malfunction of C1.

Check for open capacitor C1.

Check for loose connections at capacitor terminals.




| Status Code | Description | Cause Of Status Indication |
|---|---|---|
| **–150** | Low voltage on capacitor C1 in the hydraulic pump motor controller. | This Status Code will be indicated when SCR 2 has a failure and does not go **ON**. |

**Memory Recall**

No

**Circuit**

Hydraulic Pump

**Indication of Fault**

Hydraulic pump motor will not operate or continues to operate until the battery is disconnected.

**Possible Cause**

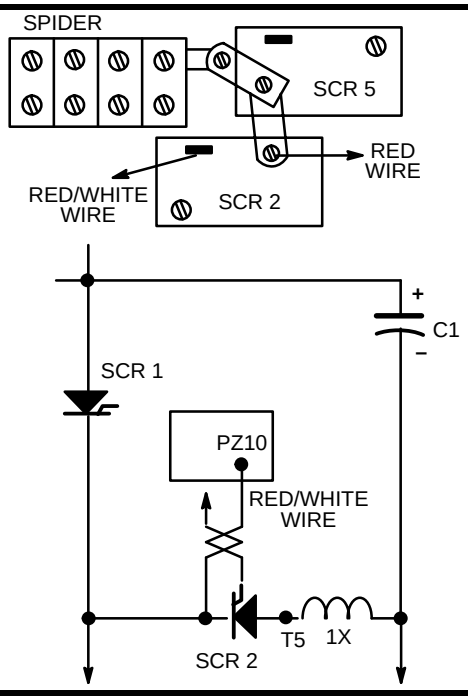
Malfunction of SCR 2 circuit.

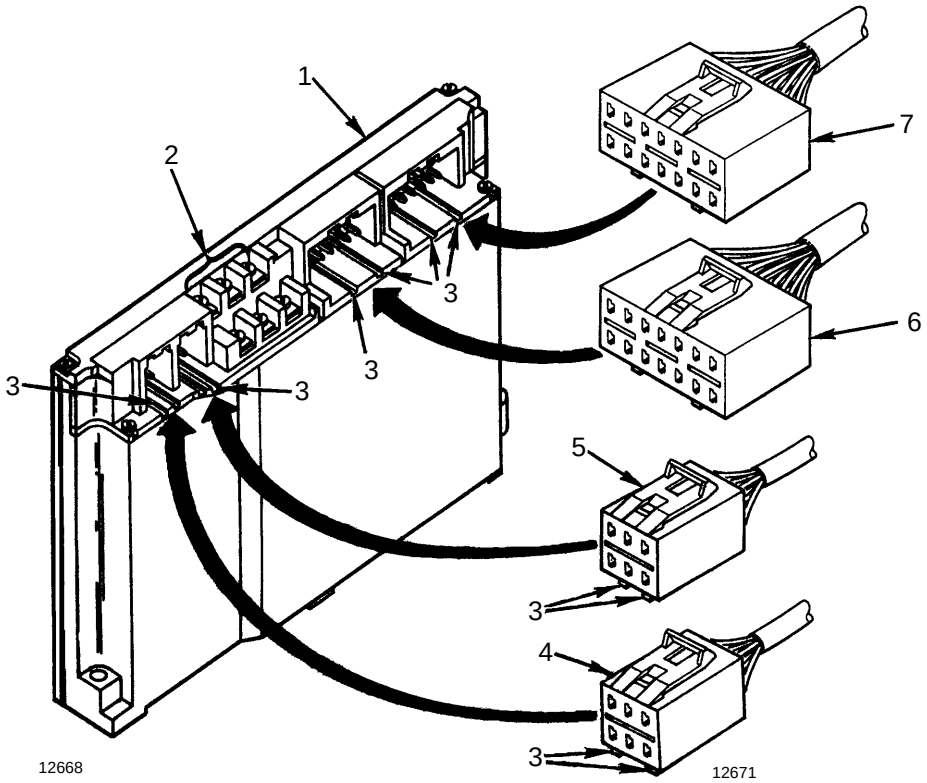
Check for an open circuit or loose connection between spider assembly and SCR 5.

Check for an open circuit or loose connection between SCR 5 and SCR 2.

Check for an open circuit or loose connection between SCR 2 and PZ11 (red wire) and between SCR 2 gate connection and PZ10 (white/red wire).

Check that SCR 2 will go **ON** with a gate signal.






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 9. CONTROL CARD CONNECTIONS

## CONTROL CARD PLUGS (See FIGURE 10.)

All control card connections are made at plugs A, B, Y or Z or at the six screws of TB terminals. If a wire of one of the plugs must be replaced, the operation to remove a pin connector must be done carefully. A special tool (Hyster Part No. 897408), must be used to remove the pin connector from the plug. How the pin connectors are held in the plug is shown in FIGURE 10. Use the tool as shown to release the lock so that the pin connector can be removed from the plug. If a pin connector must be removed, the service person must work carefully so that the pin connectors and the plug are not damaged.

When a new pin connector is installed in the plug, make sure it is not damaged and is locked into the correct position in the plug. If the pin connection becomes loose during operation of the lift truck, the malfunction is not regular and is very difficult to find and repair.

1. PLUG
2. RUBBER SEAL
3. PIN CONNECTOR (REMOVED FROM PLUG)
4. LOCK
5. PIN CONNECTOR (INSTALLED IN PLUG)
6. TOOL (HYSTER PART NO. 897408) (UNLOCKS PIN CONNECTOR FOR REMOVAL)

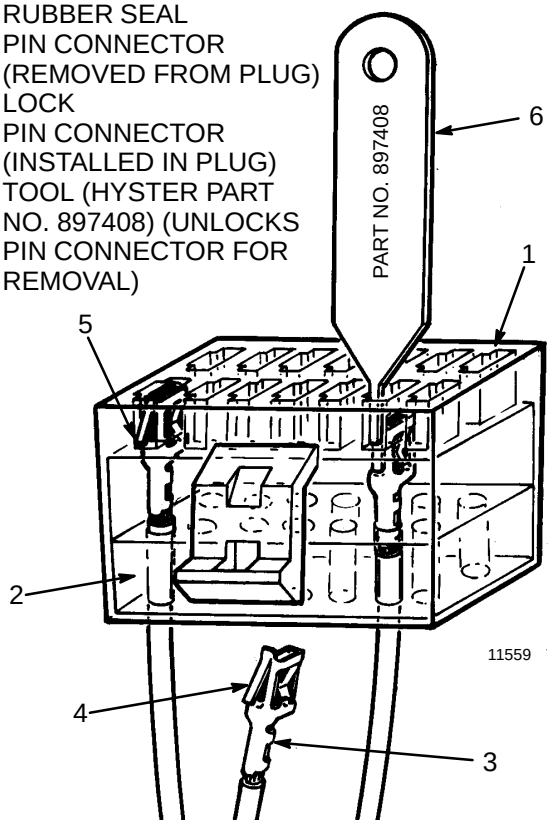
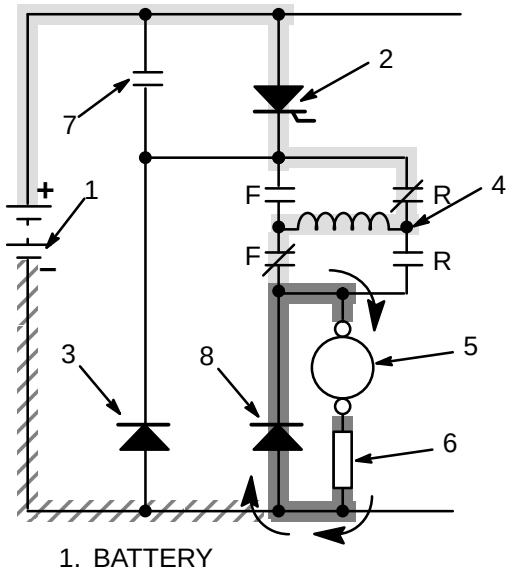



FIGURE 10. CONTROL CARD PLUG

motor and wastes battery energy.) This adjustment also permits smoother operation of the lift truck. The control card begins **1A TIME** when the accelerator voltage is decreased to less than 1.0 volts. **1A TIME** is normally 1 to 3 seconds. The full battery power is available to the traction motor through the 1A circuit after the time delay **1A TIME**.

**"PLUG".** Plugging uses the traction motor as a brake to slow or stop a lift truck. When a lift truck is being stopped, the motion of the lift truck causes the traction motor to rotate and operate like a generator. Plugging uses a current flow from the battery to be opposite the current flow generated by the traction motor. Plugging generates heat in the traction motor.




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 10. PLUGGING CIRCUIT

Plugging is energized when the direction switches in the direction control lever is moved to the opposite direction from which the lift truck is traveling. The direction contactors will 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 will stop 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. 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 will be moving 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:

**REGEN C/L** (Regenerative Braking Current Limit)
**REGEN D.O.** (Regenerative Braking Drop Out)

The "regenerative braking current limit" controls the maximum application of regenerative braking during operation. The position of the accelerator pedal by the operator controls the plugging distance up to the limit set by the **REGEN C/L** adjustment.

status code for the last fault will be indicated on the Status Code Indicator (2). If the key switch is turned to **OFF**, the status code will be removed from the four digit display.

The push button (13) will cause the status codes for the for the faults to be shown on the Status Code Indicator (2). When the button is pushed and held down, the indicator light for the traction motor (8) will illuminate. The status codes in memory for the detected faults will be displayed, starting with the most recent fault. If the push button is released, the display will stop. If the button is pushed again, the display will start from the beginning again. The hourmeter time and the battery charge at the time of the fault will not be shown. A Hand Set or a PC must be used to show this additional information. A Hand Set or a PC must be used to clear the status code from the register.

If the button is pushed twice and then held down, the indicator light for the hydraulic pump motor (9) will illuminate. The status codes in memory for the detected faults will be displayed, starting with the most recent fault. If the push button is released, the display will stop. If the button is pushed twice to start the sequence again, the display will start from the beginning. The hourmeter time and the battery charge at the time of the fault will not be shown. A Hand Set or a PC must be used to show this additional information. A Hand Set or a PC must be used to clear the status code from the register.

There can be 16 status codes in the memory for each system (traction or lift). Push and hold the push button to display all the status codes in the memory for detected faults of the traction system. The Traction Motor Indicator will be **ON** to show that the status codes are for the traction system. If the push button is released then pushed and held again, the digital display will start over showing all the status codes for the traction system. Push the button twice and hold the push button to display all the status codes in the memory for detected faults of the lift system. The Lift Pump Motor Indicator will be **ON** to show that the status codes are for the lift system. If the push button is released then pushed twice and held again, the digital display will start over showing all the status codes for the lift system.

### Brush Wear Indicators

The brush wear indicators illuminate when the motor brushes must be replaced. The sensor wires for the brush wear indicators are an insert in the brush material when it is made. The sensor wires are insulated from the brush material. When the brush wears within approximately 1.5 mm (0.060 in) of the brush lead, the insulation between the sensor wire and the brush material is destroyed. The connection between the brush and the sensor wire causes the indicator to illuminate.

The operation of the brush wear indicators can be checked during periodic maintenance. The battery must be removed from the lift truck for access to the motors.

| Type ZH (72 to 80V) (Continued) | | Default | | Permitted Range | |
|---|---|---|---|---|---|
| **Fcn. No.** | **Description** | **Factory Parameter** | **Factory Value** | **Min/Max Parameter** | **Value (Min/Max)** |
| 20 | Maintenance Alert (hours) | 99 | | | 100 to 9900 |
| 21 | Maintenance Speed Limit | 0 | None | None/0 | None to 180 |
| 22 | Mode Reference (Reference register for the instrument panel display when the battery is connected.) | — | None | None | — |
| 23 | Hourmeter (minutes) | 0 | | | |
| 24 | Hourmeter (seconds) | 0 | | | |
| 25 | Monitor Register | 0 | — | None | (Temporary storage register.) |
| 26 | Monitor Register | 0 | — | None | (Temporary storage register.) |
| 27 | Battery Volts Data | — | — | None | (Temporary storage register for battery voltage data.) |
| 28 | Fault Count Pointer<br>(Must be reset to zero to clear Status Codes) | — | — | None | (Temporary storage register that points to location of last recorded fault.) |
| 29 | Set Hourmeter (tens/units) | 0 | 0 | | 0–99 |
| 30 | Set Hourmeter (thousands/hundreds) | 0 | 0 | | 100 to 9900 |

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

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

| **Fcn. No.** | | | | Minimum Parameter | Maximum Parameter |
|---|---|---|---|---|---|
| | MODE 1 | | | | |
| 48 | Controlled Acceleration | 40 | 3.5 sec | Fcn. No. 52 | 255 |
| 49 | FW Pick–Up Current | 0 | None | 0 | Fcn. No. 53 |
| 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 Pick–Up Current | 0 | None | Fcn. No. 49 | Fcn. No. 57 |
| 54 | Speed Limit 1 | 0 | None | Fcn. No. 58 | Fcn. No. 50 |
| 55 | Not Used | | | | |

| Type ZP (36 to 48 volts) | | Default | | Permitted Range | |
|---|---|---|---|---|---|
| **Fcn. No.** | **Description** | **Factory Parameter** | **Factory Value** | **Min/Max Parameter** | **Value (Min/Max)** |
| | MODE 4 | | | | |
| 60 | Controlled Acceleration | 25 | | 25 (0.52 sec) | 150 (3.1 sec) |
| 61 | Speed Limit 2 | 70 | 26 volts | 30 (11 volts) | 70 (26 volts) |
| 62 | Speed Limit 3 | 255 | Maximum volts | 30 (11 volts) | 255 (Maximum volts) |
| The following registers store information used by the controller and the HYTECH software and do not have function numbers assigned. | | | | | |
| | Not Used | | | | |
| | Secure Hourmeter (tens/units) | | | | Read Only |
| | Secure Hourmeter (thousands/hundreds) | | | | Read Only |
| | Secure Auxiliary Hourmeter (tens/units) | | | | Read Only |
| | Secure Auxiliary Hourmeter (thousands/hundreds) | | | | Read Only |
| | Reserved for use by GE | | | | GE Use Only |
| | Reserved for use by GE | | | | GE Use Only |
| | Reserved for use by GE | | | | GE Use Only |
| | Reserved for use by GE | | | | GE Use Only |
| | Lift Truck Serial Number | | | | |
| | Lift Truck Serial Number | | | | |
| | Lift Truck Serial Number | | | | |
| | Lift Truck Serial Number | | | | |
| | Lift Truck Serial Number | | | | |
| | Lift Truck Serial Number | | | | |
| | Lift truck number assigned by user | | | | |
| | Lift truck number assigned by user | | | | |

The columns show the following information:

`Function` indicates the data register shown in the Parameter Tables.

*Function Name*

This column indicates the name of the parameter that can be checked or adjusted.

*Card*

This column indicates the current parameter set in the register. The software prevents parameters less than the minimum (*Min*) or greater than the maximum (*Max*) to be entered into the registers.

*Value*

This column indicates the actual value that the Card number represents.

*Min*

This column indicates the minimum parameter number that the can be set in the register.

*Fac*(Factory)

This column indicates the parameter number that was set in the controller at the factory when the lift truck was manufactured.

**NOTE:** If the parameters shown in the Default columns of the Parameter Tables are different than indicated by the software, always use the parameters shown by the software. Contact your dealer for Hyster lift trucks if your version of the software is not correct.

*Max*

This column indicates the maximum parameter number that the can be set in the register.

**NOTE:** An attempt to enter a parameter outside of the permitted range causes an *Error* dialogue box to be displayed with the message *Value Out of Range* Select *OK* to close Error notice.

The functions indicated at the bottom of the Card Register List screen do the following operations:

*F1 Help*

This function displays the *Help* dialogue box for the screen in use. Press Esc to close the Help screen.

*Alt F3 Close*

This closes the register list. After the current parameters of the control card are shown on the PC screen the screen displays *SAVE Yes No.*

*Alt F4*

This function changes the values in the register list to the factory default settings.

*Alt-S Save*

This function allows the present control card settings to be saved to a file that can be loaded at a later time. Pressing *Alt-S* displays the *Save Settings* dialogue box. See FIGURE 9.

### How To Enter A New Parameter

Use either the Arrow keys or the PgUp and PgDn keys to scroll through the list. Press Enter to select the parameter to be changed and the *Change Register Value* dialogue box is displayed. The `Change Register Value` dialogue box shows the name of the function selected in the upper right hand corner of the box. Make sure that this is the function that you want to change. See FIGURE 8. Enter the new values and select `OK` to make the change.

8. The main Control Status Monitor screen shows six columns and sixteen rows 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 last reset.

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

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

### How To Reset The MIN and MAX Display

When the Control Status Monitor screen is shown, press the R key on the keyboard and the display of the MAXIMUM and MINIMUM columns are reset. New maximum and minimum levels are then recorded.

When the 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 card and also record the MAXIMUM and MINIMUM of the selected functions.

### How To Exit The GE SENTRY Program

When the Control Status Monitor screen is shown and the key switch is in the **ON** position, press the ESCAPE key. If the key switch is turned to OFF, the GE SENTRY program is automatically terminated.

operation, so a resistor is added in series with the coil on 48–volt lift trucks to reduce the voltage. The same electronic driver used for the other contactors is used with the regenerative braking contactor.

The resistor in series with the coil is installed in all 36–48 volt controllers. Two wires are connected to the coil when the controller is received from the manufacturer. One wire is from the resistor and the second wire is a by–pass around the resistor. If the controller is installed in a lift truck with a 48 volt battery, the by–pass wire is disconnected. If the controller is installed in a lift truck with a 36 volt battery, both wires stay connected and the resistor does not function.

The electronic driver used for the **FORWARD, REVERSE,** and **1A** contactors has the following part number:
1C3645CPM1RDA2 (for 36–48 volt service)

The access to the electronic drivers on the bottom of the stack is difficult. Remove the two mounting screws and separate the drivers as necessary for access to the terminals.

### ⚠ CAUTION

**Make sure you disconnect the battery when you separate or connect the electronic drivers. Do not cause a short–circuit.**

The electronic driver modules are most easily checked in the lift truck. Raise the drive wheels from the floor. Connect the battery. Set the controls of the lift truck so that the electronic driver you are checking will operate. Check that there is an input signal on terminal 1 of 1.0–2.0 volts.

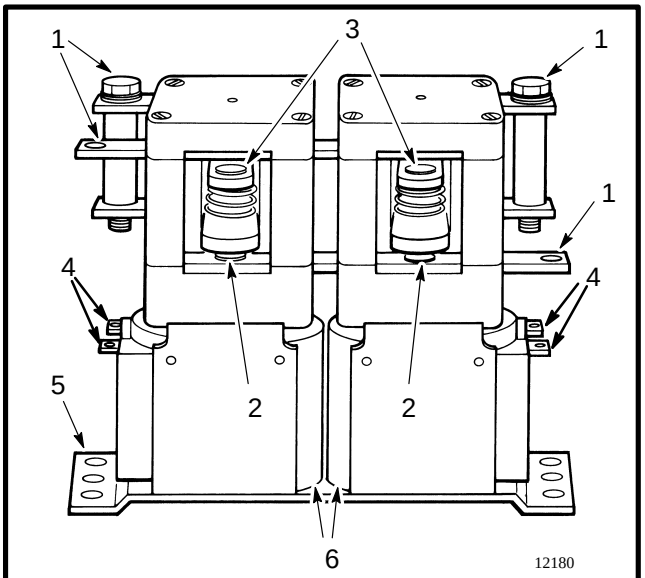
If there is 1.0–2.0 volts at terminal 1 of the electronic driver, check for approximately battery voltage between battery negative and terminal 3 or terminal 4. If there is approximately battery voltage, the electronic driver has a defect. A good electronic driver will indicate less than 10 volts when measured between terminals 2 and 3 when the contactor is closed during operation.

## CONTACTORS

The **FORWARD** and **REVERSE** contactor assemblies control the direction of current flow through each traction motor. 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. A suppressor is part of each coil. The contactors in your lift truck can look different than the contactors shown in FIGURE 12. but the operation will be similar.

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 deenergized. The only condition where the contacts open during a large current flow is PMT.

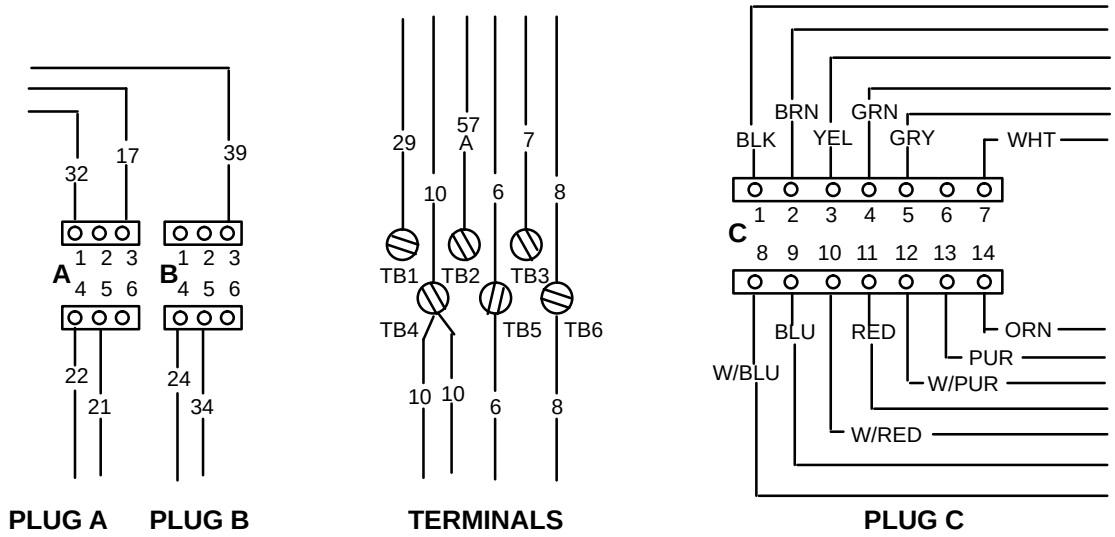



1. POWER TERMINALS
2. NC CONTACTS
3. NO CONTACTS
4. COIL TERMINALS
5. MOUNT BRACKET
6. COIL (THE SUPPRESSOR IS ADDED TO THE OUTSIDE OF THE COIL.)

FIGURE 11. CONTACTOR PARTS

**NOTE:** The other contactors (1A, field weakening, and regenerative braking) are like the design of the **FORWARD** and **REVERSE** contactors except they are single units and have only one set of NO contacts. When the lift truck does not have an SCR controller for the hydraulic pump, the hydraulic pump contactor also has one set of NO contacts.

TABLE 7. TERMINAL AND PIN ARRANGEMENT FOR THE EV–200 CONTROL CARD (TRACTION CIRCUIT)



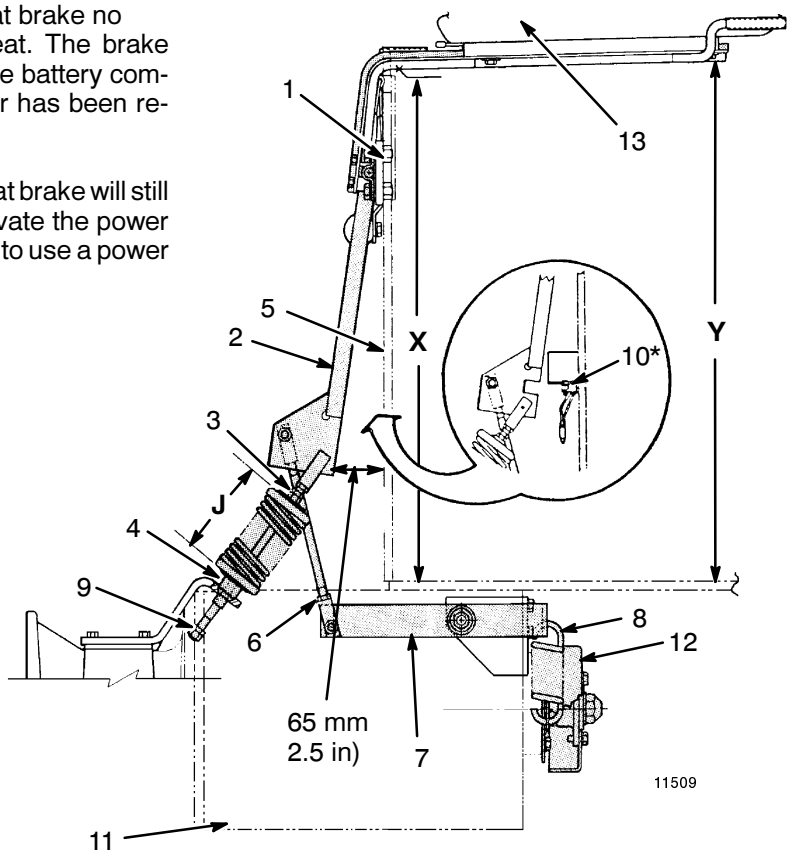

**PLUG A** **PLUG B** **TERMINALS** **PLUG C**

| NO. | FUNCTION | VOLTAGE |
|---|---|---|
| **PA1** | Signal to energize the regenerative braking electronic driver (wire 32). | |
| **PA2** | Not used. | |
| **PA3** | Voltage check for regenerative braking function (wire 17). | |
| **PA4** | Signal to the regenerative braking sensor (wire 22). | |
| **PA5** | Signal to the regenerative braking sensor (wire 21). | |
| **PA6** | Not used. | |
| **PB1** | Not used. | |
| **PB2** | Not used. | |
| **PB3** | Signal to energize the field weakening electronic driver (wire 38). | 2.0 |
| **PB4** | Signal to energize the PMT electronic driver (wire 24). | 2.0 |
| **PB5** | Signal to energize the 1A electronic driver (wire 34). | 2.0 |
| **PB6** | Not used. | |
| **TB1** | 5 volt supply to accelerator potentiometer (wire 29). | 5.0 – 0.0 |
| **TB2** | Signal connection between START switch and control card (wire 57A). | Battery Voltage |
| **TB3** | Voltage input from timer circuit (wire 7). | Battery Voltage |
| **TB4** | Battery voltage supply from key switch (wire 10). | Battery Voltage |
| **TB5** | Voltage input from FORWARD direction switch (wire 6). | Battery Voltage |
| **TB6** | Voltage input from REVERSE direction switch (wire 8). | Battery Voltage |
| **PC1** | Signal wire from SCR 1 thermal protector (black wire). | |
| **PC2** | Battery negative (brown wire). | |
| **PC3** | Signal wire from current sensor (traction circuit) (yellow wire). | |
| **PC4** | Signal wire from current sensor (traction circuit) (green wire). | |
| **PC5** | Signal wire from SCR 1 thermal protector (gray wire). | |
| **PC6** | Not used. | |
| **PC7** | Battery positive voltage (white wire). | |
| **PC8** | Signal wire to SCR 1 gate (blue/white wire). | |
| **PC9** | Signal from SCR 1 cathode (blue wire). | |
| **PC10** | Signal wire to SCR 2 gate (white wire). | |
| **PC11** | Connection between filter for SCR 2 and control card (red wire). | |
| **PC12** | Signal wire to SCR 5 gate ( white/violet wire). | |
| **PC13** | Connection between filter for SCR 5 and control card (violet wire). | |
| **PC14** | Sensor wire for voltage check across capacitor C1 (orange wire). | |

*The latest lift trucks equipped with a seat brake no longer have a switch located in the seat. The brake switch is attached to the front plate of the battery compartment. Also, the power steering timer has been replaced with a filter.

Lift trucks that are not equipped with a seat brake will still have a switch located in the seat to activate the power steering circuit. These units will continue to use a power steering timer.

1. CLAMP
2. LEVER
3. SPRING ADJUSTMENT
4. BEARING
5. BATTERY COMPARTMENT, FRONT PLATE
6. ROD ADJUSTMENT
7. LEVER
8. SPRING
9. JAM NUTS
10. BRAKE SWITCH
11. MOTOR
12. BRAKE ASSEMBLY
13. SEAT




**ADJUSTMENT PROCEDURE**

1. Put a weight in the seat to release the seat brake. Measure dimensions “X” and “Y”. Add or remove shims under the clamp (1) so that dimension “Y” is 6 to 9 mm (0.23 to 0.35 in) greater than dimension “X”.
2. Adjust the setscrew at the top of the lever (2) so that the bottom of the lever is 65 mm (2.5 in) from the front plate of the battery compartment.
3. Turn the spring adjustment (3) so that the length is dimension “J”.

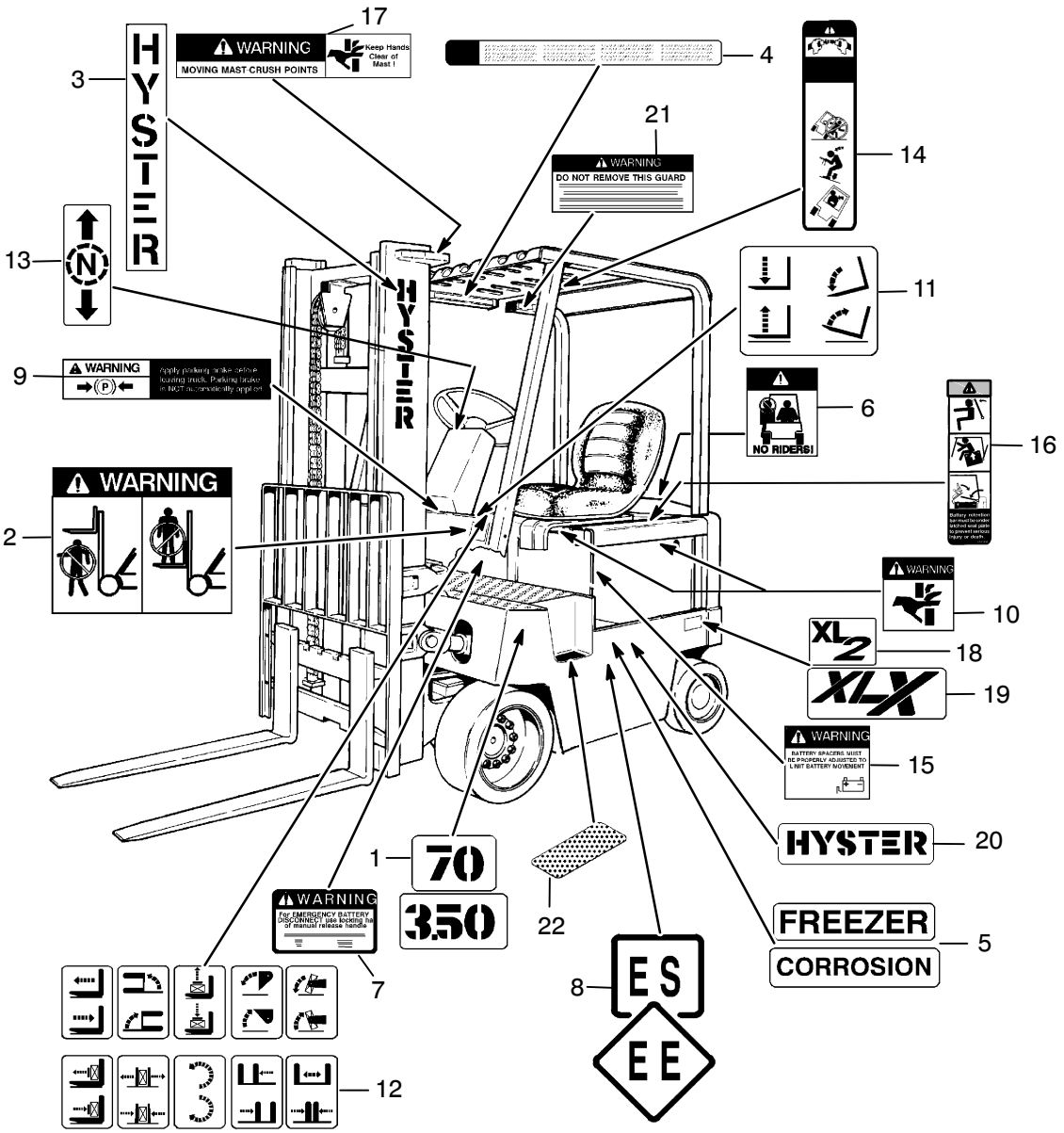
| | | | |
|---|---|---|---|
| Dimension “J”: | E/J1.25-1.75XL (E25-35XL) | standard seat | 63 mm (2.46 in) |
| | | suspension seat | 74 mm (2.91 in) |
| | E/J2.00-3.00XL (E/J40-60XL) | standard seat | 107 mm (4.13 in) |
| | | suspension seat | 118 mm (4.65 in) |

4. Adjust the length of rod (6) to remove the clearance in the lever (7) and the spring (8). Make sure that the adjustment does not apply the brake.
5. Raise the seat to the “up” position and make sure the jam nuts (9) do not hit the bearing (4). Test the operation of the seat brake to make sure the seat brake is actuated correctly. Make sure the measurements for the linkage adjustments are correctly done. If the seat brake does not correctly actuate the brake after the adjustments have been made, make additional adjustments to the length of the rod (6).

The seat can be removed from the battery restraint plate by removing four bolts. The battery restraint plate is removed from the frame by removing the hinge pin that holds the assembly to the frame.

FIGURE 5. SEAT BRAKE ASSEMBLY, E/J1.25-3.00XL (E/J25-60XL)

**INSTALL NEW LABEL IN THE SAME LOCATION AS ORIGINAL**




1. MODEL LABEL
2. MAST WARNING LABEL
3. HYSTER LABEL
4. OPERATORS WARNING LABEL
5. CORROSION/FREEZER LABEL
6. NO RIDERS LABEL
7. BATTERY DISCONNECT LABEL
8. EE/ES LABEL
9. PARKING BRAKE WARNING LABEL
10. PINCH POINT LABEL
11. LIFT/TILT LABEL
12. AUXILIARY LABEL
13. FORWARD/REVERSE LABEL
14. TIP OVER WARNING LABEL
15. BATTERY SPACER LABEL
16. OPERATOR RESTRAINT LABEL
17. MAST WARNING LABEL
18. $XL_2$ LABEL
19. XLX LABEL
20. HYSTER LABEL
21. GUARD LABEL
22. SLIP RESISTANT TREAD

FIGURE 16. LABEL POSITIONS, E3.50-5.50XL (E70-120XL)

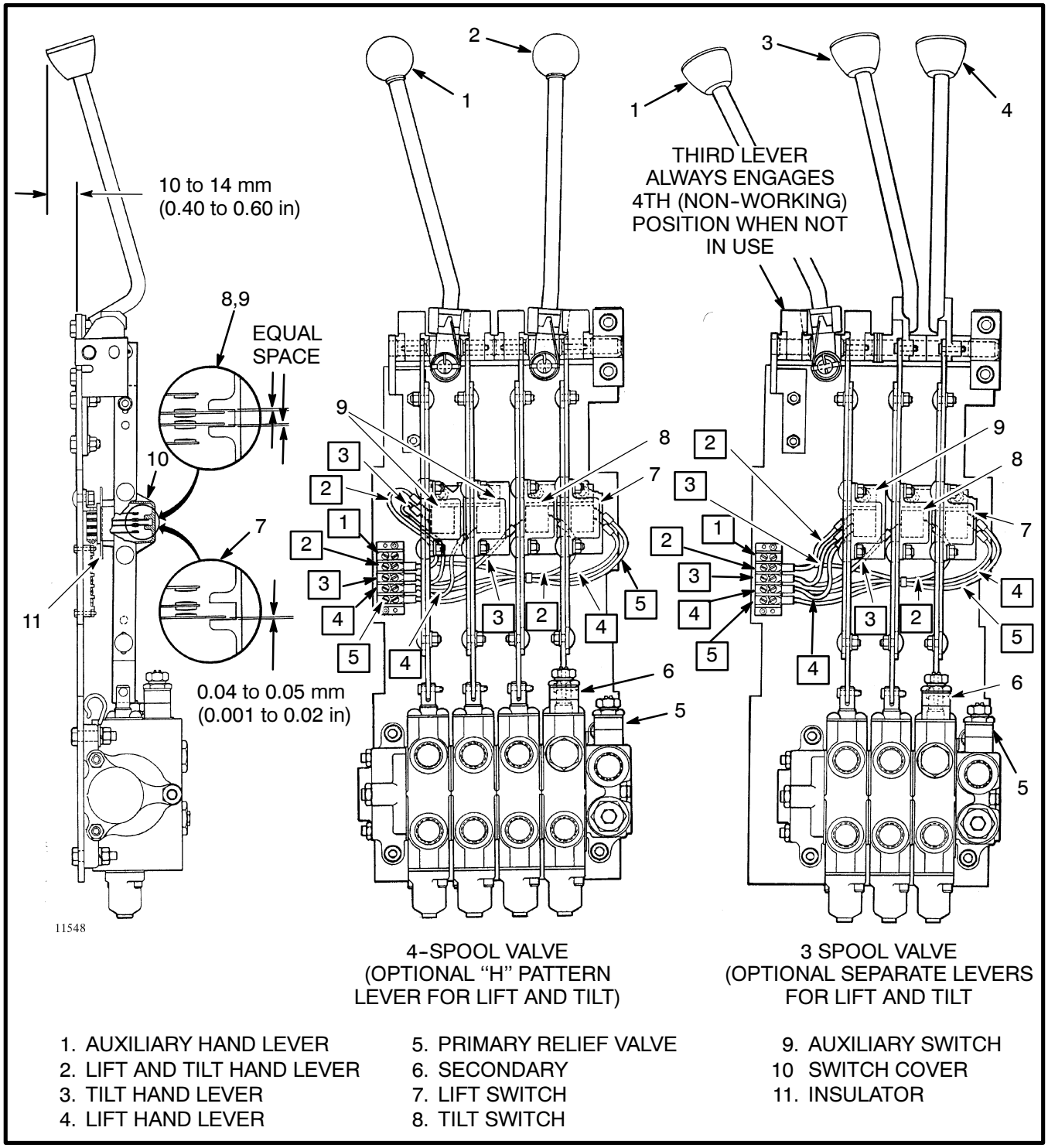



FIGURE 10. LINKAGE AND SWITCH ADJUSTMENT

## STEERING RELIEF VALVE (See FIGURE 11.)

**NOTE**: E/J2.00-3.00XL (E/J40-60XL) models from later production have a step built into the frame. Access for adjustment of the steering relief valve requires removal of the battery on these models.

1. Connect a pressure gauge to the test port. The test port on models from earlier production is a plug on the bottom of the pump housing (FIGURE 11.). Models from later production and the E3.50-5.50XL (E70-120XL, E70-120XL$_3$) series have a test port in a steering line under the floorplate. See FIGURE 6.

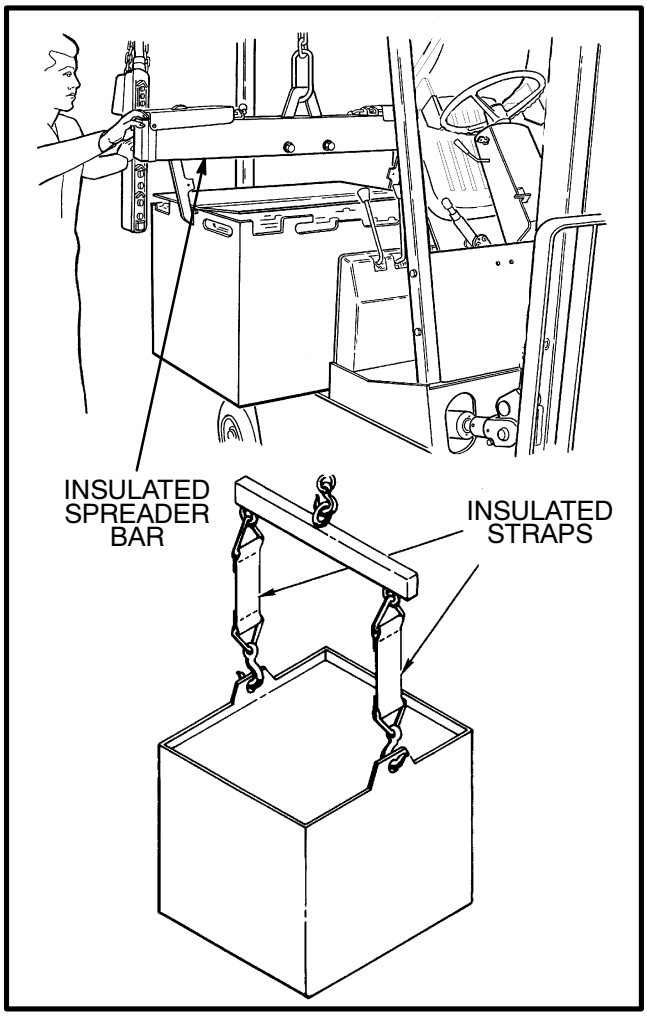


FIGURE 13. CHANGE THE BATTERY

**⚠ CAUTION**

**Always use a spreader bar and slings that lift vertically on the lifting eyes of the battery. Do not use a chain or sling without a spreader bar or you will damage the battery case.**

**Use the correct blocks or spacers to hold the battery in position in the lift truck. Make sure that the battery compartment is clean and dry. All of the vent caps must be in position when the battery is in service. If the vent caps are not installed, the electrolyte will leak, causing corrosion on the battery case and in the battery compartment.**

Always complete the Battery Inspection Report and the Daily Battery Report. See FIGURE 11. and FIGURE 12.

## HOW TO CLEAN THE BATTERY

Keep the battery compartment clean and dry. Use a clean cloth to wash the battery with water. Dry with compressed air.

**⚠ CAUTION**

**Do not clean the battery with steam or hot water. Do not use a high-pressure hose.**

Remove any electrolyte from the battery compartment to prevent corrosion. If there is electrolyte on the top of the battery, apply a solution of bicarbonate of soda. Mix a solution containing 0.5 kg of soda for every 4 litres of water. Apply the solution, then flush the solution from the battery with clean water. Wash the battery and battery compartment as needed, but within a six month period as the maximum time.

**NOTE:** If the top of the battery is wet from electrolyte, check to see if the electrolyte level is too high or the battery charger is not operating correctly.

## HOW TO ADD WATER

**NOTE:** Some batteries have sealed cells. These batteries do not need water added to the electrolyte.

Some water is lost from the electrolyte of each cell during the charge and discharge cycle when the battery is in service. Check the electrolyte level daily. Not all cells need to be checked daily. You can alternate between cells to ensure all cells are checked once a week. If the level of the electrolyte goes below the level of the top of the separators for the plates, the cell can be damaged.

KEEPING THE ELECTROLYTE LEVEL WITHIN THE CORRECT LIMITS IS THE MOST IMPORTANT ITEM OF BATTERY MAINTENANCE.

See the instructions from the manufacturer of your battery for the operating level of the electrolyte. Always use distilled water. If you add distilled water, wait five minutes before measuring the specific gravity with a hydrometer. Do not add water to a cell before or during the charging cycle; water must be added after the charging cycle. If water is added before the charging cycle, the electrolyte level may rise which will cause electrolyte to be forced out of the vent plugs. The electrolyte can flow out of the cell through the fill hole. The correct electrolyte level is shown in FIGURE 14.

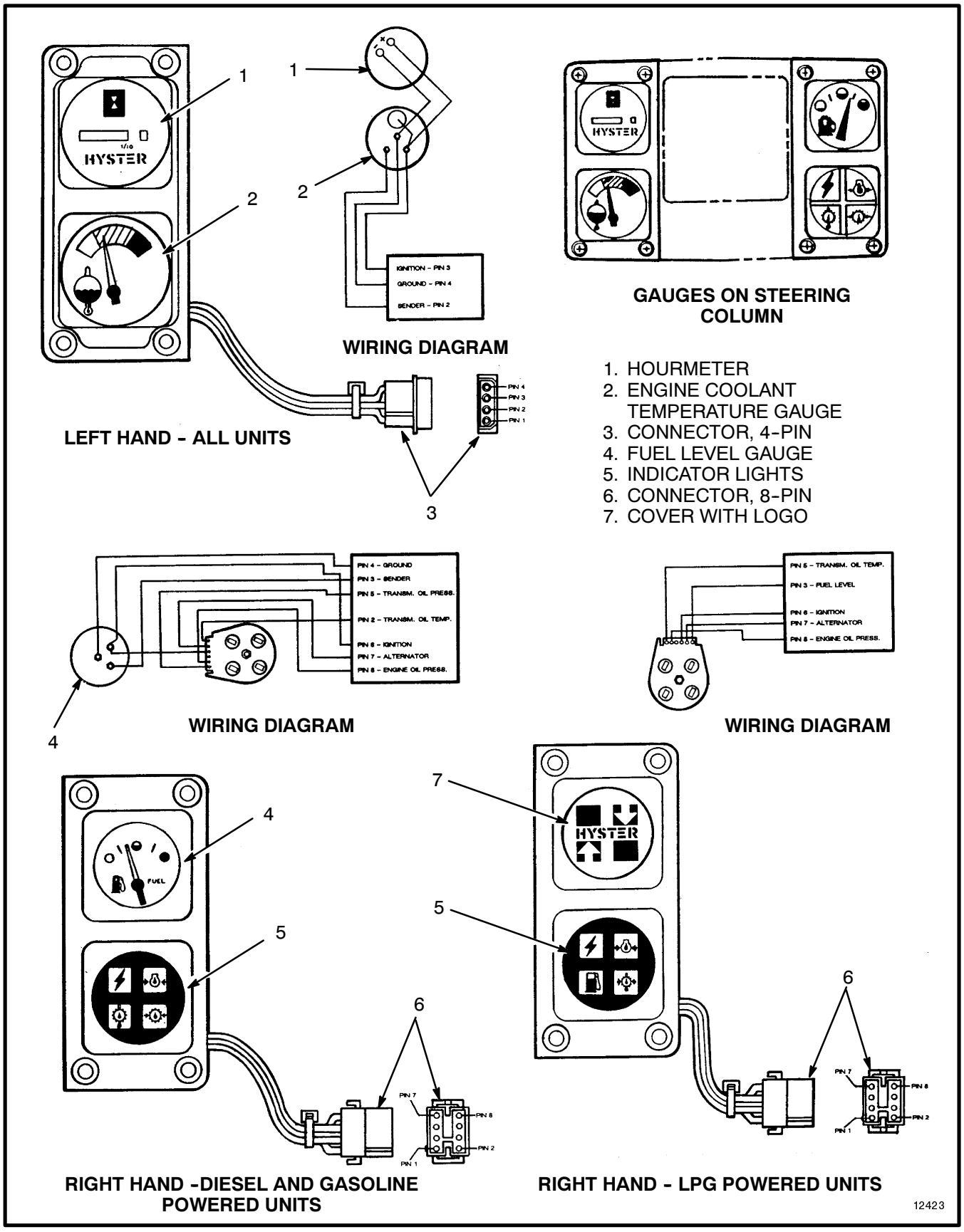


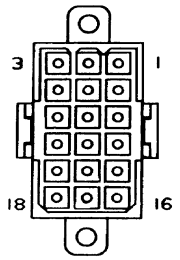

FIGURE 3. TYPICAL METERS ON STEERING COLUMN ASSEMBLY FOR LIFT TRUCKS WITH ENGINES

Hand Set or a PC must be used to clear the status code from the register.

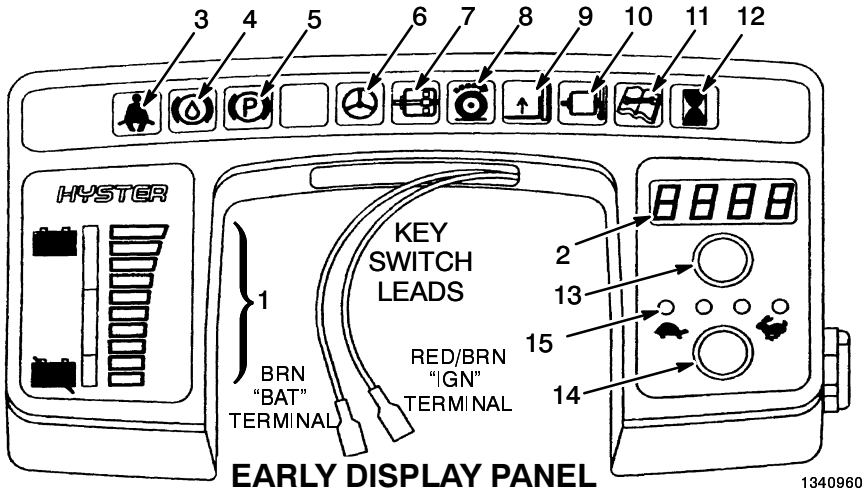
If the button is pushed twice and then held down, the indicator light for the hydraulic pump motor (9) will illuminate. The status codes in memory for the detected faults will be displayed, starting with the most recent fault. If the push button is released, the display will stop. If the button is pushed twice to start the sequence again, the display will start from the beginning. The hourmeter time and the battery charge at the time of the fault will not be shown. A Hand Set or a PC must be used to show this additional information. A Hand Set or a PC must be used to clear the status code from the register.

**ENHANCED DISPLAY**
**18 PIN CONNECTOR**

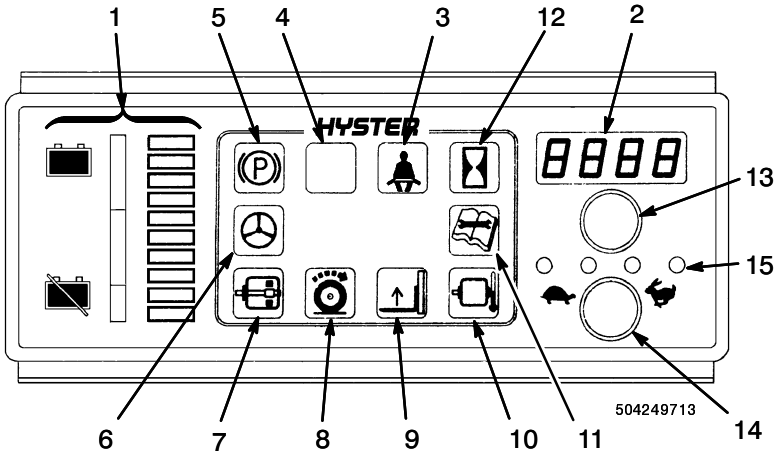
| PIN | FUNCTION |
|---|---|
| 1 | Traction Card PY 5 |
| 2 | Pump Card PY 5 |
| 3 | No Connection |
| 4 | Traction Card PY 14 |
| 5 | Traction Card PY 13 |
| 6 | Pump Card PY 14 |
| 7 | Pump Card PY 13 |
| 8 | No Connection |
| 9 | Traction Card PY 4 |
| 10 | Pump Card PY 4 |
| 11 | Brush Wear Indicator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




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




**LATER DISPLAY PANEL**




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

FIGURE 10. PERFORMANCE DISPLAY PANELS FOR THE EV-100/200ZX MOTOR CONTROLLERS

# TROUBLESHOOTING

TABLE 3. METER TROUBLESHOOTING

| TROUBLE | PROBABLE CAUSE | CORRECTIVE ACTION |
|---|---|---|
| No Indication All Meters | Battery disconnected. | Clean the battery terminals and battery cable connectors. Install connectors. |
| | Battery malfunction or discharged. | Change or replace battery. |
| | Wiring group connector or connectors not connected. | Fasten the connector or connectors. |
| No Indication – Only One Meter | Meter wires damaged or not connected. | Replace the broken wires or connectors. Install connectors on proper meter terminals |
| | Separate sender wire damaged or not connected. | Replace broken wire or connector. Install connector on sender terminal. |
| | Meter malfunction. Voltage is at terminal | Replace meter. |
| | Sender malfunction. Voltage is at terminal | Replace sender. |
| Incorrect Indication | Battery is discharged. | Charge battery. |
| | Meter movement or needle is damaged or has a malfunction. | Replace meter. |
| | Separate sender malfunction. | Replace sender. |
| | Sender will not sense because system has corrosion. | Clean and flush system. |

**NOTE:** OIL LEAKAGE IS NOT CONTROLLED BY THE TORQUE ON THE PACKING GLAND.

TIGHTEN THE PACKING RETAINER (7) TO STOP OIL LEAKS. REPLACE CHEVRON PACKING WHEN PACKING RETAINER (7) CAN NOT COMPRESS PACKING FURTHER TO CONTROL OIL LEAKS. DO NOT TIGHTEN MORE THAN NECESSARY TO STOP OIL LEAKS.

1. WIPER
2. NYLON RING
3. CHEVRON PACKING
4. BACK–UP RING
5. O–RING
6. ROD HEAD
7. PACKING RETAINER
8. PACKING GLAND
9. CYLINDER SHELL
10. INLET AND OUTLET PORT
11. WEAR RING

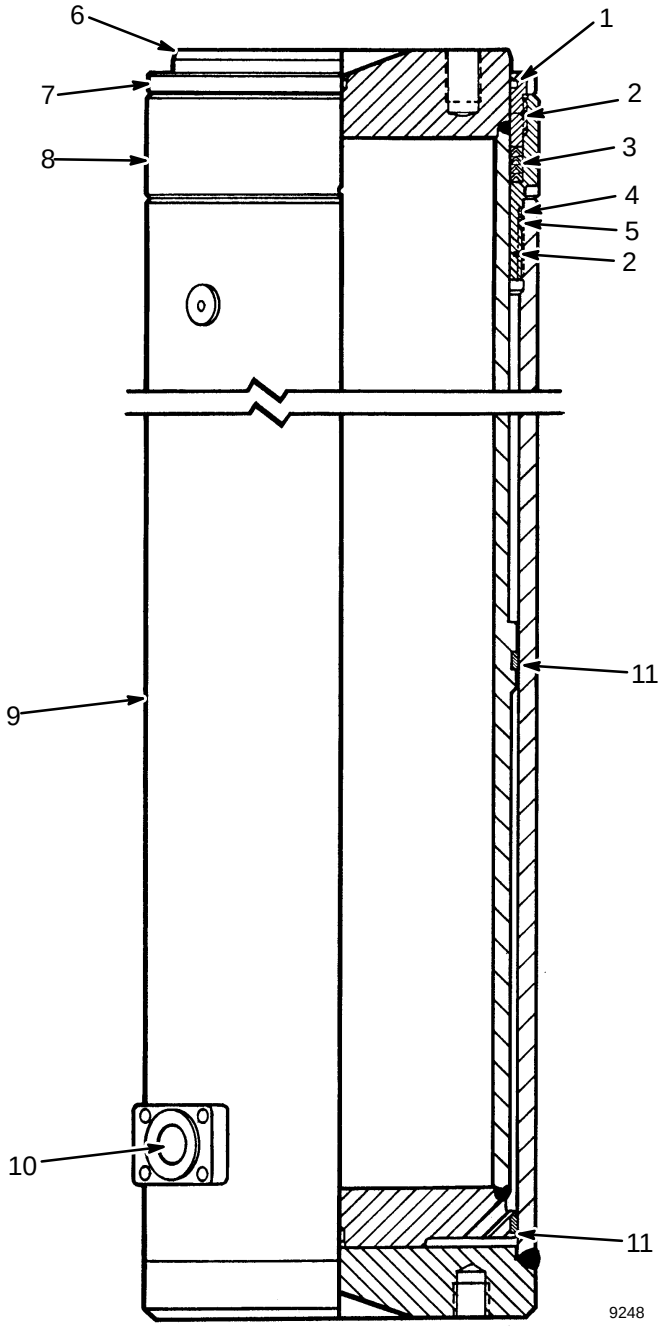



FIGURE 7. DISPLACEMENT CYLINDERS

### Cylinders (H360–460B)

The lift cylinders used in the H360–460B lift trucks are displacement cylinders. The design and repairs for these cylinders are similar to the other lift cylinder in this section. A displacement cylinder does not have a piston or piston seal. The rod diameter is almost the same as the inside diameter of the cylinder. There are wear rings on the rod that are the bearings between the rod and the walls of the cylinder. The wiper seal at the top of the cylinder is also the high pressure seal for these cylinders. The wiper seal is a chevron packing. See FIGURE 7.

### Cylinders (Two–Speed)

Two–speed lift cylinders are single–stage lift cylinders with a special valve and path for the hydraulic oil. The lift cylinder is filled with oil on both sides of the piston. For loads less than 45% of the rated capacity, the cylin-

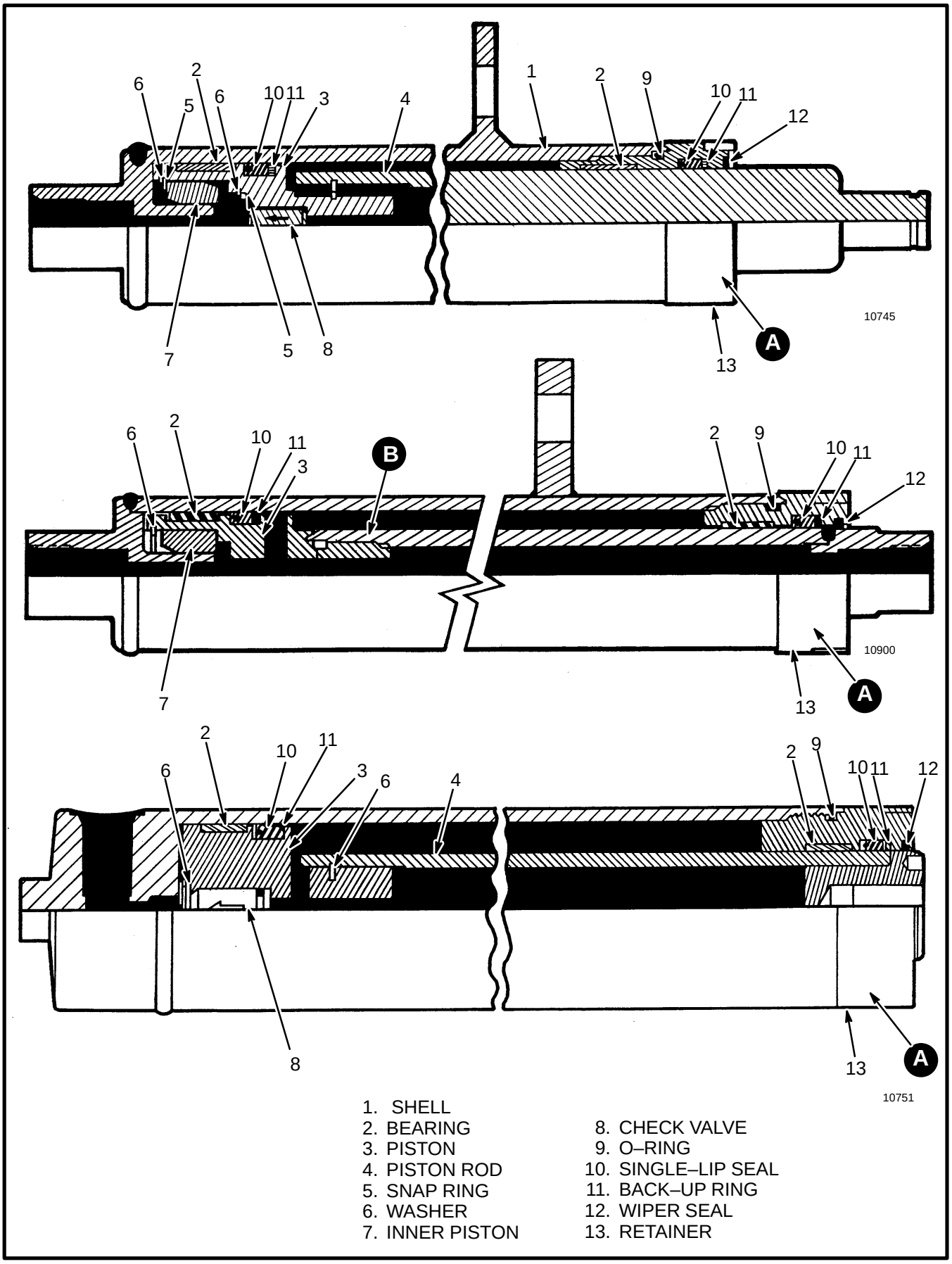



FIGURE 16. TYPICAL LIFT CYLINDERS, VISTA MASTS

of the load until the system pressure is great enough to control the load. Oil from the piston end of the tilt cylinders returns through the main control valve to the hydraulic tank.

**TILT FORWARD (See FIGURE 4.)**

The tilt control spool that is inside of the tilt spool operates during the Forward tilt function. The tilt control spool prevents cavitation in the piston end of the tilt cylinders. Cavitation occurs when the available fluid does not fill the space in a closed system. The high vacuum causes some of the fluid to change to bubbles of gas. When cavitation occurs in the tilt cylinders, the tilt forward function is not smooth.

The tilt control spool permits the regulation of the tilt speed by using the pressure from the hydraulic pump.

The pressure must be 550 kPa (80 psi) on the piston end of the tilt cylinders. The tilt control spool prevents oil flow from the rod end of the tilt cylinders until the pressure is 550 kPa (80 psi). This action makes sure that a vacuum cannot occur at the piston end of the tilt cylinders.

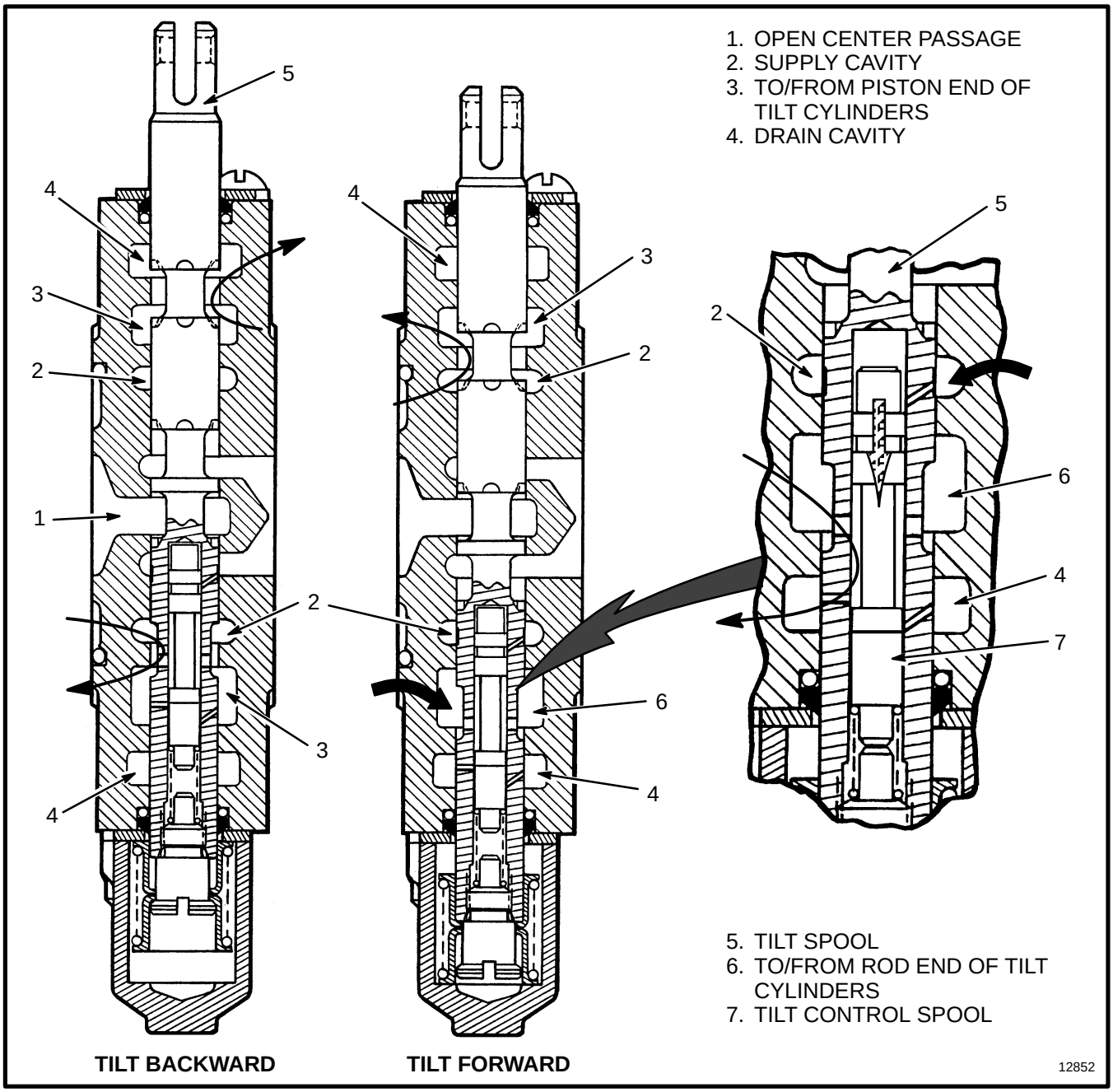



FIGURE 4. TILT SPOOL OPERATION

# TROUBLESHOOTING

## SOLENOID VALVE FOR AUXILIARY FUNCTION

If the solenoid valve does not operate, do the following steps:

A. Check the 7.5 amp fuse for the solenoid valve on the fuse panel.

B. Check for loose electrical connections:

1. Ignition switch: Check the black wire at the accessory terminal of the switch connector body.
2. Control knob button: Remove the snap ring and the knob cover, Check the wire connectors and the switch connections.
3. Solenoid valve coil: Remove the coil cover. See FIGURE 7. Check the diode connections to the coil terminals. Check the connections of the red and white wires to the diode assembly terminals. Check the connection of the black wire.
4. Cowl ground stud: Make sure there are no loose ground wires.

C. Remove the diode assembly. Test the diode with an ohmmeter for high resistance in one direction and no resistance in the other direction. If there is no resistance or infinite resistance in both directions, replace the diode.

**NOTE:** Make sure the wires and the diode are connected as shown in FIGURE 7. The diode must be installed with the color–code band toward the positive terminal.

D. Disconnect the red and white wires from the diode assembly terminals. Connect voltmeter across the wire terminals, check for current when the control knob button is depressed.

1. If there is no current, check the wiring for short circuits.
2. If there is current, test the coil. See step E.

E. Test the coil for continuity by connecting an ohmmeter lead to each coil terminal. Put the ohmmeter on the R x 1 scale.

1. If there is no ohmmeter reading, the coil is bad. Replace the coil.
2. If there is an ohmmeter reading, the coil is good. If the coil is good, but the solenoid valve does not energize when the button is depressed, the solenoid valve is bad. Replace the solenoid valve assembly.

### Tires and Wheels (See FIGURE 9.)

## ⚠ WARNING

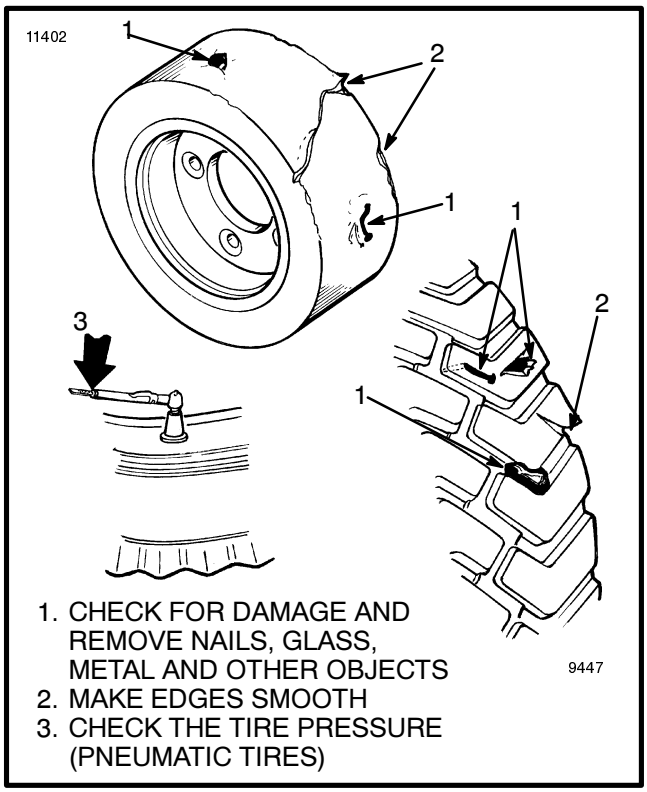
**Air pressure in tires can cause tire and wheel parts to explode. This action can cause serious injury or death.**

**Remove all of the air from the tires before the tires are removed from the lift truck.**

**If a tire has less than 80% of the correct air pressure, completely remove the air pressure from the tire. Remove the tire from the lift truck. Add air pressure to the tire only in a safety cage. See the procedures in Add Air To The Tires.**

**When air is added to the tires, use a remote air chuck. The person adding air must stand away and to the side and not in front of the tire.**

If the lift truck has pneumatic tires, keep the tires at the correct air pressure (see the nameplate). Check the air pressure with a gauge when the tires are cold. If it is necessary to add air to a tire that is warm, check the other tire on the same axle and add air to the tire that has low pressure so that the air pressures are equal. The air pressure of the warm tires must always be equal to or greater than the specification for air pressure for cold tires.




1. CHECK FOR DAMAGE AND REMOVE NAILS, GLASS, METAL AND OTHER OBJECTS
2. MAKE EDGES SMOOTH
3. CHECK THE TIRE PRESSURE (PNEUMATIC TIRES)

FIGURE 9. CHECK THE TIRES

Check the tires for damage. Inspect the tread and remove any objects that will cause damage. Check for bent or damaged rims. Check for loose or missing parts. Remove any wire, straps or other material wrapped around the axle.

Make sure that the wheel nuts are tight. Tighten the wheel nuts in a cross pattern to the correct torque value shown in the MAINTENANCE SCHEDULE.

## ⚠ CAUTION

**When the wheels have been installed, check all wheel nuts after 2 to 5 hours of operation. Tighten the nuts in a cross pattern to the correct torque value shown in the MAINTENANCE SCHEDULE. When the nuts stay tight for eight hours, the interval for checking the torque can be extended to 350 hours.**

### Forks, Adjustment

**Hook forks** are connected to the carriage by hooks and lock pins. See FIGURE 10. These lock pins are installed through the top fork hooks and fit into slots in the top carriage bar. Adjust the forks as far apart as possible for maximum support of the load. Hook forks will slide along the carriage bars to adjust for the load to be lifted. Raise the lock pin in each fork to slide the fork on the carriage bar. Make sure the lock pin is engaged in the carriage bar to lock the fork in position after the width adjustment is made.

### Forks, Removal And Installation

A fork can be removed from the carriage for replacement of the fork or other maintenance.

## ⚠ WARNING

**Do not try to move a fork without a lifting device. Each hook fork for these lift trucks can weigh 35 kg to 180 kg (80 to 395 lb).**

**Hook Fork (Removal).** Slide a hook fork to the fork removal notch on the carriage. See FIGURE 10. Lower the fork onto blocks so that the bottom hook of the fork moves through the fork removal notch. See FIGURE 11. Lower the carriage further so that the top hook of the fork is disengaged from the top carriage bar. Move the carriage away from the fork, or use a lifting device to move the fork away from the carriage. Lay the fork on its side so that it cannot fall and cause injury.

a. **E3.50-5.50XL (E70-120XL).** Remove the nut, retainer and wire clamp that hold the filter head on the tank. Remove the filter head. Remove the filter from the tank.

b. **Other Models**. Disconnect the hydraulic return hose at the filter. Loosen the band clamps on the rubber sealing ring. Turn the filter cap counterclockwise to disengage the two pins that hold the filter cap in the hydraulic tank. A coil spring under the filter holds the filter against the filter cap. Remove the filter cap and then remove the filter.

**NOTE:** The hydraulic oil filter has a by-pass relief valve that is part of the filter. Make sure the correct replacement filter with a by-pass relief valve is installed.

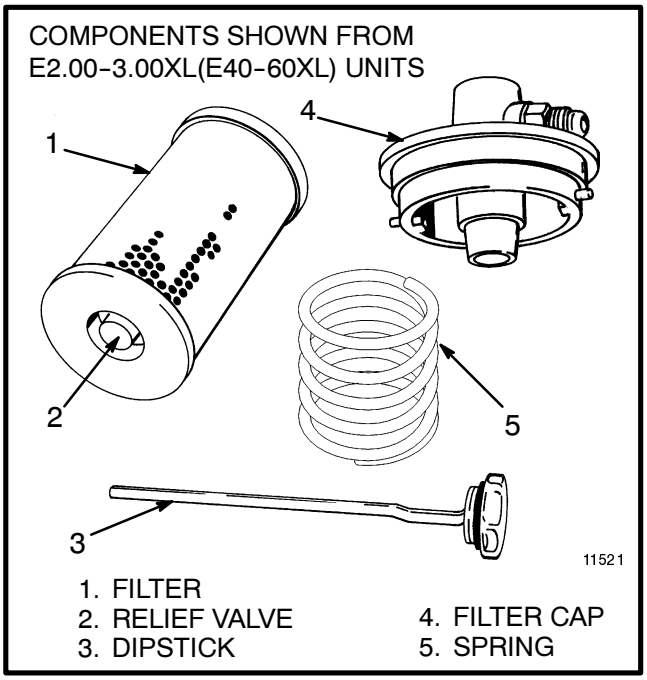



FIGURE 20. HYDRAULIC FILTER

### Change the Hydraulic Oil

Put the lift truck on a level surface. Lower the mast. Put a drain pan with a 25 litre (26 qt) capacity under the hydraulic tank. Disconnect the hydraulic hose from the hydraulic tank to the steering pump and drain the oil into the drain pan. (The quantity of oil is according to the size of the mast and the optional hydraulic equipment.)

When the oil has drained, connect the hydraulic hose. Fill the hydraulic tank with the correct oil *after* the filter is installed. See the MAINTENANCE SCHEDULE.

## DIFFERENTIAL AND SPEED REDUCER

Remove the plug from the bottom of the differential housing to drain the oil. See the MAINTENANCE SCHEDULE (Item 17) for the correct lubricant. Fill the differential and speed reducer so that the oil level is even with the fill plug or the "FULL" mark on the dipstick.

## SERVICE BRAKES

### ⚠ WARNING

**Brake linings contain asbestos or other fibers. Breathing the dust from these brake linings is a cancer or lung disease hazard. Do not create dust! Do not clean brake parts with compressed air or by brushing. Use vacuum equipment approved for asbestos dust or follow the cleaning procedure in this section. When the brake drums are removed, do not create dust.**

**Do not sand, grind, chisel, hammer or change linings in any way that will create dust. Any changes to brake linings must be done in a restricted area with special ventilation. Protective clothing and a respirator must be used.**

Cleaning Procedures:

a. Do not release brake lining dust from the brake linings into the air when the brake drum is removed.

b. Use a solvent approved for cleaning of brake parts to wet the lining dust. Follow the instructions and cautions of the manufacturer for the use of the solvent. If a solvent spray is used, do not create brake lining dust with the spray.

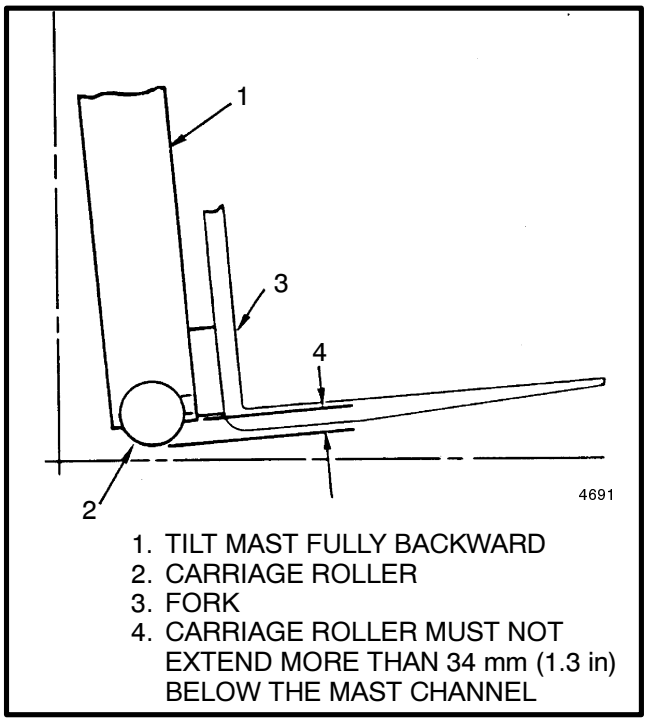
c. When the brake lining dust is wet, clean the parts. Put any cloth or towels in a plastic bag or an airtight container while they are still wet. Put an "ASBESTOS" warning label on the plastic bag or airtight container.

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

### ⚠ CAUTION

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

**The PMT circuit prevents this operation if these malfunctions occur. Do not operate the lift truck if the PMT circuit does not operate correctly.**




1. TILT MAST FULLY BACKWARD
2. CARRIAGE ROLLER
3. FORK
4. CARRIAGE ROLLER MUST NOT EXTEND MORE THAN 34 mm (1.3 in) BELOW THE MAST CHANNEL

FIGURE 26. LIFT CHAIN ADJUSTMENTS

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

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

## ⚠ WARNING

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

**Do not touch the terminals of capacitor C1 of the traction or lift control circuits. The charge on the capacitors can cause electrical shock and personal injury. Use an insulated screwdriver or jumper wire to make a short-circuit across the capacitor terminals to discharge each capacitor. This will discharge the capacitors to prevent electrical shocks.**

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

**NOTE**: The EV-200 motor controller has capacitor C2 connected in parallel with capacitor C1. Both capacitors will be discharged.

3. Disconnect the gate lead from the SCR 5 for the traction circuit (white/violet wire). The gate lead has a push-on connector. Make sure that the end of the lead does not touch any other surface. See the **DIAGRAMS** section that came with the lift truck for the location of the gate lead.

4. Connect the battery.

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

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

7. As soon as the PMT circuit disables the traction control, turn the key to the **"OFF"** position. If the PMT circuit does not disable the traction control, replace the control card. Correct procedures are in the **SERVICE MANUAL**:

- **EV-100™ MOTOR CONTROLLER, Repairs and Adjustments, 2200 SRM 288,** for models E/J1.25-1.75XL (E25-35XL) and E/J2.00-3.00XL (E/J40-60XL)
- **EV-200™ MOTOR CONTROLLER, Operation, Checks, Repairs and Adjustments, 2200 SRM 414,** for models E3.50-5.50XL (E70-120XL)
- **ELECTRICAL SYSTEM, Checks and Adjustments, 2200 SRM 464,** for SitDrive™ Models with EV-1, EV-1B, EV-1W, EV-100 or EV-200 Motor Controllers

8. Disconnect the battery, open the electrical compartment and discharge capacitors C1 (and C2 if installed) on the SCR control panels as described in the earlier WARNING.

9. Connect the SCR 5 gate lead. Connect the battery. Raise the drive wheels and remove the blocks. Check for normal operation of the traction motor.