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Quality

EQUIPMENT

VOLUME 2

WORKSHOP INSTRUCTIONS

BATTERIES

MODELS GTW & GTZ

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BATTERIES

MODELS GTW & GTZ

1. GENERAL

The Lucas GTW and GTZ batteries are of the semi-linkless type, the short inter-cell connectors being partially exposed to assist testing of the individual cells. The moulded container has no fixing lugs and is designed for "waist" or "band" fixing.

These batteries are 12 volt only, and are made in 7, 9 and 11 plate designs having capacities of 38, 51 and 64 ampere-hours respectively, at the 10 hour rate.

GTZ batteries have porous rubber separators. They are supplied in "dry-charged" condition and must be prepared for service as detailed in para. 6 — in all other respects they are identical with GTW models.

2. ROUTINE MAINTENANCE

Every 1,000 miles, or monthly (or more frequently in hot climates), examine the level of the electrolyte in the cells, and if necessary add distilled water to bring the level up to the tops of the separators. The use of a Lucas Battery Filler will be found helpful in this topping-up process, as it ensures that the correct electrolyte level is automatically maintained and also prevents distilled water from being spilled over the top of the battery.

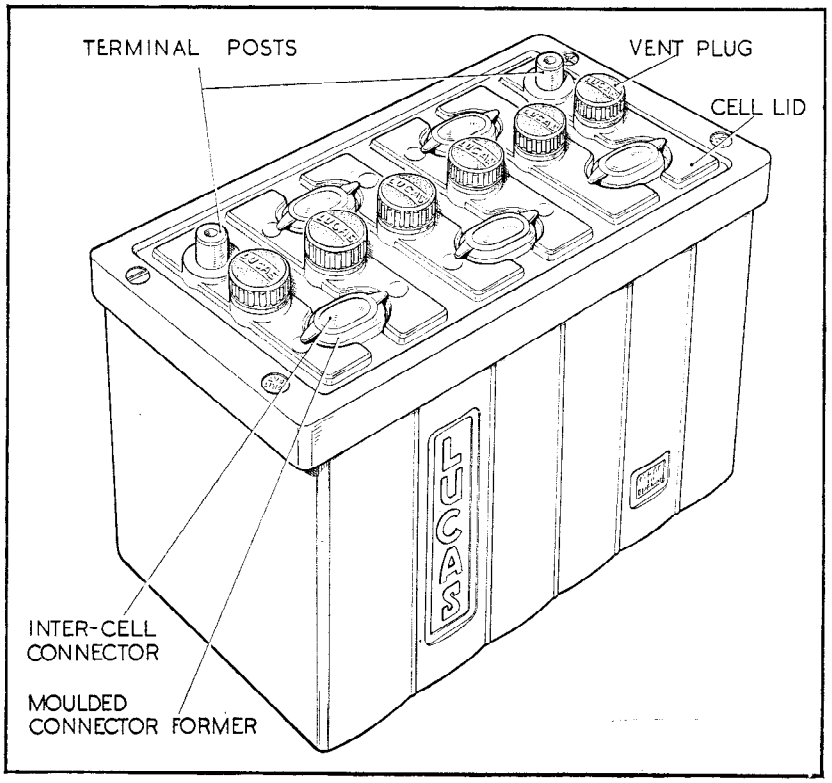

Fig. 1.
Battery type GTW or GTZ

Distilled water should always be used for topping-up. In an emergency, however, drinking water, **clean** rainwater or melted snow may be used. The following waters **must not be used**: salt water, chlorinated water, chemically softened water or stagnant water having an offensive odour.

N.B.—**Never use a naked light when examining a battery,** as the mixture of oxygen and hydrogen given off by the battery when on charge, and to a lesser extent when standing idle, can be dangerously explosive.

Examine the terminals. If they are corroded, scrape them clean and coat them with petroleum jelly. Wipe away all dirt and moisture from the top of the battery, and ensure that the connections and the fixing band are clean and tight.

Batteries which use the improved die-cast lead cable connector, secured to the terminal post by a single lead-plated screw, do not suffer from corrosion of the terminals.

3. TABLES OF SPECIFIC GRAVITIES AND CHARGING RATES

(a) BATTERY CAPACITIES AND CHARGING RATES

Battery Type	Plates in each cell.	Ampere hour capacity: at 10 hour rate	Ampere hour capacity: at 20 hour rate	Volume of electrolyte required to fill one cell.	Initial Charging Current (Amps.)	Normal Recharge Current (Amps.)
GTW 7 A GTZ 7 A	7	38	43	¾ pint	2.5 -	4
GTW 9 A GTZ 9 A	9	51	58	1 ,,	3.5 -	5
GTW 11 A GTZ 11 A	11	64	72	1 ,,	4.5 -	7

(b) SPECIFIC GRAVITY OF ELECTROLYTE FOR FILLING UNCHARGED BATTERIES

Home trade and climates normally below 80°F. (27°C).		Sub-tropical climates, 80°–100°F. (27°–38°C.)		Tropical climates, over 100°F. (38°C.)	
Filling	Fully Charged	Filling	Fully Charged	Filling	Fully Charged
1.350	1.280—1.300	1.320	1.250—1.270	1.300	1.220—1.240

(c) SPECIFIC GRAVITY OF ELECTROLYTE FOR FILLING "DRY-CHARGED" BATTERIES

Temperature of battery and surroundings not normally rising above 90°F. (32°C.)		Temperature of battery and surroundings frequently in excess of 90°F. (32°C.)	
Filling	Fully Charged	Filling	Fully Charged
1.275	1.280—1.300	1.215	1.220—1.240

(d) MAXIMUM PERMISSIBLE ELECTROLYTE TEMPERATURE DURING CHARGE

Climates normally below 80°F. (27°C.)	Climates between 80°–100°F. (27°–38°C.)	Climates frequently above 100°F. (38°C.)
100°F. (38°C.)	110°F. (43°C.)	120°F. (49°C.)

(e) The specific gravity of the electrolyte varies with the temperature. For convenience in comparing specific gravities, they are always corrected to 60°F., which is adopted as a reference temperature. The method of correction is as follows :

For every 5°F. **below** 60°F., **deduct** .002 from the observed reading to obtain the true specific gravity at 60°F. For every 5°F. **above** 60°F., **add** .002 to the observed reading to obtain the true specific gravity at 60°F.

The temperature must be that actually indicated by a thermometer immersed in the electrolyte, and not the ambient temperature.

4. SERVICING

(a) BATTERY PERSISTS IN LOW STATE OF CHARGE. First consider the conditions under which the battery is used. Remember that if the battery is subjected to heavy loads (*i.e.*, long periods of night parking with lights on) without suitable opportunities for re-charging, a low state of charge is only to be expected.

A fault in the dynamo or regulator, or neglect during a period out of commission, may also be responsible for the trouble.

VENT PLUGS

See that the ventilating holes in each vent plug are clear, and that the rubber washer fitted under the vent plug is undamaged.

LEVEL OF ELECTROLYTE

The surface of the electrolyte should be level with the tops of the separators. If necessary, top up with distilled water. Any loss of acid from spilling or spraying (as opposed to the normal loss of **water** by evaporation) should be made good by dilute acid of the same specific gravity as that already in the cell.

CLEANLINESS

See that the top of the battery is free from dirt or moisture which might provide a discharge path. Ensure that the battery connections are clean and tight.

HYDROMETER TESTS

Measure the specific gravity of the acid in each cell in turn, with a hydrometer. The reading given by each cell should be approximately the same ; if one cell differs appreciably from the others, an internal fault in that cell is indicated. This will probably be confirmed by the heavy discharge test described below.

The appearance of the electrolyte drawn into the hydrometer when taking a reading gives a useful indication of the state of the plates : if it is very dirty, or contains small particles in suspension, it is possible that the plates are in a bad condition.

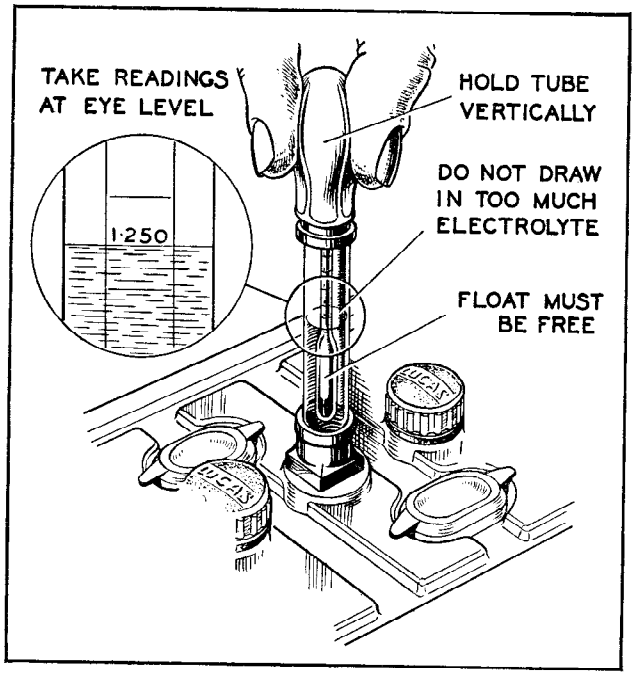

Fig. 2.
Taking hydrometer readings

DISCHARGE TEST

A heavy discharge tester consists of a voltmeter, 2 or 3 volts full scale, across which is connected a shunt resistance capable of carrying a current of several hundred amperes. Pointed prongs are provided for making contact with the inter-cell connections.

Press the contact prongs against the exposed positive and negative terminals of each cell. A good cell will maintain a reading of 1.2-1.5 volts, depending on the state of charge, for at least 6 seconds. If, however, the reading rapidly falls off, the cell is probably faulty, and a new plate assembly may have to be fitted.

(b) RECHARGING FROM AN EXTERNAL SUPPLY

If the above tests indicate that the battery is merely discharged, and is otherwise in a good condition, it should be recharged, either on the vehicle by a period of daytime running or on the bench from an external supply.

If the latter, the battery should be charged at the rate given in Para. 3 until the specific gravity and voltage show no increase over three successive hourly readings. During the charge the electrolyte must be kept level with the tops of the separators by the addition of distilled water.

A battery that shows a general falling-off in efficiency, common to all cells, will often respond to the process known as "cycling". This process consists of fully charging the battery as described above, and then discharging it by connecting to a lamp board, or other load, taking about 5 amperes. The battery should be capable of providing this current for at least 7 hours before it is fully discharged, as indicated by the voltage of each cell falling to 1.8. If the battery discharges in a shorter time, repeat the "cycle" of charge and discharge.

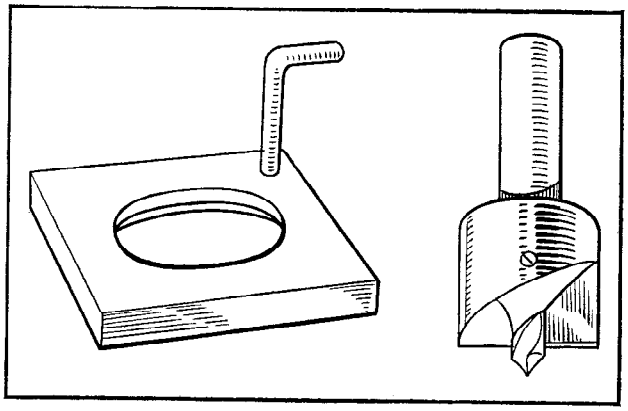

Fig. 3.
(a) Connector burner guard (b) Connector-link cutter

(c) DISMANTLING

If the heavy discharge test shows that a cell is faulty, adopt the following procedure to dismantle, inspect and if necessary refit a new plate assembly.

Special tools are available to facilitate the dismantling of the battery (Figs. 3, 4 and 5).

Remove the connector-formers by using the former-breaker (Fig. 4) as follows: rest the former-breaker on the connector-former, with the fork across the connector-link; raise the striker rod and deliver a sharp blow. Remove the severed portions of the connector-former leaving the connector-link clear.

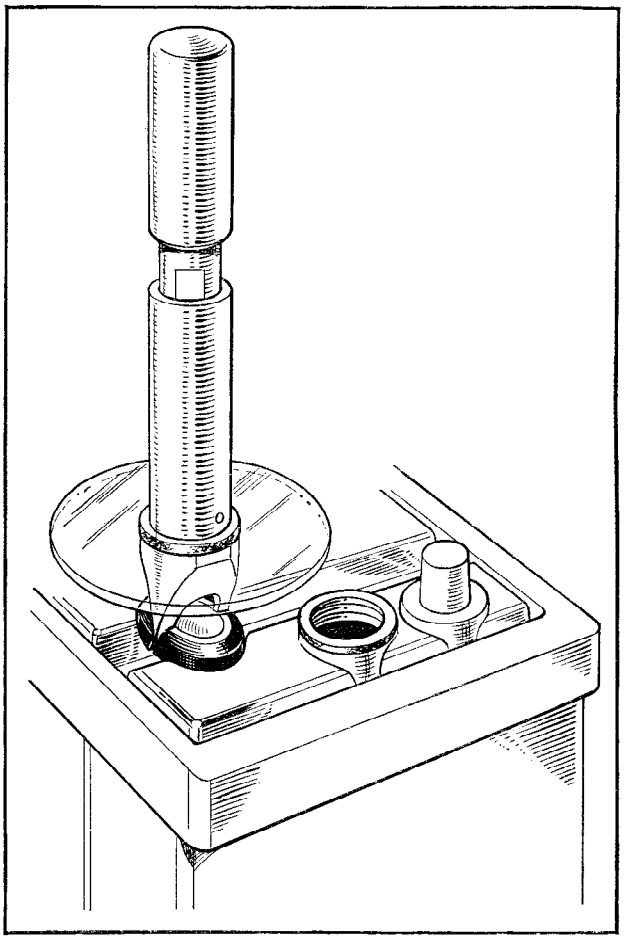

Fig. 4.
Using the former-breaker

Drill the connector links with the connector-link cutter to a depth of approximately $\frac{3}{16}$ of an inch, so that the 'D' shaped posts and the remaining part of the connector-former are just exposed. The remainder of the connector-former can now be removed. Proceed with each cell in turn if more than one is to be re-plated. No trimming of the section posts is required as the operation leaves the posts clean and of sufficient height to allow re-burning of new connector-links if the sections are to be used again. If an end cell is involved, the main battery post is then hollow milled in the normal manner until the lead seal securing the post is cut.

After removing the necessary connector-formers and drilling the connector links, the sealing compound should be softened by means of infra-red lamps or elements.

Care must be taken to protect the cell lids and battery case : stout cardboard shields are suitable for this purpose. If infra-red equipment is not available, softening of the sealing compound can be accomplished by steam in the usual manner. The softened sealing compound should now be cleared away and the jaws of the cell-lid extractor placed in one of the filler-plug apertures. The cell-lids can now be removed. Where difficulty is encountered, the cell-lid should be prised off by means of the lever used in conjunction with the extractor (Fig. 5). This operation should be carried out whilst the sealing-compound is still warm. The plate sections can now be removed from the cells, and the positive plates, negative plates and separators carefully pulled apart.

Siphon out the electrolyte from the cell(s) concerned and clean out all flaked material from the bottom of the case.

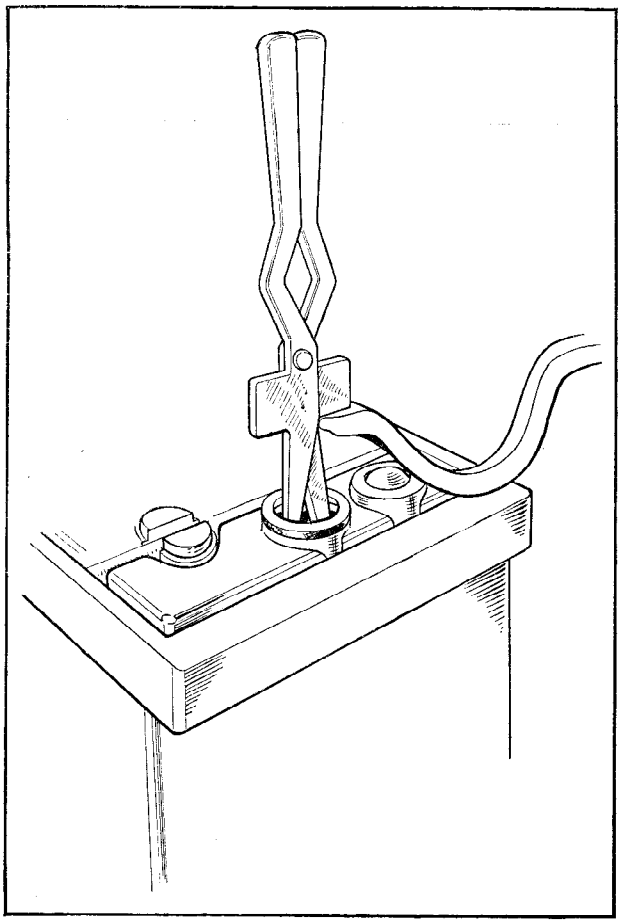

Fig. 5.
Removing cell lids

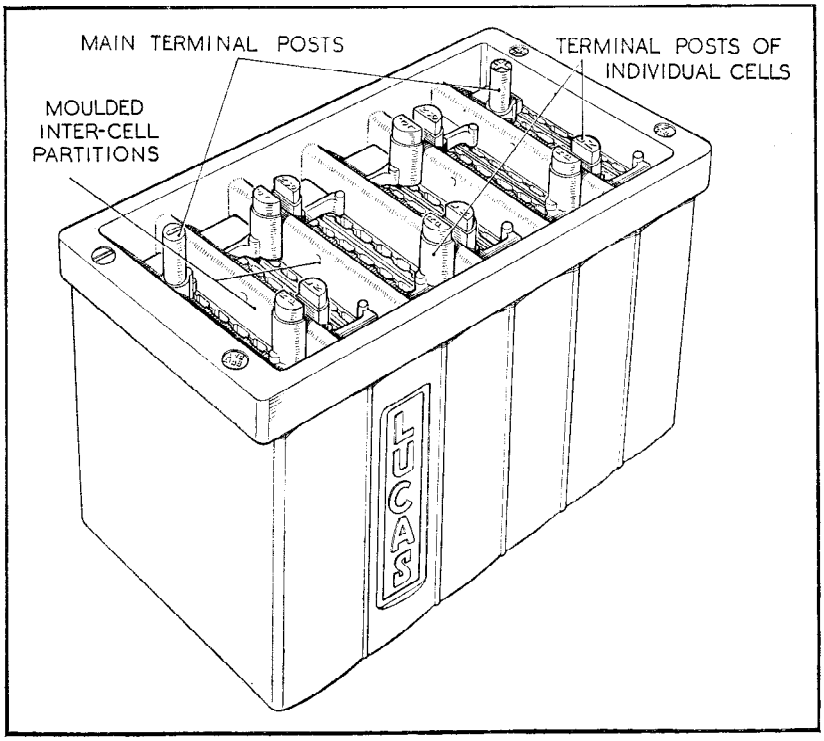

Fig. 6.
Battery with cell lids removed

Examine the plates for flaking or sulphation of the active material, and signs of buckling or distortion of the grids. If the plates are in a bad condition, it is necessary to fit new sets of negative and positive plates and new separators. Note that sets of plates are not interchangeable : six different types of plate sets are used in the battery, arranged as follows :

1st cell : Main Negative, Right Positive.
2nd ,, Left Negative, Left Positive.
3rd ,, Right Negative, Right Positive.
4th ,, Left Negative, Left Positive.
5th ,, Right Negative, Right Positive.
6th ,, Left Negative, Main Positive.

("Positive" and "negative" refer, of course, to the polarity of the plates ; "right" and "left" to the position of the "D" shaped terminal posts, looking at the terminal post end of the plates. The posts are marked "R.P.", "L.N.", etc., in order to identify the different plates).

Four different types of cell lid are also used :—

1—Main (positive end),
1—Main (negative end),
2—Intermediate (left-hand),
2—Intermediate (right-hand).

RE-ASSEMBLY

Ensure that the inside of the battery container is thoroughly clean and dry, free from any trace of sediment. If the container shows any cracks or faults, either in the outer casing or in the moulded partitions between the cells, it must be discarded.

Fit the plate assemblies into the cells, and place the cell lids in position.

Half-fill the channels between the cell lids and the casing with sealing compound, taking care that the compound runs between the "D" posts. The upper portions of the "D" posts must be kept free of compound. A coal-gas flame should be used to assist the running of the compound and to ensure a good, even surface.

Add electrolyte of the specific gravity quoted in para. 3(b) and carry out the initial charging procedure for the new cell(s), connections being made by bulldog clips to the D-shaped terminal posts of the cells.

Fit new moulded connector-formers over the "D" posts ; place the burner-guard

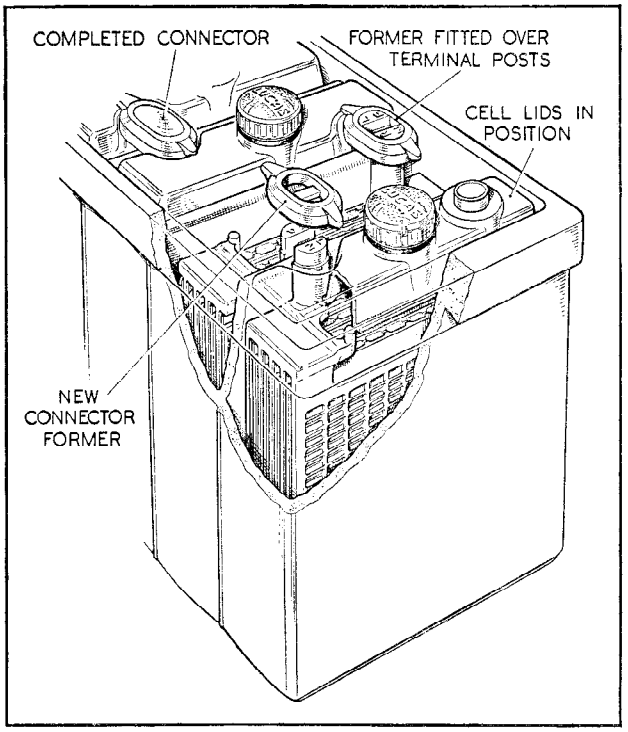

Fig. 7.
Re-fitting connectors

over each former in turn and burn-up the "D" posts, adding extra lead until the former is just full. When each connector has been formed in this manner, add further sealing-compound round each cell lid, using the coal-gas flame to ensure that the compound has a smooth, even surface.

Reform the main terminal posts in the usual manner. Where Lucas die-cast lead cable connectors are to be used with the battery, each terminal post must be drilled to take the self-tapping fixing screw. The hole should be $\frac{5}{32}$ in. in diameter and $\frac{1}{2}$ in. deep.

5. PREPARING NEW UNFILLED, UNCHARGED BATTERIES FOR SERVICE

(a) PREPARATION OF ELECTROLYTE :

Batteries should not be filled with acid until required for initial charging. Electrolyte of the specific gravity given in Para. 3(b) is prepared by mixing distilled water and concentrated sulphuric acid, usually of 1.835 S.G. The mixing must be carried out either in a lead-lined tank or in suitable glass or earthenware vessels. Slowly add the acid to the water, stirring with a glass rod. **Never add the water to the acid,** as the resulting chemical reaction causes violent and dangerous spurting of the concentrated acid. The approximate proportions of acid and water are indicated in the following table:

To obtain Specific Gravity (corrected to 60°F.) of :	Add 1 vol. of acid of 1.835 S.G. (corrected to 60°F.) to :
1.350	1.8 volumes of water
1.320	2.3 ,, ,, ,,
1.300	2.5 ,, ,, ,,

Heat is produced by the mixture of acid and water, and the electrolyte should be allowed to cool before taking hydrometer readings—unless a thermometer is used to measure the actual temperature, and a correction applied to the reading as described in Para. 3(e) — and before pouring the electrolyte into the battery.

The total volume of electrolyte required can be estimated from the figures quoted in Para. 3(a).

(b) FILLING THE BATTERY

The temperature of the acid, battery and filling-in room must not be below 32°F.

Carefully break the seals in the filling holes and *half-fill* each cell with electrolyte of the appropriate specific gravity. Allow the battery to stand for at least six hours, in order to dissipate the heat generated by the chemical action of the acid on the plates and separators, and then add sufficient electrolyte to fill each cell to the top of the separators. Allow to stand for a further two hours and then proceed with the initial charge.

(c) INITIAL CHARGE

The initial charging rate is given in Para. 3(a). Charge at this rate until the voltage and specific gravity readings show no increase over five successive hourly readings. This will take from 40 to 80 hours, depending on the length of time the battery has been stored before charging.

Keep the current constant by varying the series resistance of the circuit, or the generator output. **This charge should not be broken by long rest periods.** If, however, the temperature of any cell rises above the permissible maximum quoted in Para. 3(d), the charge must be interrupted until the temperature has fallen at least 10°F. below that figure. Throughout the charge, the electrolyte must be kept level with the top of the separators by the addition of acid solution of the same specific gravity as the original filling-in acid, until specific gravity and voltage readings have remained constant for five successive hourly readings. If the charge is continued beyond that point, top up with distilled water.

At the end of the charge carefully check the specific gravity in each cell to ensure that, when corrected to 60°F., it lies within the specified limits. If any cell requires adjustment, some of the electrolyte must be siphoned off and replaced either by distilled water or by acid of the strength originally used for filling-in, depending on whether the specific gravity is too high or too low. Continue the charge for an hour or so to ensure adequate mixing of the electrolyte and again check the specific gravity readings. If necessary, repeat the adjustment process until the desired reading is obtained in each cell. Finally, allow the battery to cool, and siphon off any electrolyte above the tops of the separators.

6. PREPARING GTZ "DRY-CHARGED" BATTERIES FOR SERVICE

"Dry-charged" batteries are supplied without electrolyte but with the plates in a charged condition. When they are required for service it is only necessary to fill each cell with sulphuric acid of the correct specific gravity. No initial charging is required. This procedure ensures that there is no deterioration of the efficiency of the battery during the storage period before the battery is required for use.

In these batteries porous rubber is used instead of wood for the separators between the plates.

(a) PREPARATION OF ELECTROLYTE

The electrolyte is prepared by mixing together distilled water and concentrated sulphuric acid, taking the precautions as para. 5(a). The specific gravity of the filling electrolyte depends on the climate in which the battery is to be used (see para. 3c).

The approximate proportions of acid and water are indicated in the following table:—

To obtain Specific Gravity (corrected to 60°F.) of:—	Add 1 vol. of acid of 1.835 S.G. (corrected to 60°F.) to:
1.275	2.8 vols. of water
1.215	4.0 vols. of water

Heat is produced by the mixture of acid and water, and the electrolyte should be allowed to cool before pouring it into the battery.

The total volume of electrolyte required can be estimated from the figures quoted in para. 3(a).

(b) FILLING THE BATTERY

Carefully break the seals in the cell filling holes and fill each cell with electrolyte to the top of the separators, **in one operation.** The temperature of the filling room, battery and electrolyte should be maintained between 60°F. and 100°F. If the battery has been stored in a cool place, it should be allowed to warm up to room temperature before filling.

(c) PUTTING INTO USE

Batteries filled in this way are 90 per cent charged, and capable of giving a starting discharge one hour after filling. When time permits, however, a short freshening charge will ensure that the battery is fully charged. Such a freshening charge should last for no more than 4 hours, at the normal recharge rate of the battery (see para. 3a).

During the charge the electrolyte must be kept level with the top edge of the separators by the addition of distilled water. Check the specific gravity of the acid at the end of the charge; if 1.275 acid was used to fill the battery, the specific gravity should now be between 1.280 and 1.300; if 1.215, between 1.220 and 1.240.

(d) MAINTENANCE IN SERVICE

After filling, a dry-charged battery needs only the attention normally given to a battery.

7. NOTES ON CHARGING

Battery charging should be carried out in a cool, well-ventilated room, preferably provided with an insulated floor covering to protect the operators from shock. The charging benches should be covered with non-conducting material such as slate, glass or earthenware, and, together with the remainder of the plant, batteries and connecting cables, should be kept as clean and dry as is practicable.

Batteries on charge should have a space of at least one inch around them. Vent plugs removed from the cells should be wiped dry and laid on the top of the battery so that there is no risk of losing them.

When calculating the number of batteries that may be charged at once by a given plant, allow 18 volts, at the appropriate charging rate, for each 12 volt battery. If batteries of different capacities are to be charged in series, the charging rate must be that of the **lowest** capacity battery. All the connections between batteries, and between the bank and the supply lines, must be tight and make good electrical contact, to obviate the risk of a spark. For the same reason the charging circuit must always be broken at the main switch before removing batteries from the bank.

8. STORAGE OF BATTERIES

(a) UNFILLED BATTERIES

Batteries received dry should be filled and charged within one year of the date of manufacture.

Battery store-rooms must be dry, and the store temperature maintained between 32°F. and 90°F. If stored in the open, batteries must be protected against direct sun-light, dirt and damp. They should be stacked the correct way up—at no time should the batteries be stacked on their sides.

When not in cartons, the batteries should be stacked in stacks not more than four batteries high. Wooden spacers must be placed between the layers, the spacers being placed lengthwise along the batteries and of such dimensions that the load of the upper layers is spread evenly along the containers of the lower layers. No part of a battery in one layer must touch a battery in another layer.

When the batteries are in cartons, they may be stacked not more than six high, taking care that the vertical edges are in line so that horizontal edges do not cut through lower layers.

Heavy objects must not be placed on top of stored batteries.

(b) FILLED BATTERIES

Batteries must be fully charged before storing, and should be examined once a month in temperate climates, weekly in the tropics, and if necessary given a short refreshing charge.

After a long period of storage, the condition of the battery will often be improved if it is put through a "cycle", *i.e.*, completely discharged at its 10 hour rate and then recharged in the normal way.

9. BATTERY CABLE CONNECTORS

When fitting diecast cable connectors, smear the inside of the tapered hole with petroleum jelly and push on the connector by hand. Insert the self-tapping screw and tighten with medium pressure only: fill in the recess around the screw with more petroleum jelly.

If the connectors are fitted dry and driven home on the tapered battery posts too tightly, difficulty may be experienced when it is required to remove them subsequently.