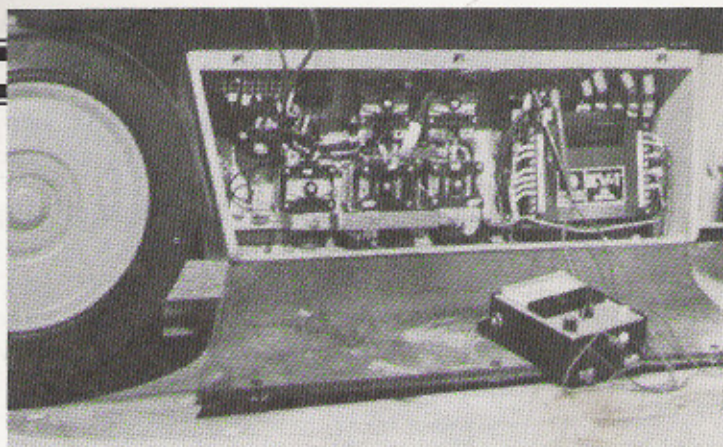


# EV-1 MOTOR CONTROLLER

## TROUBLESHOOTING AND REPAIR



8341



## SAFETY PRECAUTIONS MAINTENANCE AND REPAIR

1. When lifting parts or assemblies, make sure that all slings, chains, or cables are correctly fastened and balanced before lifting. Make sure that the crane, cable, or chain has the capacity to lift the weight.
2. Do not lift heavy parts by hand. Use a lifting mechanism.
3. Wear safety glasses.
4. **DISCONNECT THE BATTERY CABLES** before doing any maintenance or repair on electric lift trucks.
5. Always use correct blocks to prevent the unit or parts from rolling or falling.
6. Keep the unit and working area clean, and in order.
7. Use correct tools for the job.
8. Keep tools clean and in good condition.
9. Always use **HYSTER APPROVED** parts when making repairs.
10. Make sure that all nuts, bolts, snap rings and other fastening devices are removed before using force to remove parts.
11. Always fasten a **DO NOT OPERATE** sign to the controls of the unit when making repairs or if the unit needs repairs.
12. Make sure you check the **WARNING** and **CAUTION** notes in the instructions.
13. Batteries generate flammable gas when they are being charged. Keep fire and sparks away from the area. Make sure the area has ventilation.



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This section is for the following models:  
 E20-30BS, E20-30BH, E30-60BS, E60-120B  
 N30-50BA, N30-40BR, N30-50CA, N30-40CR,  
 R25A, R30B, R30BA, R30BR, J40-50A, J60AS



# INTRODUCTION

## GENERAL

This section describes the procedures for troubleshooting and repair of the EV-1 motor controller. The EV-1 motor controller is used, with modifications, in several series of lift trucks. You will also need the following information:

- **ELECTRICAL REPAIRS AND ADJUSTMENTS**  
Describes the control switches and the adjustment of the control card that are special for each series of lift trucks. There is a separate section printed for each series of lift trucks.
- **EV-1 MOTOR CONTROLLER, DESCRIPTION, 2200 SRM 112.**  
Has a description of the operation of the EV-1 controller. (This additional section is not normally necessary for troubleshooting as described in this section.)

This section is separated into the following parts:

- **SRO And PMT Circuits.** A short description of the SRO and PMT circuits and the sequence of operation of the controller is used as an introduction to Troubleshooting. You must understand some functions and operations so that you can select the correct fault procedure.
- **Troubleshooting.** General procedures and fault analysis.
- **Checks and Repair.** Additional information to make the checks and repairs of the faults you find in the troubleshooting procedures.

There are two contactors that are frequently found on the controller base: a contactor for the hydraulic pump motor, and a contactor for the power steering motor (if equipped). These two contactors are not part of the operation of the EV-1 controller. See the

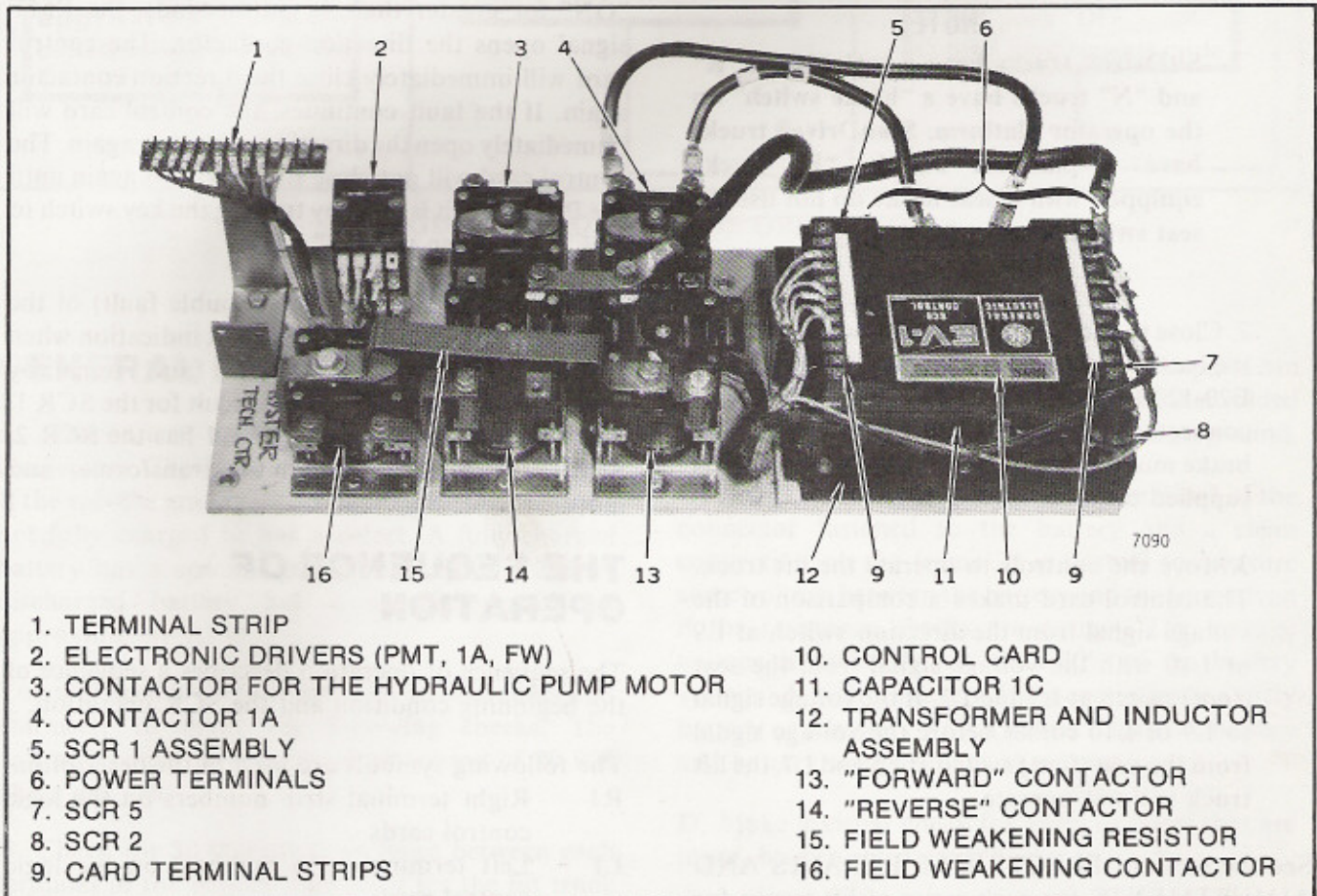


FIGURE 1. EV-1 MOTOR CONTROLLER



section on the hydraulic system or the steering system for each series of lift trucks for more information.

**WHEN YOU NEED HELP.** Call a Hyster dealer if you have correctly followed a fault procedure and

have not found the fault. This section describes the most common faults that occur in the EV-1 controller. Hyster dealers have Service Engineers that can help you check and repair a fault that is not common.

## SRO CIRCUIT AND PMT CIRCUIT

### STATIC RETURN TO OFF (SRO) CIRCUIT

The "Static Return to OFF" (SRO) circuit is a safety circuit. The SRO circuit will prevent the operation of the lift truck if the operator is not in the correct position at the controls. The starting sequence is as follows:

1. Close the seat switch (See NOTE). The operator must be in the correct position at the controls. The control card must receive the voltage from the seat switch before any of the other control signals to move the lift truck.

#### NOTE

SitDrive® trucks have a seat switch. "R" and "N" trucks have a "brake switch" on the operator platform. StanDrive® trucks have a platform switch. "E" trucks equipped with a seat brake do not use the seat switch.

2. Close the key switch. The key switch supplies the battery voltage to the control circuits. (The E20-120B lift trucks also have a switch connected to the parking brake. The parking brake must be released before battery voltage is supplied to the control card.)

3. Move the controls to operate the lift truck. The control card makes a comparison of the voltage signal from the direction switch at L9 or L10 with the voltage signal from the seat (foot) switch at L5 and L7. If the voltage signal to L9 or L10 comes before the voltage signal from the seat (foot) switch at L5 and L7, the lift truck will not operate.

See the sections ELECTRICAL REPAIRS AND ADJUSTMENTS for each series of lift trucks for more information on the control switches.

### PULSE MONITOR TRIP (PMT)

The PMT circuit opens the direction contactors if SCR 1 has two pulses without going to "OFF" between the pulses. The PMT circuit is part of the control card. After the SRO circuit is complete, the control card applies and senses the voltage across SCR 1. If the voltage across SCR 1 stays low, there is a fault across SCR 1. A fault across SCR 1 can be caused by a short-circuit in SCR 1 or the tips of contactor 1A welded closed. The voltage must be at least 50% of battery voltage before the control card will permit the direction contactor to close.

The control card checks the traction circuit for faults during operation of the lift truck. If the SCR 1 stays "ON" for greater than 32 milliseconds, the PMT signal opens the direction contactor. The control card will immediately close the direction contactor again. If the fault continues, the control card will immediately open the direction contactor again. The control card will not close the contactor again until the PMT circuit is reset by turning the key switch to "OFF" and then to "ON" again.

This rapid double operation (double fault) of the direction contactor is an important indication when troubleshooting. This double fault normally indicates a fault in the "OFF" circuit for the SCR 1. The "OFF" circuit for the SCR 1 has the SCR 2, SCR 5, capacitor C1, and the transformer and inductor assembly.

### THE SEQUENCE OF OPERATION

The sequence of operation describes a sequence of the beginning condition and the SCR operation.

The following symbols are used in the description:

- R1 Right terminal strip numbers on the logic control cards
- L1 Left terminal strip numbers on the logic control cards
- Wire 1 The wire number of the control circuits



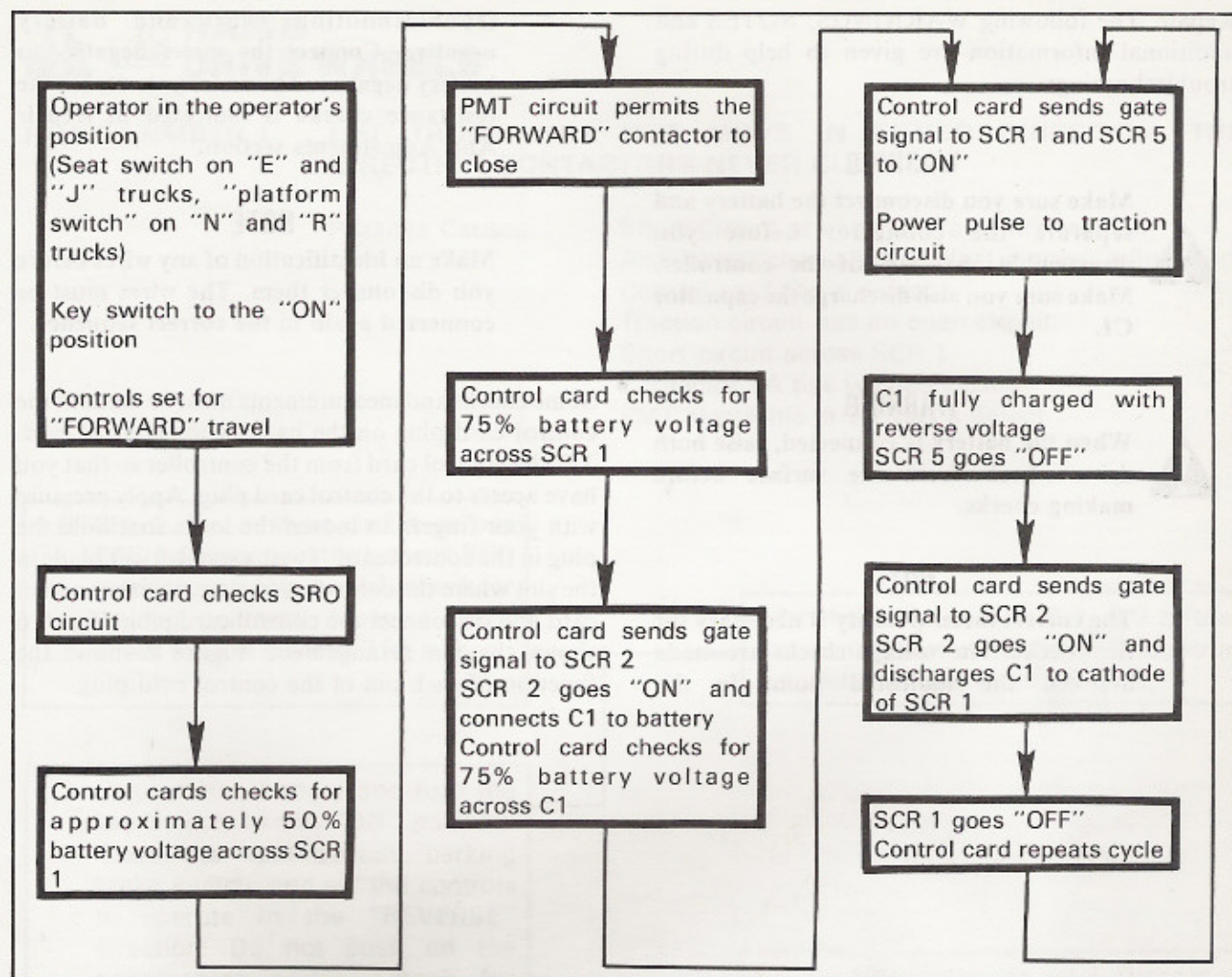


FIGURE 2. SEQUENCE OF OPERATION

## TROUBLESHOOTING

### GENERAL PROCEDURES

A. Disconnect the battery and separate the connectors. Check the specific gravity of the battery. If the specific gravity is less than 1.260, the battery is not fully charged or has a defect. A fully charged battery has a specific gravity of 1.270 - 1.290. A discharged battery has a specific gravity of approximately 1.130.

You will need a Cir/Kit meter or an ohmmeter and voltmeter to make the following checks. The voltmeter must have a minimum rating of 20 000 ohms per volt.

B. Check for 50 000 ohms or more between each terminal of the battery connector for the lift truck and a clean connection on the frame. Remove any grounds between the controller and the frame of the

lift truck. Carbon dust in a motor or other parts can cause a ground. Check if your customer has added some additional equipment that is causing a ground.

C. Check for voltage between each terminal of the connector fastened to the battery and a clean connection on the frame. It is normal to measure some voltage between the battery and the frame even if the resistance checks are correct. The leakage voltage is normally less than 30% of the battery voltage. A high leakage voltage can indicate a dirty battery or a battery with a defect. Clean the battery and battery compartment as necessary.

D. Make a visual check for parts or wires that are loose, broken, or damaged.

The instructions for checking the parts and assemblies are described in the section Checks And



Repair. The following WARNINGS, NOTES and additional information are given to help during troubleshooting:

#### **WARNING**



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

#### **WARNING**



When the battery is connected, raise both drive wheels from the surface before making checks.

#### **NOTE**

The correct meter polarity is necessary for the checks. The voltage checks are made between the indicated point in the

troubleshooting chart and battery negative. Connect the meter negative to battery negative. The meter polarity for the resistance checks is indicated in Repair And Adjustments section.

#### **NOTE**

Make an identification of any wires before you disconnect them. The wires must be connected again in the correct sequence.

Some checks and measurements must be made at the control card plug on the back of the control card. Tilt the control card from the controller so that you have access to the control card plug. Apply pressure with your fingers to loosen the locks that hold the plug in the control card. Twist a screwdriver blade in the slot where the control card plug joins the control card and disconnect the control card plug. Figure 6 shows the pin arrangement. Figure 7 shows the function of each pin of the control card plug.



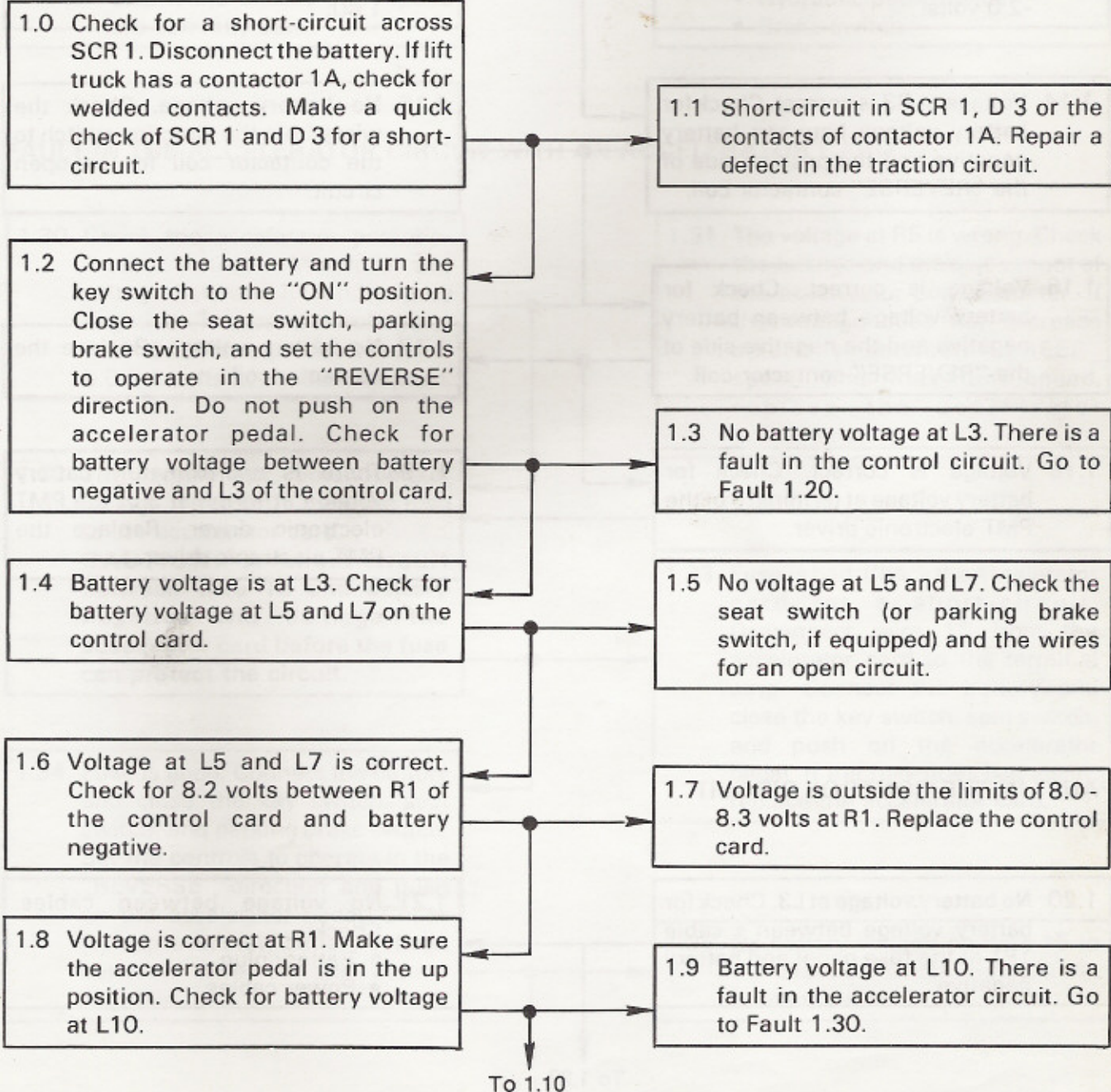


## RAISE DRIVE WHEELS

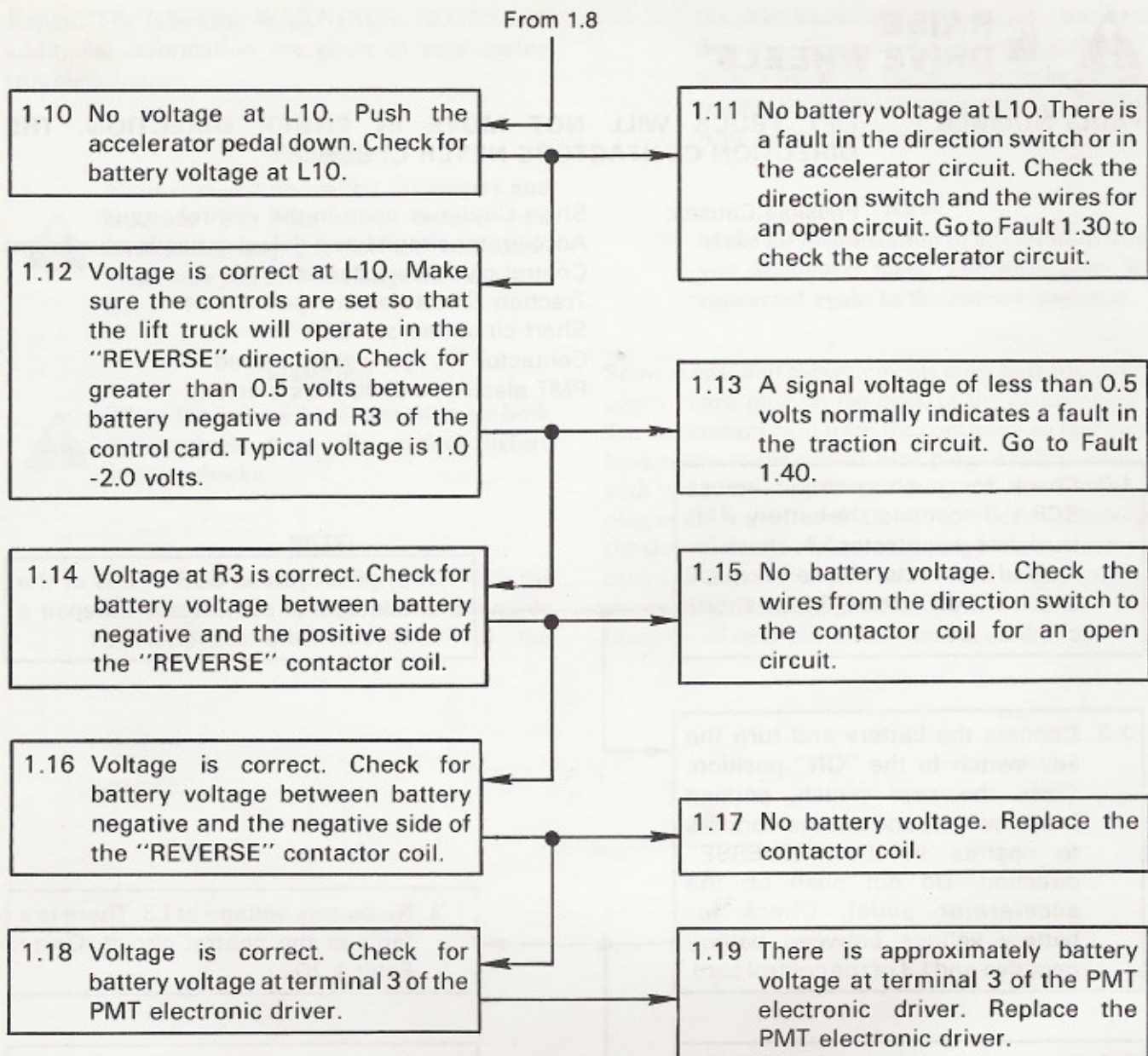
### FAULT NUMBER 1. LIFT TRUCK WILL NOT MOVE IN EITHER DIRECTION. THE DIRECTION CONTACTORS NEVER CLOSE

#### Possible Causes:

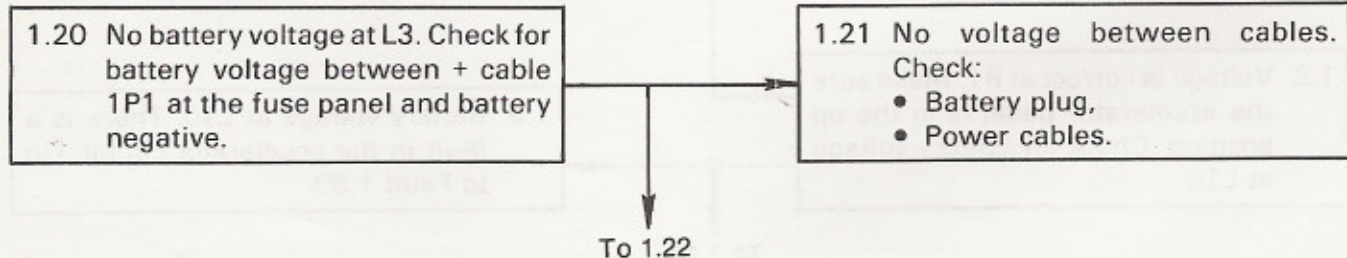
Short-Circuit or open in the control circuit.  
Accelerator circuit has a defect or needs adjustment  
Control card has a defect  
Traction circuit has an open circuit  
Short-circuit across SCR 1  
Contactor 1A tips welded closed  
PMT electronic driver has a defect



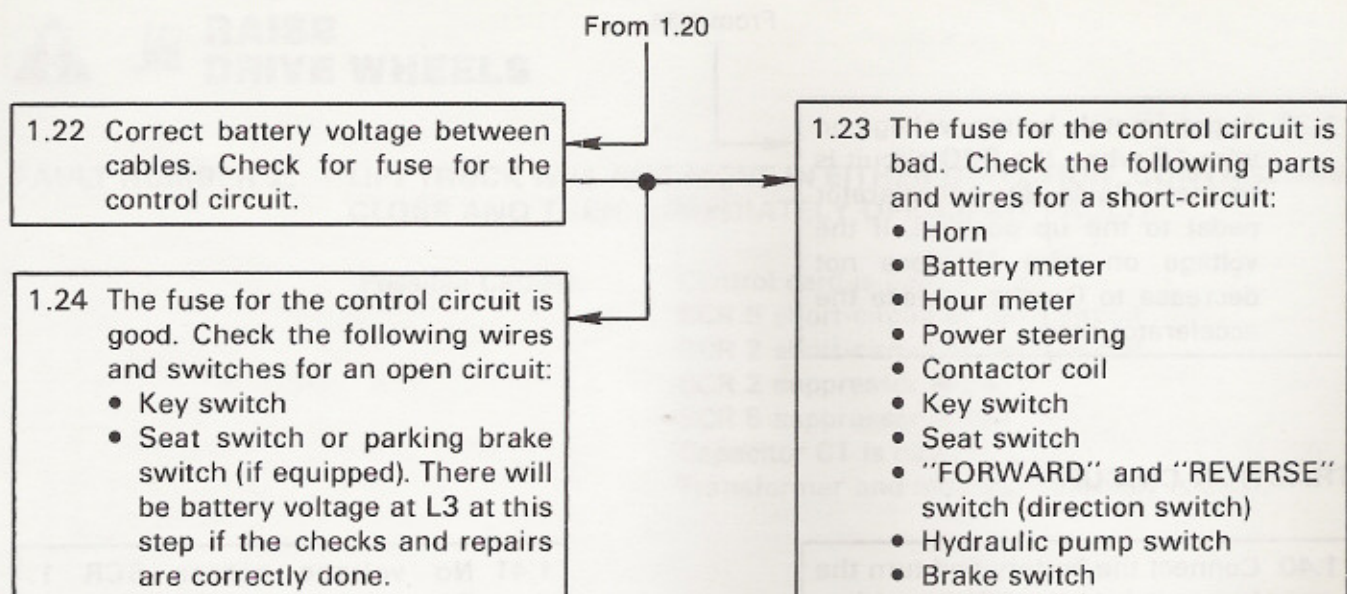




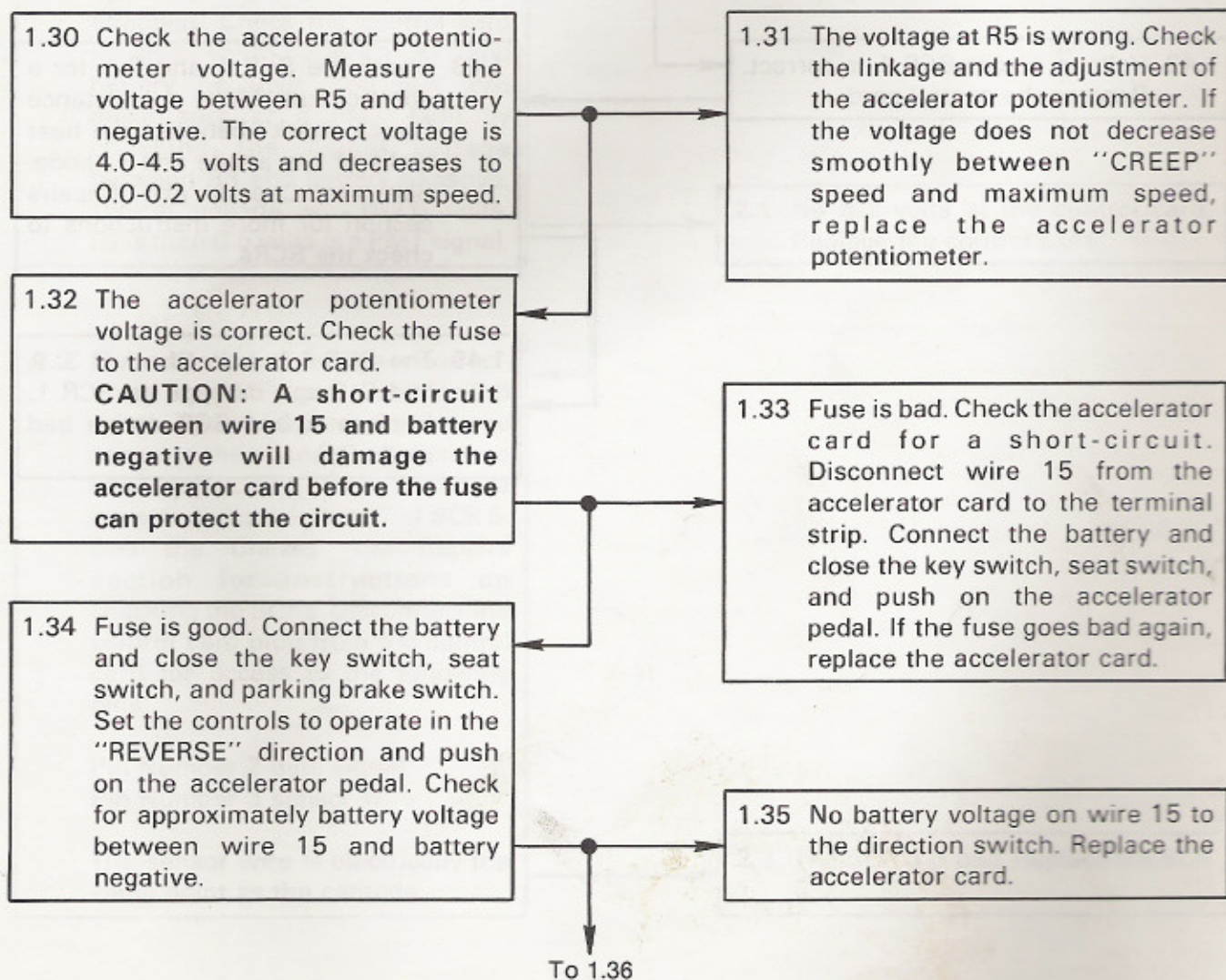
#### FAULT IN THE CONTROL CIRCUIT







### FAULT IN THE ACCELERATOR CIRCUIT WITH AN ACCELERATOR CARD





From 1.34

1.36 Approximately battery voltage on wire 15 when the SRO circuit is correct. Raise the accelerator pedal to the up position. If the voltage on wire 15 does not decrease to 0 volts, replace the accelerator card.

## TRACTION CIRCUIT

1.40 Connect the battery and turn the key switch to the "ON" position. Measure the voltage between the anode and cathode of the SCR 1. The correct voltage is approximately 50% of the battery voltage.

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

1.42 Voltage across SCR 1 is correct. Replace the control card.

1.43 Check the SCR 1 and D 3 for a short-circuit. Make a resistance "quick check" between the heat sinks of the anode and cathode. See the Checks and Repairs section for more instructions to check the SCRs.

1.45 The SCR 1 is bad. Check D 3. A bad D 3 can damage an SCR 1. Replace a bad SCR and a bad diode D 3.





## RAISE DRIVE WHEELS

### FAULT NUMBER 2. LIFT TRUCK WILL NOT MOVE IN EITHER DIRECTION. CONTACTORS CLOSE AND THEN IMMEDIATELY OPEN (PMT FAULT)

#### Possible Causes:

Control card is bad  
SCR 5 short-circuit or open circuit  
SCR 2 short-circuit or open circuit  
SCR 2 suppressor is bad  
SCR 5 suppressor is bad  
Capacitor C1 is bad  
Transformer and Inductor assembly is bad

2.0 Connect the battery and turn the key switch to the "ON" position. Close the seat switch and parking brake switch. Set the controls to operate in the "REVERSE" direction. Check the control card for 8.2 volts between R1 and battery negative. You can also make sure of a PMT fault by checking the signal voltage between R3 and battery negative. Typical voltage is 1.0-2.0 volts. Less than 0.5 volts is a PMT signal.

2.1 No 8.2 volts at the control card.  
Replace the control card.

2.2 The control card voltage is correct. There is a PMT signal (less than 0.5 volts). Disconnect the battery and separate the connector. Discharge the capacitor C1. Make a resistance "quick check" of SCR 5. See the Checks And Repairs section for instructions on checking the SCRs. Disconnect the control card plug from the control card for access to the following pins:

Pin Number 2 gate signal  
Pin Number 3 sensor wire

The sensor wire is electrically the same point as the cathode.

2.3 The SCR 5 is bad. Replace the SCR 5.

To 2.4



From 2.2

2.4 The SCR 5 is correct. Make a resistance "quick check" of SCR 2. See the Checks And Repairs section for instructions on checking the SCRs. The following pins of the card connector are for SCR 2:

Pin Number 8 gate signal  
Pin Number 9 sensor wire

The sensor wire is electrically the same point as the cathode.

2.5 The SCR 2 is bad. Replace SCR 2.

2.6 The SCR 2 is correct. Check C1 for a short-circuit. Disconnect C1 and measure the resistance between the terminals. A good C1 will first indicate a low resistance and then increase to more than 100 000 ohms.

2.7 The C1 is bad. Replace C1.

2.8 The C1 is good. If the fault has not been found by this step, replace the control card. Connect the battery and check the operation of the lift truck.

2.9 The lift truck still has the fault. Disconnect the battery and discharge the capacitors C1. Replace the SCR 2 suppressor. If the SCR 2 suppressor replacement does not correct the fault, replace the SCR 5 suppressor. Check the transformer and inductor assembly. See the Checks And Repairs section for instructions.





## RAISE DRIVE WHEELS

### FAULT NUMBER 3. LIFT TRUCK WILL NOT MOVE IN EITHER DIRECTION. THE DIRECTION CONTACTORS CLOSE NORMALLY (NO PMT FAULT)

#### Possible Causes:

Open circuit in traction circuit  
Fuse for the traction circuit is bad  
Traction motor has a defect  
Accelerator potentiometer bad or linkage needs adjustment  
Control card has defect (no gate signal to SCR 1)  
Wires to motor current sensor have an open circuit  
SCR 2 is bad  
SCR 1 is bad

3.0 Check the wires to the motor current sensor for an open circuit. The traction circuit will not operate if the wires between the current sensor and the control card have a fault.

Connect the battery and turn the key switch to the "ON" position. Set the controls to operate in the "REVERSE" direction. The "REVERSE" contactor must close.

Check for battery voltage between battery negative and the anode of SCR 1.

3.1 No battery voltage at the anode of SCR 1. Check the fuse to the traction circuit. Check for battery voltage between battery negative and the fuse.

Fuse for the traction circuit is bad. Disconnect the battery. Check the following parts for a short-circuit:

- Diode D 3
- Traction motor
- Power cables and connections

3.2 Battery voltage at the anode of SCR 1 is correct. Check the voltage between the anode and cathode of SCR 1.

3.3 No voltage between the anode and cathode of SCR 1. Check the following parts for an open circuit:

- Power cables and connections.
- Traction motor brushes.
- Armature of field of the traction motor.

3.4 Battery voltage between the anode and cathode of SCR 1. Disconnect the battery and check SCR 1.

3.5 Replace a bad SCR 1.

To 3.6



From 3.4

3.6 SCR 1 is correct. Check SCR 2.

3.7 Replace a bad SCR 2.

3.8 SCR 2 is correct. Check the accelerator potentiometer voltage between R5 and battery negative. The correct voltage is 4.0-4.5 volts and decreases to 0.0-0.2 volts at maximum speed.

3.9 The voltage at R5 is wrong. Check the linkage and the adjustment of the accelerator potentiometer. If the voltage does not decrease smoothly between "CREEP" speed and maximum speed, replace the accelerator potentiometer.

3.10 The accelerator potentiometer voltage is correct. Replace the control card.





## RAISE DRIVE WHEELS

### FAULT NUMBER 4. ONE DIRECTION CONTACTOR WILL NOT CLOSE. TRACTION CIRCUIT OPERATES NORMALLY IN ONE DIRECTION

#### Possible Causes:

Direction switch has a defect  
Control card has a defect  
Contactor coil is bad  
Broken or disconnected wires  
PMT electronic driver has a defect on one output

4.0 Connect the battery and turn the key switch on the "ON" position. Close the seat switch, and push on the accelerator pedal. Set the controls to operate in the direction that the contactor will not close.

If the "FORWARD" contactor does not close, check for battery voltage between L9 and battery negative. If the "REVERSE" contactor does not close, check for battery voltage between L10 and battery negative.

4.1 No voltage between L9 or L10 and battery negative. Repair or replace the directional switch or the wires. Make sure that you check for a broken wire that still has the outer insulation in good condition.

4.2 Voltage at L9 or L10 is correct. Check the PMT signal. Check for greater than 0.5 volts between R3 and battery negative of the control card. Typical voltage is 1.0-2.0 volts. A voltage less than 0.5 volts indicates a fault.

4.3 The PMT signal is less than 0.5 volts. The control card has a fault. Replace the control card.

4.4 The control card is correct. Check for battery voltage on the negative terminal of the contactor coil that will not close.

4.5 The voltage on the negative terminal of the contactor coil is approximately 0 volts. Check the voltage on the positive terminal of the contactor coil. If there is voltage on the positive terminal, replace the contactor coil. If there is no voltage on the positive terminal, check and repair the direction switch or the wires.

To 4.6



From 4.4

4.6 The voltage on the negative terminal of the contactor coil is approximately battery voltage. The PMT electronic driver has a defect. Measure the voltage between the terminal 3 (REVERSE") or terminal 4 ("FORWARD") and battery negative. 0 volts is correct between the terminal and battery negative in the direction that the contactor will not close. Battery voltage indicates that the PMT electronic driver is not sending a signal to the contactor coil.

4.7 Voltage is wrong across the PMT electronic driver. Replace the PMT electronic driver.

4.8 Voltage is correct across the PMT electronic driver. Check the wires between the PMT electronic driver and the contactor coil.





## RAISE DRIVE WHEELS

### FAULT NUMBER 5. DIRECTION CONTACTOR WILL NOT OPEN WHEN PEDAL IS RETURNED TO THE UP POSITION

#### Possible Causes:

Accelerator potentiometer has a defect or has a wrong adjustment

Accelerator card is bad

5.0 Check that the "CREEP" setting on the control card is correct. Connect the battery and turn the key switch to the "ON" position. Close the seat switch and parking brake switch. Set controls to operate in the "REVERSE" direction and push on the accelerator pedal. Measure the voltage between R5 and battery negative. The correct voltage is 4.0-4.5 and decreases to 0.0-0.2 volts when the accelerator is moved to maximum speed.

5.1 The accelerator voltage is not correct. Repair or adjust the accelerator potentiometer.

5.2 The accelerator voltage decreases correctly. Check for a short-circuit in the accelerator card. A short-circuit in the accelerator will cause the following problems: The control card will sense a voltage from the direction switch at L9 or L10 and the contactor coil before the voltage is applied at L5 and L7. The SRO circuit will prevent the PMT electronic driver from closing the direction contactor. If the direction switch is moved when the SRO circuit is completed, the movement will momentarily interrupt the SRO circuit. The logic in the control card will sense the SRO circuit as being correct and the direction contactor will close. When the accelerator is returned to the up position, and the lift truck will stay at "CREEP" speed. The direction contactor will not open.

5.3 The accelerator card has a short-circuit. Replace the accelerator card.

#### CAUTION

If an accelerator card has a short-circuit, check the coil of the contactor for a short-circuit. A short-circuit in the contactor coil will cause a fault in a replacement accelerator card. Make sure any fault has been corrected in the circuit for the direction contactor before you install a new accelerator card.





## RAISE DRIVE WHEELS

### FAULT NUMBER 6. DIRECTION CONTACTORS CLOSE NORMALLY. THE LIFT TRUCK HAS ONLY LOW POWER OR MOVES SLOWLY

#### Possible Causes:

Diode D3 has an open circuit  
Thermal sensor has an open circuit  
SCR 2 bad  
Accelerator potentiometer is bad or has a wrong adjustment  
Control card has a fault  
Field weakening contactor (if equipped) has the contacts welded closed  
Auxiliary plugging contactor is open (E60-120B and N30-50C lift trucks only)  
SCR 2 or SCR 5 suppressors are bad

6.0 Disconnect the battery and discharge the capacity C1. Check D 3 for an open circuit. Check SCR 2. Disconnect SCR 2 to check for this type of fault. The SCR 2 will not indicate a short-circuit, but will indicate a resistance that is less than 50 000 ohms.

6.1 An SCR 2 with less than 50 000 ohms can cause a fault that is not regular. Replace a bad D 3 or bad SCR 2.

6.2 Check the thermal sensor. Remove the wires from both terminals of the thermal sensor. Measure the resistance between the terminals. The correct resistance is 100-200 ohms at approximately 21°C (70°F).

6.3 The thermal sensor is bad. Replace the thermal sensor.

6.4 If the lift truck is equipped with a field weakening contactor, check that the contactor tips are not welded closed. Check that the adjustments "F.W.P.U." and "F.W.D.O." on the control card are set to the correct specifications.

6.5 Repair a bad field weakening contactor.

To 6.6



From 6.4

6.6 Connect the battery and turn the key switch to the "ON" position. Close the seat switch and parking brake switch. If the lift truck is equipped with an auxiliary plugging contactor, check that the (AP) contactor closed after one of the direction contactors closed.

6.7 The auxiliary plugging contactor did not close. See Fault Number 9A for the procedure to check the auxiliary plugging system.

6.8 Check the acceleration controls. Measure the voltage between R5 on the control card and battery negative. The correct voltage is 4.0-4.5 volts and decreases to 0.0-0.2 volts when the accelerator is moved to maximum speed.

6.9 The accelerator voltage is not correct. Repair or adjust the accelerator potentiometer.

6.10 If the lift truck is equipped with a field weakening contactor, check if the contactor closed when you connected the battery and closed the SRO circuit.

6.11 If the field weakening contactor is closed, replace the field weakening electronic driver.

6.12 If the fault is not found before this step, replace the control card.

**NOTE.** Make sure the correct control card is used. If a 1H3 control card is used as a replacement for a 1E3 control card, the field weakening function can be continuously energized.

6.13 If a replacement control card did not correct the fault, replace the suppressor for the SCR 2 and SCR 5.

6.14 If the fault is not found before this step, make sure that you are using the correct fault procedure. Contact a Hyster dealer for other recommendations.





## RAISE DRIVE WHEELS

### FAULT NUMBER 7. CONTACTOR 1A WILL NOT ENERGIZE. THE OTHER OPERATIONS OF THE LIFT TRUCK ARE NORMAL

#### Possible Causes:

Control card is bad or needs adjustment

Contactor 1A has a defect

1A electronic driver is bad

Accelerator card is bad.

Violet sensor wire from T2 to pin 2 on the control card is open

7.0 Disconnect the battery and separate the connector. Check the adjustments "C/L", "1A TIME" and "1A D.O." on the control card. Check the wires between the current sensor and the control card.

7.1 Set the adjustments according to 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.

7.2 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 R5 and battery negative. The correct voltage is 4.0-4.5 volts and decreases smoothly to 0.0-0.2 volts when the accelerator is moved to maximum speed.

7.3 The voltage at R5 is wrong. Check the linkage and the adjustment of the accelerator potentiometer. If the voltage does not decrease smoothly between "CREEP" 0.0-0.2 volts at maximum speed, replace the accelerator potentiometer. This signals voltage must decrease to less than 0.5 volts before the control card will permit the contactor 1A to close on "DEMAND".

To 7.4