AUTOMOTIVE TACKLESS FORMATION

Presented by:

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FORMATION

1.0 After the pasting and ageing processes the active materials of both positive and negative plates consist essentially of lead oxides, basic lead sulphates, a small amount of residual lead and moisture, together with the relevant additives.

The formation process is that during which the dried aged active material is electrochemically converted or "formed" in the presence of dilute sulphuric acid in the case of the negative into highly porous sponge lead and in the case of the positive into highly porous lead dioxide. When the objective is to obtain dry charged batteries the plates are formed in tanks, subsequently dried and assembled, and the operation is called tank formation.

In the early 1950's Chloride introduced a formation process in which unformed plates were assembled into batteries. These were then filled with a more concentrated acid and the plates formed in the container. This process is called jar formation.

These batteries are normally sent to car manufacturers as original equipment. Since wet batteries self discharge on standing , this type of formation is not used with a long distribution chain.

In both processes the electrochemical charges are the same.

1.1 Tank Formation

In practise the efficiency of the formation process is about 50%. This figure is due to the fact that a portion of the electrical energy input is used in overcoming the resistance of the electrolyte and plates and is dissipated as heat and also a large portion of the electrical energy is wasted due to the large amount of gas evolved during the process.

Using standard Chloride paste mixes/processes it has been found that 16.5 amps are required to form each Kg of dry unformed positive active material and this figure is used in calculating formation schedules.

2.0 Clearly in trying to organise the electrochemical processes outlined in the previous section on an efficient production basis, some standardised basic systems must be evolved. These can be summarised as:

i circuitry/schedules
ii equipment

2.1 Circuitry/Schedules

During the formation process the positive and negative plates become charged relative to each other and set up a voltage opposing the applied voltage. This means that as the process proceeds a constant applied voltage will result in less current actually going through the plates or if a constant current is applied then the applied voltage will have to rise to compensate for the opposing voltage generated by the plates.

All tank formation in the Chloride Group is carried out by the latter route i.e. Constant current. As the back voltage rises during the schedule the rectifier voltage rises automatically by means of a variable resistance ensuring that the current through the circuit remains constant.

It is standard practise in the Chloride Group to have each circuit in sets of 40 tanks in series. The normal procedure is to have 20 tanks doublebanked for ease of loading/unloading.

In the tank itself there are rows of positive and negative castings interlaced in parallel and immersed in electrolyte. The whole circuit can thus be likened to a huge "battery" of 40 cells. The open circuit voltage of this battery is thus 80 volts and the applied voltage from the rectifier will vary between 80-120v during the schedule.

Using the straight 20 schedule, then 16.5 amps are required to form 1 Kg of dry unformed positive active material. This corresponds to 330 Ah input, which is considerably more than the theoretical requirements and highlights the relatively low efficiency of the process.

Taking the case of a tank containing 100 positive castings each having 200 g dry unformed active material, then the total positive active material per tank is 20 Kg. Hence the formation current required is 16.5 x 20 amps or 330 amps.

One point in the layout of a formation circuit generally is that although the rectifiers are in separate rooms (for protection against acid spray) the actual cable runs to the circuit should be as short as possible to minimise excessive voltage drops.

2.2 Equipment

Basically in its simplest form, all that is required to successfully tank form plates is a tank made from acid resisting material which is physically strong (to hold the considerable weight of electrolyte and pasted grids) and a means of securing the castings in position during the process together with good electrical connections.

The tanks were originally (and still exist in some locations) made of wood or steel with a lead lining. These have been superceded, due to maintenance problems, by more modern materials e.g. fibre glass. The tanks have 3"-6" mud spaces at the bottom, to colect "sediment" falling off the plates.

The equipment which supports the castings is called the furniture and consists of grooved boards (which are adjustable in order to cater for both standard and narrow width plates). The grooved boards were made of wood but received considerable wear and tear and needed replacing frequently. In the past, the electrical connections to form the cirucit were made by hand tacking lead strips on top of the plate lugs - this is called "tacked" formation. This system is both labour and material intensive.

The actual tacking operation is a skilled job and casting of lead strips (each strip can only be used a maximum of four times before scrapping) is a full time job in the factory.

A further disadvantage of the tacked system is that only "single ply" formation (i.e. one casting per slot) can be achieved.

In the Chloride Group this method has largely been replaced by tackless formation. In this system connection is made by physical contact between the plate lug and a permanently submerged contact bar. This contact bar is permanently connected to an inter tank bar.

The tackless system has the advantage that once it is set up (i.e. all the contact bars in position) it is less labour intensive and double or triple castings may be put into each slot. Care must, however, be taken to ensure that good contact is achieved and the relevant process specifications must be followed. The normal procedure for operating tackless, is to reverse the current on alternate runs to achieve good contact and a reversal switch is normally included in the circuit for this purpose.

CTL Tackless Formation

The tanks are made from fibreglass and are shaped such that they have ledges which internally support the furniture unit and externally can be used for supporting the tank by wooden beams in the circuit. The internal dimensions are 1'11 3/4" long 1'4" wide and 1'10" deep including a 3 1/4" mud space below the ledges.

As stated the furniture is assembled as a complete unit which is relatively easily removed/adjusted. The furniture is made from structural polypropylene foam (plate rack) and with polypropylene nuts and spacers. There are 21 slots per row and with standard width plates there is room for three rows per tank. With narrow width plates there is room for four rows per tank. This gives (with the normal loading of a single negative casting at each end and twins alternating in the middle) a loading of
(2 + 19 x 2) x 3 = 120 castings per tank
and 4800/circuit (standard)

or (2 + 19 x 2) x 4 = 160 castings/tank
and 6400 narrow width/circuit

The submerged contact bar in the CTL Tackless system is a V bar type. This bar is longitudinal V shaped in section with an open base to allow sediment to fall through during formation. Electrical contact is made between the V bar and the corners of the plate lugs i.e. the lugs lie across the V. The contact bar is common for both positive and negative and is made of antimonial alloy (4%) and is easily cast.

The formation procedures with regard to current reversal in the CTL tackless are specified in process specifications.

The CTL tackless system is in use in many companies and is considered to be the best system in terms of operational simplicity and maintenance.

Jar Formation

In jar formation, raw unformed (or "green") plates are assembled into cells or batteries and filled with dilute sulphuric acid of a specific gravity such that the fully charged battery needs a minimum of adjustment to achieve the service S.G.

During formation the reaction is exactly the same as in the tank formation in that sulphate in the plates comes out into the electrolyte as sulphuric acid causing the S.G. to rise. The positives are converted into lead dioxide and the negatives into sponge lead.

Basically, two types of charging are used in Chloride. Constant current is where the charging current is constant throughout the schedule and the voltage varies.

Constant potential is where the current varies and the applied voltage is constant.

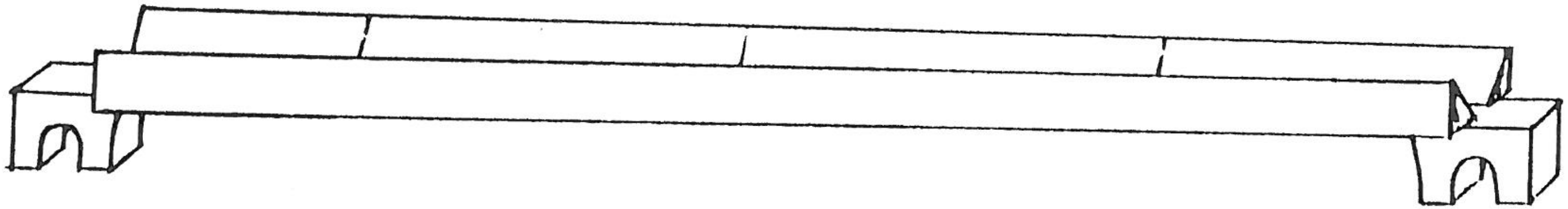
The preferred and most modern method is to use constant current, as more control on the ampere hour input is obtained.

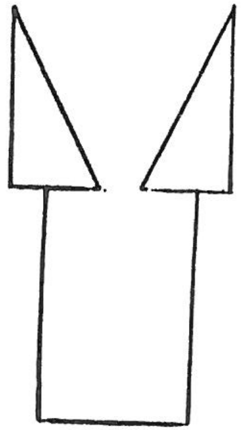
Circuits are built up of a number of cells depending on the applied voltage e.g. for rectifiers producing 110 V, 36 cells can be formed in series i.e. 6, 12 volt batteries or 12, 6 volt batteries. With the constant potential system, one rectifier feeds the bus bars with a fixed voltage. Circuits of batteries are then connected to the bars.

In the constant current systems, individual rectifiers form batteries in series.

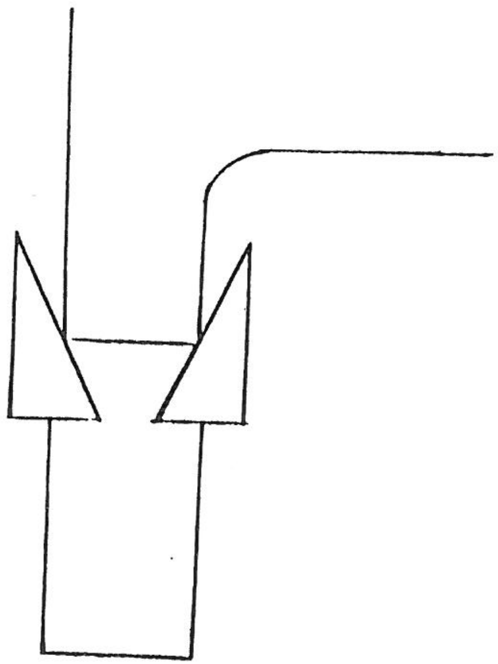
The charging current is normally set at 10% of the 20 hour capacity and normally schedules run for 24 hours. Hence ampere hour input varies between 2.5 and five times the 20 hour capacity. The schedules vary with country and the various customer requirements.

SKETCHES OF "V" BAR FOR C.T.L. TACKLESS FORMATION SYSTEM

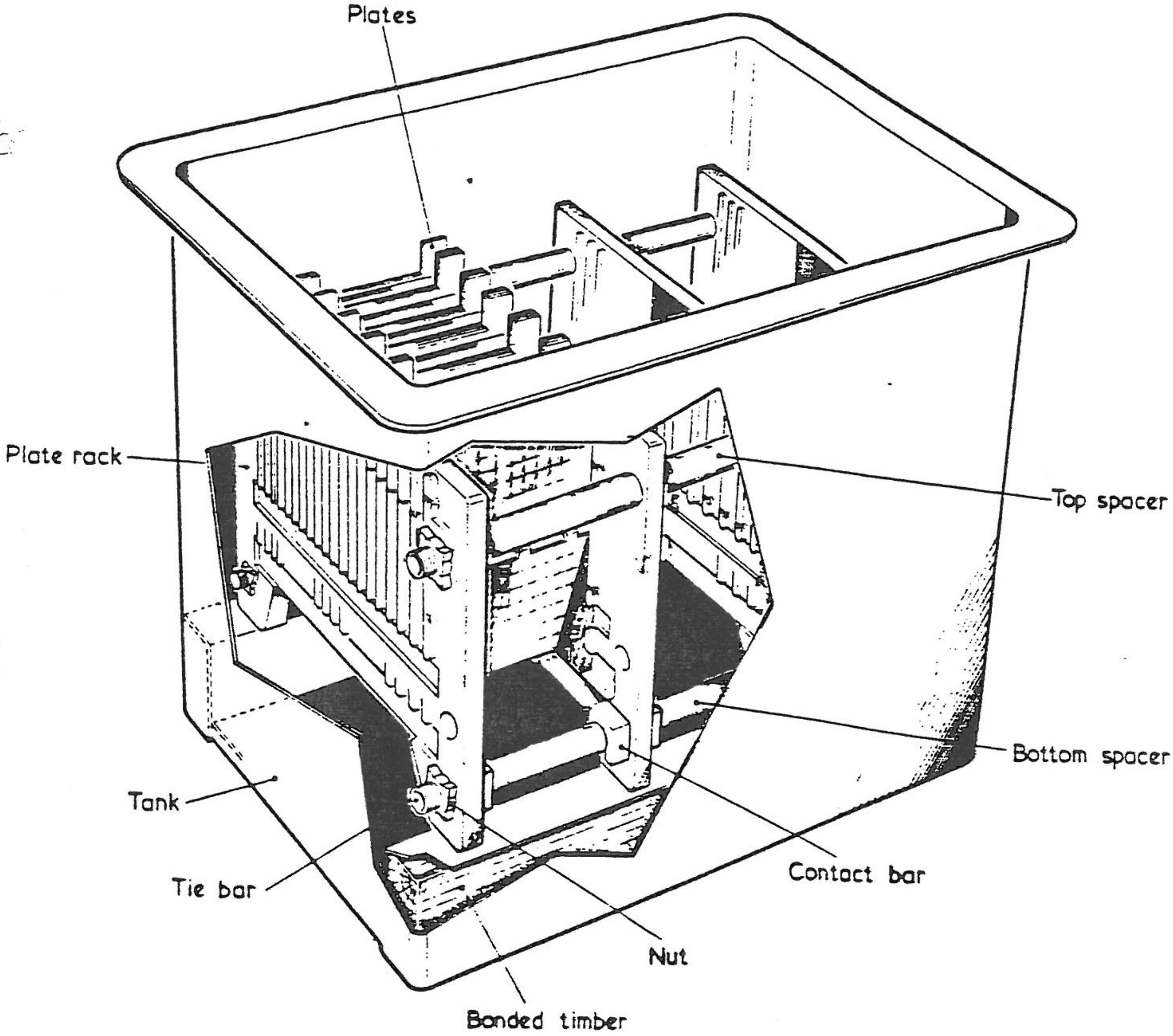




End View
Slot Width 0.25"



End View
Showing Position
of Casting Lug
Across "V"



C.T.C. TACKLESS FORMATION SYSTEM.