# MANUAL

*of*

# "Exide" Batteries

IN

AUTOMOBILE

STARTING & LIGHTING

SERVICE

THE ELECTRIC STORAGE BATTERY CO.

PHILADELPHIA, PA.

FORM 1296 Seventh Edition FEBRUARY, 1919

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# "Exide" Batteries

IN

# AUTOMOBILE STARTING & LIGHTING SERVICE

This Manual consists of two sections. Section I, which is also issued separately as Form 1369, is intended primarily for the owner or chauffeur of the automobile and covers the care and operation of the storage battery. Section II deals with the repair of above batteries together with other information for the garage man or battery repair man and is not intended for the owner or chauffeur.

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THE ELECTRIC STORAGE BATTERY CO.
PHILADELPHIA, PA.

FORM 1296 Seventh Edition FEBRUARY, 1919

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### THE ELECTRIC STORAGE BATTERY CO.

EXPORT DEPARTMENT
**100 BROADWAY, NEW YORK CITY, U. S. A.**

THIS book is entirely devoted to the care and operation of a storage battery used for automobile starting, lighting and ignition. Section I has been issued separately as Form 1369 for the use of the owner or chauffeur of an automobile, but is given in the following pages together with Section II, which deals with repairs to batteries and care of batteries in storage, for the guidance of the garage man and battery repair man.

In just a few words, let us first tell you how the "Exide" Battery is particularly adapted to the starting, lighting and ignition of automobiles.

At the start, let us impress upon you the fact that the design and manufacture of a battery for starting and lighting service is no easy problem. It requires a lot of ability and experience to design a battery that will satisfactorily meet the conditions of starting and lighting service. A battery must have a great amount of power in order to crank an engine for perhaps thousands of revolutions, in addition to lighting the lamps on the car and furnishing current for ignition, electric horn, etc.

Do you realize that an "Exide" Auto Battery which measures only 12⅝ inches long, 7⅜ inches wide and 9⅛ inches high, and weighs only 63½ pounds, can deliver over 2,000,000 foot pounds of energy—sufficient to raise its own weight to a vertical height of over 6 miles? Do you realize that in cranking an engine, a 50 or 60 pound storage battery must often develop power at the rate of over two electrical horse power?

Power is not all. A storage battery, to be successful, must do its work instantly, automatically and unfailingly month in and month out and at temperatures ranging from below zero to 100 degrees F. Again, it must be so designed as to require a minimum of care and to be easily kept in first class condition.

The "Exide" Battery is manufactured by the oldest, largest and most experienced battery manufacturer in the country. Seven years ago there arose a demand for storage batteries for automobile starting, lighting and ignition. At that time this Company, with over twenty-three years' experience in storage battery design, and with unequaled manufacturing facilities, undertook to develop the best starting and lighting battery possible. It possessed a great advantage in the fact that as a foundation it had the "Exide" Battery, which for years had shown such successful results in electric vehicle and other allied services. It was with the "Exide" Starting and Lighting Battery, put into service in 1912, that the commercial practicability of electric cranking was definitely established. Each year since 1912 has seen an enormous increase in the use of "Exide" Batteries until at the time this is written more than 1,110,000 "Exide" Batteries have given and are giving satisfaction in starting and lighting service. This number is being added to at the rate of many thousands each month.

The following are some of the many exclusive "Exide" features that are responsible for its success:

First. **The Unit Cell Assembly**—a really notable forward step in battery construction—dispensing with bulky and troublesome sealing and packing compound, saving space and weight and making the battery clean, dry and attractive in appearance.

Second. **Non-Flooding Filling Plug and Vent**—preventing in a simple and practical way the overfilling of cells with its attendant evils.

Third. **Improved Methods of Sealing**—securing a tight and perfect closure of the cells without waste of space or weight and facilitating opening of cells for inspection or repair when necessary.

Fourth. **Rubber Jars of Special Compound**—tough and semi-flexible, making jar breakage in service very rare.

Fifth. **Increased Power for a Given Weight and Size**—obtained by the use of thin plates of large area, yet so designed as to be rugged and long-lived.

Sixth. **Cases of Improved Construction**—having lock-jointed corners and handles anchored in case ends.

"Exide" construction makes the "Exide" Battery the highest priced starting and lighting battery on the market. But while it costs the most to make, it is the least expensive to use. The higher price is more than compensated for by the longer life, greater reliability and the high quality of service generally which it gives to a car owner.

In addition to manufacturing a battery of the very highest quality, this Company is further serving its customers by maintaining a Service Organization which makes it easy for a car owner to obtain an "Exide" Battery or any battery help or information or to have his battery renewed or repairs made when such are necessary.

This Company has fifteen Sales Offices in this country and one in Canada, as shown on page 2. In addition there are fourteen "Exide" Depots and hundreds of "Exide" Service Stations equipped to give prompt and reliable service in the larger cities and towns throughout the country.

Ascertain the location of the "Exide" Service Station nearest you and go there the next time you wish any information on batteries. Our nearest office will gladly furnish you with a list of the "Exide" Service Stations.

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# FOREWORD

The storage battery is an exceedingly important part of the equipment of the modern automobile. It is the "heart" of the electrical system, supplying the power for starting the engine, lighting the lamps and often current for ignition as well.

The average car owner or chauffeur is fairly familiar with the engine and its care, but is apt to regard the battery as mysterious and therefore to ignore it.

A storage battery, like the tires, will eventually wear out with use. The normal life, however, can be very much shortened by neglect, the result of which is the same as abuse.

The object of this book is to give information which will enable the garage man or battery repair man to obtain the best results and is not intended for the owner or chauffeur.

Although the whole subject is covered in considerable detail, it will be found that the actual care, while essential, amounts to very little and is easily understood. It may be summed up in four rules:

**1. Add nothing but pure water to the cells and do it often enough to keep the plates covered.**

**2. Take frequent hydrometer readings.**

**3. Give the battery a special charge whenever the hydrometer readings show it to be necessary.**

**4. Keep the filling plugs and connections tight and the battery clean.**

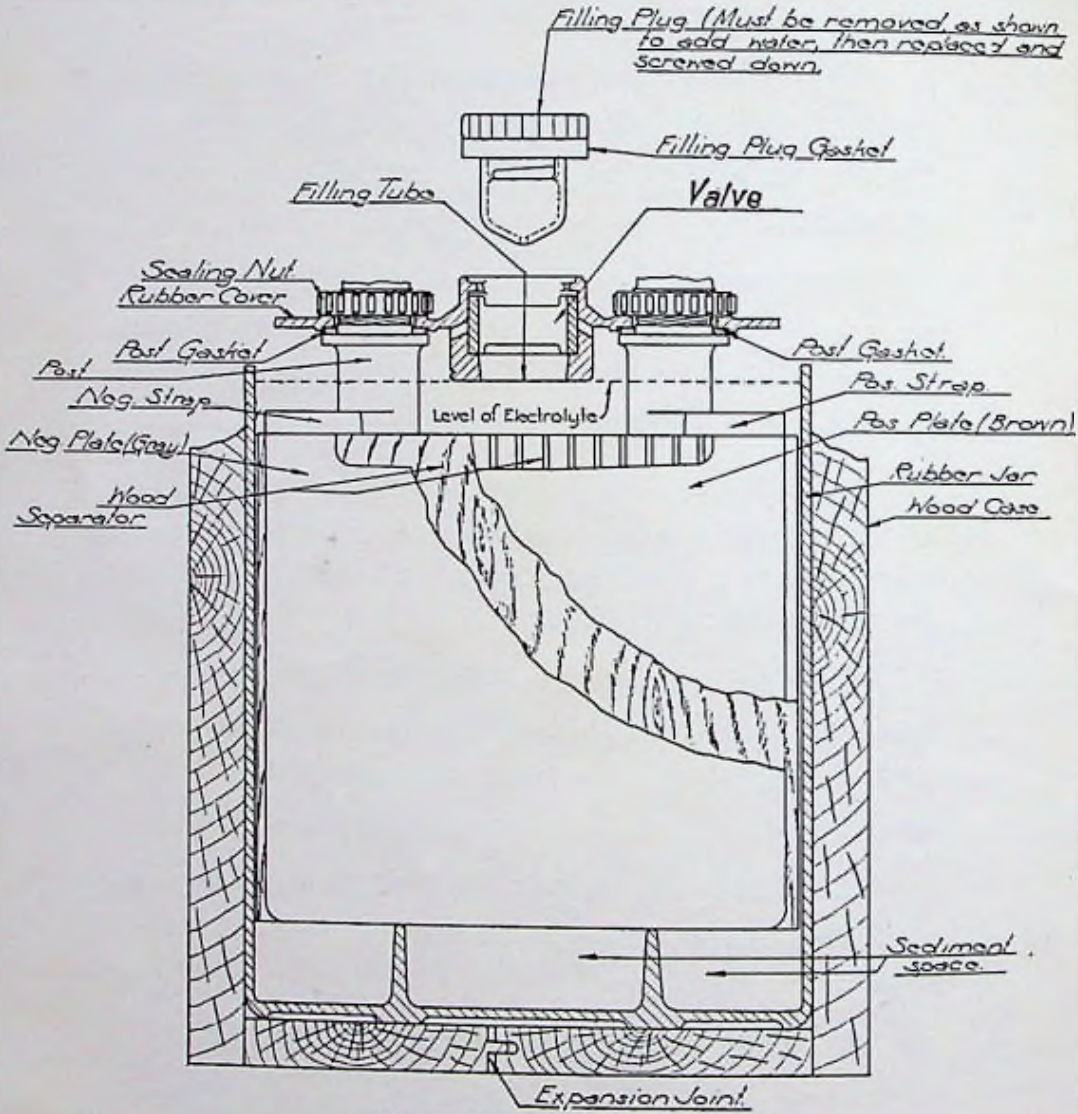



**Fig. 1. Section of Battery**

# TABLE OF CHARGE RATES

| TYPE OF CELL ▲ | | | Charge Rate in Amperes |
|---|---|---|---|
| XC-5 | X-55 | X-5 | 2 |
| XC-7 | X-75 | X-7 JX-7 | 3 |
| XC-9 | X-95 | X-9 | 4 |
| XC-11 | X-115 | X-11 JX-11 | 5 |
| XC-13 | X-135 | X-13 JX-13 | 6 |
| XC-15 | X-155 | X-15 XA-15 JX-15 | 7 |
| XC-17 | X-175 | X-17 | 8 |
| XC-19 | X-195 | X-19 JX-19 | 9 |
| XC-21 | X-215 | X-21 | 10 |
| XC-23 | X-235 | X-23 | 11 |
| XC-25 | X-255 | X-25 | 12 |
| PH-13 | PHA-13 | PHB-13 PH-135 | 8 |
| MH-11 | MHA-11 | MH-115 | 8 |

▲ *Note.—To identify type of cell, note the marking on the name plate, but disregard the first and last numerals, which refer respectively to the number and arrangement of cells in the battery. For instance, with name plate marked* 3-*XC*-15-1 *look for XC*-15 *in table.*

# FIRST CARE OF A NEW BATTERY

(This refers to batteries shipped filled with electrolyte and installed on car. For batteries shipped separately from car, but filled, see page 29. For batteries shipped unfilled, see page 65.)

Remove filling plugs, and read the specific gravity of the electrolyte in each cell with the hydrometer syringe (page 20).

If the gravity is below 1.250 (1.180*), and running the car will not charge the battery sufficiently to raise the gravity to this value, remove the battery from the car and give a charge from an outside source (page 13).

If the gravity is above 1.250 (1.180*), note the level of the electrolyte. If the level is below the bottom of the filling tube (Fig. 1), add pure water until the level rises into the tube; then replace the filling plugs and tighten by turning to the right.

If level of electrolyte is so low that a specific gravity reading cannot be taken, then add water as above described. After the car has been run several times, take a hydrometer reading of each cell, and if gravity is below 1.250 (1.180*), give a charge from an outside source (page 13).

Examine battery carefully to see that it is firmly secured in place. Examine connections to see that they are **tight** and **clean.**

If battery is installed in an enclosing box, be sure that any ventilating holes are not clogged.

* The lower gravity refers to batteries used in tropical climates (see page 17).

# BATTERY IN SERVICE

## GENERAL

The care of a battery in service is summed up in the four following rules, which, if observed with reasonable care, will result in the best service being obtained:

*1. Add nothing but pure water to the cells and do it often enough to keep the plates covered.*

*2. Take frequent hydrometer readings.*

*3. Give the battery a special charge whenever the hydrometer readings show it to be necessary.*

*4. Keep the filling plugs and connections tight and the battery clean.*

## ADDING WATER

**When Necessary**

**Water must be added often enough to keep the plates covered. If the plates are exposed for any length of time, they may be seriously damaged.**

The length of time a battery can go without the addition of water will depend upon the season of the year, water being required more frequently in summer than in winter.

The best plan is to make it an invariable rule to remove the filling plugs once each week and add water if level of electrolyte is below bottom of filling tube.

Never bring an open flame, such as a match or candle, near the battery. Use an electric lamp for inspection.

**Never add water while the battery is charging. If water is added while charging the gassing may cause flooding.**

Always add the water regularly, though the battery may seem to work all right without it.

In freezing weather, when necessary to add water, always do it just before running the car.

The reason for this is that water being lighter than electrolyte will remain on the surface and will freeze in cold weather. If the engine is run, however, the gassing, due to the charging current, will thoroughly mix the water with the electrolyte; the motion of the car when running will have a similar effect. Thoroughly mixed electrolyte will not freeze solid except at very low temperatures.

The electrolyte in a fully charged battery (gravity above 1.270) freezes at about 80 degrees below zero Fahrenheit; while in a normally discharged battery (gravity 1.150 to 1.175) it freezes at about zero Fahrenheit. Therefore, it is especially important to have the battery well charged when the car is standing in a very cold place.

**How to Add Water**

Remove filling plugs by turning to the left, and if level of electrolyte is found to be below bottom of filling tube (Fig. 1), add water by means of the hydrometer syringe (page 20) or a very small pitcher until the level begins to rise in the tube.

After adding water, be sure to replace filling plugs and tighten by turning to the right. **If filling plugs are not tightened, the electrolyte will flood out of the battery and cause damage** (page 22).

Wipe off the top of the battery after adding water.

**Kind of Water to Use**

The water used must be of reasonable purity, as the use of impure water, if persisted in, will injure the plates. Distilled water, melted artificial ice or rain water collected in clean receptacles is recommended.

**Add Nothing but Water**

**Nothing but water must be put into the cells. If acid of any kind, alcohol, or in fact anything but water, is added to the cells, it will result in very serious injury to the plates and may ruin them.**

The electrolyte in a cell consists of a mixture of sulphuric acid and water. Sulphuric acid does not evaporate, water does. When the level of the electrolyte in a cell becomes low, it is due, under normal conditions, to the evaporation of water, which should be replaced with water only.

**There being no loss of acid, it is never necessary, during normal service, to add any acid to a battery.**

If electrolyte has been spilled from the battery by accident the loss may be replaced with electrolyte of 1.250 (1.180*) specific gravity.

## HYDROMETER READINGS

**Value of Hydrometer Readings**

**Take frequent hydrometer readings, for they show whether the battery is receiving sufficient charge.**

When the battery is used in connection with a charging generator system, the system is so designed and adjusted that the amount of charging current received by the battery from the charging generator (dynamo) should about compensate for the discharge current used when starting the engine or when lighting the lamps from the battery. At medium or high speeds, the current for lamps does not come from the battery, but from the dynamo.

It sometimes happens, due to unusual conditions, such as excessive use of lamps, especially when car is driven at low speed, that the battery will not receive enough charge from the dynamo and will become more or less discharged, which will be indicated by lowered hydrometer readings (page 12).

**When to take Readings**

Take a hydrometer reading of each cell with the hydrometer syringe (page 20) at least once a week and just before adding water.

If hydrometer readings are taken after adding water and before the car is run, they are of no value, as only water or very weak electrolyte will be drawn into the syringe. This is due to the water being lighter than the electrolyte, and therefore remaining on the surface until thoroughly mixed by running the car.

* The lower gravity refers to batteries used in tropical climates (see page 17).

Take hydrometer readings at any time that any part of the electric system on the car does not work properly, as they may indicate the trouble.

**How to Take Readings**

The method of taking hydrometer readings is fully explained on page 20.

**What Readings Indicate**

Specific gravity above 1.225 (1.155*), indicates that the battery is more than half charged.

Gravity below 1.200 (1.130*), but above 1.150 (1.080*), indicates battery less than half charged, *i.e.*, is approaching exhaustion.

Such a condition may be due to excessive use of lights, together with slow running of the car, which cuts down the charging current from the generator, or it may be due to trouble in the system.

The remedy is to use lights sparingly until the gravity rises above 1.200 (1.130*). If gravity will not rise above 1.200 (1.130*) within a reasonable time, look for trouble in the system.

Gravity of 1.150 (1.080*) or below indicates battery completely discharged (exhausted).

**An exhausted battery should be removed from the car and given a full charge at once (page 13).**

If, after the battery has been fully charged, the gravity again falls to 1.150 (1.080*), it indicates there is trouble somewhere in the system which must be located and corrected.

The specific gravity readings of all cells of a battery should normally rise and fall together, as all cells of a battery as used with most systems are connected in series so that the charging and discharging current passes through all alike.

If the hydrometer reading of one cell should be considerably lower than the readings of the other cells in the battery, and if this difference should increase from week to week, it is an indication of trouble in that cell.

The trouble may be due to a short circuit (glossary), causing the cell to discharge itself, or it may be due to an impurity in the cell or to a leaking jar. A slight leak will allow electrolyte to escape, and if not noticed, the addition of water to replace its loss will lower the gravity.

Whatever the cause of low gravity, it should be attended to at once (page 18).

* The lower gravity refers to batteries used in tropical climates (see page 17).

## CHARGING

**General**

A battery charge is complete when, with charging current flowing at the normal rate, all cells are gassing (bubbling) freely and evenly and the specific gravity and voltage of all cells have reached a maximum; that is, have shown no further rise during a period of 5 hours.

Such a charge, as above described, can be given by running the engine idle if in connection with charging generator system. On account of the length of time required, however, it is usually preferable to remove battery from the car and give the charge from an outside source. In either case, such a charge is termed a "Special Charge."

### Special Charging

**When Necessary**

When the hydrometer readings indicate the battery to be exhausted, or approaching exhaustion, it should be charged.

When lamps burn dimly (running on battery), the battery should be charged.

When voltage with lamps burning has fallen below 1.80 volts per cell, the battery should be charged.

When the car is not in use, the battery should be charged at least once every two months if practicable to do so (page 19).

If battery is not giving satisfactory service, and, owing to low level of electrolyte, it is not possible to obtain a hydrometer reading, water should be added and the battery charged.

Sometimes a battery will be completely discharged, as shown by low voltage and dim lights, but the hydrometer readings will show the gravity to be well above 1.200 (1.130*). This is one of the evil effects of adding acid or electrolyte. In such cases, charge the battery at once, and reduce the specific gravity to between 1.270 and 1.300 (1.200* and 1.230*).

**How to Charge**

Remove the filling plugs and add water if necessary. **Then replace and tighten filling plugs to prevent flooding.** Never charge a battery with the filling plugs removed.

An exception to this rule is that in order to observe the gassing and to take hydrometer readings during charge, the filling plug may be removed from one or more cells, but care should be taken to turn the valve inside the filling tube so that it will be at right angles to its normal position. The filling plug can be used to turn the valve, holding it so that only the tip engages the valve. If the valve is not turned, electrolyte may flood out of the cell. After the charge, the filling plug must be replaced and tightened (page 22).


Fig. 2

**Normal Position of Valve when Filling Plug is Removed**


Fig. 3

**Valve Turned to Prevent Flooding while Charging with Filling Plug Removed**

* The lower gravity refers to batteries used in tropical climates (see page 17).

Connect the battery to the charging circuit (page 15) **The positive terminal of the battery marked "+" or "POS" must be connected to the positive wire from the charging source.**

Charge at the rate given in the table (page 9) for the type of battery in question.

**Indications of Complete Charge**

Continue the charge until the gravity has risen to a maximum, that is, shows no further rise over a period of 5 hours, six successive hourly hydrometer readings taken on the same cell being alike.

The battery voltage should likewise rise to a maximum.

Near the end of charge, remove the filling plugs to make sure that the cells are all gassing (bubbling) freely, as this is also an indication of full charge. Be careful to quickly replace and tighten the plugs or flooding will result.

If the battery becomes very warm during the charge (temperature of electrolyte above 110 [125*] degrees Fahrenheit), either stop the charge or reduce the rate until temperature lowers.

**Length of Charge**

To charge a completely discharged battery (gravity 1.150 [1.080*] or thereabout) will require about 24 hours at the normal rate. If it is very urgent to charge the battery in quicker time than this, the first part of charge may be given at twice normal rate, **but great care must be taken to reduce the rate to normal when the cells start gassing or when the temperature approaches 110 (125*) degrees Fahrenheit**, as otherwise serious damage may be done.

If the battery has been overdischarged (gravity below 1.150 [1.080*]) the plates will be in poor condition and will be permanently damaged unless charged at a low rate. This may require 3 to 5 days, using a rate about three-quarters to half normal.

After the charge is completed, take and record the hydrometer reading of each cell, as these readings taken at full charge are useful as a standard for comparison when subsequent readings are taken.

If, during the charge, it is noticed that the temperature of the battery rises very rapidly and the gravity does not rise to at least 1.250 (1.180*) and there is little or no gassing in one or all of the cells, it is an indication of trouble in the cells. If, after the charge, the battery soon becomes exhausted again, have it examined, as it is probably in need of repairs (page 18).

Replace and tighten filling plugs, wipe off top and sides of battery. When connecting to car circuit, be sure that all connections are clean and tight.

## Charging Circuit

A storage battery must be charged with direct current; never use alternating current for this purpose as it will ruin the battery.

If alternating current only is available, it will be necessary to provide apparatus for converting it into direct current. Several forms of apparatus are on the market for this purpose, either motor generator sets or rectifiers.

*The lower gravity and higher temperature refer to batteries with low gravity electrolyte used in tropical climates (see page 17).

## To Charge One Battery From a Direct Current Circuit

**Polarity**

Always connect the **positive terminal of the battery** to the **positive wire of the charging circuit** and the negative battery terminal to the negative wire of the circuit.

To determine the polarity of the charging circuit, if a suitable voltmeter is not at hand, dip the ends of two wires from the charging circuit into a glass of water in which a teaspoonful of salt has been dissolved, but do not allow ends of wires to touch. Fine bubbles of gas will be given off from the negative wire.

**Resistance Required**

If only one battery is to be charged from a 110 volt direct current circuit, resistance must be used in series with the battery to reduce the voltage of the circuit to that of the battery. The most convenient resistances to use are 110 volt, 32 candle power carbon filament lamps connected in parallel with each other, and the combination in series with the battery (Fig. 4). With

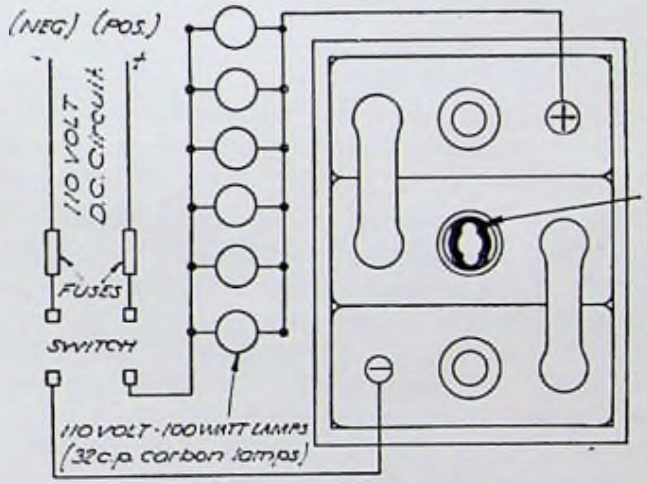



**Fig. 4. Charging Connections**

this arrangement, each lamp will allow one ampere of charging current to pass through the battery, so that the number of lamps required will depend upon the charge rate of the battery (table, page 9). For instance, for Type XC-13, charge rate 6 amperes, six lamps will be required.

If 32 candle power lamps are not available, then double the number of 16 candle power lamps will be required.

If tungsten or other high efficiency lamps are used, more will be required than if carbon filament lamps are used, owing to the lower current rating of the former.

If the battery is to be charged from a 220 volt circuit, use two lamps in series in place of each of the lamps necessary when charging from 110 volts.

If only a 500 to 600 volt circuit is available, it is necessary to use five lamps in series in place of each of the lamps used when charging from 110 volts.

## CLEANLINESS

**Necessity**

As with mechanical apparatus, cleanliness is essential to obtain the best results. Care must be taken to keep exposed portions of the battery and its connections clean and dry.

If reasonable attention is given to this requirement, much annoyance from trouble with the starting, lighting and ignition system will be avoided.

**Care of Battery Case**

If water or electrolyte is spilled upon the battery or in the compartment, wipe dry with waste. If electrolyte is present in any quantity, use waste moistened with weak ammonia in order to neutralize the acid in the electrolyte. Do not allow electrolyte to collect upon the woodwork as it will cause deterioration.

Once a week, when adding water, inspect all the battery connections and make sure that they are tight and clean. A loose or dirty connection may cause trouble when least expected.

**Care of Connections**

If signs of corrosion of any brass or copper parts should appear, clean the parts thoroughly with weak ammonia and apply vaseline.

Connections throughout the system must be examined periodically and kept tight and clean. Sometimes a connection, even if tight, will give trouble, due to foreign matter, such as paint or varnish, on the contact surfaces. This must be removed with a file or sand paper. The connections to the generator and the grounding connections to the frame of the car (if car is equipped with a grounded system) must not be neglected.


**"Exide" Starting and Lighting Battery**
**Type 3-XC-13-1**

## BATTERY NOT GIVING SATISFACTORY SERVICE

**How to Locate Trouble**

If trouble should develop, as shown by the engine not cranking properly, lights burning dimly or "missing" of the engine when battery is used for ignition, look for the cause as indicated below.

Make sure that all connections are tight and that all contacts are clean.

**Take a hydrometer reading** of each cell. If battery is found to be exhausted (gravity 1.150 [1.080*] or thereabout), give a special charge (page 13).

If, after having been fully charged, the battery is soon exhausted again, there is trouble somewhere else in the system, which should be located and corrected.

If a broken jar or short circuited cell is indicated (gravity considerably lower than in other cells), have the battery repaired (page 18).

Examine battery. If there is a broken connection, terminal, jar or cover, have the battery repaired.

### Additional Tests

When lamps burn dimly and a low reading portable voltmeter is at hand, turn on all the lamps and read the voltage of each cell or of the battery. If the voltage per cell is 2 volts or thereabout, the trouble is in the connections. If voltage is low (1.80 volts per cell or lower), the trouble is in the battery.

**Failure to Start**

When lamps burn brightly, but engine will not crank, notice, when attempting to start engine, whether lamps become very dim or go out; if they do, the trouble is in the battery. If they continue to burn brightly, the trouble is in the motor or motor circuit.

**Wiring Grounded**

The wiring may have become grounded to the frame of the car, and cause a leakage of current which in time may completely discharge the battery. This may be tested for as follows: At night or in a dark garage, turn on all the lamp switches, but remove the bulbs from the sockets and disconnect one of the cables at the battery terminals. Then strike the cable terminal against its battery terminal; if sparks are noticed, there is a ground in the wiring which must be looked for and removed.

## BATTERIES USED IN TROPICAL CLIMATES

Batteries used in tropical climates give better results with low gravity electrolyte. Places where freezing of water never occurs are regarded as having tropical climate. With low gravity electrolyte the high temperature limit may be raised to 125 degrees Fahrenheit.

*The lower gravity refers to batteries used in tropical climates (see above).

# BATTERY IN NEED OF REPAIRS

Any repairs necessitating taking cells apart should not usually be attempted by the individual owner, but should be done by a competent repair man (preferably one of the "Exide" Battery Depots or an "Exide" Distributor). Shipping instructions for batteries to be repaired will be forwarded upon application to the nearest office of the Company (page 2).

In countries outside of the United States and in outlying territories of the United States, if a reliable repair shop cannot be located, apply to the agent from whom the car was obtained, or to The Electric Storage Battery Co., Export Dept., 100 Broadway, New York City, U. S. A.

## PACKING FOR SHIPMENT

It is not safe to ship a battery without proper packing, as the rough handling received is almost sure to do damage. The following procedure is recommended:

1. Procure a strong box made with steeple shaped top (Fig. 5) to prevent the package from being placed upside down. The inside dimensions should be at least 2 inches greater than the overall size of the battery.

2. Cover the bottom of the box with a layer of excelsior, shavings or coarse saw dust about 2 inches thick, and on this place the battery. Over the tops of the cells place paper, preferably paraffined, and then cover the whole battery with stout wrapping paper, folding it down over the sides to keep off packing material and dust.

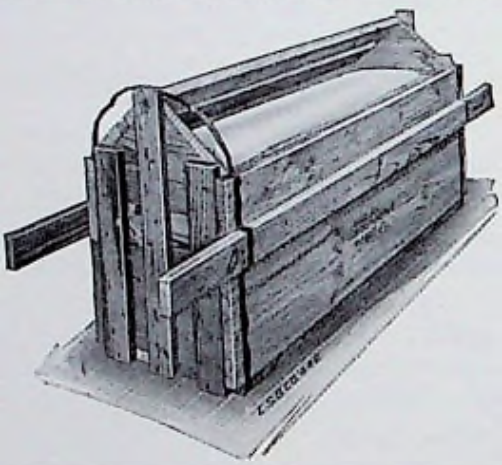


Fig. 5

3. Fill the space around the sides and ends of battery with excelsior, shavings, coarse saw dust or even twisted and crumpled balls of paper, ramming down tight.

4. Leave the top of the battery free of packing material and covered only with the paper.

5. Nail slats on the box for a cover; never make a solid cover. The slatted cover enables the freight handlers to see the contents of the package and helps toward careful handling. A stout strip of wood nailed on each side and projecting beyond the ends for handles will prevent the package from being stood on end.

6. Label the box "Handle with Care" and "Do Not Drop."

7. In addition to the address of destination, as given in shipping instructions, be sure to mark with name of shipper for identification upon arrival.

8. When shipping by freight, the proper freight classification in the United States is "Electric Storage Batteries, Assembled." No railroad caution labels are required.

9. When shipping by express in the United States, "Acid" caution labels must be attached to each package.

# CARE OF BATTERY OUT OF SERVICE

When a car is to stand idle for any considerable period, as when it is laid up for the winter months, the battery should not be left on the car without attention.

When a car is likely to be out of service as long as one month, but less than two, be careful to add water to the cells just before the last time the car is used and endeavor then to run the car (using lamps sparingly) so that the battery will be as nearly fully charged as possible, the specific gravity of the electrolyte reading between 1.270 and 1.300 (1.200* and 1.230*). Disconnect the wires of the battery, as even a slight leak in the wiring will cause the battery to discharge.

When a car is likely to be out of service for two months or longer, send the battery to a reliable garage where it will receive proper attention. If this is not practicable, the battery should be taken out of the car and treated as follows:

Remove filling plugs and add pure water until the level reaches the bottom of the filling tube. Replace filling plugs, turning them as far as they will go to insure their being firmly seated. **Never charge a battery with the filling plugs out, as the automatic vents are then closed and flooding may result.** See exception to this rule at bottom of page 13.

**Preliminary Charge**

Put on charge at the proper current rate as given in table (page 9), and continue the charge until the specific gravity of the electrolyte in all cells, as shown by the hydrometer syringe, has held at a maximum (ceased to rise) for a period of 5 hours and all the cells are gassing freely. When fully charged, place the battery where it will be dry, cool and free from dust.

**Freezing**

To avoid freezing in cold weather especial care must be taken that water is added just before and not after charging (page 10).

**Adding Water**

**Periodic Charge**

Once every two months during the out of service period, remove filling plugs and add water, replace plugs and give battery what is known as a "freshening charge"; that is, charge until all cells have been gassing freely and evenly for one hour. Then the battery may be allowed to stand for another two months.

If it is not practicable to have the battery charged at periodic intervals as above described, or sent to a reliable garage where it will receive attention, it can be allowed to stand (provided it has first been fully charged) for a period not exceeding six months, but better results will be obtained if the freshening charge every two months is given.

Always add water and charge the battery before putting back in service.

If the periodic charges have not been given during the out of service period, charge for at least 24 hours at normal rate before putting battery into service again.

* The lower gravity refers to batteries used in tropical climates (see page 17).

# THE HYDROMETER AND ITS USE

**Type In General Use**

The specific gravity or density of the electrolyte is measured by an instrument called the "hydrometer," (Fig. 6), S-1 type. This consists of a closed glass tube in the form of a short barrel with a longer stem of small diameter. Inside of the stem is a graduated scale. The hydrometer floats upright in the liquid and the point on the scale at the surface of the liquid shows the specific gravity, usually called "gravity."

Fig. 6 Hydrometer

**Hydrometer Syringe**

For greater convenience, the hydrometer is usually placed inside of a larger glass tube provided with a rubber bulb on top and a suitable nozzle on the lower end. This combination is known as the "hydrometer syringe" (Fig. 7).

Fig. 7 Hydrometer Syringe

**Method of Use**

By squeezing the bulb, inserting the nozzle into the electrolyte and releasing the bulb, electrolyte is drawn up into the glass tube. Sufficient electrolyte should be drawn up to float the hydrometer clear of the rubber plug in the bottom (Fig. 8).

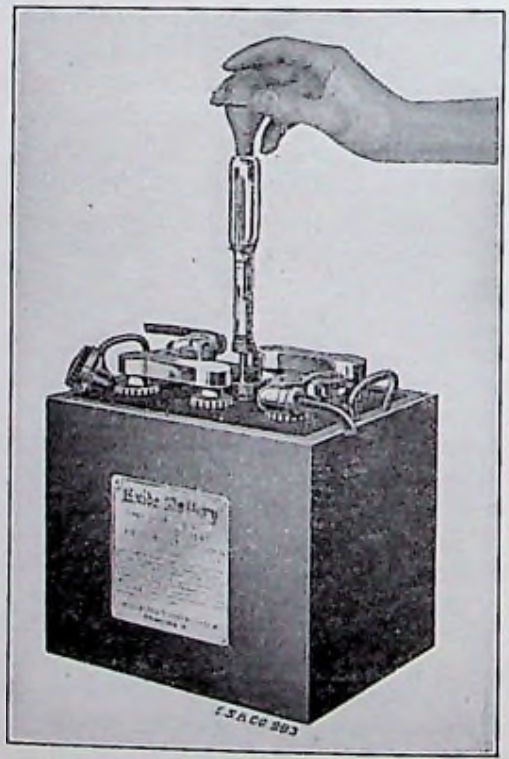


Fig. 8. Taking Hydrometer Readings

To prevent the hydrometer from sticking to the side of the tube, it is necessary that the syringe be held in a vertical position. The reading is taken at the surface of the electrolyte and when there is no compression on the bulb.

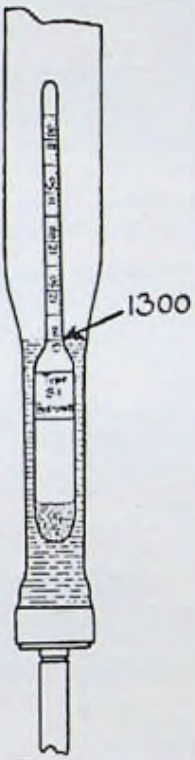



Fig. 9
**Hydrometer Reading, 1.300**

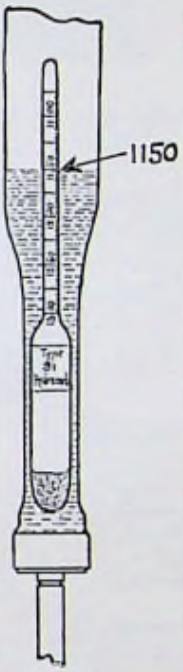
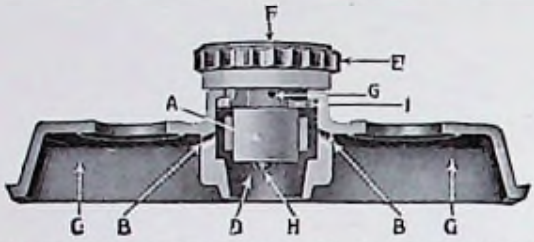



Fig. 10
**Hydrometer Reading, 1.150**

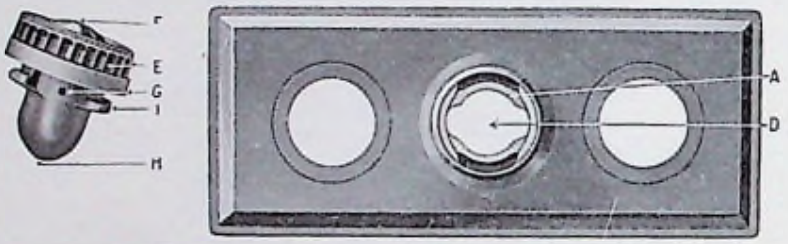
In recording the gravity of the different cells, it is customary to begin with the cell at the positive end.

When the readings have been taken, be careful to put the electrolyte back into the same cell from which it was taken. Failure to do this often leads to trouble; that is, electrolyte is often taken out of one cell, the gravity noted and the electrolyte put back into another cell. The result is that the amount of electrolyte taken out of the first cell is eventually replaced with water, leaving the electrolyte weaker; whereas the electrolyte which was taken out and put into another cell would make the electrolyte of that cell stronger, resulting in irregularity in the different cells.

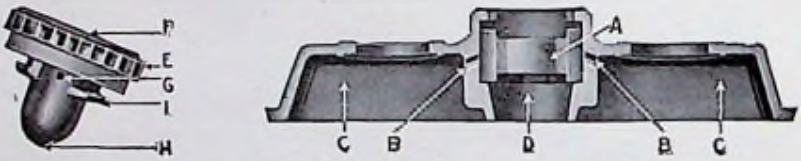
# DESCRIPTION OF NON-FLOODING VENT AND FILLING PLUG




**Sectional View of Cover Plug in Place. Valve (A) in Position to Allow Free Escape of Gas Through Passages (BB)**




**Top View of Cover and Filling Plug, Plug Removed**




**Sectional View of Cover, Plug Removed. Air Passages (BB) Closed and Valve (A) in Position to Prevent Overfilling**

**Fig. 11**

From the illustrations (Fig. 11) of the vent and filling plug, it will be seen that they provide both a vented stopper (vents F, G, H) and an automatic device for the preventing of overfilling and flooding. In a simple and effective manner, the amount of water that can be put into the cells is limited to the exact amount needed to replace that lost by evaporation. This is accomplished by means of the hard rubber valve (A) within the battery cover and with which the tip of the filling plug (E) engages, as shown in the illustrations. The action of removing the plug (E) turns this valve (A), closing the air passage (BB), and forming an air tight chamber (C) in the top of the cell. When water is poured in, it cannot rise in this air space (C) so as to completely fill the cell. As soon as the proper level is reached, the water rises in the filling tube (D) and gives a positive indication that sufficient water has been added. Should, however, the filling be continued, the excess will be pure water only, not acid. On replacing the plug (E), the valve (A) is automatically turned, opening the air passages (BB), leaving the air chamber (C) available for the expansion of the solution, which occurs when the battery is working.

# GLOSSARY

**Acid.** As used in this book refers to sulphuric acid ($H_2SO_4$), the active component of the electrolyte.

**Active Material.** The active portion of the battery plates; peroxide of lead on the positives and spongy metallic lead on the negatives.

**Alternating Current.** Electric current which does not flow in one direction only, like direct current, but rapidly reverses its direction or "alternates" in polarity so that it will not charge a battery.

**Ampere.** The unit of measure of the rate of flow of electric current.

**Ampere Hour.** The unit of measure of the quantity of electric current. Thus, 2 amperes flowing for ½ hour equals 1 ampere hour.

**Battery.** Any number of complete cells assembled in one case.

**Battery Terminals.** Devices attached to the positive post of one end cell and the negative of the other, by means of which the battery is connected to the car circuit.

**Buckling.** Warping or bending of the battery plates.

**Burning Strip.** A convenient form of lead, in strips, for filling up the joint in making burned connections.

**Case.** The containing box which holds the battery cells.

**Cell.** The battery unit, consisting of an element complete with electrolyte, in its jar with cover.

**Cell Connector.** The metal link which connects the positive post of one cell to the negative post of the adjoining cell.

**Charge.** Passing direct current through a battery in the direction opposite to that of discharge, in order to put back the energy used on discharge.

**Charge Rate.** The proper rate of current to use in charging a battery from an outside source. It is expressed in amperes and varies for different sized cells.

**Corrosion.** The attack of metal parts by acid from the electrolyte; it is the result of lack of cleanliness.

**Cover.** The rubber cover which closes each individual cell; it is flanged for sealing compound to insure an effective seal.

**Discharge.** The flow of electric current from a battery through a circuit. The opposite of "charge."

**Electrolyte.** The fluid in a battery cell, consisting of specially pure sulphuric acid diluted with pure water.

**Element.** One positive group and one negative group with separators, assembled together.

**Filling Plug.** The plug which fits in and closes the orifice of the filling tube in the cell cover.

**Flooding.** Overflowing through the filling tube. With the "Exide" automatic filling tube, this can usually occur only when a battery is charged with the filling plug out.

**Freshening Charge.** A charge given to a battery which has been standing idle, to insure that it is in a fully charged condition.

**Gassing.** The bubbling of the electrolyte caused by the rising of gas set free toward the end of charge.

**Generator System.** An equipment including a generator for automatically recharging the battery, in contradistinction to a straight storage system where the battery has to be removed to be recharged.

**Gravity.** A contraction of the term "specific gravity," which means the density compared to water as a standard.

**Grid.** The metal framework of a plate, supporting the active material and provided with a lug for conducting the current and for attachment to the strap.

**Group.** A set of plates, either positive or negative, joined to a strap. Groups do not include separators.

**Hold-down Clips.** Brackets for the attachment of bolts for holding the battery securely in position on the car.

**Hydrogen Flame.** A very hot and clean flame of hydrogen gas and compressed air used for making burned connections.

**Hydrogen Generator.** An apparatus for generating hydrogen gas for lead burning.

**Hydrometer.** An instrument for measuring the specific gravity of the electrolyte.

**Hydrometer Syringe.** A glass barrel enclosing a hydrometer and provided with a rubber bulb for drawing up electrolyte.

**Jar.** The hard rubber container holding the element and electrolyte.

**Lead Burning.** Making a joint by melting together the metal of the parts to be joined.

**Lug.** The extension from the top frame of each plate, connecting the plate to the strap.

**Maximum Gravity.** The highest specific gravity which the electrolyte will reach by continued charging, indicating that no acid remains in the plates.

**Oil of Vitriol.** Commercial name for concentrated sulphuric acid (1.835 specific gravity). This is never used in a battery and would quickly ruin it.

**Plates.** Metallic grids supporting active material. They are alternately positive (brown) and negative (gray).

**Polarity.** Electrical condition. The positive terminal of a cell or battery, or the positive wire of a circuit, is said to have positive polarity; the negative, negative polarity.

**Post.** The portion of the strap extending through the cell cover, by means of which connection is made to the adjoining cell or to the car circuit.

**Rectifier.** Apparatus for converting alternating current into direct current.

**Resistance.** Material (usually lamps or wire) of low conductivity inserted in a circuit to retard the flow of current. By varying the resistance, the amount of current can be regulated.

**Rubber Sheets.** Thin, perforated hard rubber sheets used in combination with the wood separators in some types of batteries. They are placed between the grooved side of the wood separators and the positive plate.

**Sealing Compound.** The acid proof compound used to seal the cover on the jar.

**Sealing Nut.** The notched round nut which screws on the post and clamps the cell cover in place.

**Sediment.** Active material which gradually falls from the plates and accumulates in the space below the plates provided for that purpose.

**Separators.** Sheets of grooved wood, specially treated, inserted between the positive and negative plates to keep them out of contact.

**Short Circuit.** A metallic connection between the positive and negative plates within a cell. The plates may be in actual contact or material may lodge and bridge across. If the separators are in good condition, a short circuit is unlikely to occur.

**Spacers.** Wood strips used in some types to separate the cells in the case, and divided to provide a space for the tie bolts.

**Specific Gravity.** The density of the electrolyte compared to water as a standard. It indicates the strength and is measured by the hydrometer.

**Starvation.** The result of giving insufficient charge in relation to the amount of discharge, resulting in poor service and injury to the battery.

**Strap.** The leaden casting to which the plates of a group are joined.

**Sulphated.** The condition of plates having an abnormal amount of lead sulphate caused by "starvation" or by allowing battery to remain discharged.

**Tie Bolts.** Bolts which, in some types, extend through the battery case between the cells and clamp the jars in position.

**Top Nut.** The hexagon nut which, in batteries with bolted connections, screws on the post and holds the connectors and sealing nut in place.

**Voltage.** Electrical potential or pressure, of which the volt is the unit.

# SECTION II

## REPAIRS TO BATTERIES
## CARE OF BATTERIES IN STORAGE

The preceding chapters deal with the care and operation of batteries and are intended primarily for the user. The following pages, dealing with repairs to batteries and care of batteries in storage, are for the guidance of garage and repair men, since work of this nature should be undertaken only by those who have the necessary equipment and experience.

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# RECEIVING A NEW BATTERY

## BATTERY RECEIVED INSTALLED ON CAR

See page 9—"First Care of Battery."

## BATTERY SHIPPED SEPARATELY FROM CAR

(This refers to batteries shipped filled. For batteries shipped unfilled see page 65).

In unpacking a battery, keep the packing case right side up to avoid spilling the electrolyte (battery solution).

First remove all packing material from the top and sides of the battery in order to insure nothing getting into the cells when the filling plugs are removed.

Examine battery case carefully to see if there is any evidence of a cell leaking due to a broken jar, or other indication of injury received in transit. If such is found, claim should be made against the carrier.

**Batteries with bolted connections** are shipped with a metal strip underneath the top nuts of the cell terminal posts to keep the sealing nuts from loosening. These strips should be discarded.

Remove filling plugs, giving a quarter turn to the left, and examine height of electrolyte; if it is below the bottom of the filling tube (Fig. 1), add pure water until the level of the solution is even with the bottom of the tube.

If there is evidence that electrolyte has been spilled from the cells in transit, use electrolyte of 1.250 specific gravity instead of water to make up the loss.

After adding water, replace and tighten filling plugs by turning to the right and give the battery a charge (page 13) at the proper rate for the type of battery as given in the table (pages 67 and 68). Continue charge until voltage of battery and specific gravity of electrolyte of each cell (as read by the hydrometer syringe) show no rise over a period of 5 hours.

At the end of this charge, take a careful gravity reading of each cell. The specific gravity should be between 1.270 and 1.300 (1.200* and 1.230*); if it is not, continue the charge and proceed as follows:

If the specific gravity is low, withdraw some of the solution with the hydrometer syringe and add 1.300 (1.230*) specific gravity electrolyte. If gravity is too high, withdraw some solution and add water. Repeat until gravity is within the proper limits.

**Never add electrolyte to a cell after the gravity has been adjusted to the proper point, unless to replace actual loss by spilling.**

Wipe off the top and sides of the battery case, being careful to remove any water or electrolyte that may have been spilled. If the connections are bolted, tighten all the top nuts, as they may have worked loose during shipment. The battery is then ready to be installed on the car.

* The lower gravity refers to batteries used in tropical climates (see page 17).

## Installing Battery on Car

It is very important that the battery be properly installed on the car, and considerable attention has been given by car manufacturers to providing for the battery a suitable battery compartment in a reasonably accessible location.

The battery **must be securely fastened in place** by means of holding devices which grip the case or case handles, so that this strain is not put upon the cells or terminals.

In making connections to the car wiring, be sure to follow the diagram as given in the car or system instruction book. Clean the wire terminals before inserting in the battery terminals and make sure that the connections are secure so they will not jar loose in service.

# GENERAL DESCRIPTION OF BATTERY

**Plates**

The positive and negative plates in "Exide" Starting and Lighting Batteries are of the same general design as the "Exide" plates so well known in vehicle batteries. A grid made of a stiff lead alloy supports the active material in the form of a series of vertical strips held between the grid bars and locked in place by horizontal surface ribs which are staggered on the opposite sides. Fig. 12 shows a section through the horizontal ribs and makes clear their staggered relation.

**Grid**

Fig. 12

**Material**

After the grids are cast, they are "pasted" with oxides of lead made into a paste of special composition which sets in drying, like cement. The plates then go through an electro-chemical process which converts the material of the positives into brown peroxide of lead and that of the negatives into gray, spongy lead. Fig. 13 shows the finished positive plate and Fig. 14 the negative.

**Lug**

Both the positive and negative plates are provided with an extension or "lug," and they are so assembled that all the positive lugs come at one side of the jar and all the negative lugs at the other, thus enabling each set to be burned together

Fig. 13. Positive Plate

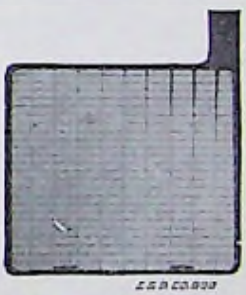


Fig. 14. Negative Plate

with a connecting strap, giving one positive and one negative pole. The burning is done by a hydrogen flame, which melts the metal of both lugs and strap into an integral union.

**Group**

A set of plates burned to a strap is known as a "group" (Fig. 15), either positive or negative.

**Straps**

The straps (Fig. 15) are made of a hard lead alloy and are provided with posts to which the cell connections are made.

**Separators**

When the positive and negative groups are assembled together, the adjoining plates are kept out of contact by means of wood separators ribbed on the side against the positive. The separators (Fig. 16) are made of tough wood particularly

adapted for the purpose and given a special treatment to remove harmful substances.

**Element** A positive and a negative group, together with the separators, constitute an "element" (Fig. 17).

**Electrolyte** The fluid, known as "electrolyte" (page 34), is dilute sulphuric acid.

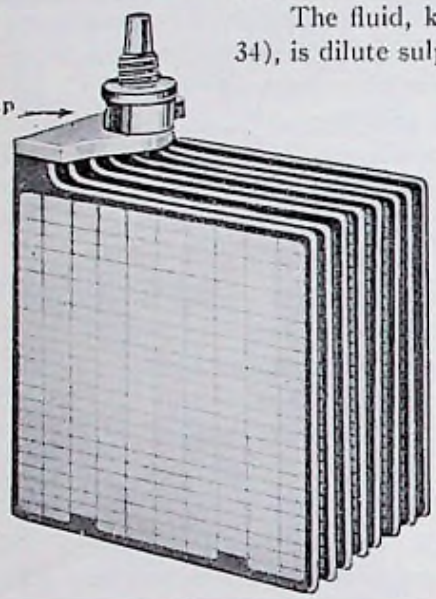


Fig. 15. Group

The cell container is a rubber jar of special composition which will withstand the vibration of the car and any ordinary handling without breakage. The plates rest on stiff ribs or bridges in the bottom of the jar (Fig. 1), allowing space for the gradual accumulation of "sediment."

Fig. 16. Separator

**Cover** The jar cover and method of sealing and venting represent a radical improvement over previous practice. The cover is flanged in such a way as to give a more perfect seal to the jar than the old flat type of cover, and each cell is a separate sealed unit.

A special feature is the method of making a tight seal where the post goes through the cover (Fig. 1). The strap post has an alloy collar which supports the jar cover, a soft rubber gasket being placed between. The post is threaded where it comes

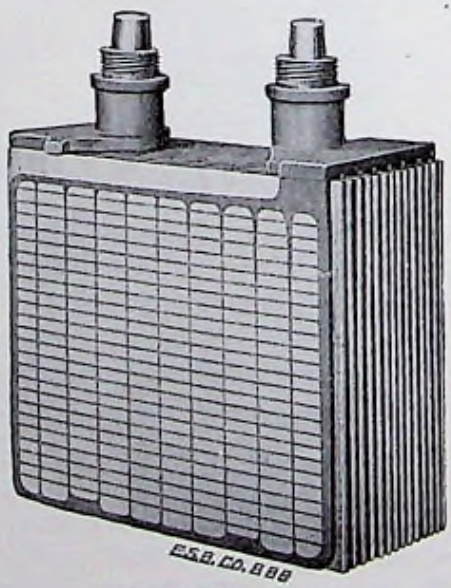


Fig. 17. Element

through the cover and the sealing nut clamps the cover tight, the soft rubber gasket underneath giving a very effective seal.

**Vent**

For description of vent see page 22.

**Case**

The case is substantially built of hard wood thoroughly coated with acid proof paint. The thorough method of sealing adopted prevents electrolyte from splashing or seeping out and keeps the case from becoming weakened and unsightly. So effective is the individual cell sealing that no layer of compound over the entire battery, as is general in other types, is required. This fact adds greatly to the ease with which the battery can be taken apart.

**Handles**

The loop handles are neat and strong and are securely anchored in the case without the use of screws.

**Hold-Down Clips**

It is **absolutely essential** that the battery be securely held in position on the car, and for this purpose brackets which fit on the case are used. The battery is made fast to the car by means of bolts engaging the hold-down clips.

# ELECTROLYTE

**Composition**

Electrolyte, as used in all "Exide" types of batteries, consists of a mixture of pure sulphuric acid and distilled or other pure water (page 11).

**Concentrated Sulphuric Acid**

Concentrated sulphuric acid is a heavy, oily liquid having a specific gravity of about 1.835. A battery will not operate if the acid is too strong, and it is therefore diluted with sufficient pure water to bring it to a gravity of 1.270 to 1.300 (1.200* to 1.230*) for a fully charged battery. Stronger electrolyte than this is injurious.

**Preparing Electrolyte**

To prepare electrolyte from sulphuric acid of 1.835 specific gravity, mix with water in the proportions indicated in Fig. 18 for the desired specific gravity, taking the following precautions:

Use a glass, china, earthenware or lead vessel. **Never metallic,** other than lead.

Carefully pour the acid into the water, never water into acid.

Stir thoroughly with wooden paddle and allow to cool before reading the gravity.

**Chemically Pure Electrolyte**

Both the water and the sulphuric acid used in making electrolyte should be chemically pure to a certain standard. This is the same standard of purity as is usually sold in drug stores as "CP" (chemically pure) or by the chemical manufacturers as "battery acid."

In this connection, the expression "chemically pure" acid is often confused with acid of "full strength." Acid may be of full strength (approximately 1.835 sp. gr.) and at the same time chemically pure. If this chemically pure acid of full strength be mixed with chemically pure water, the mixture would still be chemically pure, but not of full strength. On the other hand, if a small quantity of some impurity be introduced into chemically pure acid, it would not materially reduce the strength, but would make it impure.

The usual method of determining the strength of electrolyte is by taking its specific gravity. The method is possible on account of the fact that sulphuric acid is heavier than water. Therefore the greater the proportion of acid contained in the electrolyte the heavier the solution or the higher its specific gravity.

**Specific Gravity**

By specific gravity is meant the relative weight of any substance compared with water as a basis. Pure water, therefore, is considered to have a specific gravity of 1, usually written 1.000 and spoken of as "ten hundred." One pound of water is approximately one pint. An equal volume of concentrated sulphuric acid (oil of vitriol) weighs 1.835 pounds. It therefore has a specific gravity of 1.835 and is spoken of as "eighteen thirty-five."

**Temperature Correction**

Since electrolyte, like most substances, expands when heated, its specific gravity is affected by a change in temperature.

* The lower gravity refers to batteries used in tropical climates (see page 17).

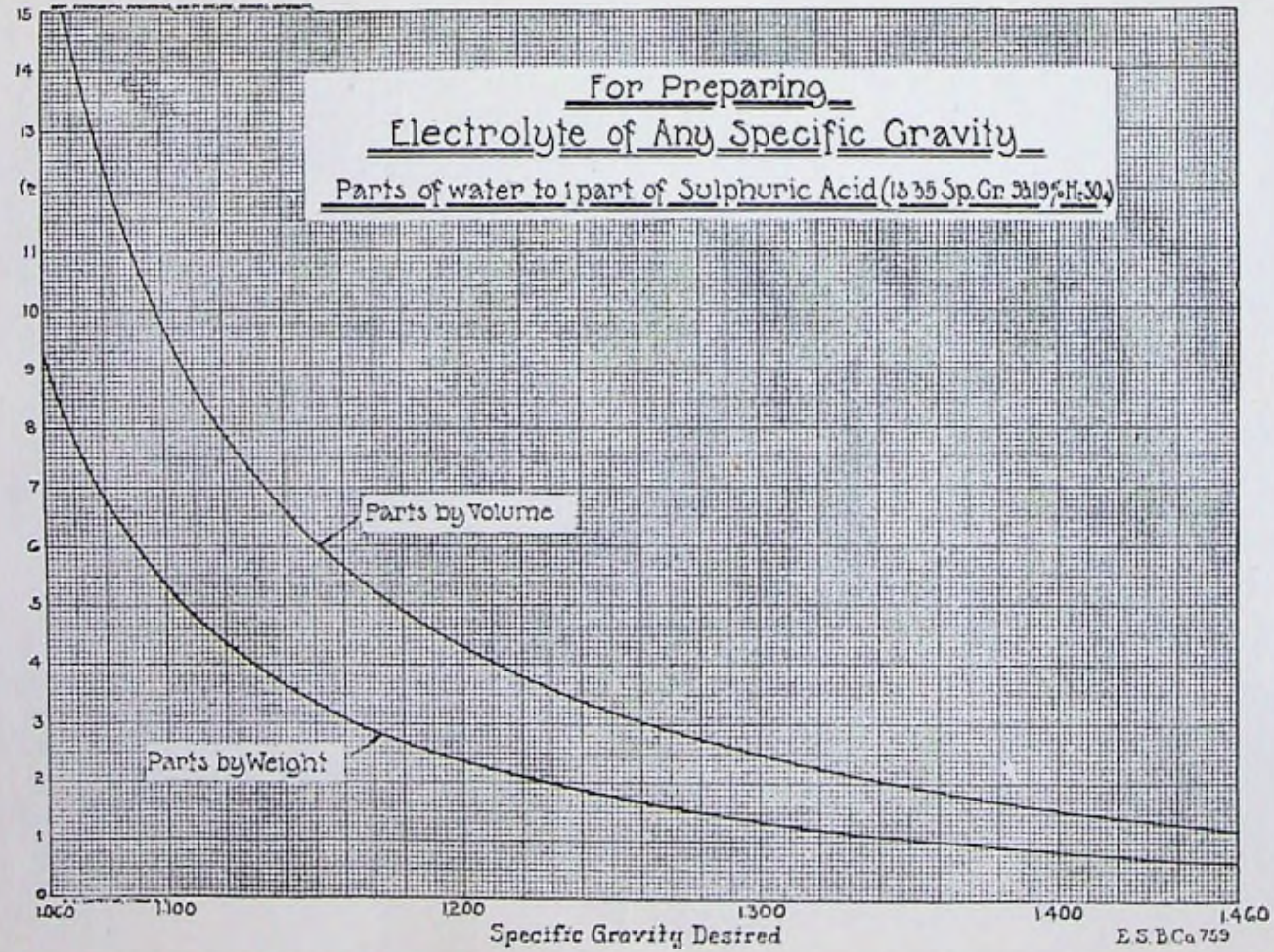
For Preparing
Electrolyte of Any Specific Gravity
Parts of water to 1 part of Sulphuric Acid (1.835 Sp. Gr. 93.19% $H_2SO_4$)
Parts by Volume
Parts by Weight
Parts of Water
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
1000 1100 1200 1300 1400 1460
Specific Gravity Desired
E.S.B.Co. 759

Fig. 18

If electrolyte has a certain gravity at a temperature of 70 degrees Fahrenheit and be heated, the heat will cause the electrolyte to expand, and, although the actual strength of the solution will remain the same as before heating, yet the expansion will cause it to have a lower gravity, of approximately one point (.001) for each three degrees rise in temperature. For instance, if electrolyte has a gravity of 1.275 at 70 degrees Fahrenheit and the temperature be raised to 73 degrees Fahrenheit, this increase in temperature will cause the electrolyte to expand and the gravity to drop from 1.275 to 1.274. On the other hand, if the temperature has been lowered from 70 degrees to 67 degrees, this would cause the gravity to rise from 1.275 to 1.276. Since the change of temperature does not alter the actual strength of the electrolyte, changing its gravity only, the gravity reading should be corrected one point for each three degrees change in temperature. For convenience, 70 degrees Fahrenheit is considered as normal, from which point the corrections are made.

For the convenience of the user, a thermometer has been designed with a special scale on which the amount of correction is indicated. This is on the opposite side of the mercury column and parallel to the temperature scale; that is, opposite to the temperature 70 degrees is figure 0, showing that no correction is made at that temperature. Three degrees below 70 degrees is shown minus 1, indicating that the gravity should be corrected at that temperature by deducting one point. Three degrees above 70 degrees is shown plus 1, which indicates that the gravity at that temperature should be corrected by adding one point to the reading, as shown by the hydrometer. The thermometer is shown in Fig. 19.

When the temperature is considerably above or below normal, the hydrometer readings should be corrected as explained above.

Fig. 19
Thermometer

**Freezing Point**

The freezing point of electrolyte depends upon its specific gravity. From the curve (Fig. 20) it will be seen that there is little danger of freezing except with a discharged battery.

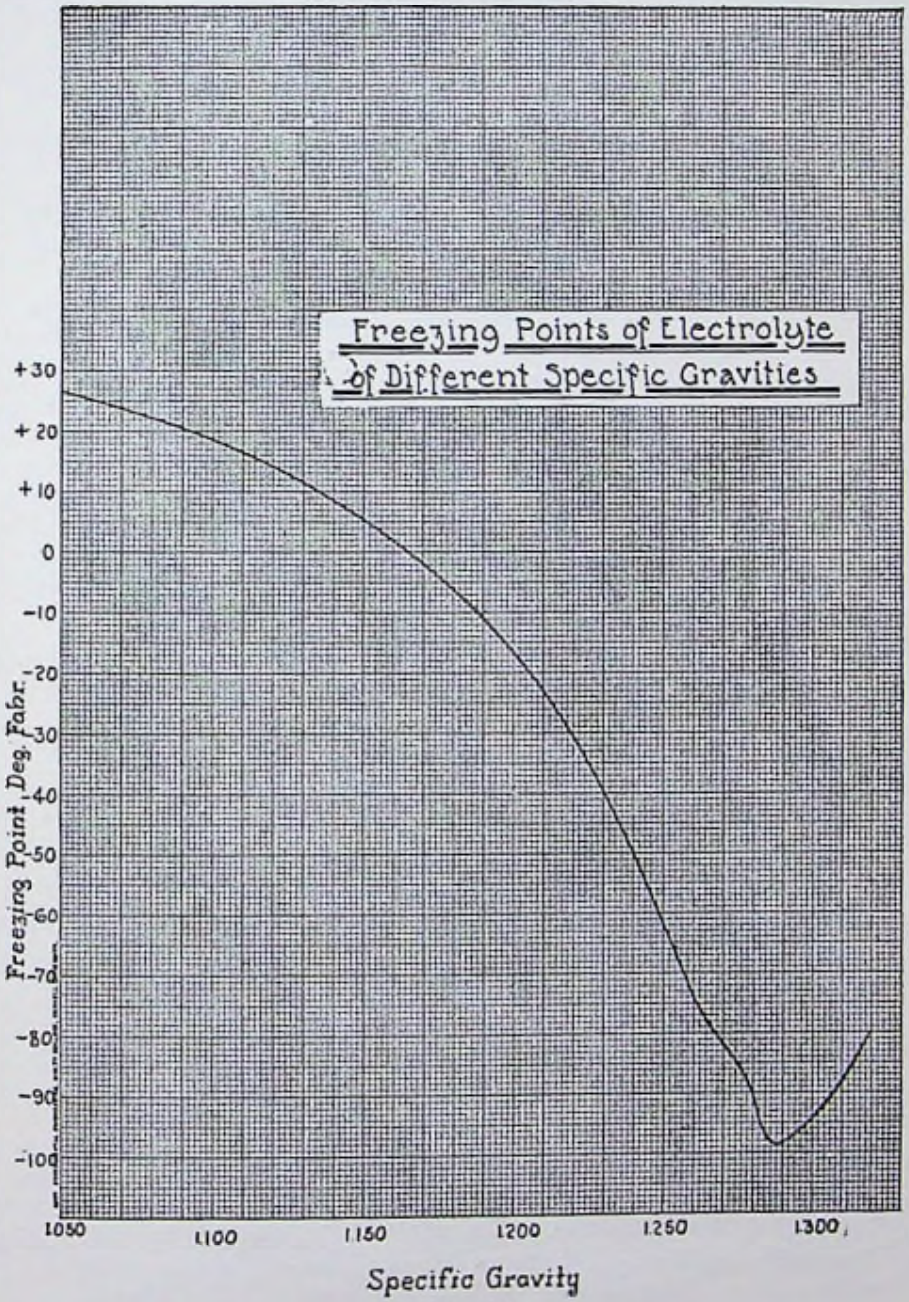
Freezing Points of Electrolyte
of Different Specific Gravities
+30
+20
+10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
Freezing Point, Deg. Fahr.
1050
1100
1150
1200
1250
1300
Specific Gravity

Fig. 20

# OUTLINE OF THE ACTION IN A STORAGE BATTERY

**General**

A storage battery consists of one or more cells.

A cell consists essentially of positive and negative plates immersed in electrolyte.

The electrolyte of the "Exide" cell consists of a mixture of sulphuric acid and water.

The voltage of one cell is about two volts.

The voltage of a battery (with cells in "series") is the number of cells multiplied by two.

When a cell is put on discharge, the current is produced by the acid in the electrolyte going into and combining with the lead of the porous part of the plates called "active material." In the positive plate, the active material is lead peroxide, and in the negative is metallic lead in a spongy form.

**Formation of Lead Sulphate**

When the sulphuric acid in the electrolyte combines with the lead in the active material, a compound, lead sulphate, is formed.

As the discharge progresses, the electrolyte becomes weaker by the amount of acid that is used in the plates, producing the electric current and incidentally producing the compound of acid and lead called "lead sulphate." This sulphate continues to increase in quantity and bulk, thereby filling the pores of the plates. As the pores of the plates become thus filled with the sulphate, the free circulation of acid into the plates is retarded; and since the acid cannot then get into the plates fast enough to maintain the normal action, the battery becomes less active, as is indicated by the drop in voltage.

**Drop in Voltage**

**Drop in Specific Gravity During Discharge**

During a normal complete discharge, the amount of acid used from the electrolyte in "Exide" cells will cause the specific gravity to drop about 150 points (0.150 sp. gr.). Thus if the gravity of a fully charged cell is 1.300 (1.230*), it will, at the end of discharge, be about 1.150 (1.080*). The battery should receive charge before it is discharged below this point.

**Charging**

To charge, direct current is passed through the cells in a direction opposite to that of discharge. This current, passing through the cells in the reverse direction, will reverse the action which took place in the cells during discharge. It will be remembered that during discharge the acid of the electrolyte went into and combined with the active material, filling its pores with sulphate and causing the electrolyte to become weaker.

**Action of Current**

Reversing the current through this sulphate in the plates restores the active material to its original condition and returns the acid to the electrolyte. Thus, during charge, the electrolyte

*The lower gravity refers to batteries used in tropical climates (see page 17).

gradually becomes stronger as the sulphate in the plates decreases, until no more sulphate remains and all the acid has been returned to the electrolyte. It will then be of the same strength as before the discharge and the same acid will be ready to be used over again during the next discharge. **Since there is no loss of acid, none should ever be added to the electrolyte.**

**Object of Charging**

**The acid absorbed by the plates during discharge is, during charge, driven from the plates by the charging current and restored to the electrolyte. This is the whole object of charging.**

**Gassing**

When a battery is fully discharged, it can absorb current at the highest rate. As the charge progresses, the plates can no longer absorb current at the same rate and the excess current goes to form gas. In a battery which is charged or nearly charged, the plates can absorb current without excessive gassing only at a low rate, and a high charge rate will be almost entirely used in forming gas, resulting in high temperature and wear on the plates.

In starting and lighting systems, the aim is to provide sufficient current under average running conditions so that the battery will not be "starved," and yet the charge will be at a rate which will not cause injurious gassing.

**Normal Sulphate**

The sulphating which takes place during an ordinary discharge is entirely normal. If, however, charging is insufficient, the sulphate increases and becomes hard and the plates become lighter in color, lose their porosity and are not easily charged; this is the abnormal condition usually referred to as "sulphated." This condition is usually the result of "starvation" of the battery.

**Abnormal Sulphate**

**High Rates of Discharge**

A very general misapprehension has existed in the past as to the effect on a lead storage battery of discharging at very high rates. The fact that a starting battery will spin one of the big modern engines which a strong man can scarcely turn over shows what its capabilities are; and the length of time it will with proper charging and care continue to do this heavy work without giving out shows that it is not injured thereby.

**Over-discharge**

It is not **discharge** at any rate which injures a battery, but **overdischarge**, or, what in time amounts to the same thing, undercharge or "starvation."

**"Starvation"**

If a car is so run that the battery gets insufficient charge and is "starved," it cannot be expected to do its work properly.

**Overcharge**

Persistent overcharging not only tends to wash out the positive active material, but also acts on the positive grids, giving them a scaly appearance.

**Low Temperature**

Temperature has quite a marked effect on a battery. Low temperature temporarily both lessens the ampere hour capacity which can be taken out of the battery and lowers the discharge

voltage. It is as if the battery were numbed by the cold and unable to make the same effort as at normal temperature. The effect of cold is only temporary, the battery returning to its normal state upon its return to normal temperature even without charge. Starting batteries are usually designed with sufficient margin over the ordinary requirements so that they will still perform their functions under reasonably low temperature conditions. It is just as well, however, to bear in mind the effect of cold weather and to aim to keep the battery unusually well charged in winter and not expose it unnecessarily to low temperatures. There is no danger of the electrolyte freezing in a fully charged cell; but in one which is overdischarged or has had water added without subsequent charging this is likely to occur in cold climates.

**High Temperature**

High temperature is to be avoided from the standpoint of life. 110 degrees Fahrenheit (125 degrees F. in tropical climates with low gravity electrolyte; see page 17), is usually given as the limiting temperature, and even this would be harmful if maintained steadily. Heating is ordinarily the result of charging at too high a current rate. If the temperature of the electrolyte in a battery is found to run consistently high, the system should be inspected; it may be out of adjustment and be charging the battery at too high a rate.

The effects of continued high temperature are to distort and buckle the plates, to char and weaken the wood separators, to soften and sometimes injuriously distort the jars and covers.

# SPECIAL INSTRUCTIONS FOR BATTERIES USED WITHOUT GENERATOR SYSTEM

If the battery is used alone (without generator) to supply current for lights or ignition, it will not be necessary to add water except when the battery is removed from the car for charging. Add water just before charging, not during or immediately after charge.

Frequent hydrometer readings should be taken, however, and when the gravity falls below 1.200 (1.130*), the battery should be removed from the car and charged (page 13).

Do not allow the battery to discharge until completely exhausted, as shown by gravity falling to 1.250 (1.080*) or thereabout and by lamps burning dimly or voltage falling below 1.8 volts per cell.

Give the battery a charge at least once every two months whether the hydrometer readings show this to be necessary or not.

**"Exide" Lighting and Ignition Battery**
**Type 3-LX-9**

* The lower gravity refers to batteries used in tropical climates (see page 17).

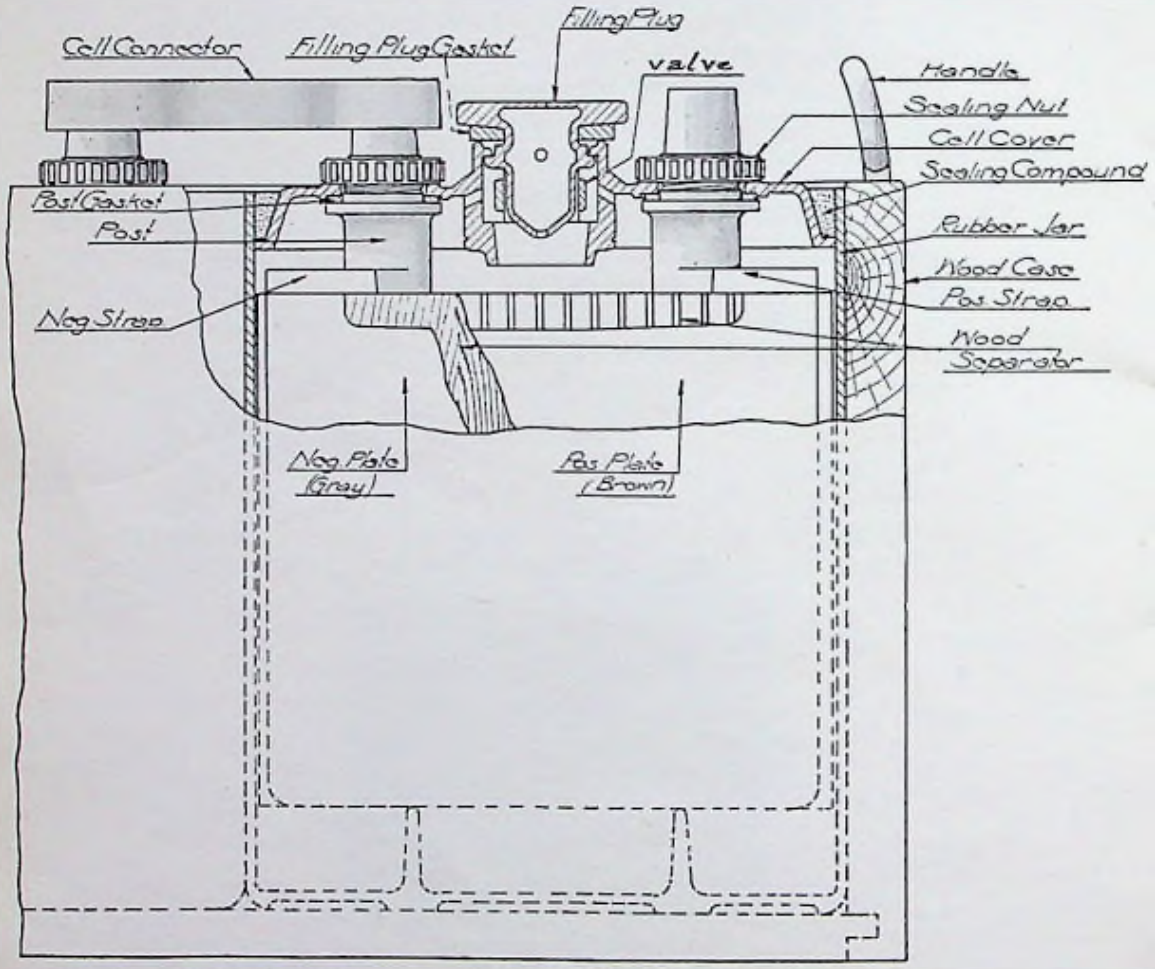


**Fig. 21. Section of Battery—Burned Connections, Single Flange Cover**

# REPAIRS

The top construction shown in Fig. 1 is common to all modern types of "Exide" Starting and Lighting Batteries.

There are three general types, differing in minor details, which are clearly set forth in Figs. 21, 24 and 28.

Fig. 21 shows the burned connection type with the single flange cover.

Fig. 24 shows the burned connection type with the double flange cover.

Fig. 28 shows the bolted connection type, which always takes the double flange cover.

## TAKING BATTERY APART

The first step is to remove the filling plugs, to give more room to work upon the battery terminals. Then disconnect the terminals and intercell connectors.

### Disconnecting

a. *Burned Connections* (Types XA, XC, LX, SX, ZA, JX, PHA, MHA).

Remove the connectors, which are solid lead links (Fig. 22), as follows: Take a brace with a 5/8 inch wood bit and bore the connectors 1/4 inch centrally over each post (Fig. 23). Another method is to play a burning flame on the joint, at the same time pulling the connector with a pair of pliers until it comes loose.

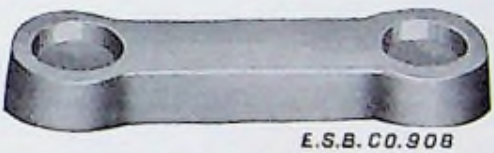


Fig. 22. Lead Connector

Fig. 23. Boring Connector

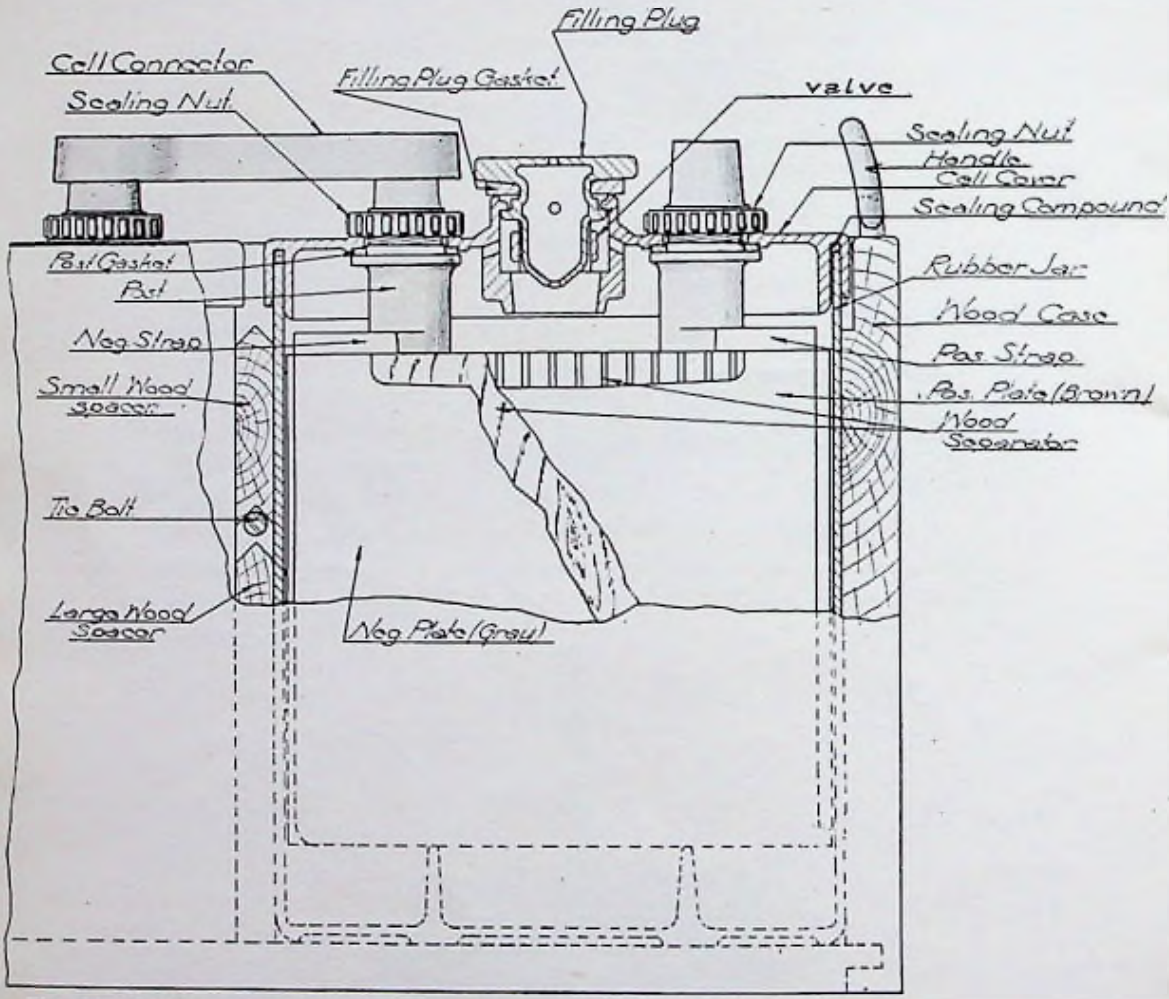


**Fig. 24. Section of Battery—Burned Connections, Double Flange Cover**

b. *Bolted Connections* (Types X, PH, PHB, MH, ZB).

Remove the alloy covered top nuts, using a properly fitting socket wrench (Fig. 25). Take off the connectors without bending. These are lead-coated copper strips. Save the alloy washers, of which there are three—one above, one between and one below the connectors (Fig. 26).

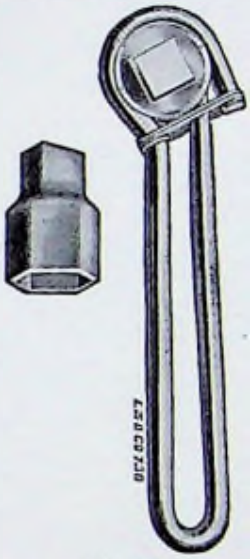

Fig. 25
Socket Wrench

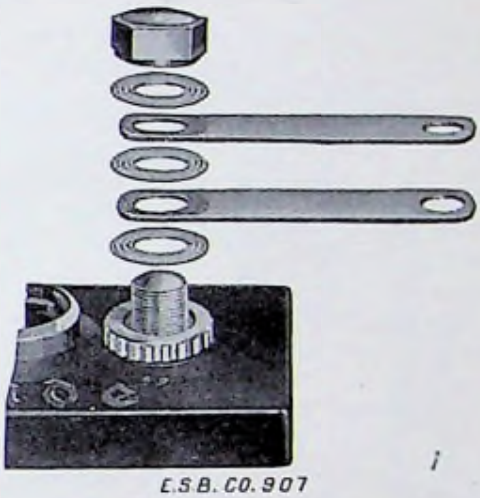


Fig. 26
Parts for Bolted Connections

## Removing Cell from Case

Types X, XA, PH, MH have the jars separated in the case by painted wood spacers divided horizontally, and between the two sections runs a tie bolt (Figs. 24 and 28). These should now be unscrewed one or two turns with a screw driver, thus releasing the jars. If the jars stick to case, loosen by running a thin bladed knife between.

The complete cell can now be lifted out of the case.

## Removing Element from Jar

a. *Single Flange Type of Cover* (Types XC, LX, SX, JX). **To Unseal Single Flange Covers**

This type of cover (Fig. 27) has sloping sides flanged outwardly at the base to fit the inside of the jar snugly, while at the top it clears the jar, giving a space of about ¼ inch for sealing (Fig. 21).

To unseal, heat a flat-bladed knife (a putty knife will answer) in a flame and run it through the sealing compound close to the jar wall all the way around. This will loosen the compound, and the element with the cover on it can be lifted out of the jar.


Fig. 27. Single Flange Cover

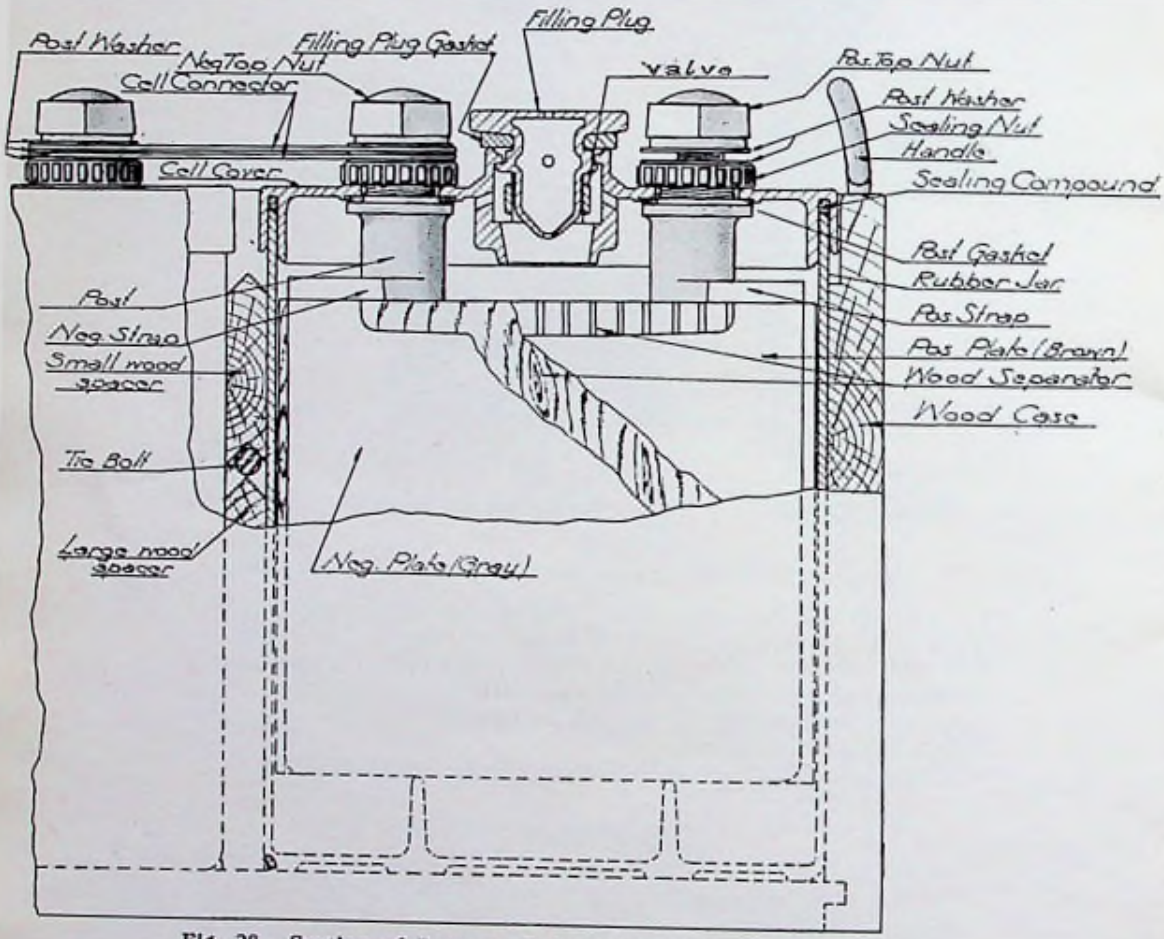


**Fig. 28. Section of Battery—Bolted Connections**

b. *Double Flange Type of Cover* (Types X, XA, PH, MH, ZB, ZA).

This type of cover is made with two flanges projecting downward, one fitting inside and the other outside of the jar walls. The two flanges form a channel or slot, holding jar walls and sealing compound between the flanges (Fig. 28).

The sealing nuts must be removed (see below) before unsealing the cover.

**To Unseal Double Flange Covers**

To unseal, procure two stout boards about ¼ inch longer than the height of the jar and rest the side flanges of the cover on these so that the cell is raised. Now warm the cover all around the edges, and the compound will soften so that by pressing down on the posts the jar with the element in it will readily drop free from the cover (Fig. 29). The warming may be accomplished by passing a moderate flame quickly around the cover, taking care not to hold it on one spot long enough to burn the rubber. After removing cover the element can be lifted out of the jar.

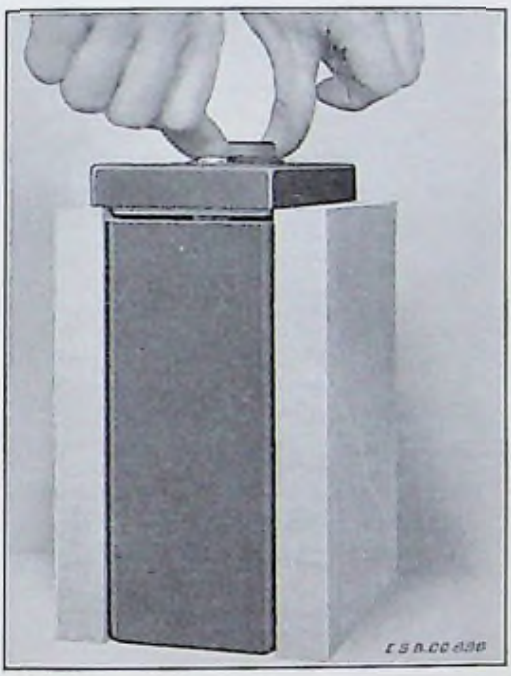

**Fig. 29. Removing Double Flange Cover**

## Removing Sealing Nuts

This is done by unscrewing with the special wrench (Fig. 30) provided for the purpose. **Do not use gas pliers or anything except the proper wrench in removing the sealing nuts.**

**Fig. 30. Sealing Nut Wrench**

## Removing Cover from Element

Loosen and remove sealing nuts (see above) and lift off the cover. For double flange type the cover must be unsealed and removed (Fig. 29) before removing element from jar.

A cover can, if desired, be taken off without removing the cell from the case, by removing the connectors and sealing nuts, and, for the single flange type, unsealing the cover. For the double flange type apply heat to the top of the cover and gradually pull it from the jar by means of a flat hook placed under the edge of the cover and worked around the jar.

### Taking Element Apart

After removing the cover, lay the element down with the plates on edge and, slightly spreading the plates, withdraw the separators one at a time. The positive and negative groups can then be separated, and the dismantling is complete.

If the negative plates are to be used again, do not let them dry, but place the group in water or electrolyte. This will save time in the length of charge required after reassembling.

## INSPECTION OF PARTS

**Broken Jar** If a jar is broken, but the cell is otherwise in good condition, it is not necessary to remove the sealing nuts, as the cover may be unsealed and the element with cover attached removed from the jar.

**Broken Cover** If the cover is cracked or broken, a new one should be used.

**Loose Post** If a post is loose or in bad condition, it is advisable to have an entire new group of plates, either positive or negative as the case may be.

**Positive Plates** The positive plates should be examined particularly for washing out of material and buckling (warping). If the material has washed out on the surface to a depth below the base of the horizontal ribs, a new group should be substituted. If the plates are only slightly buckled, they can be replaced as they are, since this generally does no harm. If they are badly buckled, a new group should be substituted.

**Negative Plates** The negative plates are nearly always in good condition mechanically, as they are not affected by abuse as readily as the positives. If the positives are buckled, the negatives will be also; but if in a charged condition, can be readily straightened as follows: Place boards of suitable thickness between the plates and outside of the group and slowly apply a gradual pressure. This is best done in a vise, leaving the pile in the vise for some minutes during the operation to give the plates a chance to straighten without undue strain (Fig. 31). If the battery has been badly abused, "starved" or neglected, the negatives may have shed material; in this case it is best to use a new group. If the negative material is very hard and not spongy, it is "sulphated," and particular care should be used that the subsequent charge is carried to maximum gravity.

**Wood Separators**

The wood separators should be examined as to their physical condition—wearing off of the ribs, splits or perforations and mechanical strength. As a rule, however, unless a battery is comparatively new, it will be found advisable to install new separators whenever a cell is dismantled for repairs, since it is of vital importance in a battery to have the separators in good condition.

No wood separators should be used except the specially treated separators furnished by this Company. These should be kept in stock wet, preferably in water acidulated with electrolyte.

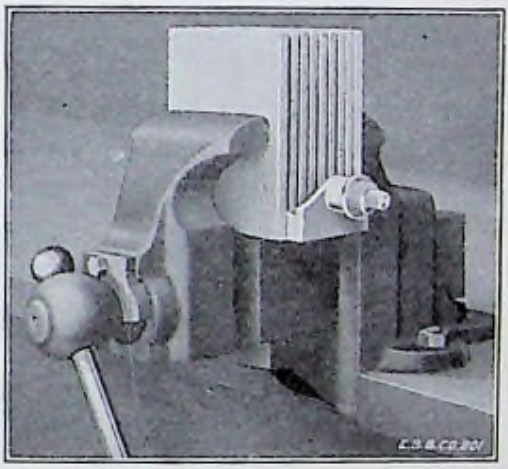

**Fig. 31. Straightening Plates**

**Perforated Rubber Sheets**

Perforated rubber sheets, when used (Types PH and MH), are nearly always in condition to put back unless broken in handling. It is advisable to carry a small stock of these for emergencies.

**Sediment**

The sediment in the bottom of the jars will rarely be found to have reached the plates, but whenever a cell is taken apart for any purpose it is advisable to wash the sediment out of the jar.

**Electrolyte**

Sometimes impurities get into the electrolyte through carelessness or ignorance, but their detection is not practicable except by an expert chemist. As a precautionary measure, the use of new electrolyte of known purity is recommended when repairing a battery.

> Take a hydrometer reading of the old electrolyte before discarding, as this determines the proper gravity of the new electrolyte to be used in case the old plates are put back.

When the positive plates are badly disintegrated, it is usually a sign of foreign matter in the electrolyte, and in such a case it is safer to discard the negatives and separators as well, since they may hold some of the impurity and be the means of ruining the new positives in a short time.

**Case** Unless there have been broken jars or abuse of some sort, the battery case will usually be found to be in good condition. If the case has become acid soaked and rotted, a new one should be used. When the old case is to be used again, it should be soaked in a solution of baking soda and water. This will neutralize any acid and prolong the life of the wood. Rinse with water and allow to dry thoroughly. Repaint the case inside and out with asphaltum or other acid proof paint.

## REASSEMBLING BATTERY

After the necessary repairs have been made, as described above, the battery should be reassembled as follows:

Wipe the posts with a piece of waste moistened with ammonia, rinse with water and dry thoroughly with clean waste.

**Assembling Elements** Slip the positive and negative groups together without the separators and place the cover in position, being sure not to omit the soft rubber washers under the cover. Lubricate the sealing nuts with a little graphite mixed to a paste with water, but never use grease or vaseline. Put on the sealing nuts and tighten them only partially with the fingers.

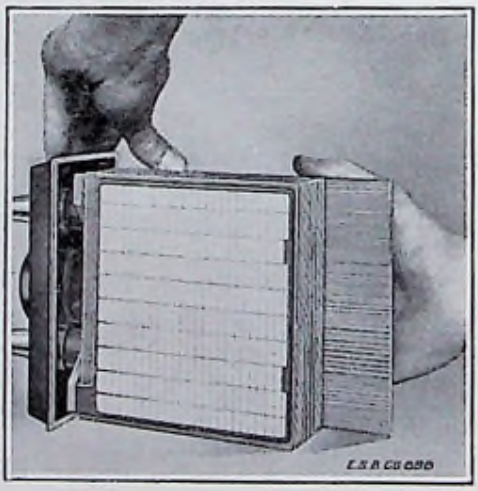

Fig. 32. Inserting Separators

**Inserting Separators** Now place the groups on edge (Fig. 32) and insert the separators, being sure that the flat side of the wood goes against the negative plate. Where rubber sheets are used (Types PH and MH), place one against the grooved side of each wood separator before inserting. When the separators are all in place (count them to be sure none are missing), stand the element up again and tap the edges of the wood separators with a wood block until they project equally on each side of the plates. Tighten up the sealing nuts, using the special wrench (Fig. 27).

## Locking Sealing Nuts

*With burned connections*, the thread of the post extends slightly above the sealing nut. When the nuts are tight, take a center punch (a sharp nail will answer) and carefully drive it on the thread in a few spots just above each nut (Fig. 33). This will slightly upset the alloy thread on the post and prevent the nut from coming loose.

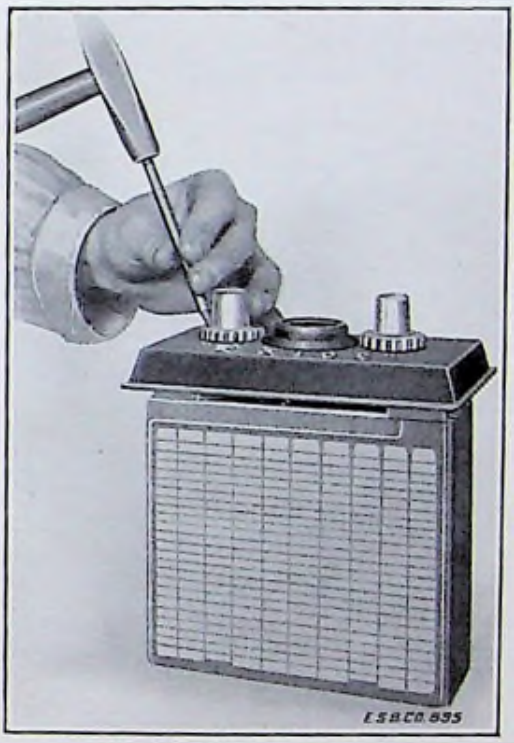


**Fig. 33. Locking Sealing Nut**

*With bolted connections*, the thread of the post does not extend above the sealing nut. The top nut, when in position, prevents the sealing nut from coming loose, so that no further locking is necessary.

## Sealing

Before sealing always wipe the surfaces to be sealed with ammonia, and then allow to **thoroughly dry**, otherwise the compound will not stick and a leak may result.

a. *Single Flange Type of Cover* (Types XC, LX, SX, JX).

Slip the element with cover attached into the jar, and then place hot compound in the channel, finishing it off flush with a hot knife.

b. *Double Flange Type of Cover* (Types X, XA, PH, MH, ZB, ZA).

Have ready a string or worm of sealing compound about $\frac{3}{16}$ inch in diameter, made by rolling between boards some of the special compound furnished in tubes for the purpose. Stand the element upside down, with the cover resting upon two strips (Fig. 34). Lay the string of compound all around the cover channel. Now turn the element right side up and insert it in the jar, taking care that the jar walls enter the cover channels at all points. Apply heat carefully to the edges of the

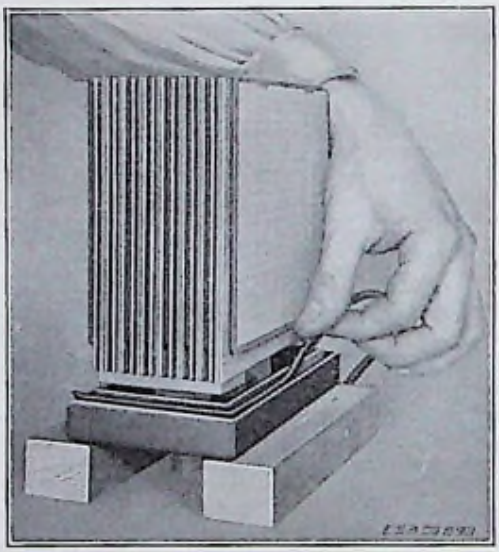

**Fig. 34. Sealing Double Flange Cover**

cover and gently force cover and element down until the latter is seated on the ribs in the bottom of the jar. If too much compound has been used, so that it squeezes out around the cover, scrape off the excess with a hot knife.

## Placing Cells in Case

When all the cells are assembled, place them in the case, taking care that the wood spacers are in position in types which have them (X, XA, PH, MH). These types also have the tie bolts through the case, and these should now be tightened to clamp the jars.

In types without tie bolts, the cells should be tight in the case; pack them in with thin boards if necessary.

## Connecting

a. *Burned Connections.*

First see that the posts and the eyes of the lead connectors are clean and bright. If the disconnecting has been carefully done, the posts and connectors will be in good condition and need only washing with ammonia followed, when dry, by slight polishing with sand paper or scraping with a knife. Place the connectors over the posts, lightly tapping them to a firm seat, and burn the joint, using a burning outfit (page 54), or, if nothing better is available, a soldering iron. Do not use any soldering acid or other flux.

b. *Bolted Connections.*

First grease the studs well with vaseline. Slip one of the connector links over the posts of adjoining cells, then an alloy washer over each post, followed by a second connector and second washer. Put on the top nuts and pull up tight with a properly fitting socket wrench (Fig. 25).

## FILLING WITH ELECTROLYTE

Fill the cells with new electrolyte until the level rises in the filling tubes, and be sure to replace and tighten the filling plugs before starting to charge.

**Specific Gravity**

The specific gravity of electrolyte to use will depend upon the condition of the plates.

If new elements are used, fill with 1.350 (1.260*) gravity for all types except PH and MH, which take 1.330 (1.260*) gravity.

If old plates and new separators are used, fill with electrolyte 50 points (.050 sp. gr.) higher than the old electrolyte. When the old separators are put back, use the same gravity as the old electrolyte (page 49).

**Purity**

The electrolyte must be of proper purity (page 34).

If electrolyte of the desired gravity is not at hand, electrolyte of any higher gravity can be diluted with pure water (page 11).

To mix electrolyte from strong sulphuric acid, see pages 34 and 35.

## CHARGING

**Preliminary Stand**

Do not start the charge until at least 10 hours after filling with electrolyte. This is to give the cells a chance to cool, and in very hot weather a longer stand may be necessary.

**Maximum Gravity**

Charge at about two-thirds the normal charge rate (pages 67 and 68) until the specific gravity and voltage show no rise over a

* The lower gravity refers to batteries used in tropical climates (see page 17).

period of 10 hours and all the cells are gassing freely. This will require at least 60 hours in the case of new elements, while with old plates, which are badly sulphated or have dried out, considerably more time may be necessary.

**Temperature**

Take occasional temperature readings, and if the temperature reaches 110 (125*) degrees F., either lower the current rate or interrupt the charge.

When the charge is complete, adjust the electrolyte to the proper level (Fig. 1), continuing the charge to allow the gassing to thoroughly mix the solution. Take a hydrometer reading on each cell and adjust the specific gravity to the proper value of between 1.270 (1.200*) and 1.300 (1.230*).

**Adjusting Gravity**

If the adjustment necessary is slight, this may be accomplished by removing some of the solution and adding water or stronger electrolyte as required.

If the adjustment necessary is considerable, it will be found more convenient to empty out the solution and refill with electrolyte of specific gravity estimated to bring it right, allowing for the effect of the old solution held in the cells. A little experience will enable the operator to gauge this quite accurately.

After any adjustment, charge for some minutes to allow the gassing to thoroughly mix the solution before taking hydrometer readings.

**Temperature Correction**

If the temperature is far from normal, correct the hydrometer readings by adding one point (.001 sp. gr.) for each 3 degrees above and subtracting one point for each 3 degrees below 70 degrees F. (page 36).

Always wipe off the top and sides of battery with weak ammonia after adjusting electrolyte.

## LEAD BURNING

In batteries having burned connections, the joints are made by melting the parts to be joined and forming a solid weld. The process is called "lead burning," and is carried out by means of illuminating or hydrogen gas and compressed air, illuminating or natural gas and oxygen, or by an electrically heated carbon.

**Cleaning Surfaces**

In all lead burning, absolutely clean surfaces are essential to good workmanship. Lead is soft and very readily cleaned with a scraper or file. In the case of a battery which has had electrolyte in it, the surfaces to be burned should first be wiped with ammonia to neutralize the acid and then allowed to dry before scraping.

Before starting to burn, the connector or terminal should first be lightly tapped to a snug fit on the post. The top of the post should be ⅛ inch below the top of the connector to allow space for burning. If the post is too long, remove the connector and trim off the post.

*The lower gravity and higher temperature refer to batteries with low gravity electrolyte used in tropical climates (see page 17).

Method of Burning

The top of the post should be melted first and then fused to the connector, after which lead from a piece of burning strip can be run in until the joint is flush.

Precautions while Lead Burning

In order to avoid the possibility of an explosion of the gaseous mixture contained in the upper part of a cell, when doing repair work with a gas flame or carbon burning outfit, the following precautions should be taken: The filling plugs should be in place, and the entire battery, with the exception of the part on which the burning operation is to be performed, should be covered by a cloth thoroughly wet with water. The cloth should be pressed down upon the vents of the cells (Fig. 35), or handfuls of wet waste may be packed around and over the vents. A large piece of burlap or a towel thoroughly soaked in water is suitable.

The wet cloth is recommended for two reasons. First, it prevents the burning flame or arc from communicating to the interior of the cell, and, second, if an explosion should occur, the cloth will prevent the solution and small parts from being thrown about.

**Fig. 35. Battery Covered with Wet Cloth before Lead Burning**

## The Illuminating Gas Outfit

Parts

The outfit (Fig. 36) consists of a special burning tip and mixing valve. Sufficient $\frac{5}{16}$ inch hose should be provided, and the hose wired to the apparatus in making connections. The comparatively high air pressure renders this precaution advisable.

A supply of compressed air is necessary, the proper pressure ranging from 5 to 10 pounds, depending upon the length of hose and the size of parts to be burned. When air from a compressor for pumping tires is used, a suitable reducing valve must be introduced.

This outfit is designed for use with the ordinary city gas supply; **natural gas cannot be used.**

**Directions for Use**

Connect the air hose to cock A, the gas hose to cock B. The leader hose, which should not be more than 5 or 6 feet long, is connected to the pipe C and to the burning tip at D.

When the air pressure at the source is properly adjusted, close the air cock (A) and turn the gas cock (B) on full. Light the gas at the tip and then turn on the air. If the flame blows out, the air pressure is too high and must be reduced, preferably at the source.

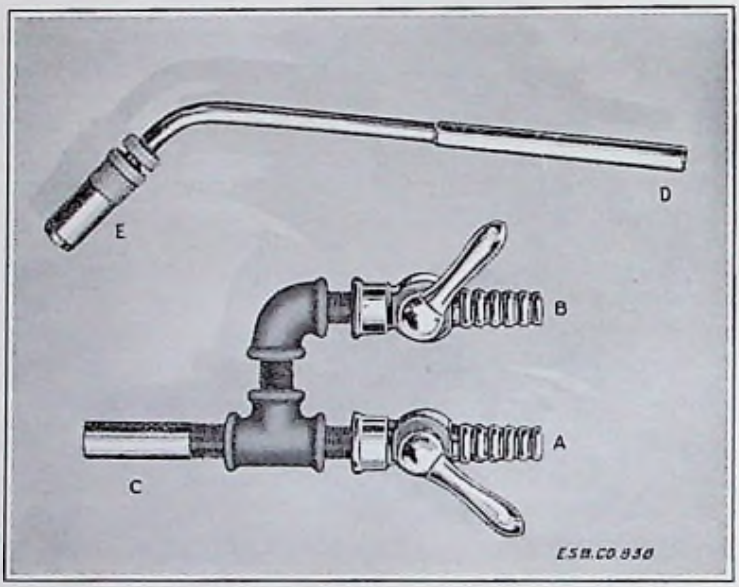


**Fig. 36. E. S. B. Co. Illuminating Gas Outfit**

With the gas turned on full, the flame will have a ragged appearance and show a waist about ½ inch from the end of the tip, the flame converging there and spreading out beyond. This flame is not suitable for burning.

Slowly turn off the gas until the outer portion at the waist breaks and spreads, with an inner tongue of flame issuing through the outer ring. The flame will now have a greenish color, and is properly adjusted for burning.

If the gas is turned off further, or too much air is turned on, the flame assumes a blue color, gradually becoming invisible, and is then deficient in heating power.

When properly adjusted, the hottest part of the flame is just past the end of the inner point. Do not hold the flame too close to the work when burning, as its heating effect is greatly reduced and the flame is spread so as to make control difficult.

The burning tip is provided with an outer sleeve and lock nut (E). The sleeve is removable and can be taken off in case any of the holes in the tip become clogged. The position of this sleeve is adjustable, the best position varying with the pressure of the flame, etc. This position should be determined by experiment.

A still better method of burning is by use of illuminating gas, either artificial or natural, and oxygen in tanks for which suitable apparatus has been recently developed. Detailed information regarding the procuring of proper apparatus and full instructions for its use will be furnished upon request.

**Illuminating or Natural Gas and Oxygen**

## The Hydrogen Gas Outfit

Hydrogen gas, while more expensive and troublesome than illuminating gas, gives a hotter flame and therefore permits of more rapid work. Some garages doing a large amount of work may still prefer its use, although in most cases the use of illuminating gas offers more advantages.

Hydrogen gas may be made with a hydrogen outfit, or, in most localities, it may be procured in tanks under pressure. Instructions for using hydrogen from tanks will be furnished upon request.

**Parts**

The portable hydrogen outfits supplied by The Electric Storage Battery Company each consist of the following parts:

1 generator (in two parts).
1 wash bottle.
1 branch pipe.
2 rubber stoppers.
1 air pump and tank combined.
1 finger pipe and set of tips.
1 length 50 ft. $\frac{3}{16}$ in. rubber tubing.
1 length 2 ft. $\frac{3}{4}$ in. rubber tubing.
1 triangular scraper.

The material required for charging is as follows:

| Type | Zinc | Water | Vitriol |
|---|---|---|---|
| F | 5 lbs. | 7 pts. | 1½ pts. |
| E | 15 lbs. | 7 pts. | 1½ pts. |
| D | 15 lbs. | 12 qts. | 2½ qts. |

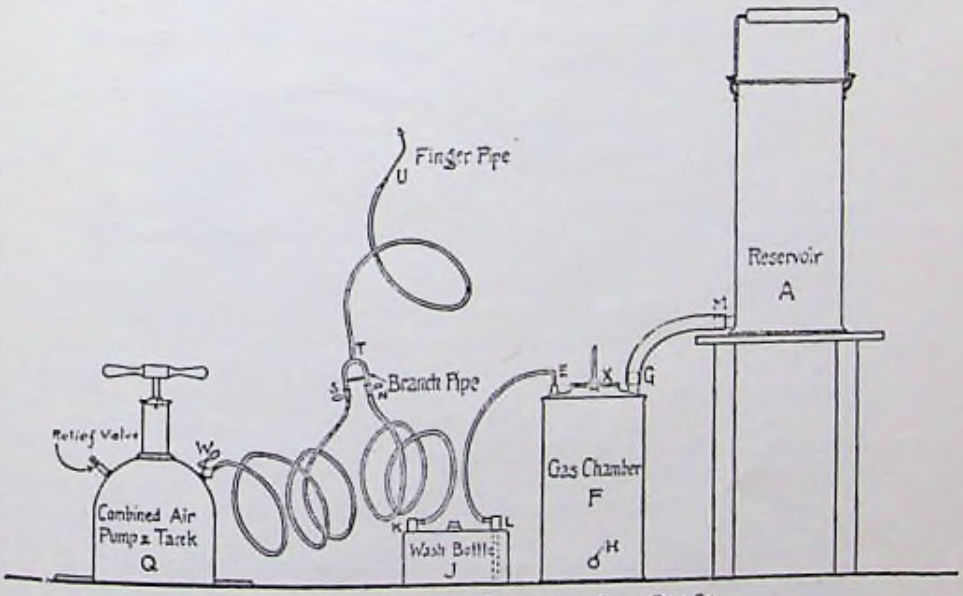


**Fig. 37. Hydrogen Gas Outfit**

**Directions for Use**

Fig. 37 shows how the apparatus should be set up and connected. The bottom of the reservoir "A" must be higher than the top of the gas chamber (F). Connect the lower outlet

"M" from reservoir "A" with the pipe "G" coming out the top of gas chamber "F." Put a short piece of $\frac{5}{16}$ inch hose on the outlet "E" coming from gas chamber "F" and kink this hose so as to prevent anything passing through it. Put rubber stopper in outlet "H" of gas chamber "F," and be sure that it is tight. Remove hand hole cover "X" from gas chamber "F" and place the required quantity of zinc on the grating in gas chamber. Replace hand hole cover "X," being sure that it is screwed down tight on its gasket. Put the required amount of water in reservoir "A," and then pour into the water the required amount of vitriol, being sure always that the water is placed in the reservoir first; then rinse wash bottle "J," fill it half full of water, connect its outlet "K" with one side "N" of the branch pipe, and connect the other side "S" of the branch pipe with the outlet "W" on the air tank "Q." Connect the finger pipe "U" with the outlet "T" of branch pipe, closing both cocks "S" and "N."

Take the kink out of the hose connected to outlet "E" of the gas chamber, and allow the air to escape until the charge of water and vitriol runs down from reservoir "A" into the gas chamber "F," then slip the free end of this hose over the outlet stamped "L" of the wash bottle.

To prepare the flame for burning, close the air cock at "S" and pump up air tank until air escapes at relief valve, then open gas cock at "N," hold a lighted match or candle to the finger pipe until the gas burns, then add air and adjust both cocks until the flame, when tried on a piece of lead, melts the metal and leaves a clean surface.

If the gas chamber "F" becomes very hot, stand it in a pail of water.

The prescribed amount of zinc is sufficient for several charges of water and vitriol.

To avoid danger of an explosion, never bring an exposed flame near the generator.

When a charge is exhausted or the generator is to be laid up for the night, proceed as follows:

Remove the hose at the nipple "E" and then pull out the stopper at "H." After the solution has run out, thoroughly flush with water poured into the reservoir "A," and continue until the water emerges at "H" in a clear state. This is highly important, as otherwise the gas chamber may clog. Care should be taken not to allow the solution to come in contact with anything that may be damaged by the acid. If run into a drain, thoroughly flush the drain with water at the same time, and allow the water to run for a few minutes. If solution is spilled, its action can be stopped by using Gold Dust, Pearline, washing soda, lime or ammonia.

A new charge of water and vitriol should not be put in until just before the generator is to be used again.

The following precautions should be observed when handling vitriol:

The vitriol must invariably be poured into the water; never pour the water into the vitriol. When pouring the vitriol into reservoir "A," stand on a box or platform, which will bring the top of the reservoir about to the waist line, and in pouring it

care should be taken not to splash the vitriol. If burned by vitriol, immediately apply oil to the burn, not water.

### The Carbon Burning Outfit

The advantage of this outfit lies in the fact that a spare six volt battery can be used as the source of current for the operation, rendering unnecessary the use of further accessory apparatus, like the hydrogen generator.

**Parts**

This outfit (Fig. 38), as supplied by The Electric Storage Battery Co., consists of the following parts: Carbon holder with cable, clamp and ¼ inch carbon rods.

**Directions for Use**

The method of using it for reburning connectors is as follows: One terminal of a spare six volt battery is connected by a piece of cable with the connector to be burned. The cable can be made fast to the latter by means of a clamp and care should be used that the surfaces are clean and a good contact secured. The cable attached to the carbon holder is then attached to the spare battery, either at the other terminal or on the connector of the cell adjoining, depending upon whether the battery is partially discharged or fully charged. In the latter case, three cells will give too much voltage and make the work difficult. The number of cells used should be sufficient to heat the carbon to at least a bright cherry red while it is in contact with the joint. The carbon should be sharpened to a long point like a

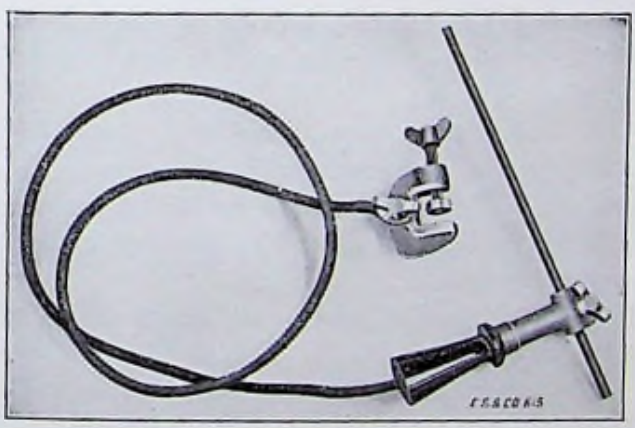

**Fig 38. Carbon Burning Outfit**

lead pencil and should project about one inch from the holder. The latter should be cooled off occasionally by plunging it, carbon and all, into a pail of water. After being used for a short time, it will be found that the carbon will not heat properly, due to a film of scale formed on the surface. This should be cleaned off with a knife or file, as occasion requires.

As in the case of flame burning, additional lead to make a flush joint should not be added until the metal of the pieces to be joined has melted. The carbon should be moved around to insure a solid joint at all points.

A pair of dark glasses should be used with this outfit.

## TOOLS AND EQUIPMENT

Anyone undertaking to care for or repair batteries must, in time, gather the equipment he considers necessary or desirable for the work. Many of the tools are questions of personal taste or present equipment but there are four things absolutely essential:

(1) Suitable charging apparatus (for suggestions see pages 61 to 64).

(2) A hydrometer syringe (Type S-1 is made for this work).

(3) A battery thermometer (illustrated on page 36).

(4) A lead burning outfit (pages 54 to 59).

In addition tools and equipment must be available for the following purposes, and suggestions are here given along with the list of purposes:

(1) To read battery or cell voltage (portable voltmeter, such as Weston, Model No. 279).

(2) To remove connectors (for burned connectors a brace with $\frac{5}{8}$ inch wood bit—see Fig. 23. For bolted connectors, a special ratchet socket wrench—see Fig. 25).

(3) To tighten or loosen sealing nuts (a special wrench, Fig. 30. There are three sizes).

(4) To tighten or loosen tie bolts (a screw driver or else special spanner bit).

(5) To unseal covers (a putty knife).

(6) To remove element from jar (two pair of 6 inch or 8 inch gas pliers).

(7) To prepare surfaces for lead burning (knife, scraper, file, or end cutting pliers).

(8) To handle sealing compound (receptacles in which to heat and from which to pour).

(9) To handle electrolyte (non-metallic or lead vessels for storing, mixing and pouring. Rubber gloves or fingers for protection. Soda or ammonia solution for neutralizing effects of spillage or sloppage).

A stock of spare battery parts should, of course, be kept on hand and with these should be included:

(1) Sealing compound for resealing cells.

(2) Burning strip for lead burning.

(3) Electrolyte for replacing actual spillage or loss and never for normal operation (see rule 1, page 10).

(4) Acid-resisting paint for painting cases.

(5) Petroleum grease for terminals to prevent corrosion.

# BATTERIES IN STORAGE

When a car is to stand idle for any considerable period, as when it is held for future delivery, or laid up for the winter months, or when batteries are kept in stock, the batteries should be put into storage. **When Necessary**

There are two general methods of putting a battery into storage, one known as "wet storage" and the other as "dry storage," the method adopted depending upon the condition of the battery and the length of time the battery is to be out of commission, thus: **Two Methods**

**WET STORAGE**

Any battery out of commission for less than a year, providing it will not soon require repairs necessitating dismantling.

**DRY STORAGE**

(1) Any battery out of commission for longer than a year, no matter what its condition.

(2) Any battery on which repairs necessitating dismantling are, or soon will be, required.

## WET STORAGE

Provide a bench or shelf in a convenient location and with sufficient space for all the batteries not in cars. Place the batteries upon wood strips in order to keep the bottom of the cases clear of the bench, and allow a little air space between adjacent batteries. **Location**

Install the necessary wiring, etc., so that batteries can be easily connected up and charged where they stand on the bench. Apply vaseline freely to battery terminal and exposed copper wire.

Batteries may be kept in wet storage by means of either "trickle" charge or periodic charge.

### Trickle Charge

When a number of batteries are to be held in wet storage, the most satisfactory results can be obtained by charging continuously at a very low rate. This charge is termed a "trickle" charge and in many cases will be found more convenient to arrange for than the periodic charges at a higher rate.

Connect not more than fifteen 3-cell batteries (45 cells) in series (positive terminal of one battery to negative terminal of the next battery and so on) across a 110-volt direct current circuit and in series with a 110-volt incandescent lamp (Fig. 39) and charge continuously. If only from one to ten batteries are to be taken care of, use a 25-watt lamp; if from eleven to fifteen batteries, use a 40-watt lamp.

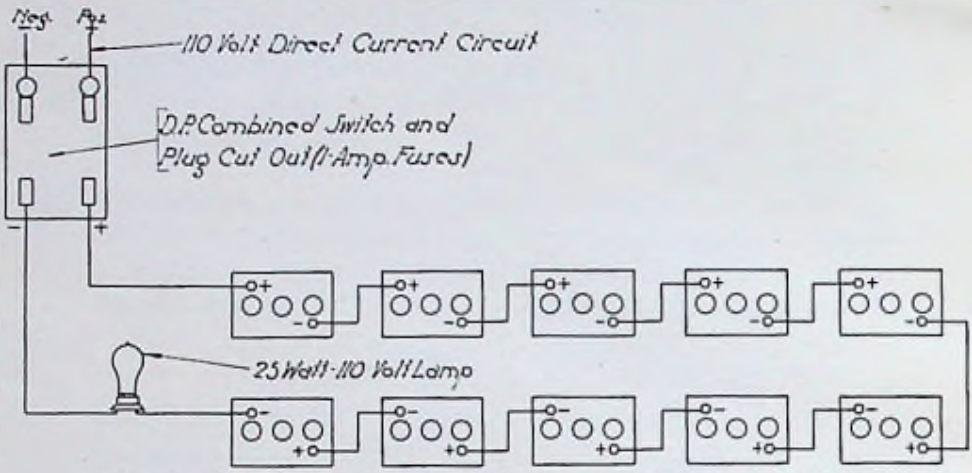


**Fig. 39. Connections for "Trickle" Charge for Ten 3-Cell Batteries (For eleven to fifteen 3-cell batteries use a 40-watt 110-volt metallic filament lamp)**

The lamp will burn at reduced candle power and allow a current of so low a rate to pass that gassing is avoided, yet enough charge is given to maintain the batteries in good condition.

Before going on "trickle" charge and at intervals during the charge, the filling plugs should be removed and water added if necessary.

Soon after the charge is started, take a gravity reading of each cell in order to ascertain whether any cells are in need of repairs. Gravity readings are also advisable from time to time and at the end of the charge to determine whether all cells are in good condition.

### Periodic Charge

In cases where it is not practicable to arrange for the "trickle" charge, the batteries should be charged periodically, as given under "Care of Battery Out of Service," page 19. It may be more convenient to charge all the batteries at the same time, even if they have stood for different periods, or they may be charged in groups at different times.

When direct current at 110 volts is available, the lamp bank shown in Fig. 40 is convenient for giving the periodic charge.

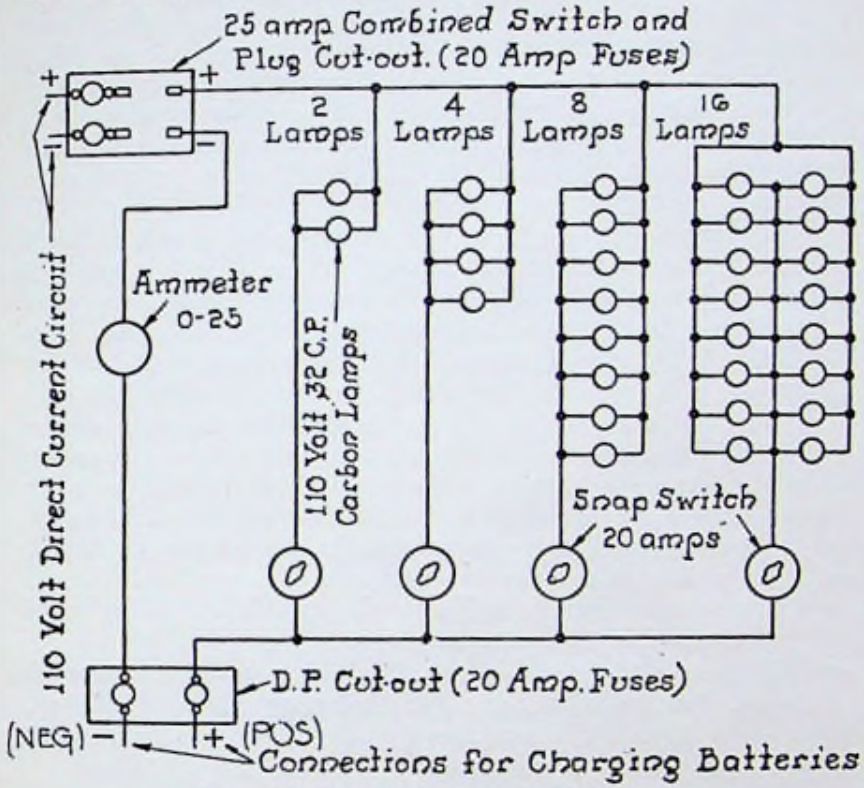


**Fig. 40. Diagram for Lamp Resistance**

**Lamp Resistance**

Thirty ordinary lamp sockets are mounted on a board and wired up to snap switches in groups containing two, four, eight and sixteen lamps respectively. A suitable main switch, fuse cutout, ammeter and terminal block complete the outfit.

Any good electrician will understand this layout and can make it up and install it quickly and at moderate expense.

With this equipment from one to twelve 3-cell batteries can be connected in series (the positive terminal of one connected to the negative terminal of the next and so on) and charged at one time.

The lamps which are in series with the batteries make it possible to regulate the current passing through the battery to the proper value. Different combinations of the switches permit current to pass through two, four, six and eight and so on up to all thirty lamps and then through the batteries in series with them.

**Unit Resistance**

Instead of lamps, resistance units of approximately 35 ohms resistance and 3.3 amperes capacity each may be used. This equipment will occupy less space than the lamps and serve the same purpose, each resistance unit replacing two lamps.

**Rheostat**

Instead of either a lamp resistance or unit resistance panel, a special form of rheostat may be used for charging. The Electric Storage Battery Company will be glad to furnish prices upon application to its nearest office.

## DRY STORAGE

**Location**

Provide a dry place for storage free from dust.

Take the battery out of the car, remove the filling plugs and add pure water until the level reaches the bottom of the filling tube. Replace filling plugs, turning them as far as they will go to insure their being firmly seated. **Never charge a battery with the filling plugs out, as the automatic vents are then closed and flooding may result.** (See exception to this rule at bottom of page 13).

**Preliminary Charge**

Put on charge at the proper current rate in table (pages 67 and 68) and continue the charge until the specific gravity of the electrolyte in all cells, as shown by the hydrometer syringe, has held at a maximum (ceased to rise) for a period of five hours and all cells are gassing freely. Record the specific gravity for future use when putting the battery back into commission.

Have on hand enough pure water to fill all the cells, remove the filling plugs and empty the electrolyte as soon as possible after the charge is completed by tilting and turning over the battery and immediately replace the electrolyte with water. After electrolyte has been removed do not allow battery to stand without water as the negative plates may become hot. Should any of the electrolyte be spilled on the case it should be wiped off with a rag moistened with ammonia.

Allow the battery to stand filled with water for approximately 5 hours, then empty out the water, take the battery apart and inspect it as explained on pages 43 to 50, and store parts in a dry place free from dust.

**Putting Battery into Commission Again**

When putting the battery back into commission proceed as instructed on pages 50 to 54, being sure to charge in accordance with the instructions on page 53.

## POLARITY

Always be sure that the **positive terminal of the series of batteries** is connected to the **positive terminal of the line** and the negative battery terminal to the negative of the line.

To determine the polarity of the charging circuit, if a suitable voltmeter is not at hand, dip the end of the two wires from the charging circuit into a glass of water, in which a teaspoonful of salt has been dissolved, but do not allow ends of wires to touch. Then close the switch. Fine bubbles of gas will be given off from the **negative** wire. Open the switch, and connect the negative wire to the negative battery terminal and the positive wire to the positive battery terminal. The connections are now completed.

## ALTERNATING CURRENT

When only alternating current is available, it is necessary to provide apparatus to change it into direct current, since only direct current can be used to charge batteries. For this purpose a motor generator set or rectifier can be used.

# BATTERIES SHIPPED UNFILLED

Batteries shipped to far distant countries are generally shipped unfilled with electrolyte to eliminate spillage and loss of charge during shipment. The following special instructions are applicable to these batteries for putting them into service and should be carefully followed:

**Object of Shipping Unfilled**

## Directions for Putting into Service

**Filling Cells with Electrolyte**

As soon as practicable after receipt, the cells must be filled with electrolyte and given an initial charge. To fill, remove filling plugs and pour electrolyte of 1.350 (1.260*) specific gravity or its equivalent 38 degrees (30* degrees) Baume carefully into cells until level with bottom of filling tubes, using a china or glass pitcher or rubber syringe. Then replace and tighten filling plugs and allow battery to stand not less than 10 hours before starting the initial charge.

> If electrolyte of above specific gravity cannot be obtained, it can be made by mixing especially pure sulphuric acid of 1.835 specific gravity (66 degrees Baume, oil of vitriol) and distilled water as described on page 34.

Examine battery case carefully to see if there is any evidence of a cell leaking due to a broken jar, or other indication of injury received in transit. If such is found, claim should be made against the carrier.

**Batteries with bolted connections** are shipped with a metal strip underneath the top nuts of the cell terminal posts to keep the sealing nuts from loosening. These strips should be discarded.

**Charging Circuit**

For connecting up charging circuit, follow instructions at bottom of page 14 and all of page 15, except that the resistance or lamps should be arranged so that the charging rate will be as near as possible the rate given in the table on the next page. For instance, for Type XC-13, a charge of 4 amperes instead of 6 should be used. For charging more than one battery, use diagram and instructions under Periodic Charge (page 62). On account of the length of charge required it is not advisable to attempt charging with the generator on an automobile.

**Initial Charge**

Not less than 10 hours after filling, remove filling plugs, add water to restore level of electrolyte if it has fallen, and replace filling plugs screwing them tight. **Never charge with filling plugs out or loose** as flooding may result. Start charging and continue for at least four days (96 hours) or until the battery has received at least the number of ampere hours given in the table on the next page.

If temperature of electrolyte approaches 110 degrees F. (125 degrees F. in tropical climates with low gravity electrolyte)

*The lower gravity refers to batteries used in tropical climates (see page 17).

stop charging or reduce rate until it lowers. Add water, if necessary, during this charge to keep the plates covered. When adding water, the charge should be interrupted while filling plugs are out.

Throughout the charge keep filling plugs turned to the right as far as they will go or flooding may result (see exception to this rule at bottom of page 13).

At the end of this charge take a careful gravity reading of each cell. The specific gravity should be between 1.270 and 1.300 (1.200* and 1.230*); if it is not, continue the charge and proceed as follows:

If the specific gravity is low, withdraw some of the solution with the hydrometer syringe and add 1.300 specific gravity electrolyte. If gravity is too high, withdraw some solution and add water. Repeat until gravity is within the proper limits.

Adjusting Gravity

**Never add electrolyte to a cell after the gravity has been adjusted to the proper point, unless to replace actual loss by spilling.**

Wipe off the top and sides of the battery case, being careful to remove any water or electrolyte that may have been spilled. If the connections are bolted, tighten all the top nuts, as they may have worked loose during shipment. The battery is then ready to be installed on the car (see page 30).

## INITIAL CHARGE TABLE

| Type (See name plate) | | Charging Rate Amperes | Minimum Ampere Hours |
|---|---|---|---|
| XC-5 | | 1¼ | 120 |
| XC-7 | JX-7 | 2 | 190 |
| XC-9 | | 2½ | 240 |
| XC-11 | JX-11 | 3 | 290 |
| XC-13 | JX-13 | 4 | 385 |
| XC-15 | JX-15 | 4½ | 430 |
| XC-17 | | 5 | 480 |
| XC-19 | JX-19 | 6 | 575 |
| XC-21 | | 6½ | 625 |
| XC-23 | | 7 | 675 |
| XC-25 | | 7½ | 720 |

* The lower gravity refers to batteries used in tropical climates (see page 17).

# "Exide" STARTING AND LIGHTING BATTERIES

| *TYPE OF CELL | Charge Rate in Amperes | CRANKING CAPACITY | LIGHTING CAPACITY | | | | |
|---|---|---|---|---|---|---|---|
| | | 20 Minute Discharge Rate in Amperes | Ampere Hours when Discharged Intermittently | Ampere Hours at 3 Ampere Rate | Ampere Hours at 5 Ampere Rate | Ampere Hours at 7½ Ampere Rate | Ampere Hours at 10 Ampere Rate |
| XC-5 X-55 X-5 | 2 | 32½ | 30 | 25 | 22 | 19 | 17½ |
| XC-7 X-75 X-7 JX-7 | 3 | 49 | 45 | 40 | 36 | 33 | 30 |
| XC-9 X-95 X-9 | 4 | 65 | 60 | 57 | 52 | 47 | 44 |
| XC-11 X-115 X-11 JX-11 | 5 | 81½ | 75 | 74 | 67 | 62 | 58 |
| XC-13 X-135 X-13 JX-13 | 6 | 98 | 90 | 90 | 84 | 77 | 72 |
| XC-15 X-155 X-15 XA-15 JX-15 | 7 | 114 | 105 | 105 | 100 | 93 | 88 |
| XC-17 X-175 X-17 | 8 | 130 | 120 | 120 | 117 | 109 | 103 |
| XC-19 X-195 X-19 JX-19 | 9 | 146 | 135 | 135 | 135 | 125 | 118 |
| XC-21 X-215 X-21 | 10 | 163 | 150 | 150 | 150 | 142 | 134 |
| XC-23 X-235 X-23 | 11 | 179 | 165 | 165 | 165 | 158 | 150 |
| XC-25 X-255 X-25 | 12 | 195 | 180 | 180 | 180 | 176 | 167 |
| PH-13 PHA-13 PHB-13 PH-135 | 8 | 152 | 160 | 160 | 150 | 140 | 132 |
| MH-11 MHA-11 MH-115 | 8 | 152 | 160 | 160 | 150 | 140 | 132 |

*NOTE.—To identify type of cell, note the marking on the name plate, but disregard the first and last numerals, which refer respectively to the number and arrangement of cells in the battery. For instance, with name plate marked 3-XC-15-1, look for XC-15 in table.

Form 1296—4-'19—5M

# "Exide" LIGHTING AND IGNITION BATTERIES

| TYPE | Charge Rate in Amperes | Ampere Hours in Ignition Service | LIGHTING CAPACITY | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Ampere Hours when Discharged Intermittently | Ampere Hours at 1 Ampere Rate | Ampere Hours at 1½ Ampere Rate | Ampere Hours at 3 Ampere Rate | Ampere Hours at 5 Ampere Rate | Ampere Hours at 7½ Ampere Rate | Ampere Hours at 10 Ampere Rate |
| 3–LX–5 .... | 3 | 50 | 40 | 39 | 36½ | 32 | 28 | 25 | 23 |
| 3–LX–9 .... | 6 | 100 | 80 | 86½ | 81½ | 73 | 66 | 60½ | 56 |
| 3–LX–13 ... | 9 | 150 | 120 | 136 | 130 | 118 | 108 | 100 | 94 |
| 3–LX–17 ... | 12 | 200 | 160 | 186 | 180 | 164 | 151 | 141 | 133 |
| 3–SX–9..... | 5 | 80 | 64 | 68 | 64 | 57 | 51 | 46 | 43 |
| 3–SX–13.... | 7 | 120 | 96 | 109 | 102 | 91 | 84 | 77 | 73 |
| 3–ZA–5 }<br>3–ZB–5 } ... | 1 | ..... | 13¼ | 10½ | 9½ | 8 | 6¾ | ..... | ..... |
| 3–ZA–7 }<br>3–ZB–7 } ... | 1½ | ..... | 20 | 17 | 15½ | 13½ | 11¾ | ..... | .... .... |