

# INTRODUCTION

## GENERAL

This section describes how to select and do the maintenance for large batteries used in electric lift trucks. This information is for service personnel that must do the maintenance on large lead–acid batteries. Battery repair requires special training and equipment. Do not try to repair a battery unless you have the correct tools, equipment and experience. Most battery repairs are done by a special repair service.

## LEAD–ACID BATTERIES

A lead–acid battery converts chemical energy into electrical energy. Chemical changes within the battery gives the electrical energy. When the chemical reaction has occurred so that the battery will not give its rated voltage and current, the battery is discharged. A reverse chemical action must occur so that the battery can be used again. The batteries described in this section can be charged again by an electric voltage and current from an outside source so that there is a reverse chemical action. The lead–acid chemicals store the electric energy until the electric energy is needed to operate an electric device.

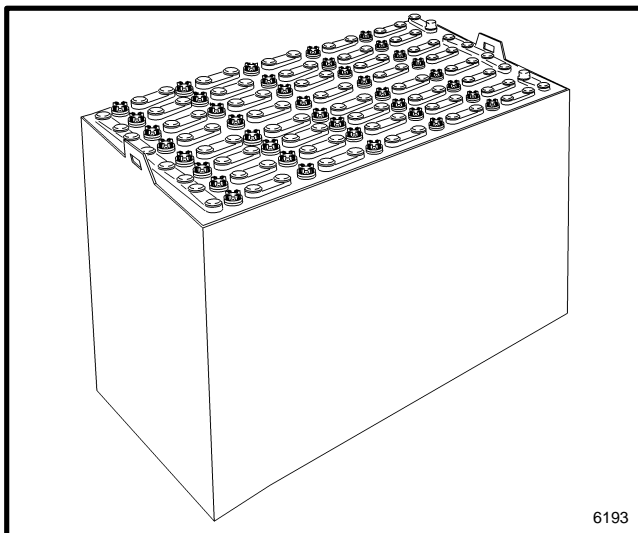


FIGURE 1. LEAD–ACID INDUSTRIAL BATTERY

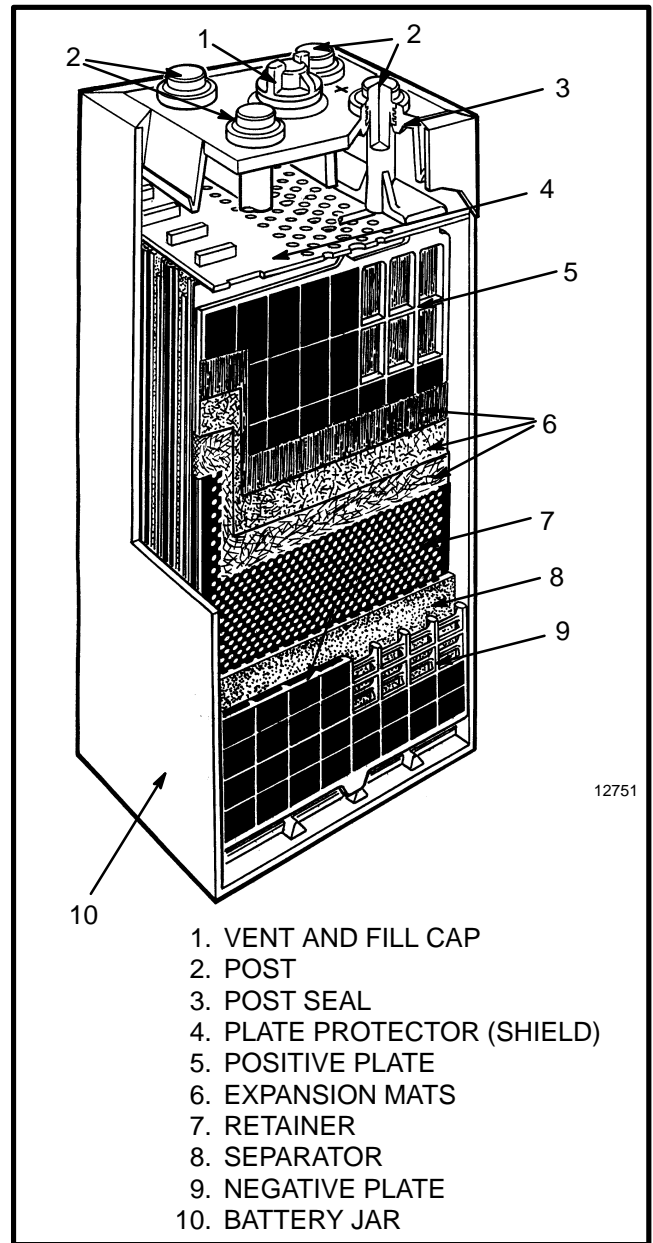


FIGURE 2. THE BATTERY CELL

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

## SPECIFIC GRAVITY

The strength of the electrolyte is measured in points of specific gravity. For example, a solution of sulfuric acid has a specific gravity of 1.835. Water has a specific

gravity of 1.000. Electrolyte is 27% acid and 73% water and has a specific gravity of 1.275.

**⚠ CAUTION**

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

**THE CHEMICAL REACTION IN A CELL**

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

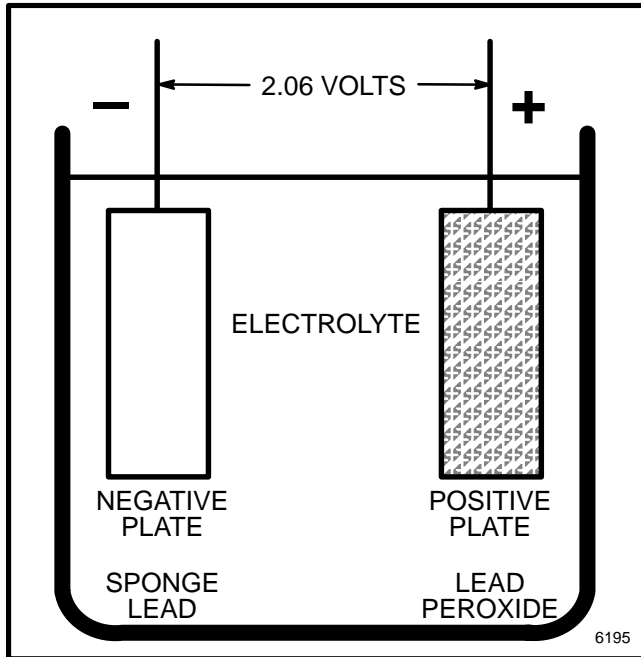


FIGURE 3. FULLY CHARGED CELL

The cell generates a voltage (potential difference) when two different types of metal are in the electrolyte. The two metals in a lead–acid cell are lead peroxide ( $PbO_3$ ) for positive plates, and sponge lead ( $Pb$ ) for negative plates. See FIGURE 3. A potential difference of approximately two volts per cell is generated. The potential difference does not vary according to the size of the cell.

During the discharge of the cell, lead peroxide and sponge lead mix with sulfuric acid to make lead sulfate ( $PbSO_4$ ) on both plates. See FIGURE 4. This action decreases the voltage in the cell. When the sulfuric acid is

removed from the electrolyte, the specific gravity of the electrolyte decreases. See FIGURE 5. The potential difference of a discharged cell is approximately 1.75 volts.

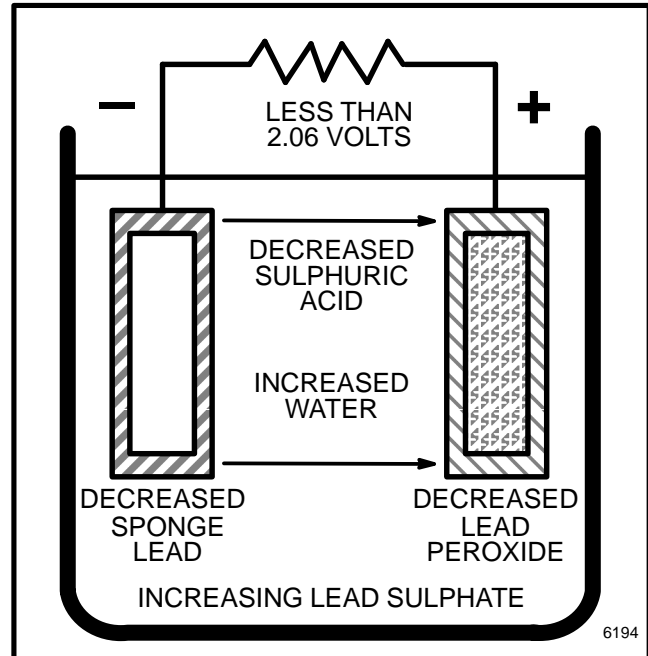


FIGURE 4. CELL IS DISCHARGING

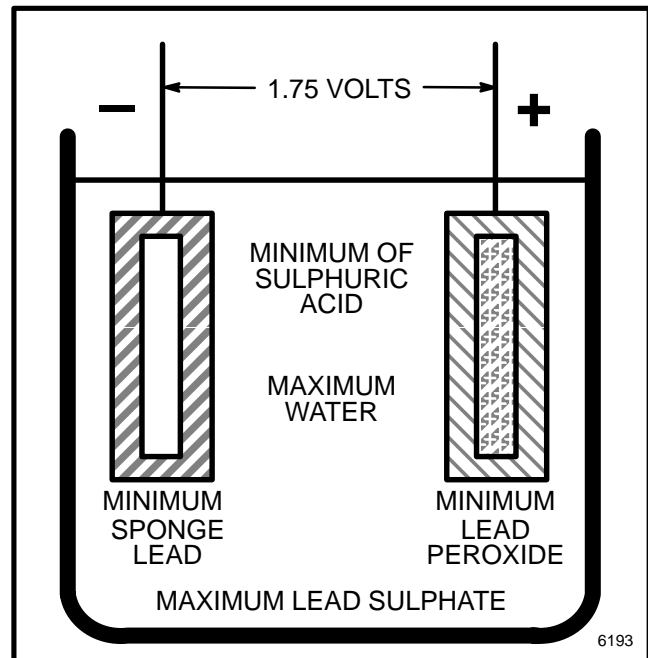


FIGURE 5. DISCHARGED CELL

When a direct current is applied to a discharged cell, the lead sulfate is changed into lead and sulfuric acid. The lead goes to the positive plate and stays as lead and to the negative plate and stays as lead peroxide. See FIGURE 6. The concentration of sulfuric acid in the

electrolyte increases. The specific gravity of the electrolyte increases as the concentration of sulfuric acid increases. In a fully charged cell, the positive plate again contains the lead peroxide and the negative plate contains the sponge lead.

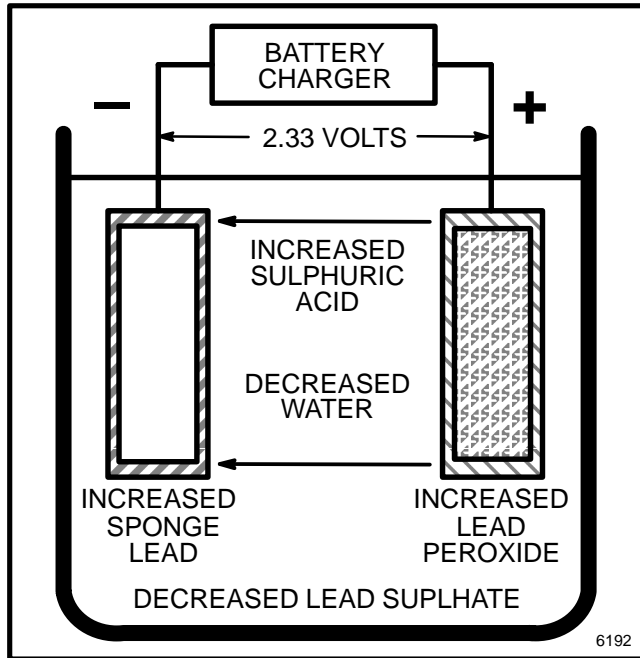


FIGURE 6. CELL IS CHARGING

## ELECTRICAL TERMS

**Voltage** is an electromotive force (EMF) (also called “potential difference”) caused by the difference in electric charge between two points.

**Ampere** is a measurement of electric current.

**Watt** is a measure of electric power. The number of watts is equal to the number of volts multiplied by the number of amperes. A kilowatt-hour is 1000 watts of electric power used in one hour.

**Ohms** is the measurement of electrical resistance.

**Polarity.** In a battery, the electric current is shown to flow from the positive terminal to the negative terminal.

**Direct Current (DC).** When the voltage between the two terminals is always the same polarity, the current flow and voltage is called Direct Current.

**Alternating Current (AC).** When the polarity of voltage between two terminals is changing between positive and negative at a quick and constant rate, the voltage is called Alternating Current.

## HOW TO SELECT THE BATTERY

The battery needed to operate a period of eight hours depends on many conditions. Operations that require the lift truck to go up ramps or require the use of additional attachments increases the use of power from the battery. Some work conditions require that more than one battery must be used during a work period. The number of eight hour work periods per day is normally equal to the number of batteries needed. For example, for three work periods you need three batteries. The capacity of the battery you need is found as follows:

- The size of the lift truck and the attachments.
- The type of work. Heavy duty operation or normal operation for one eight hour work period.

Lift trucks are available in various voltage ranges. The small “WALKIE” lift trucks are normally 12 or 24 volts. The larger sit-down rider lift trucks are normally 24, 36, 48, 72, or 80 volts. The number of cells in a lead-acid battery gives the battery voltage. A fully charged cell has a potential difference of approximately two volts. This potential difference does not change with size of the cell.

## VOLTAGE OF A BATTERY

The battery voltage you need is found as follows:

- Will your lift truck operate on more than one voltage?
- If you have more than one lift truck in operation, do the battery voltages need to be the same?

To reach the necessary battery voltage, the cells are connected in series. For example:

24 volts = 12 cell battery  
 36 volts = 18 cell battery  
 48 volts = 24 cell battery  
 72 volts = 36 cell battery  
 80 volts = 40 cell battery

(More Content includes: Brake system, Capacities, and specifications, Frame, Hydraulic, System, Industrial battery, Main control, Valve, Mast repair, Fasteners, Schematics diagrams, Steering axle, Steering system, Wire harness repair And more)

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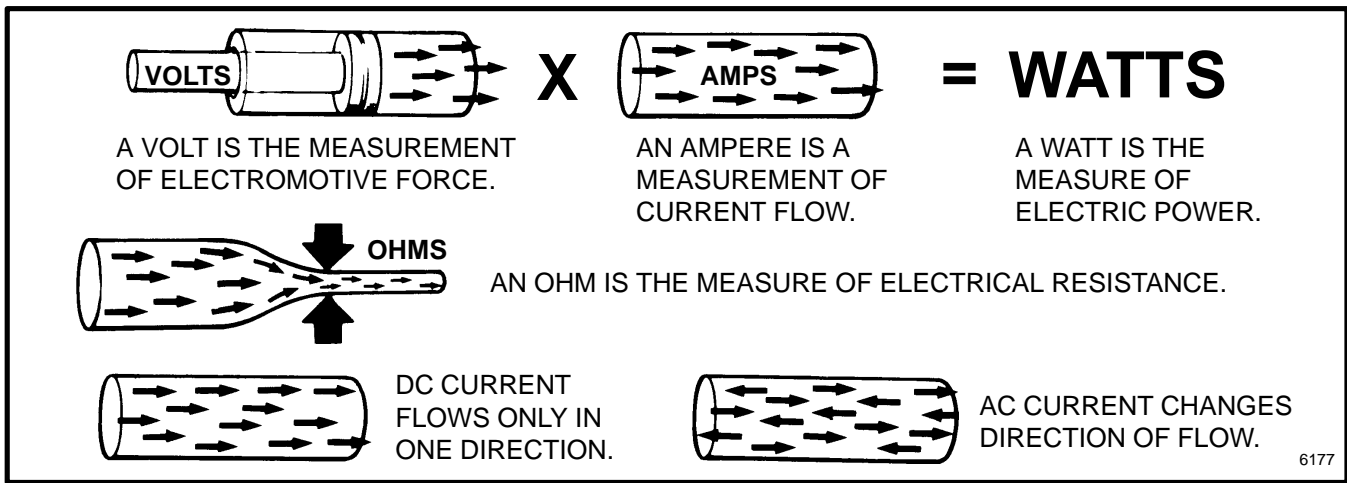


FIGURE 7. ELECTRICAL TERMS

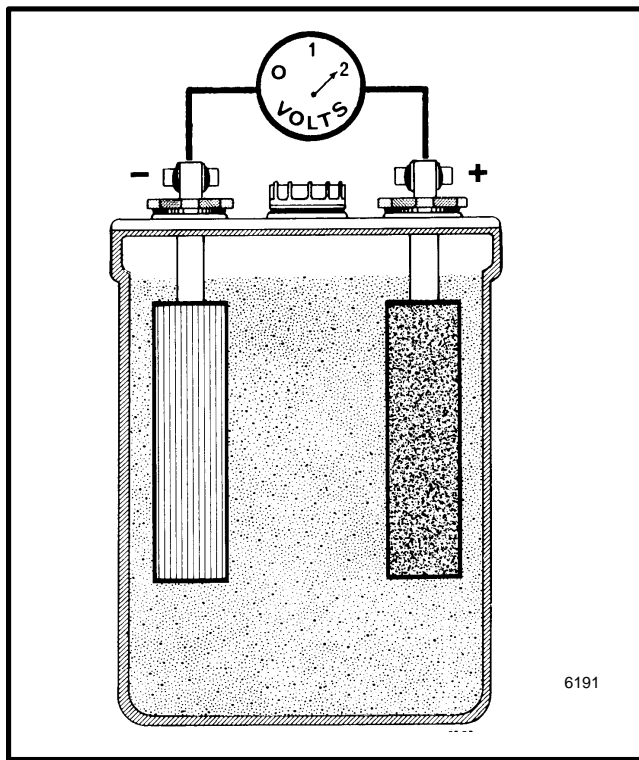


FIGURE 8. CELL VOLTAGE

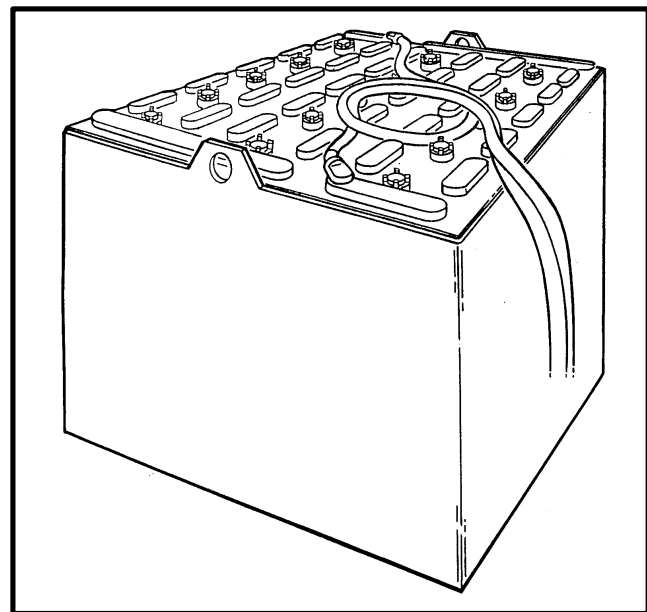


FIGURE 9. MULTI-CELL BATTERY FOR ELECTRIC LIFT TRUCK

## THE BATTERY AS A COUNTERWEIGHT

On electric lift trucks that use the battery as part of the counterweight, the battery is part of the capacity of the lift truck to lift loads. The minimum weight of the battery is shown on the nameplate. If the battery is not the minimum weight, the capacity of the lift truck is reduced. If the battery used in the lift truck is less than the size of the battery compartment, blocks and spacers must be installed to hold the battery in position.

## BATTERY RATINGS

The ratings of batteries are measured in ampere-hours and kilowatt-hours at a constant rate of discharge. A rating of six hours is the standard. Ampere-hours is the measurement of battery capacity. To calculate ampere-hours, multiply amperes by hours. For example, 5 amperes times 5 hours is 25 ampere-hours. You cannot change the potential difference of a cell. You can increase the ampere-hour rating by increasing the number of plates in a cell, or by installation of larger plates. The constant rate of discharging can be compared to a measurement of the battery capacity and ampere-hours. For example, a battery with a rating of 600 ampere-hours during a work period of six hours will generate 100 am-

peres per hour for six hours. The same battery can not generate 300 amperes for two hours. The heat generated within the battery will damage the battery.

### Kilowatt–Hours

A kilowatt is 1000 watts. A watt is a measure of electric power. The capacity in kilowatt–hours is the total power generated by the battery. Watt–hours are measured by multiplying the voltage by ampere–hours. To measure the kilowatt–hours, divide the watt–hours by 1000.

$$\frac{\text{Volts} \times \text{amperes} \times \text{hours}}{1000} = \text{kilowatt–hours or KWH}$$

To calculate the kilowatt–hours for a battery that has a rating of 600 ampere–hours and a 48 volt system, use this formula:

$$\frac{48 \text{ volts} \times 600 \text{ ampere–hours}}{1000} = 28.8 \text{ KWH}$$

Read the battery selection book available from your dealer for HYSTER lift trucks. This book shows the watt–hours in electric energy needed for various operations. A description of the operation includes distances, loads, ramps, lifting heights, attachments, etc. The watt–hours can be converted to kilowatt–hours to indicate the battery needed for the operation. Always select the correct type of battery. Remember, a battery that has a rating of 300 ampere–hours will not do the same job as a battery that has a rating of 600 ampere–hours. Do not permit the specific gravity to go below the limits shown in the manual.

AMPERES x HOURS = AMPERE–HOURS

600 AMPERE–HOURS =  
100 AMPERES FOR SIX HOURS

VOLTS x AMPERES x HOURS/1000 =  
KILOWATT–HOURS (KWH)

FIGURE 10. BATTERY CAPACITY TERMS

## BATTERY MAINTENANCE

Battery maintenance must include the following items:

- a good battery charger
- a clean battery
- keep the electrolyte at the correct level
- and keeping a record of the battery.

2. Batteries generate hydrogen gas when they are being charged. Keeps open fire away from batteries. Do not check the electrolyte level with a match or a lighter. No smoking and do not create sparks.

3. Lift batteries correctly with a crane or equipment designed for the job. Always use a spreader bar designed and adjusted for the battery. Move batteries with a lift truck or a conveyor or rollers designed for that purpose. If the battery does not have a cover, a rubber mat or

### SAFETY PROCEDURES

1. Wear a rubber apron, gloves, boots, and goggles or a face shield when doing maintenance on batteries.

Battery Inspection Report <span style="float: right;">Date _____</span>									
Battery No. _____				Dept. Used In _____					
Battery Type _____				MFR. _____					
Serial No. _____				Date New _____					
Reading on Charge at _____ Amperes				Charger No. _____					
CELL NO.	CELL VOLTS	POSITIVE CADMIUM	SPECIFIC GRAVITY	TEMP.	CELL NO.	CELL VOLTS	POSITIVE CADMIUM	SPECIFIC GRAVITY	TEMP.
1					21				
2					22				
3					23				
4					24				
5					25				
6					26				
7					27				
8					28				
9					29				
10					30				
11					31				
12					32				

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FIGURE 11. BATTERY INSPECTION REPORT

Daily Battery Record									
Battery No. _____					Month _____ Year _____				
Battery Type _____					MFR. _____				
Serial No. _____					Date New _____				
Total Cycles For Month _____					Total Cycles To Date _____				
DATE	TRUCK NO.	SPECIFIC GRAVITY		TEMP. PILOT CELL	TIME ON CHARGE	TIME OFF CHARGE	INITIAL AMPS	WATER ADDED	OPERATOR
IN	OUT								

FIGURE 12. BATTERY INSPECTION REPORT

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insulating material must be put over the top of the battery to prevent a short-circuit with other equipment. Make the the lifting equipment has enough capacity for the job. Do not use chain or wire rope slings.

- 4. Never put metal materials or tools on a battery.
- 5. Disconnect the battery from the lift truck before doing maintenance or repairs.
- 6. When maintenance on the battery or the battery charger is required, disconnect both the AC and DC power. If the battery connectors must be replaced, make sure the positive and negative terminals and cables are kept separate and insulated from each other. Even a momentary short-circuit can cause an explosion and damage the battery.
- 7. Keep water readily available to flush spilled electrolyte. Electrolyte in the eyes must be flushed with water immediately and then quickly get medical attention. Special showers and eye wash systems are required in areas where battery maintenance is done.
- 8. If electrolyte is spilled on a work surface or the floor, flush the area with water, use a solution of soda (sodium bicarbonate) to make the acid neutral.

9. Only trained persons are permitted to do maintenance on batteries and battery chargers. Make sure that the regulations by government safety agencies, government insurers, private insurers, and private organizations are followed when doing maintenance on batteries.

**MAINTENANCE RECORDS**

**NOTE:** Follow the same sequence when you record the cell number. Always begin the record with a positive cell. Follow a sequence so that the last cell is always the cell for the negative cable.

Record the beginning ampere reading of the charger each time the battery is charged. Any difference in the daily ampere reading can indicate a problem with the battery or the charger.

**THE NEW BATTERY**

Inspect a new battery for damage. Make sure the electrolyte in each of the cells is at the correct level. Charge the battery for six hours or until the specific gravity is correct. Make sure the battery is correctly installed in the lift truck. Use a spreader bar with slings designed for the battery to lift and move the battery. See FIGURE 13.

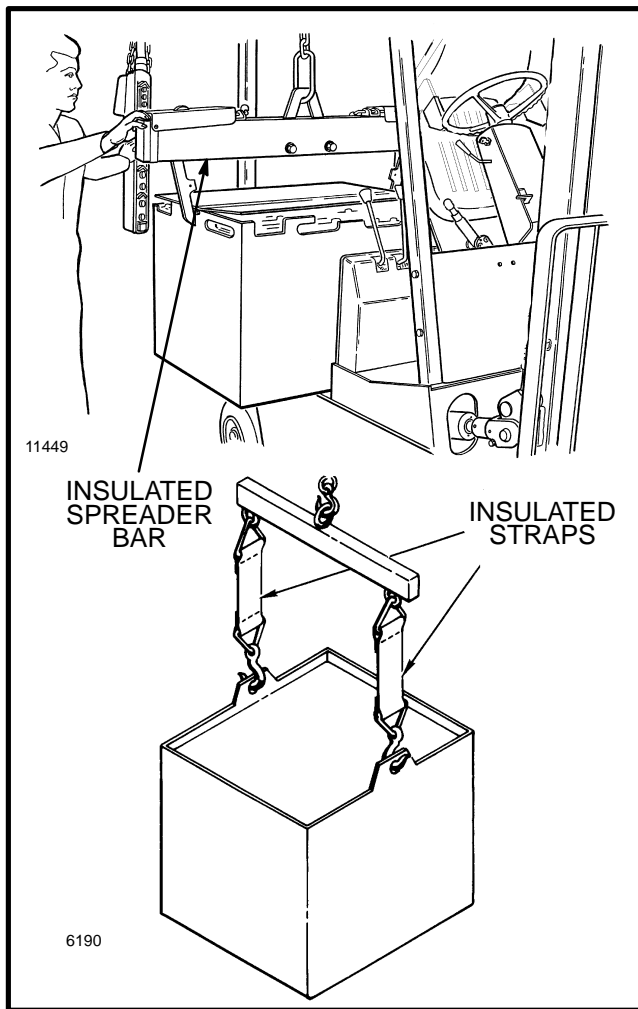


FIGURE 13. CHANGE THE BATTERY

### ⚠ 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 that 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. Some service persons check some of the cells each day so that all of the cells are checked each 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.



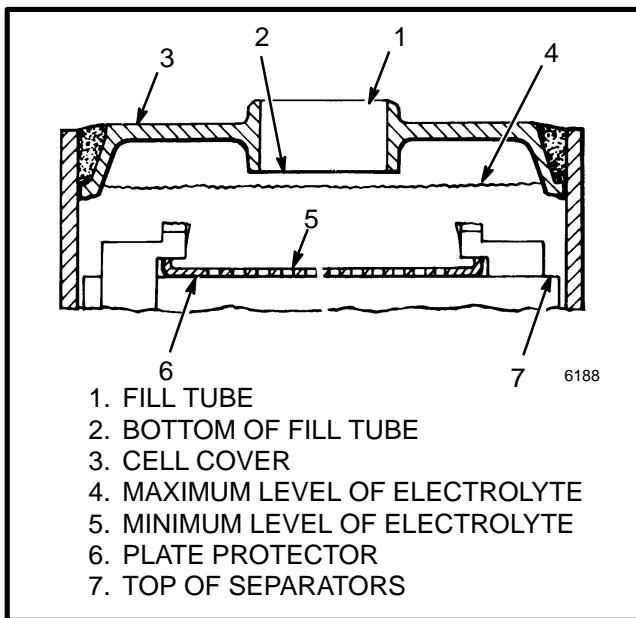


FIGURE 14. ELECTROLYTE LEVEL

## THE HYDROMETER

**NOTE:** Some batteries have sealed cells. The specific gravity of the electrolyte cannot be checked on these batteries.

Use a hydrometer to measure the specific gravity of the battery. Make sure there is enough electrolyte in the battery cells. See "How To Add Water". A high level or low level of the electrolyte can change the specific gravity measurement. When the electrolyte level is low, the percent of sulfuric acid in the electrolyte increases. When

the electrolyte level decreases by 3 mm (1/8 in), the specific gravity measurement can increase by 3 to 5 points.

When you use the hydrometer, make sure there is enough liquid in the barrel to let the float move freely. The float must not touch the side, top, or bottom of the barrel. See FIGURE 15. for the correct method of reading the hydrometer.

## BATTERY TEMPERATURE

The temperature of the electrolyte will change the reading of the specific gravity. When the temperature increases approximately 6°C (10°F), the specific gravity will decrease by 0.003 points. See FIGURE 16. for making specific gravity corrections. If the hydrometer you are using does not have a temperature correction, you will have to use a thermometer. Special battery thermometers are available that will indicate the correction factor directly and add or subtract the correct number of points. See FIGURE 17.

Never charge a battery at a rate that will raise the electrolyte temperature above 49°C (120°F). Never let a battery stay discharged for long periods. A temperature above this amount will damage the battery. The cells in the center of the battery are normally at the highest temperature. If the battery temperature is too hot, make sure the ventilation of the battery is increased and make sure that the charge or discharge rate is not too high. A recommendation for a battery in service is 8 hours of use (discharge), followed by 8 hours of cooling, followed by 8 hours of charging.

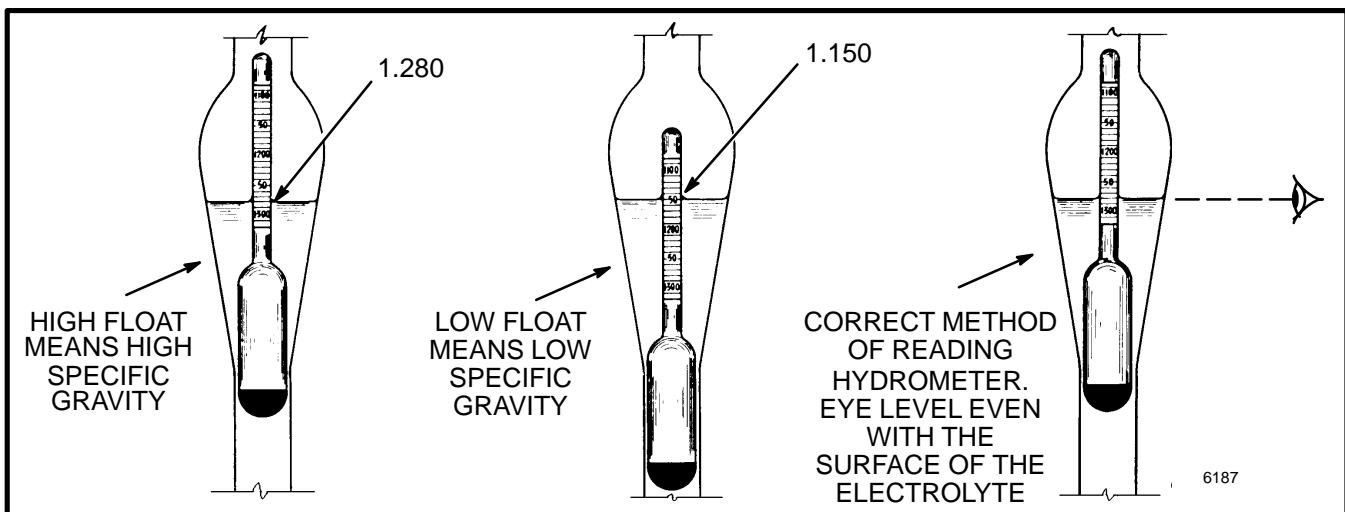
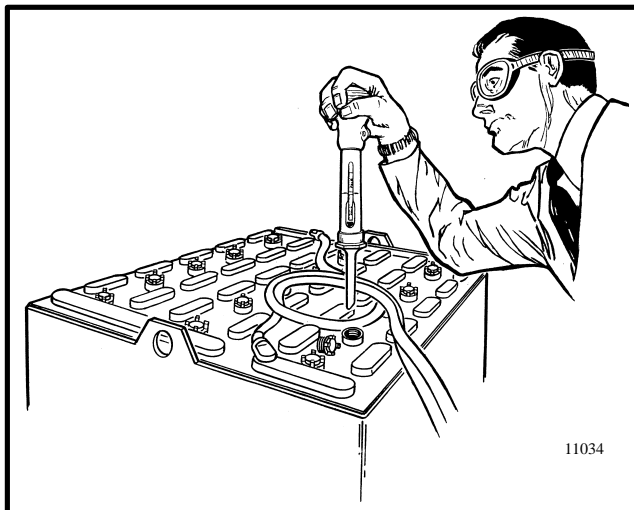


FIGURE 15. READING THE HYDROMETER

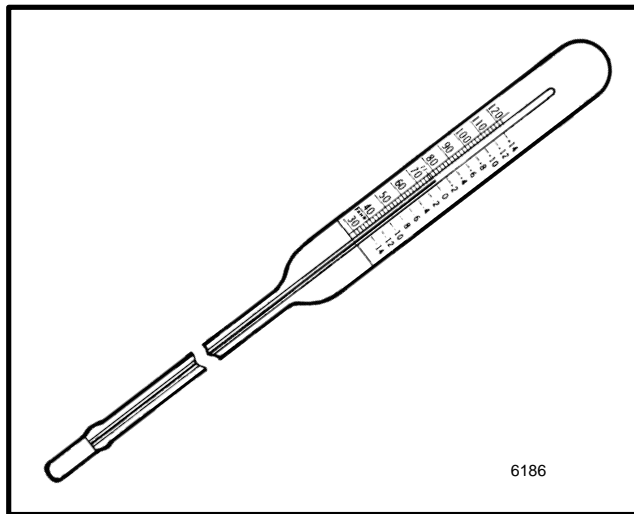


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SPECIFIC GRAVITY READING	ELECTROLYTE TEMP.	CORRECTION POINTS	CORRECT VALUE
1.210	31°C (87°F)	+0.003	1.213
1.210	27°C (80°F)	+0.001	1.211
1.210	25°C (77°F)	0.000	1.210
1.210	18°C (64°F)	-0.004	1.206

+0.001 or -0.001 for each 2 degrees C from the 25 degree base value.

FIGURE 16. CHECK SPECIFIC GRAVITY



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FIGURE 17. BATTERY THERMOMETER

To charge the battery, a direct current must pass through the cells in the opposite direction to the discharging current. The ampere-hours must be equal to the discharging ampere-hours plus the energy lost as heat. This additional amount of charge will vary according to the battery and the temperature, but the average additional charge is 12%. When the battery is nearly charged, the

final charging must be at a low rate. A charging rate that is too high will cause heating in the battery and a high loss of water from the electrolyte. The charging of the battery must be done correctly or the service life of the battery will be decreased.

## CHARGING THE BATTERY

### ⚠ CAUTION

Use only battery chargers approved by the battery manufacturer or dealer.

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

### ⚠ WARNING

The acid in the electrolyte can cause injury. If electrolyte is spilled, use water to flush the area. Make the acid neutral with a solution of sodium bicarbonate.

Batteries generate explosive fumes when they are being charged. Keep fire, sparks and burning material away from the battery charger area. Prevent sparks from the battery connectors.

Charge batteries only in the special area for charging batteries. When charging the batteries, keep the vent caps clean. The battery charger area must have ventilation so that explosive fumes are removed. Open the hood over the battery or remove the cover if the battery has a cover.

Disconnect the battery when doing cleaning and maintenance.

If the lift truck has been operated with a low battery, check the contactors for welded contacts before a charged battery is connected. The circuit will not reset and lift truck operation cannot be controlled if the contacts are welded. To check the contacts, see the section EV-100 SCR MOTOR CONTROLLER, 2200 SRM 557 of the SERVICE MANUAL.

### ⚠ CAUTION

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

Correct use of the hydrometer (see FIGURE 15.) and proper operation of the battery charger is important. Also see FIGURE 16. Follow the instructions of the charger manufacturer. Never let the battery discharge below the minimum value given by the battery manufacturer. A fully charged battery will have a specific gravity of 1.265 to 1.310 at 25°C (77°F). See FIGURE 16. Never charge a battery at a rate that will raise the electrolyte temperature above 49°C (120°F). Never let a battery to stay discharged for long periods.

### Types Of Battery Charges

1. **NORMAL CHARGE:** This charge is usually given to a battery that is discharged from normal operation. This is often an eight hours charge. Many customers charge the battery at regular intervals that depend on use. This procedure will keep the battery correctly charged if the battery is not discharged below the limit. Always use a hydrometer to check the battery if the battery is charged at regular intervals. Frequent charging of a battery that has a  $\frac{2}{3}$  or more charge can decrease the life of the battery.

2. **EQUALIZING CHARGE:** This charge is at a low rate and balances the charge in all of the cells. The equalizing charge is usually given approximately once a month. It is a charge at a slow rate for three to six hours in addition to the regular charging cycle. Do not give an equalizing charge more than once a week. The most accurate specific gravity measurements for a charged battery will be after an equalizing charge. If the specific gravity difference is more than 0.020 between cells of the battery after an equalizing charge, there can be a damaged cell. Consult your battery dealer.

**NOTE:** Many customers have battery chargers that can follow a program to automatically charge a battery according to recommendations of the battery manufacturer. Use the recommendations of the battery manufacturer for charging the battery. See the section **DC MOTOR MAINTENANCE, 620 SRM 294** for additional information.

The discharge limits and the limits for the specific gravity before the battery must be charged again are shown in FIGURE 18. NEVER discharge a battery below the

limits shown. Discharging a battery beyond the design limits will decrease the service life of the battery.

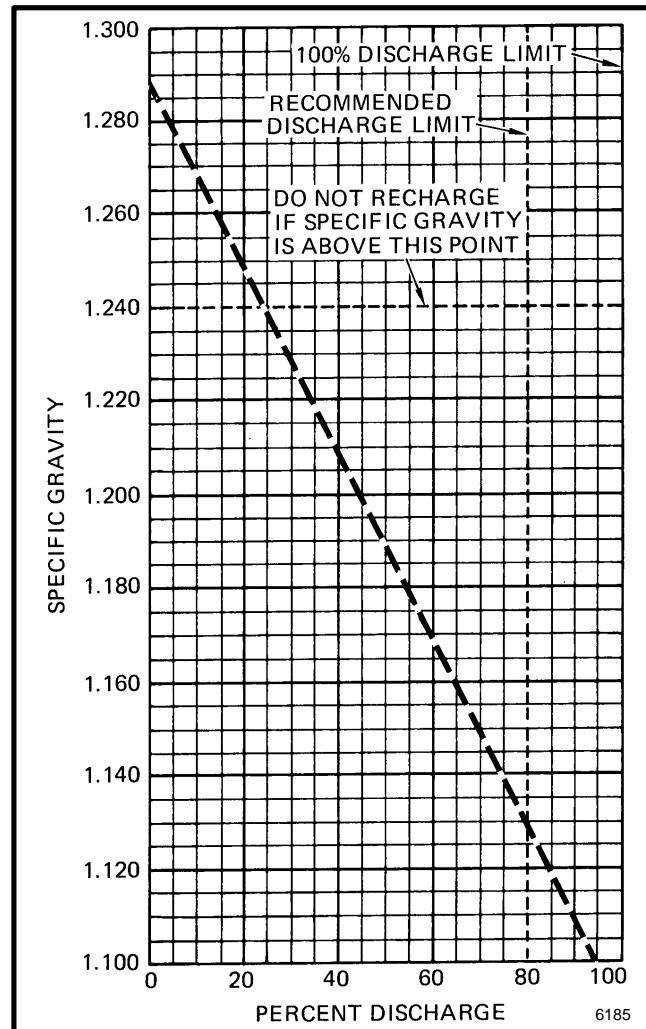


FIGURE 18. SPECIFIC GRAVITY VERSUS PERCENT DISCHARGE

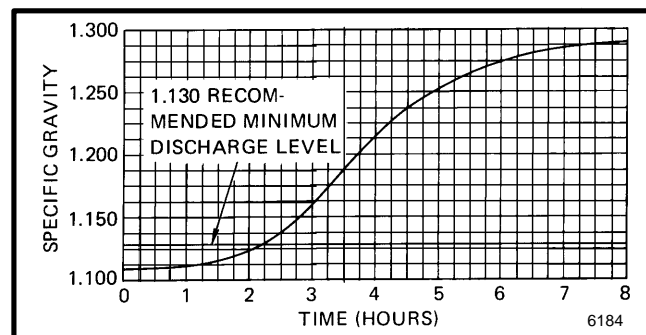


FIGURE 19. SPECIFIC GRAVITY COMPARED TO CHARGING TIME

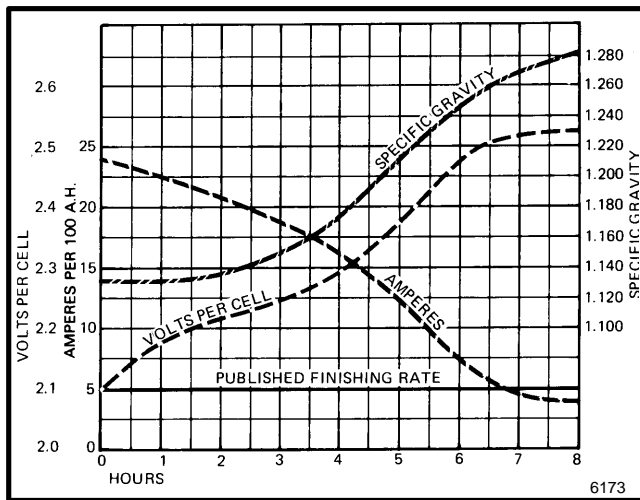


FIGURE 20. SPECIFIC GRAVITY COMPARED TO CHARGING TIME

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

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

### Methods Of Charging

There are three methods of charging a battery.

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

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

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

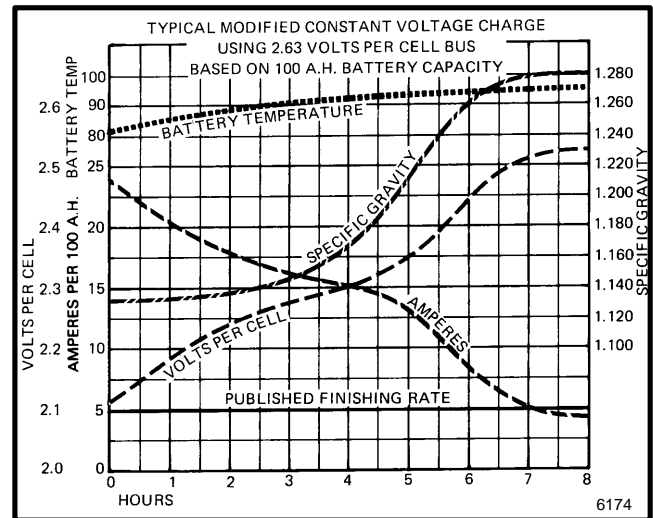


FIGURE 21. MODIFIED CONSTANT VOLTAGE CHARGER

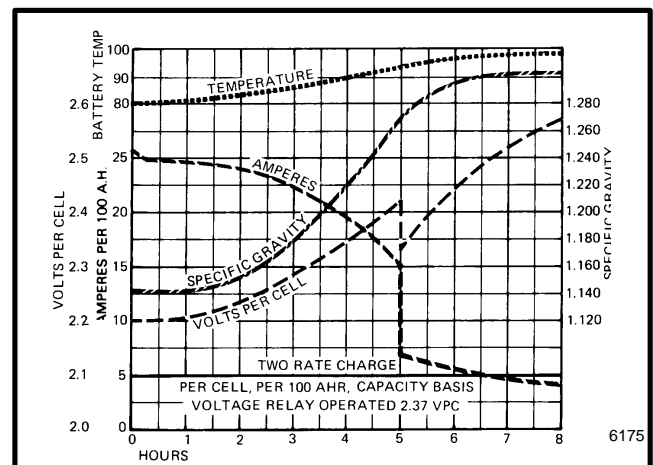


FIGURE 22. TWO-RATE CHARGING CYCLE

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

### Troubleshooting The Charger

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

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

1. Battery temperature is too high. The temperature in a battery will not normally rise more than 14°C (25°F) during an eight hour charging period. Higher temperatures indicate that the charging rate needs adjustment.

2. Continuous operation of the charger. Check the automatic controls on the charger. Check the charging rate. A low charging rate can be the problem.

3. Continuous operation of a charger at a high rate. Normally, the charging rate begins at a high rate and decreases as the battery becomes charged. If the rate does not decrease, the controls need repair or adjustment.

### **WARNING**

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

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

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

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

### **How To Know When The Battery Is Fully Charged**

1. During charging, the voltage increases slowly. When the battery is fully charged, the voltage level is constant.

2. Remove a vent cap and look in the opening. If you see bubbles in the electrolyte, the battery is either fully charged or in the final stage of charging.

3. The specific gravity reading is constant and within the limits of a charged battery. If the temperature increases after the battery is charged, the specific gravity will decrease a small amount.

4. Constant meter indications on the charger will indicate the end of the charging cycle.

## **WHERE TO CHARGE THE BATTERIES**

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

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

### **Equipment Needed**

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

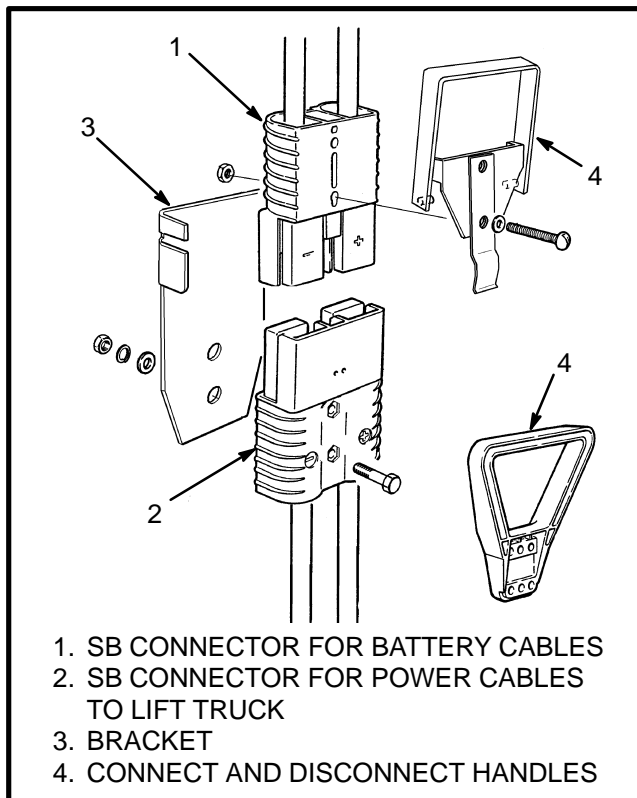


FIGURE 23. THE SB BATTERY CONNECTOR

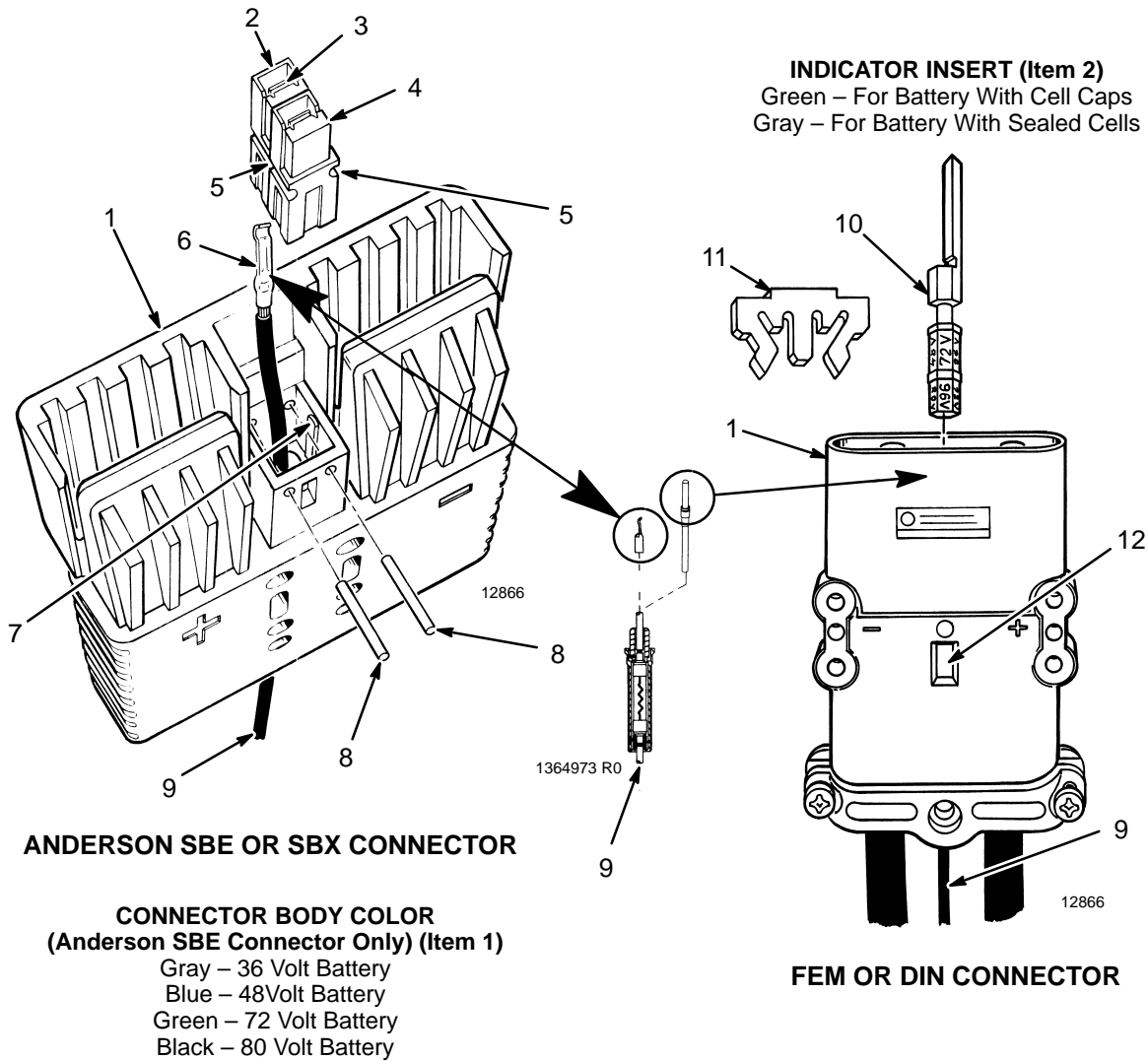
## BATTERY CONNECTORS

A special heavy-duty connector is used to connect the battery to the electrical system of the lift truck. See FIGURE 23. Also see FIGURE 24. When a connector has a handle and is within the operator's reach, the connector is also a safety device that can be used to quickly disconnect the battery in an emergency. Most connectors have a handle to connect the two halves of the connector. The connector can be quickly disconnected by pulling the handle upward. This action separates the two halves of the connector. The connector and its attached

handle must be kept in good repair so that it will function correctly. The battery connector must be disconnected when maintenance is done on the lift truck that does not require electric power. The SBE, SBX, and FEM or DIN 12 volt battery connectors are shown in FIGURE 24.

## BATTERY CARE

1. Keep batteries clean. Remove any spilled electrolyte.
2. Do not over-charge the battery. This action will damage the battery.
3. Do not discharge the battery to less than the recommendation. A deep discharge will shorten the battery life.
4. Charge batteries in an area with good ventilation to remove explosive gases and acid fumes.
5. Keep the electrolyte at the correct level. Check the electrolyte level before and after charging the battery. Use distilled water. Do not add acid.
6. Prevent batteries from freezing.
7. Keep batteries charged. A discharged battery in storage will shorten the battery life.
8. Use a battery charger that is correct for the battery. A battery charger that is set for an ampere-hour rate that is too high will cause a high internal heat and damage the battery. A low ampere-hour rate setting on a battery charger can require a longer charging time but will not damage the battery.
9. When batteries are moved, make sure a short-circuit does not occur. See the Safety Procedures in BATTERY MAINTENANCE of this section.



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

FIGURE 24. DETAIL OF BATTERY CONNECTORS WITH +12 VOLT TAP