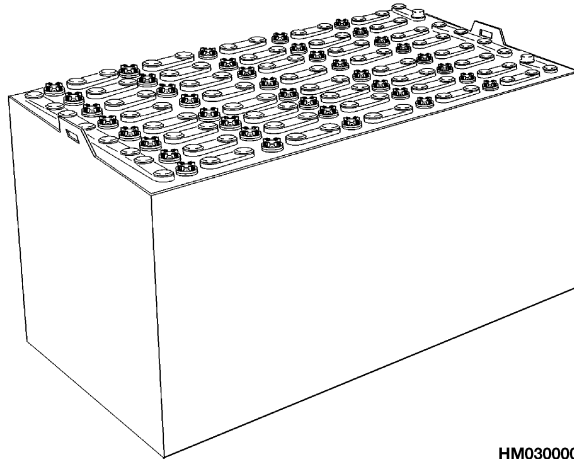


# INDUSTRIAL BATTERY

ALL ELECTRIC LIFT TRUCKS



HM030000

# ***HYSTER***

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This section is for the following models:

All Electric Lift Trucks

(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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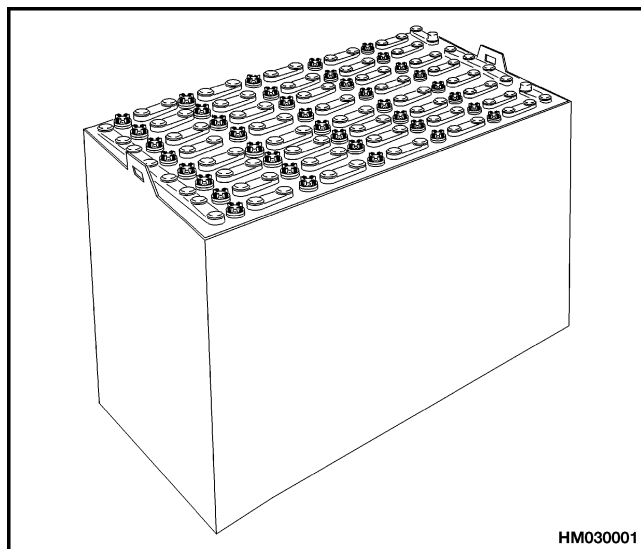
## General

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. Some

batteries have a nameplate attached to the face of the battery cover. This nameplate communicates specific information about the battery including the name of the battery manufacturer, battery type, serial number, nominal voltage, capacity in amperes at the five-hour rate, and service mass (with ballast if used to compensate for lack of battery mass).

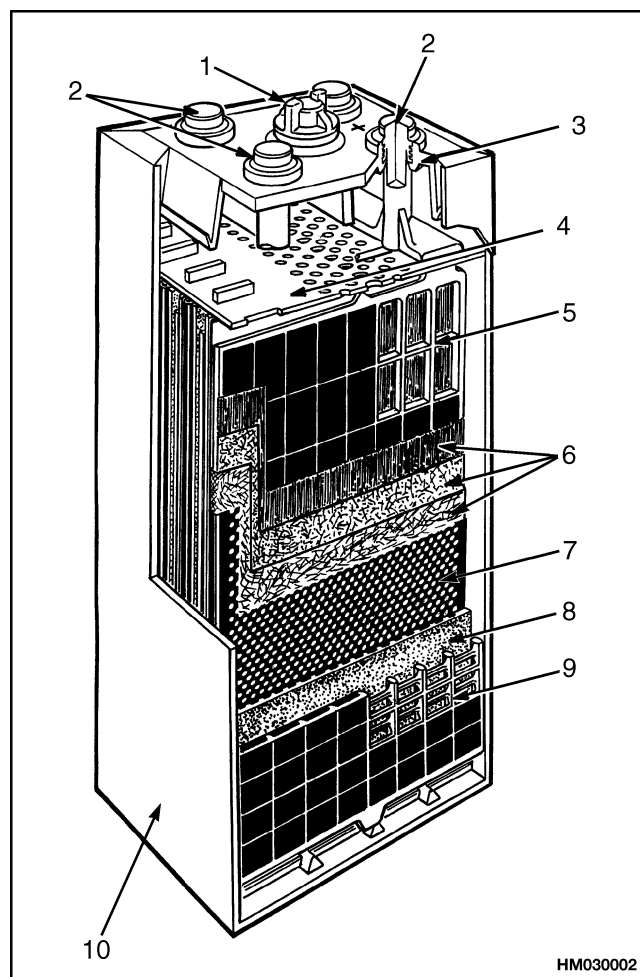
## Lead-Acid Batteries

A lead-acid battery converts chemical energy into electrical energy. See Figure 1. Chemical changes within the battery give the electrical energy. When the chemical reaction has occurred so the battery will not give its rated voltage and current, the battery is discharged. A reverse chemical action must occur so 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 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**

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.



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

**Figure 2. Battery Cell**

## 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 percent acid and 73 percent water and has a specific gravity of 1.275.

## Chemical Reaction in a Cell

### WARNING

**NEVER pour water into concentrated acid. Combining these liquids creates the rapid production of heat which can cause the water to boil and the acid to erupt and splash out of the container. ALWAYS pour concentrated acid into water when making a dilute solution of acid.**

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.

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 ( $PbO_2$ ) for positive plates, and sponge lead ( $Pb$ ) for negative plates. See Figure 3. A potential difference of approximately 2 volts per cell is generated. The potential difference does not vary according to the size of the cell.

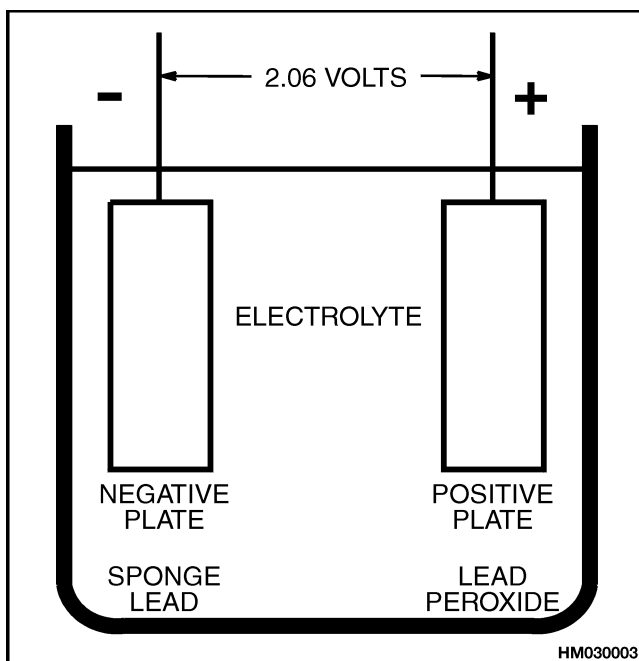


Figure 3. Fully Charged Cell

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.

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

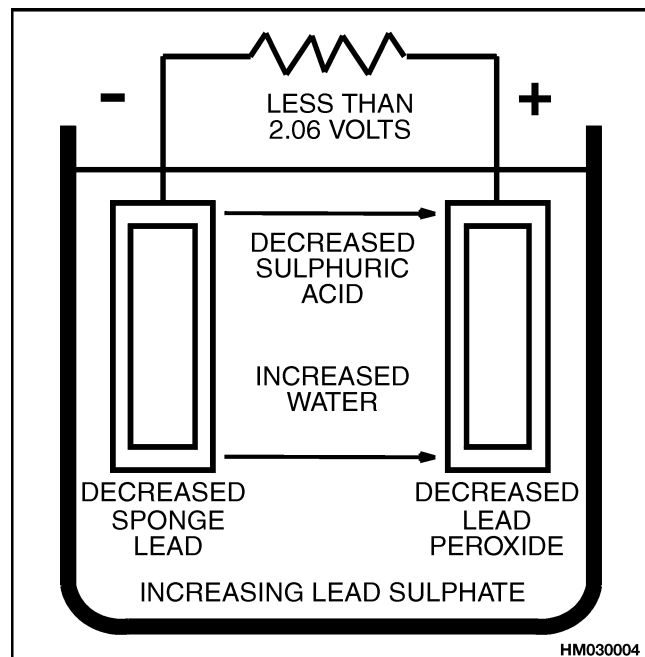
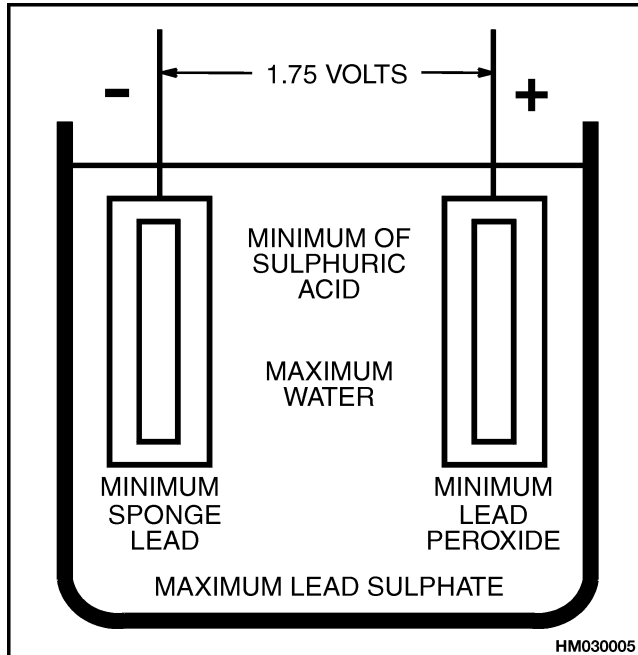
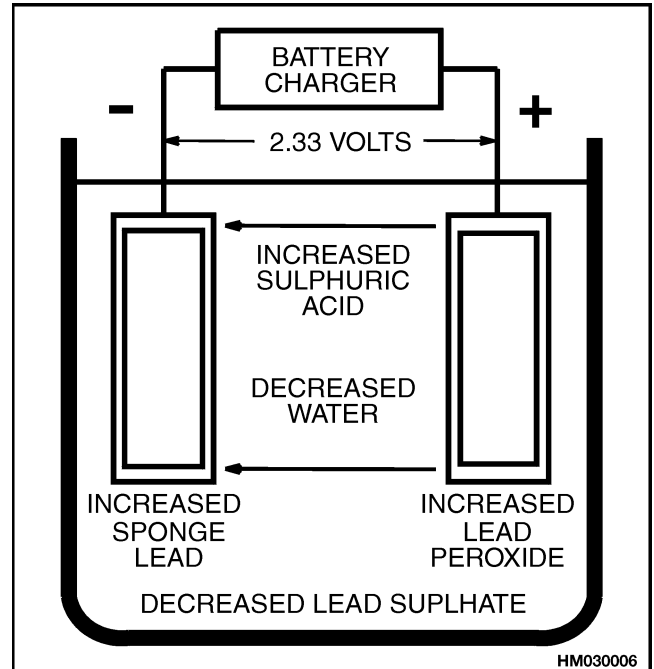


Figure 4. Discharging Cell



*Figure 5. Discharged Cell*



*Figure 6. Charging Cell*

## Electrical Terms

**Voltage:** Is an electromotive force (EMF) (also called "potential difference") caused by the difference in electric charge between two points. See Figure 7.

**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 1 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.

**Maintenance-Free Battery:** The electrolyte level in the battery does not need to be checked during the life of the battery. Maintenance-free batteries use a calcium alloy of lead instead of an antimony alloy, which reduces the amount of electrolysis. In a

maintenance-free battery, the amount of free-standing electrolyte above the plates is much higher, ensuring enough electrolytes to keep the plates covered during extended periods of use. Therefore, there is no need to add water to a maintenance-free battery during the course of its life.

**Flooded Cell:** This is a lead acid battery that has free flowing electrolyte fluid in each cell of the battery. The electrolyte is a mixture of sulfuric acid and water.

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

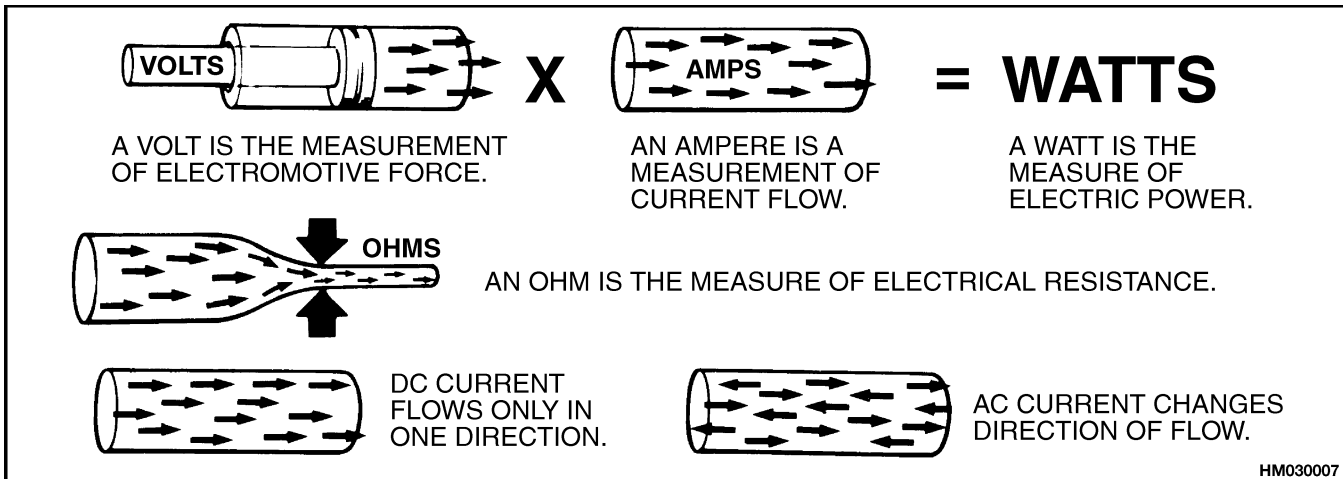


Figure 7. Electrical Terms

## Battery Selection

**NOTE:** The capacity of the battery can be found on the lift truck's Nameplate. See the **Frame** section or **Operating Manual** for your lift truck for the location of the Nameplate.

The battery needed to operate a period of 8 hours depends on many conditions. Operations that require the lift truck to go up ramps or require the use of additional attachments increase 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 8-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 8-hour work period.

Lift trucks are available in various voltage ranges. See Figure 8. 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. See Figure 9. A fully charged cell has a potential difference of approximately 2 volts. See Figure 8. This potential difference does not change with size of the cell.

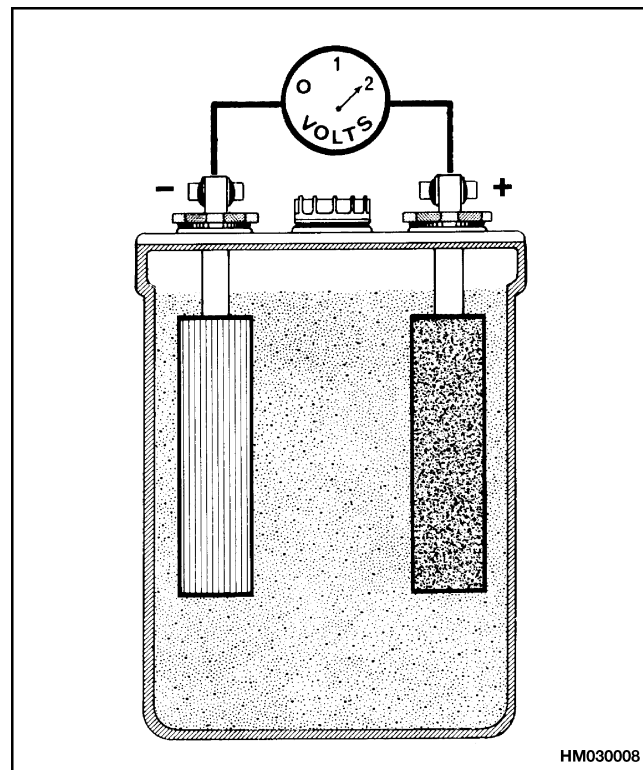
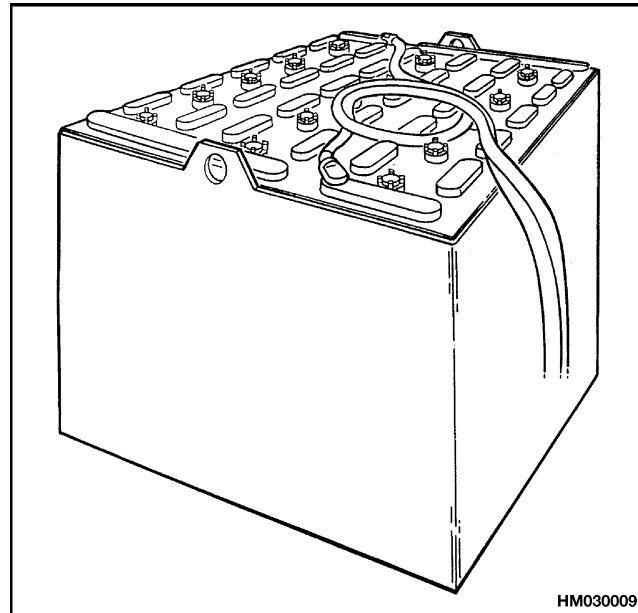


Figure 8. Cell Voltage



*Figure 9. Multicell Battery for Electric Lift Truck*

## Battery Voltage

**NOTE:** The voltage of the battery can be found on the lift truck's Nameplate. See the **Frame** section or **Operating Manual** for your lift truck for the location of the Nameplate.

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

## 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.

See the **Frame** or **Periodic Maintenance** service manual or **Operating Manual** for your lift truck model for the correct measurements for installing battery spacers.



## Battery Ratings

The ratings of batteries are measured in ampere-hours and kilowatt-hours at a constant rate of discharge. A rating of 6 hours is the standard. Ampere-hours is the measurement of battery capacity. To calculate ampere-hours, multiply amperes by hours. See Table 1. 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 6 hours will generate 100 amperes per hour for 6 hours. The same battery cannot generate 300 amperes for 2 hours. The heat generated within the battery will damage the battery.

**Table 1. Battery Capacity Terms**

<p>Amperes × Hours = Ampere-Hours</p> <p>600 Ampere Hours = 100 Amperes for 6 Hours</p> <p>Volts × Amperes × Hours/1000 = Kilowatt-Hours (KWH)</p>
--

### 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:

$$\frac{48 \text{ volts} \times 600 \text{ amperes} \times \text{hours}}{1000} = 28.8 \text{ kWh}$$

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.

## Battery Maintenance

Battery maintenance must include the following items:

- A good battery charger
- A clean battery
- Keep the electrolyte at the correct level (see Figure 13)
- Keep a record of the battery
- An Equalization Charge once a month

### SAFETY PROCEDURES

1. Wear a rubber apron, gloves, boots, and goggles or a face shield when doing maintenance on batteries.
2. Batteries generate hydrogen gas when they are being charged. Keep open fire away from batteries. Do not check the electrolyte level with a

match or a lighter. Do not smoke 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 insulating material must be put over the top of the battery to prevent a short circuit with other equipment. Make sure 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 battery from 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 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 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 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.

## NEW 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 the battery compartment is clean and dry. All**

**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.**

Inspect a new battery for damage. Make sure the electrolyte in each of the cells is at the correct level. Charge the battery for 6 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 10.

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

## CLEANING BATTERY



### WARNING

**Compressed air can move particles so that they cause injury to the user or to other personnel. Make sure that the path of the compressed air is away from all personnel. Wear protective goggles or a face shield to prevent injury to the eyes.**

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

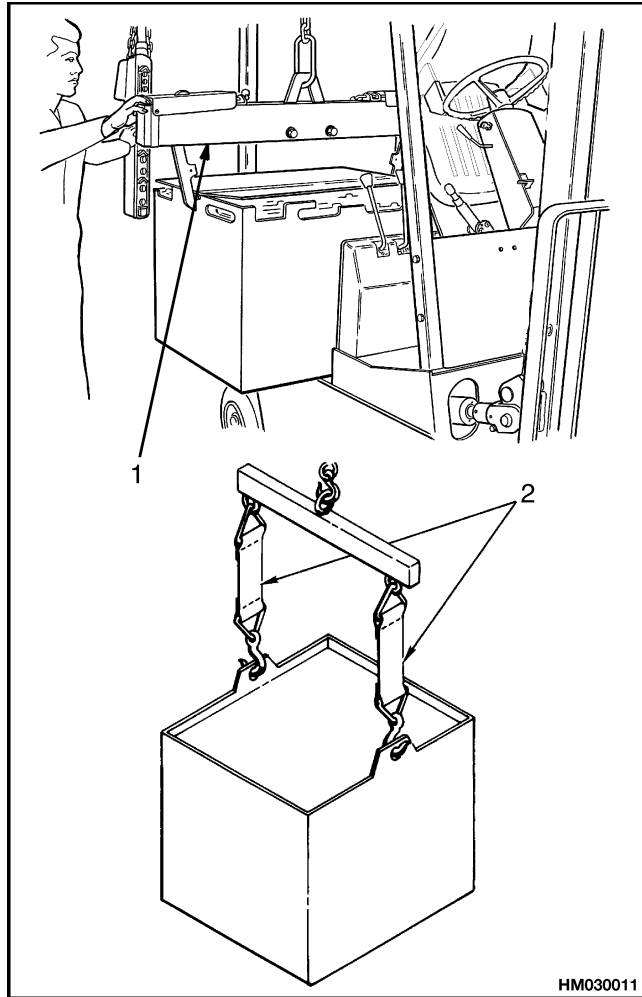


### CAUTION

**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 liters 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 6-month period as the maximum time.

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



**Legend for Figure 10**

- 1. INSULATED SPREADER BAR
- 2. INSULATED STRAPS

**Figure 10. Change the Battery**

Battery Inspection Report									
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				

**Figure 11. Battery Inspection Report**

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

HM030013

Figure 12. Daily Battery Report

**ADDING WATER TO BATTERY**

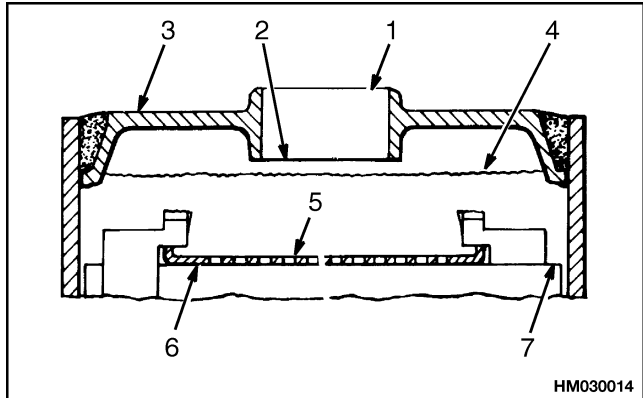
**NOTE:** Some batteries have sealed cells. These batteries do not need water added to the electrolyte.

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 all 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 5 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 13.



HM030014

- 1. FILL TUBE
- 2. BOTTOM OF FILL TUBE
- 3. CELL COVER
- 4. MAXIMUM LEVEL OF ELECTROLYTE
- 5. MINIMUM LEVEL OF ELECTROLYTE
- 6. PLATE PROTECTOR
- 7. TOP OF SEPARATORS

Figure 13. Electrolyte Level

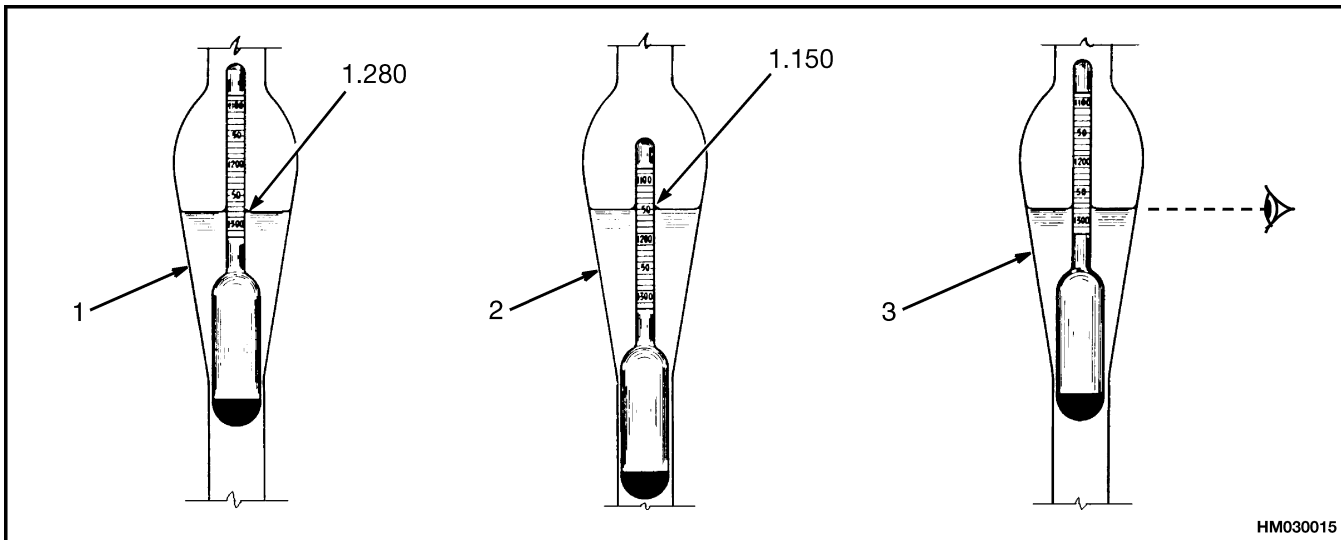
## HYDROMETER

**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 Adding Water to Battery in this section. 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 14 for the correct method of reading the hydrometer.



1. HIGH FLOAT MEANS HIGH SPECIFIC GRAVITY.
2. LOW FLOAT MEANS LOW SPECIFIC GRAVITY.
3. CORRECT METHOD OF READING HYDROMETER: EYE LEVEL EVEN WITH SURFACE OF ELECTROLYTE.

*Figure 14. Reading Hydrometer*

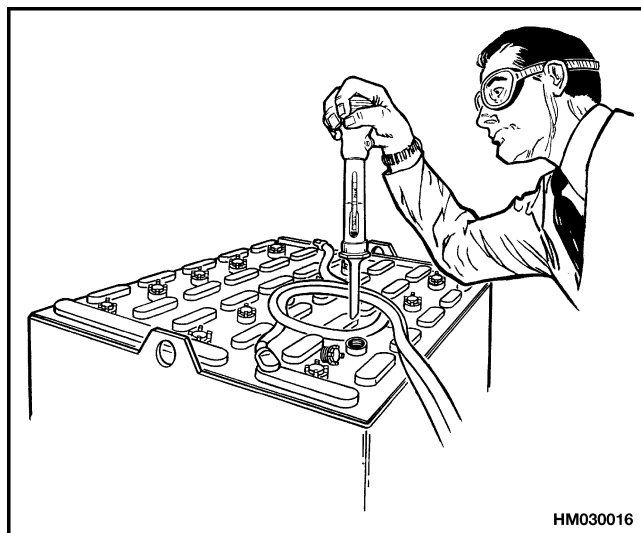
## BATTERY TEMPERATURE

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 point. See Figure 15 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 16.

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 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 charging, followed by 8 hours of cooling.

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 percent. 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.



Specific Gravity Reading	Electrolyte Temp.	Correction Points	Correct Value
1.210	31°C (88°F)	+0.003	1.213
1.210	27°C (81°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 15. Specific Gravity Check

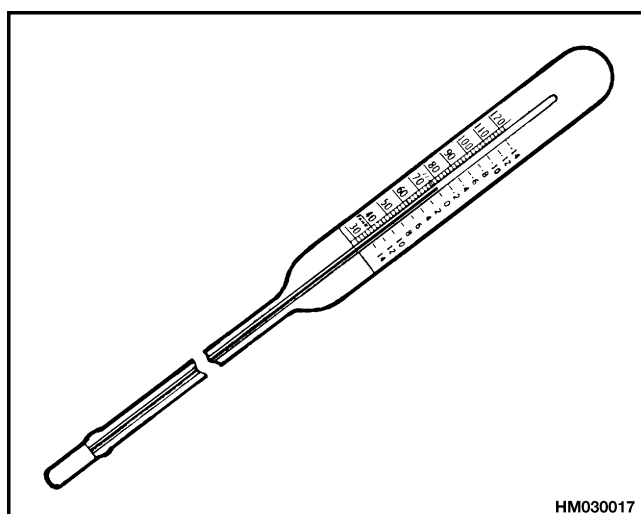


Figure 16. Battery Thermometer

**CHARGING BATTERY**

**NOTE:** There can be one of two types of batteries. One type has removable cell caps. The other type

has sealed cells. The sealed batteries require a different charger. The electrolyte level or specific gravity cannot be checked, and water cannot be added to the electrolyte 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 Contactor inspection procedure for your lift truck.

**CAUTION**

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

**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 14) and proper operation of the battery charger is important. Also see Figure 15. 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 15. 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.

**Types of Battery Charges**

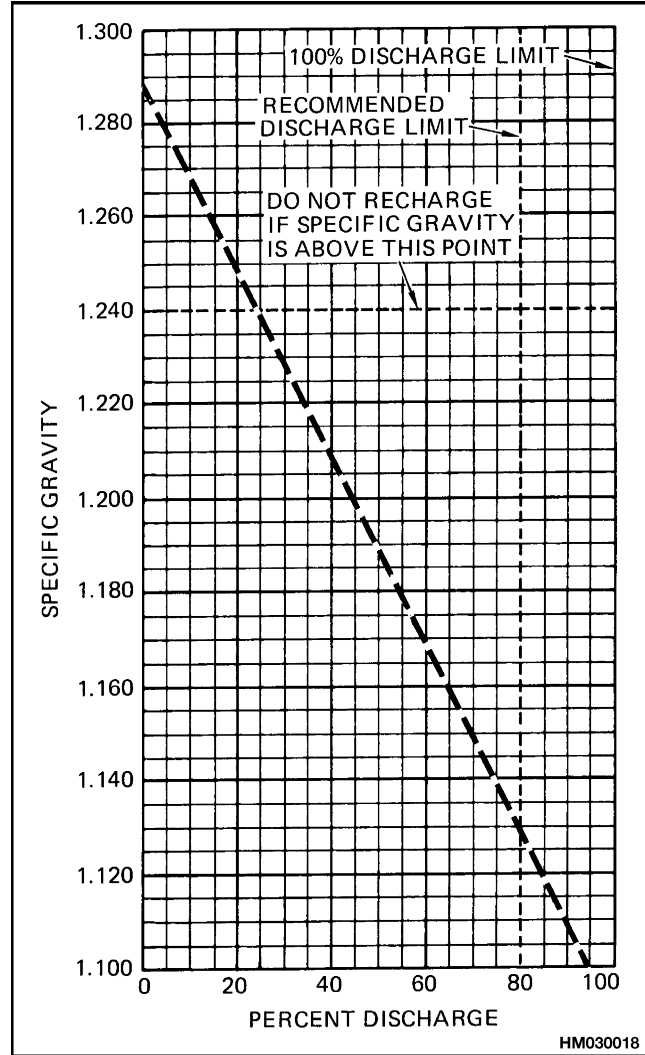
1. **NORMAL CHARGE.** This charge is usually given to a battery that is discharged from normal operation. This is often an 8-hour charge. Many customers charge the battery at regular intervals that depend on use. This procedure will keep the battery correctly charged if the battery is not discharged 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 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 the cells. The equalizing charge is usually given approximately once a month. It is a charge at a slow rate for 3 to 6 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.

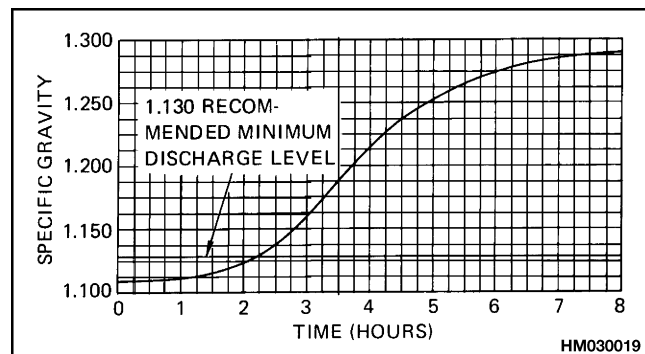
The discharge limits and the limits for the specific gravity before the battery must be charged again are shown in Figure 17. NEVER discharge a battery below the limits shown in Figure 18. Discharging a battery beyond the design limits will decrease the service life of the battery.

**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.



**Figure 17. Specific Gravity Versus Percent Discharge**



**Figure 18. Specific Gravity Compared to Charging Time**

### 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 percent charged. The charging current decreases when the voltage across the cell increases during the charging cycle shown in Figure 19. The increase in the voltage from the charger is approximately the same as the increase in the specific gravity in the cells.

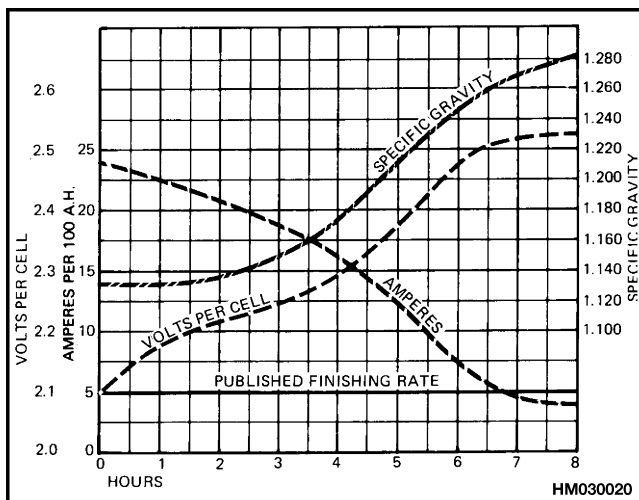


Figure 19. Specific Gravity Compared to Charging Time

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 are shown in Figure 20.
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 reaches 2.37 volts. A relay automatically controls the second resistor. The two-rate charging cycle is shown in Figure 21.

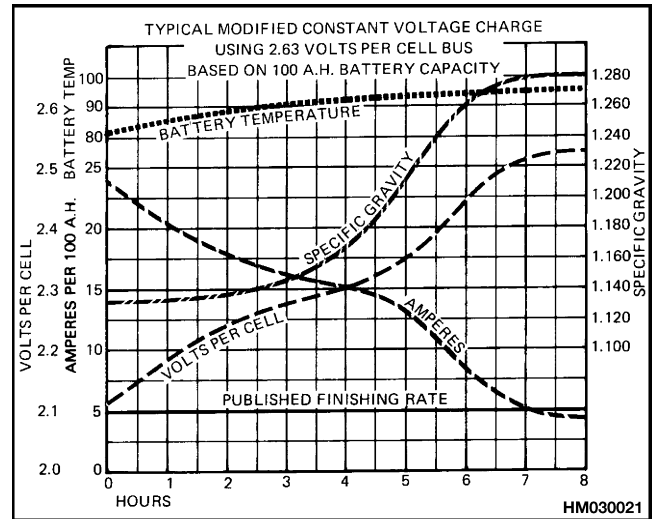


Figure 20. Modified Constant Voltage Charger

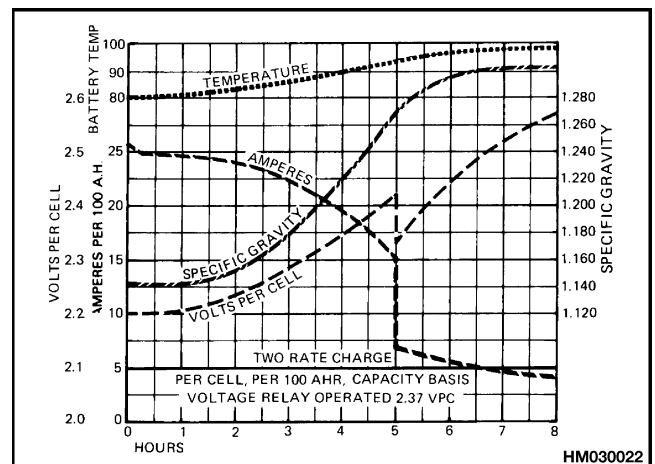


Figure 21. Two-Rate Charging Cycle

**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 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 8-hour charging period. Higher temperatures indicate 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.

## Knowing When Battery Is Fully Charged



### 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 de-energize 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.**

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 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:

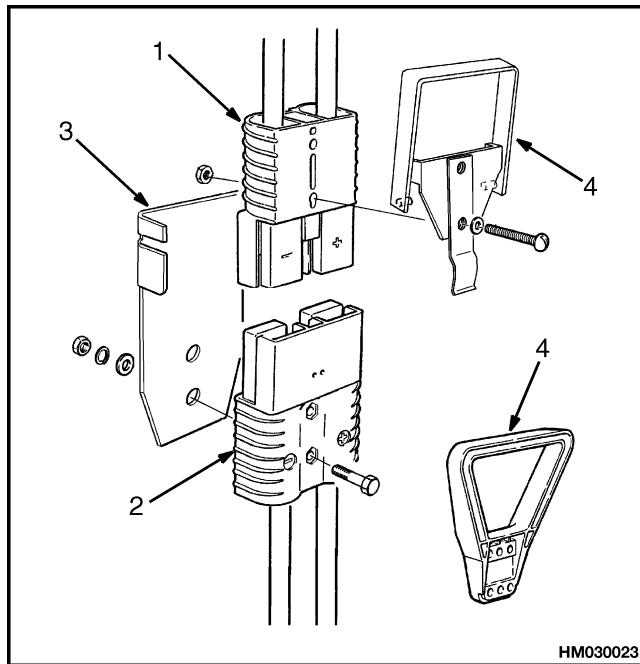
- Location of power supply
- Ventilation; hydrogen gas comes from the batteries during charging
- Drains for cleaning the batteries
- Type and size of the batteries
- Type of lift trucks
- Distances the lift trucks must travel for service
- Safety regulations and instructions

## 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 workbench
- 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

## BATTERY CONNECTORS

A special heavy-duty connector is used to connect the battery to the electrical system of the lift truck. See Figure 22 and Figure 23. 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 23.



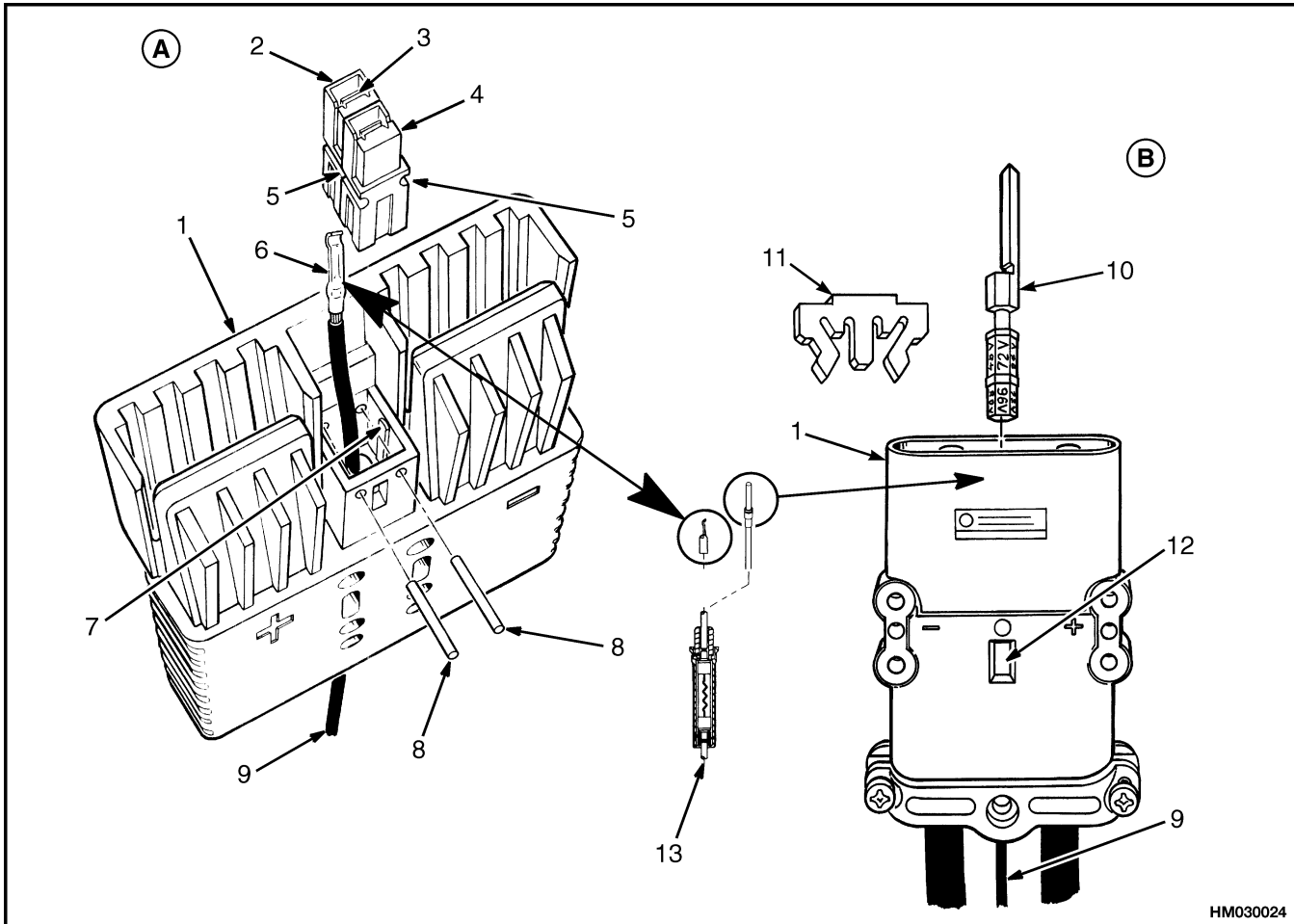
**Figure 22. SB Battery Connector**

### *Legend for Figure 22*

1. SB CONNECTOR FOR BATTERY CABLES
2. SB CONNECTOR FOR POWER CABLES TO LIFT TRUCK
3. BRACKET
4. CONNECT AND DISCONNECT HANDLES

## BATTERY CARE

1. Keep batteries clean. Remove any spilled electrolyte.
2. DO NOT overcharge 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.



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

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

**A. ANDERSON SBE OR SBX CONNECTOR**

1. HALF OF CONNECTOR SET
2. RED HOUSING FOR +12 VOLT "BATTERY TAP"
3. LOCK SPRING (TIP OF CONTACT MUST LOCK OVER TOP OF LOCK SPRING)
4. BLACK CONNECTOR HOUSING (ASSEMBLED ON RED HOUSING WITH SLOTS FOR LOCK PINS ALIGNED AS SHOWN - NO WIRE OR CONTACT IN HOUSING)
5. SLOT FOR LOCK PIN
6. CONTACT FOR CONNECTOR OF +12 VOLT BATTERY TAP
7. KEY [RED (2) AND BLACK (4) CONNECTORS ALIGN ON KEY]
8. LOCK PINS FOR +12 VOLT CONNECTOR (MUST INSTALL FROM FRONT OF CONNECTOR THROUGH RED AND BLACK CONNECTORS)

**B. FEM OR DIN CONNECTOR**

9. +12 VOLT WIRE TO TRUCK (TRUCK HALF) OR TO BATTERY (BATTERY HALF)
10. INDICATOR INSERT FOR BATTERY VOLTAGE AND BATTERY TYPE [ROTATE FOR CORRECT VOLTAGE IN WINDOW (12); COLOR SHOWS BATTERY TYPE]
11. LOCK FOR ALL CABLE TERMINALS AND INDICATOR
12. WINDOW SHOWING BATTERY VOLTAGE
13. IN-LINE FUSE ASSEMBLY AND CONTACT FOR +12 VOLT CONNECTOR (TRUCK HALF OF BATTERY CONNECTOR ONLY) (SBE/SBX CONTACT SHOWN)

**Figure 23. Detail of Battery Connectors With +12 Volt Tap**

