CH PTER 2

STORAGE B TTERY CONSTRUCTION AND DE IGN.

Portable Lead - Acid Battery Construction.

The Faure or pasted plate is used in all lead - acid batteries for portable applications on account of its higher capacity per unit weight and volume compared to that of the Plante plate. The main difference between the two types is that the active material of the pasted plate is in the form of a paste held securely in an antimonial - lead grid or frame, whilst the active material of the Plante positive plate is derived from the lead of the plate itself by electrochemical action during charge.

Pasted plates vary considerable in size and thickness, the thinnest and smallest being used where portability combined with a high - ratio of capacity to weight or volume is required. Batteries used for private motor - cars, aircraft and light vans have thin pasted plates about 0.07 to 0.1 (1.8 to 2.5 mm.) thick. The close and compact assembly of thin plates results in a battery of low internal resistance and therefore minimum voltage drop when delivering large currents for engine starting. The largest and thickest plates, up to about 0.25 inch thick (6.4 mm.), are used for heavy traction and commercial vehicle batteries, where a long life under arduous operation conditions is required. One important type of positive plate for heavy traction work is of tubular design used in conjunction with a flat pasted negative

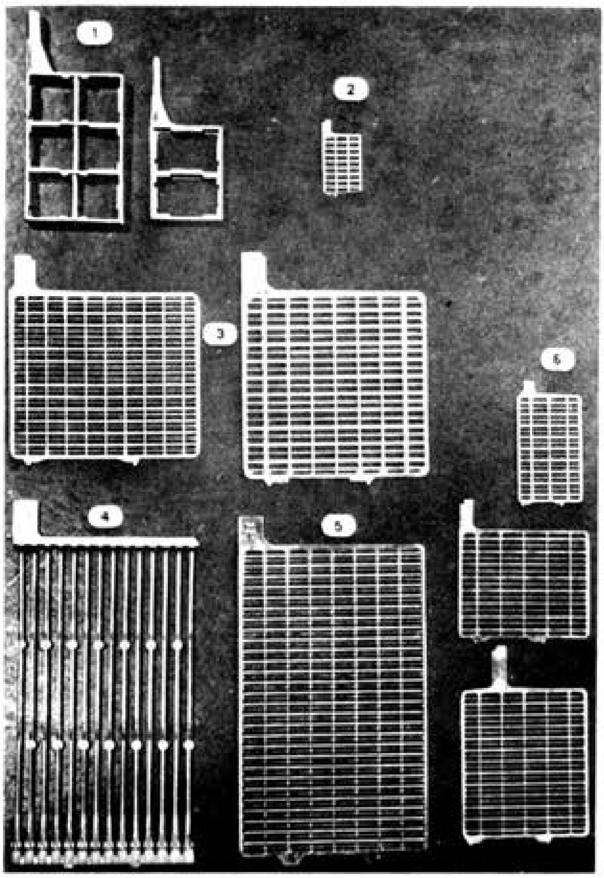

Fig 2 Various Types of Grid.

1. Heavy grids for " low - loss " cells.
2. Miniature grid.
3. Automotive battery grids.
4. Grid for tubular positive plate.
5. Grid for negative plate of tubular cell.
6. Scooter and motor - cycle battery grids.

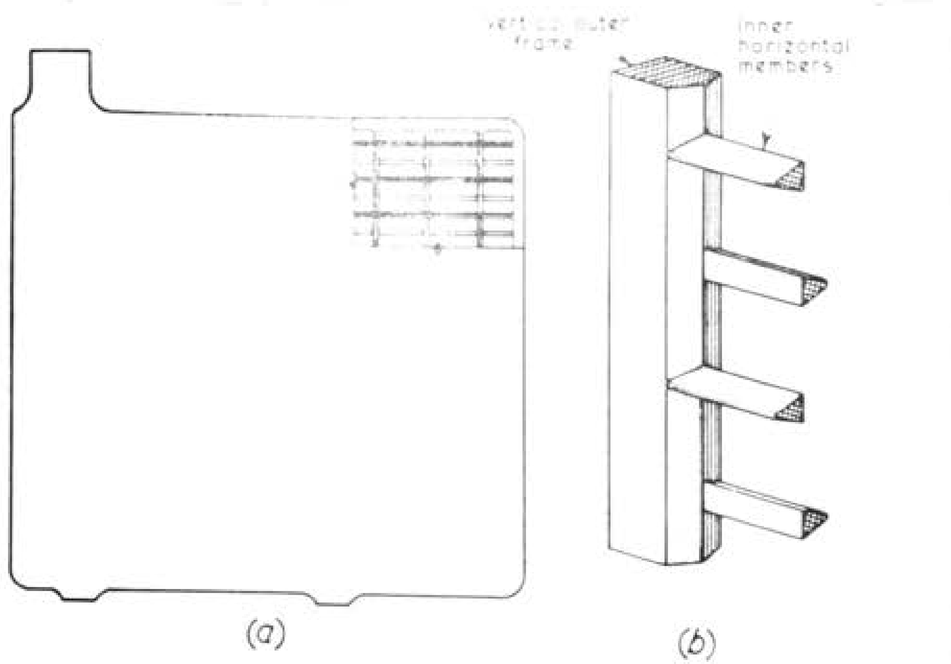

Fig 3 Car Battery Plate.

a) Cut away to show portion of grid.

b) Enlarged cross - section of grid.

plate, but usually in portable batteries both positive and negative plates are of the flat pasted type.

Grids. The grid is the framewerk, or lattic which supports the paste, or active materials. Grids for positive and negative plates are of the same basic design, although the negative grid is usually somewhat thinner as it is not subjected to the same corrosive wear and tear in service as the positive grid.

Various types of grid are shown in fig 2 The grid is made mainly of antimonial - lead alloy, consisting of pure lead to which has been added from 6 to 12 percent of antimony. Frequently small quantities of other metals such as tin, copper, silver or arsenic added to give greater corrosive resistance or similar prepertics. The addition of antimony to the pure lead produces a sharper and stronger casting than of lead alone, and also gives it a greater resistance to the electrolytic action and chemical changes which take place in the active material which the grid supports.

A grid consists of an outer frame with take - off lug and a central mesh or lattice of vertical and horizental ribs. The ribs serve as conductors for cellecting and distributing the current throughout the active material, and as retainers for the paste. Fig 3 is a cross - section of the grid showing the staggered horizontal ribs, which are designed to provide a continuous ribbon of paste from top to bottom of the plate.

Plates. Pasted plates are made by applying to the grid, by hand or by machine, a paste consisting mainly of lead oxides and dilute sulphuric acid. The pasted plates are dried and then formed electrochemically in a tank containing dilute sulphuric acid. Formation of pasted plates produces oxidation of the lead oxide paste to lead dioxide (positive) and its reduction to spongy lead (negative). When formation is completed the plates are taken out of the acid tanks, rinsed in water and dried.

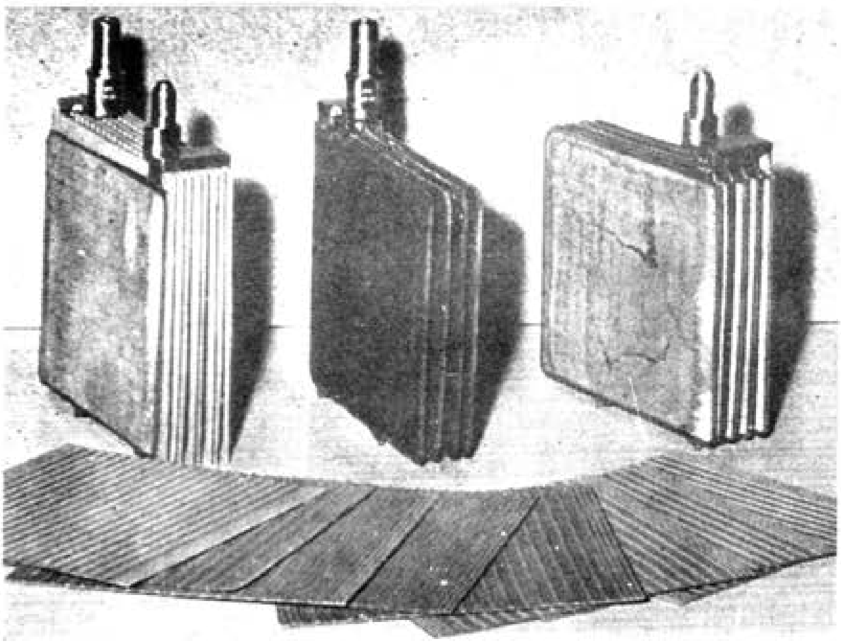

Fig 4 Nine - Plate Element, 4 - Plate Positive Group and 5 - Plate Negative Group.

Positive and Negative Groups. The dry, formed plates suitably spaced apart are assembled into positive and negative groups by burning the plate lugs to a plate bar or strap complete with terminal post.(Fig 4)

A negative group always has one more plate than its matching positive group, so that when the two groups are interleaved each positive plate is located between two negative plates. This arrangement ensures that the surfaces of each positive plate are worked equally, and prevents distortion or buckling of the positive plates, which would occur with unequal working of their active material.

Elements. When positive and negative groups are interleaved, adjacent plates of opposite polarity must be prevented from touching each other; otherwise a short - circuit would develop within the cell. Separators of various materials are inserted between the plates, and the assembly of plate groups and separators is called an element. (A 9 - plate element would consist of 4 positive, 5 negative plates and 8 separators Fig 4)

Separators. The essential features of any separator are:

1. High porosity : This ensures low resistance to passage of current between the plates and free diffusion of the acid.

2. Good insulation : To prevent metallic conduction between plates of opposite polarity.

3. It must be inert to the action of sulphuric acid and electrochemical oxidation.

4. Absence of harmful impurities.

5. Mechanical strength separators which are easily damaged or split are source of internal short - circuits.

Various types of separator are shown in Fig 5 these may consist of any suitable material such as:

1 Microporous rubber

2 Microporous plastic

3 Paper base (resin treated).

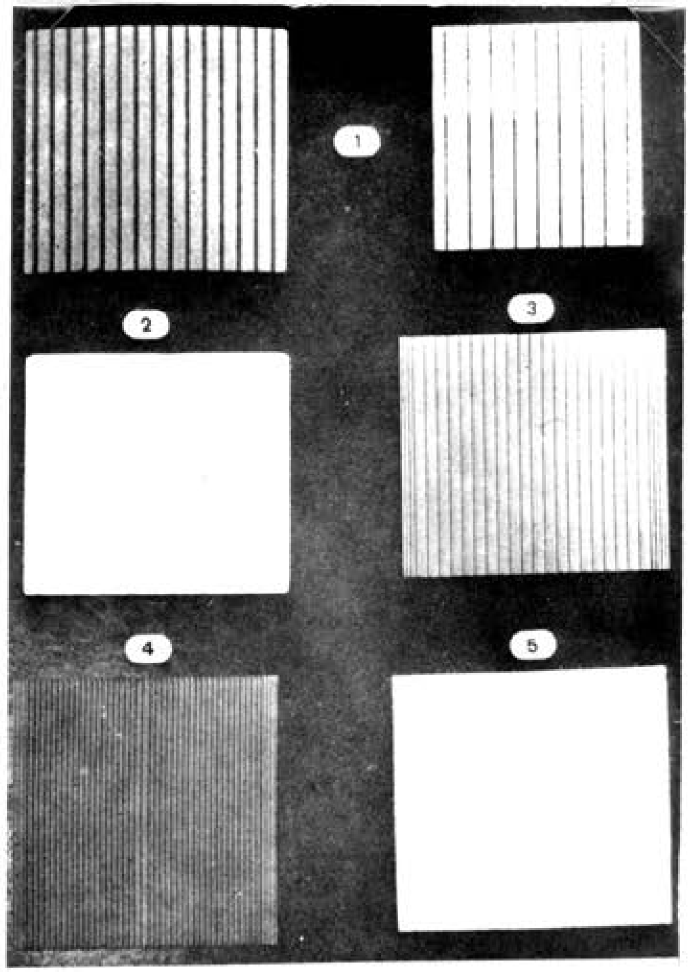

Fig 5 Various Separators for Automotive Batteries.

1. Fibre - based resin - treated
2. Glass - wool/kieselguhr
3. Povic, micro porous p.v.c.
4. Povic, micro porous p.v.c. used with
5. Glass - wool mat for dual separation of heavy - duty batteries.

4. Certain kinds of wood, the most suitable being Port Orferd ceder or Douglas fir:
5. Glass - wool mats.
6. Glass - wool and kieselguhr.

Before 1940 most separators used in portable batteries were of wood, but since about 1946 these have been replaced mainly by microporous plastic (Polyvinyl chloride) or microporous rubber, which are highly suitable for this type of work.

The width and height of separators are always greater than those of the plates. This provides a separator overlap at the plate edges and so prevents lead treeing, or formation of lead moss, across adjacent plates. Most separators are ribbed or grooved on the side adjacent to the positive plate, so as to ensure a liberal supply of free electrolyte, which is essential for efficient working of the positive active material.

Batteries intended for heavy duty as in traction service road vehicles, industrial trucks use a dual separation of microporous rubber or microporous plastic separator, together with a mat of glass - wool. In this assembly the plates and separaters are compacted tightly together with the glass - wool mat adjacent to the surface of the positive plate. The glass - wool mat serves as an " armouring " for the positive plate by supporting and retaining the active material in the grid. This extends battery life, particularly on heavy work, by preventing shedding of the positive paste from the grid.

<u>Containers</u>. In general, the containers used for portable batteries are made of hard rubber, resin rubber or composition material. More use is being these are generally confined to small batteries used for motorcycles, scooters, radio and light - weight aircraft batteries. Containers are either individual boxes for a single element or multi - compartment moulded containers for housing 2 to 6 elements A 12-V battery would consist of 6 elements housed in a 6 - compartment (monobloc) container. Each cell must be a separate electrical unit, consisting

of element and electrolyte, insulated from the next cell by the compartment partitions.

The plate of most portable cells are never allowed to sit on the bottom of the base but next on ribs or grids moulded in the base. This arrangement provides a space below the plates for sediment, or mud. Sediment is an accumulation consisting largely of lead sulphate which is thrown down as active material from the plates during life, particularly if the battery is subjected to repeated cycles of heavy discharge and charge, or abused by excessive overcharging or undercharging. As the sediment acts as a metallic conductor, the space below the plates must be sufficiently deep to keep the sediment away from the bottom of the plates during the life of the battery.

Large cells, as used in traction or marine batteries, are housed in separate moulded or wrapped hard - rubber boxes for convenience in handling*

* Wrapped box. A box prepared by wrapping thin layers of soft processed rubber round a metal former. A tough, rigid box is produced by curing or baking in a steam oven.

Lid. Battery lid are moulded in hard rubber or composition material they are made as single units with three holes, two for the terminal posts, and the third for the vent plug. Alternatively, the lid can be made as one piece, or " monolid " (Fig 6) In either form the lid is fitted over the cell posts, and an acid - tight seal is made between lead post and lid, either by pressing against a rubber gasket or by lead - burning the cell post to a lead insert in the lid.

The cell is acid - proof sealed by pouring a sealing compound in the trough between the lid and the container walls.

Sealing Compound. Sealing compounds are used to form an acid tight joint between covers and containers. They are blends of specially processed bituminous substances having resistance to flow at high summer temperatures and resistance to cracking at low winter temperatures.

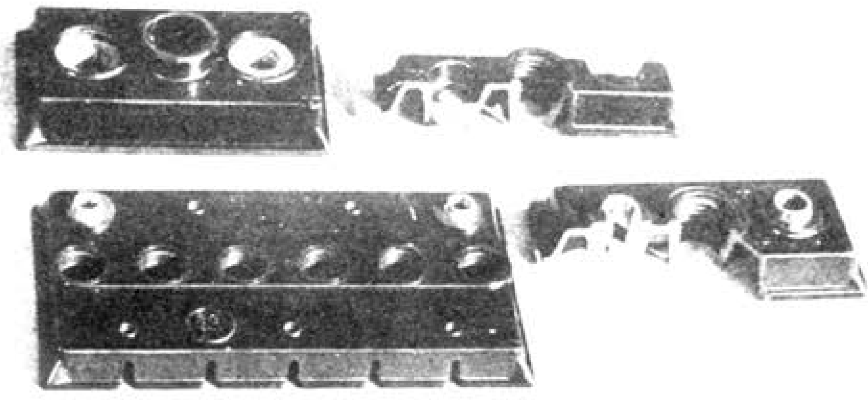

Fig 6 Various Lids.

The two lids in the upper part of the picture are designed for rubber gasket seal; the two in the lower part are fitted with lead bushes (lid - insert type of seal).

These battery sealers are designed to :

a. Ad here tenaciously to hard rubber, composition and certain plastic battery cases.

b. Provide a bubble - free seal with little or no flaming or heat needed on the production line.

c. Be sufficiently hard to withstand normal internal pressures in hot weather and flexible enough to resist cracking in cold weather.

d. Maintain a trouble - free seal inert to the corrosive effects of acids, alkalines, anti - freeze, road salts, etc.

e. Facilitate ease of handling in the battery manufacturing plants.

Vent Plugs. The vent plugs fit in the holes of the lid which are provided for filling the battery with electrolyte, for topping - up with distilled water or taking hydrometer reading. The vent plugs are of the baffle type which allow the gases to escape freely but return the acid spray to the cell. Modern vent plugs are moulded in polystyrene and are lighter in weight than the older ones of rubber of porcelain. They are either screw or quarter - turn type, the latter being used in multicell traction batteries for ease of removal.

Connectors. Connectors are antimonial lead or lead - plated copper intercell straps burned or bolted to adjoined positive and negative - posts of adjacent cells or element (Fig 7)

The type of connector most commonly used for automotive batteries is made from a casting of antimonial - lead alloy. Lead-plated copper connectors have the advantage of greater flexibility and are used as intercell connectors for most traction batteries. Connectors are designed to be of low resistance and capable of carrying a current in amperes equal to about 5C, where C is the nominal ampere - hour capacity, without any undue voltage drop or heating.

Electrolyte. A battery when constructed must be filled with dilute - sulphuric acid and given an initial charge to activate the plates. The acid must be chemically pure as specified in Appendix 1

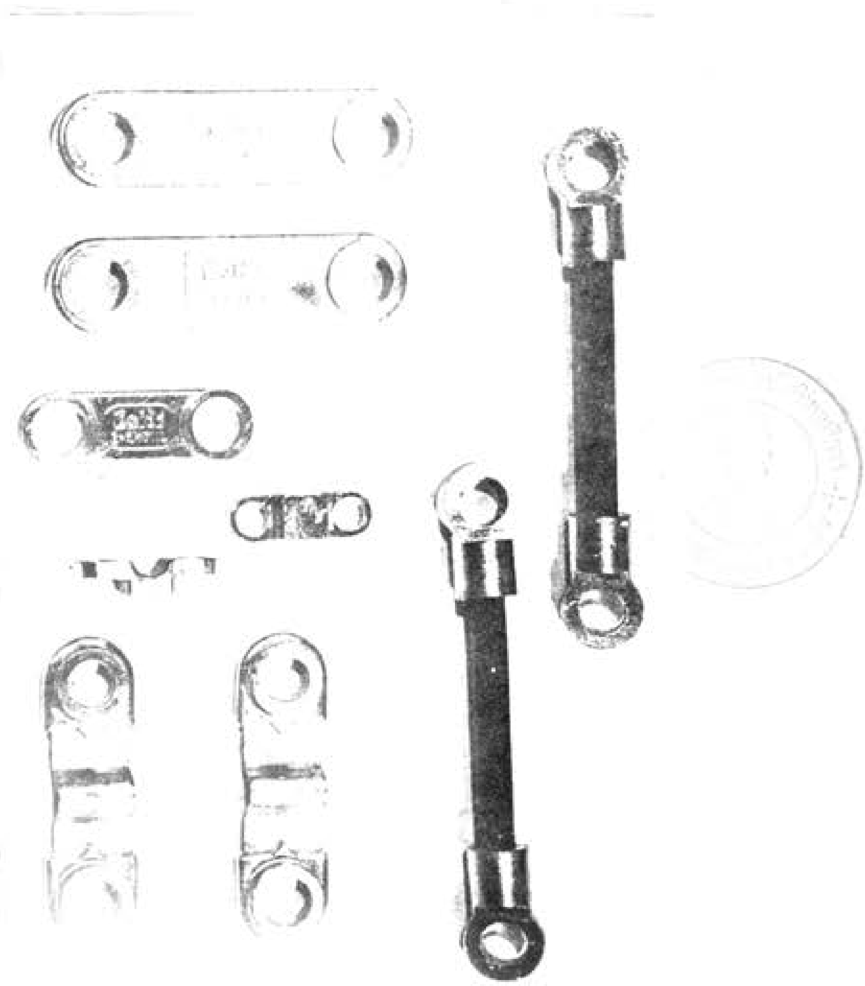

Fig 7 Various Connectors for Automotive and Traction Batteries.