Battery

General

The battery serves as a power supply for the electric accessories when the engine is not running and to supply power to the starter for cranking the engine. When the engine is running the generator supplies part of its output to charge battery. The energy thus stored can be drawn from the battery at any time.

Construction and Function

The 6 volt battery consists of 3 cells, each of which contains positive lead dioxide (PbO_2) plates and negative lead (Pb) plates. There is one more negative plate than positive plate so that there is a negative plate at each end of the cell. The plates are held apart from each other by separators made

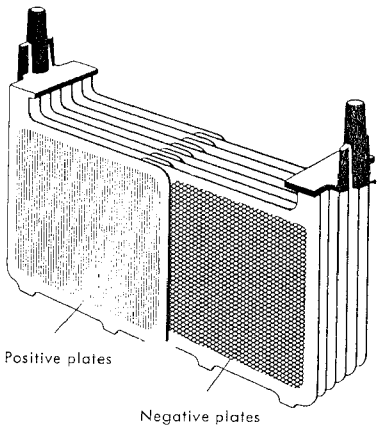

Fig. 34

of acid resistant porous material. There is a complete set of negative and positive plates in each of the three cells of the battery case which are sealed with plastic material.

The bottom of the battery housing has fins which support the plates. The space between the fins serves as a mud space where the small particles which break off the plates can accumulate without causing short circuits between the plates. The detachable battery cell caps also function as ventilators.

Each cell when fully charged has a voltage of approx. 2 volts. By connecting the three cells in series a combined battery voltage of 6 volts is obtained.

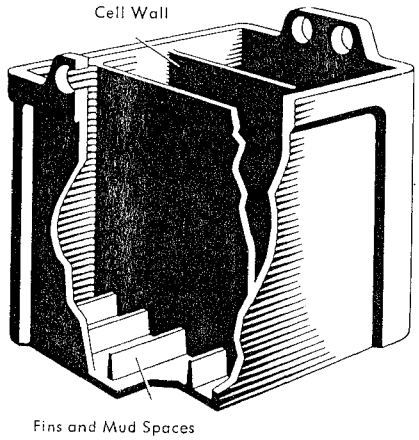

Fig. 35

For clear identification the positive and negative poles are provided with a plus (+) and a minus (—) sign respectively. They are also of different size (positive pole is larger in diameter).

The electrolyte consists of dillute sulphuric acid ($H_2SO_4 + H_2O$) which has a specific gravity of 1.285 or 32° Bé (Baumé).

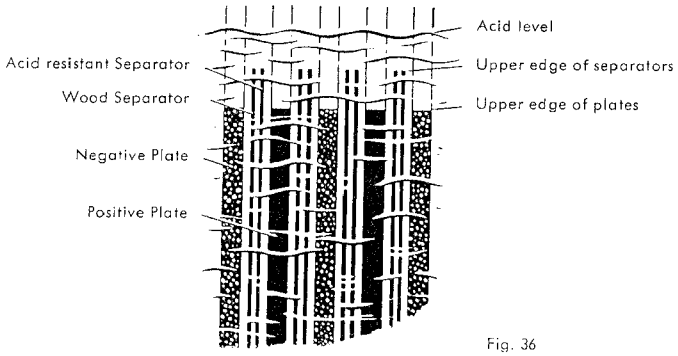

Fig. 36

Cell voltage

The average test voltage of each cell is 2 volts. It increases to about 2.5 to 2.7 volts while the battery is being charged and decreases to between 2.1 and 2.0 volts soon after the charging current has been cut off. The battery is discharged when the cell voltage has dropped to approx. to 1.8 volts under no-load test conditions.

Battery Rating

The capacity of the battery is 84 ampere-hours. This rating gives the amount of current the battery can deliver for 20 hours at an electrolyte temperature of 27° C (80° F). Formerly 10 hours delivery at 20° C (68° F). The capacity of a fully charged battery is determined by the discharging current which can be drawn so that the voltage drops to 1.75 volts in 20 hours. Thus a battery of 84 ampere-hours can deliver a current of 4.2 amperes for 20 hours while the cell voltage does not drop below 1.75 volts. The temperature is a very important factor since the capacity increases with rising electrolyte temperature due to lower internal resistance and the lower viscosity. The capacity drops at decreasing electrolyte temperature.

Charging the Battery

The battery can only be charged with direct current (from the generator). It is important that the proper polarity is obtained. In other words the positive pole of the power supply must be connected to the positive pole of the battery, and the negative pole of the power supply to the negative pole of the battery.

Battery charging process

Under the action of the d.c. charging current the grey-white lead sulphate ($PbSO_4$) at the negative plate is converted to lead sponge (Pb), and that of the positive plate to lead dioxide (PbO_2). Additional sulphuric acid is formed in the process. As a result the acid concentration in the cell increases.

Battery gas

During gassing the acid concentration of the battery increases further, owing to dissociation of the H_2O molecules yielding combustible gases.

As the charging proceeds, the voltage at the terminals of each cell increases to a maximum of 2.8 volts at full charge. This value is not exceeded even if the cell gasses for a longer time. Normally the battery is allowed to gas a certain amount to insure that at all points, especially in the active material, the lead sulphate has been converted to lead or lead dioxyde. Hydrogen and oxygen escape in a highly explosive mixture called oxy-hydrogen gas. Extreme care must be taken to avoid bringing open flames, lighted matches etc. near a battery which is or has been gassing. Likewise care must be taken to avoid causing sparks near a battery, since this can also ignite the gases. No smoking or open flames should be allowed near a charger.

Battery discharging process

The brown lead dioxide of the positive plate and the light grey colored lead of the negative plate combine with sulphuric acid (H_2SO_4) to yield lead sulphate ($PbSO_4$), water (H_2O) and electric current. The density of the battery acid is reduced by the water produced by discharging.

Battery Maintenance

A battery in good working order is required to properly start the engine. The battery should therefore be given proper care and inspections at regular intervals.

Hydrometer Test

The state of the battery can be checked my means of a battery hydrometer. The specific gravity of the battery acid increases with the charging of the battery. Tested with the hydrometer, the gravity can be read from the scale on the float.

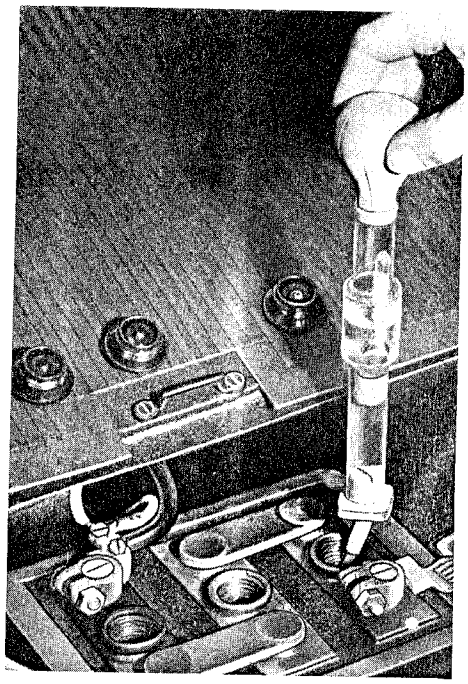

Fig. 37

Battery fully discharged	18° Bé, s.g. 1.142
Battery half charged	27° Bé, s.g. 1.230
Battery fully charged	32° Bé, s.g. 1.285

Electrolyte level

During operation, the electrolyte level in the battery drops due to evaporation. Only distilled water should be added since other water contains chemicals which are harmful to the electrolyte. The electrolyte level should be approx. 10 to 15 mm ($^3/_8$ to $^5/_8$ in.) above the plates. Never add acid, unless it is known that acid has been spilled from the battery. In this case check the specific gravity of the remaining electrolyte and add acid of identical density. If this is not possible, fill the cell with distilled water, charge fully as described, empty the cell and fill with acid of correct strength (1.285 s.g.).

Voltage Test

The full-load test is carried out with a special cell tester consisting of a low-reading voltmeter and a heavy resistance of 80 to 100 amperes capacity connected in parallel. The two prods of this instrument are placed across the terminal posts of each battery cell in turn. The voltage of each cell (normally 2 volts) should not fall below 1.6 volts while taking the reading (10 to 15 seconds). Otherwise the cell is discharged or defective. The difference between the cells should not exceed 0.2 volts.

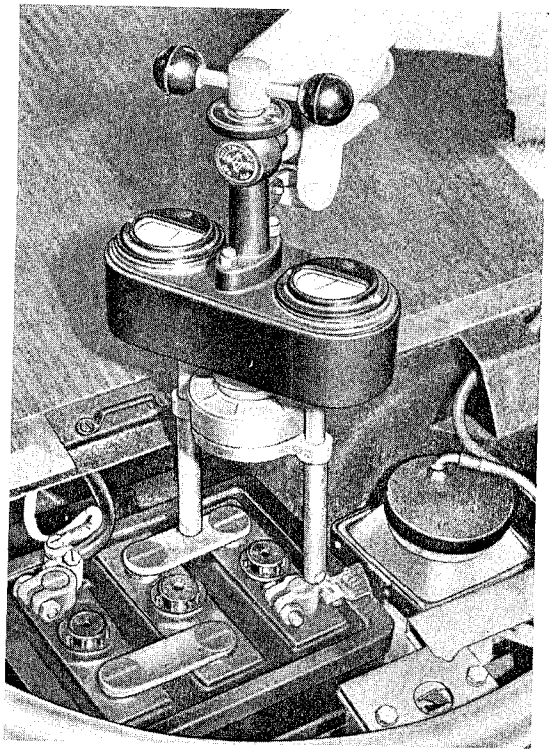

Fig. 38

Care of the Battery

Due to the heavy load imposed on the battery when starting, the average service life of a battery is two years. The battery is stressed very heavily by continuously trying to start an engine which does not fire at once, since a current of up to 250 amperes may be drawn from the battery at this time.

The battery must be held firmly in its mounting. Terminal posts and cable clamps should be kept free from corrosion to prevent excessive electrical resistance.

The terminals should be cleaned with a clean rag or in severe cases with battery terminal cleaner. The posts and cable clamps should be coated with terminal grease to prevent corrosion. Cable clamps which are difficult to remove from the terminal posts due to corrosion should be removed using a battery clamp remover. (Do not use force.)

When working on the battery, clean traces of spilled electrolyte off immediately using common baking soda solution to prevent damage to fabric and metal parts.

Recharging the Battery

It is a good practice to remove the battery at intervals of three or four months and discharge it to a cell voltage of 1.8 volts before recharging it at a rate not to exceed 5 amp.

Batteries are subject to a self discharge of 1 per cent per day with the battery in good condition. If the car is not used for a longer period, the battery must be recharged at 6 to 8 week intervals. The charging rate of the battery depends on the capacity of the battery and should, with a battery of 84 amp.-hours, not exceed a rate of 8.4 amperes. Thus, the charging requires about 10 hours, and longer at a lower charging rate.

The fully charged condition is reached when the cell voltage has increased to approx. 2.5 to 2.7 volts, the battery is gassing freely and there is no further rise in voltage in one hour. Heavy gassing occurs at this time. During the charging process the cell plugs should be removed to prevent acid from being forced through the vents.

Winter operation

The conductivity and viscosity of the electrolyte is greatly affected by temperature changes. At low temperatures the battery capacity is severely reduced. At an electrolyte temperature of —15° C (5° F), the output of the battery is only one half of the output at 20° C (70° F).

The higher the specific gravity of the electrolyte, the lower the freezing point. The battery must, therefore, be kept in a sufficiently charged condition to prevent freezing. If freezing has not ruined the battery it can be restored by slow thawing and recharging. While frozen, a battery cannot furnish current.

Specific Gravity	Electrolyte Freezing Point
1.285	— 65° C (— 85°F)
1.18	— 25.5° C (— 13°F)
1.14	— 13° C (+ 9°F)

The increased load imposed on the battery at low temperatures by the starter which has to crank the sluggish engine, necessitates more frequent inspection of the battery. In severe cold it is recommended to remove the battery at 4-weeks intervals for recharging and checking specific gravity and electrolyte level.

Warning

Do not smoke or use open flames in a room where batteries ar charged. It is advisable not to keep precision tools and instruments in such rooms because of the corrosive gases which are generated.

Charging New Batteries

18 LI

New batteries are generally shipped dry. If no instructions are supplied by the manufacturer, proceed as follows:

1. Remove vent plugs and fill cells with chemically pure battery acid diluted with distilled water to a specific gravity of 1.285 at 20° C (68° F). The level should be approx. 15 mm ($^5/_8$ in.) above the plates.

2. Let the battery soak for 5 or 6 hours in order to saturate the plates with electrolyte. The electrolyte level will drop slightly during this period.

3. Add electrolyte to restore the correct level. Insure that the small vent holes in all plugs are open. Loosely replace caps to prevent acid "spitting".

4. Charge battery at a rate of 5 amperes or less until the voltage of each cell is between 2.5 and 2.7 volts, and the cells gas freely.

5. Check the temperature of the battery electrolyte from time to time. If the permissible temperature of 40° C (105° F) has been exceeded, reduce the charging current.

6. After charging, check specific gravity (1.285 or 32° Bé) and adjust if necessary. If acid or distilled water are added, the battery should be connected to the charger again for a short time to insure good mixing.

7. Replace vent plugs not earlier than two hours, if possible later, after the charging process has been completed (to allow gas to escape). Wash off electrolyte and dry the battery.

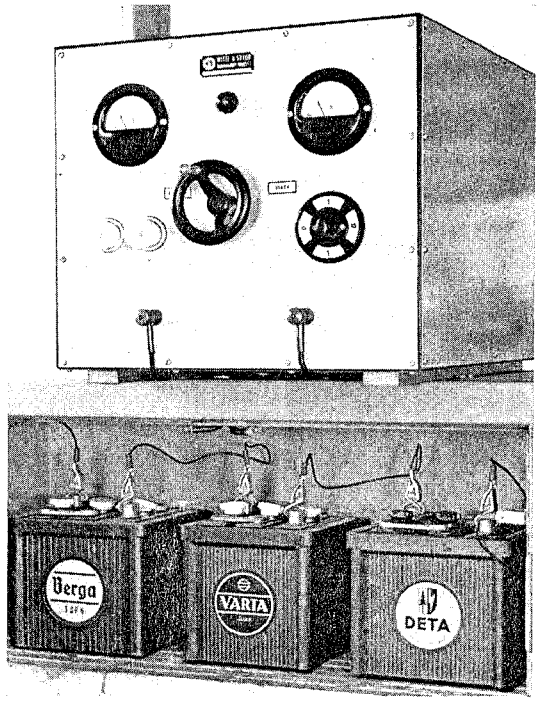

Fig. 39

Note

Never quick-charge a new battery.