MANUAL

of

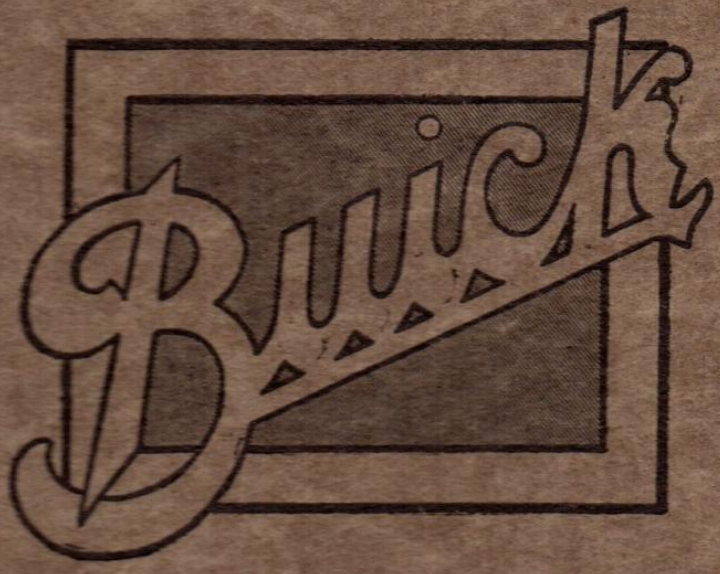
"Exide" Batteries

IN

AUTOMOBILE

STARTING & LIGHTING

SERVICE



THE ELECTRIC STORAGE BATTERY CO.

PHILADELPHIA, PA.

MANUAL

of

"Exide" Batteries

IN

AUTOMOBILE

STARTING & LIGHTING

SERVICE

FOR

Buick Cars

MODELS D-44, D-45, D-46 AND D-47

USE "Exide" BATTERY, TYPE 3-XC-13-1

MODELS D-54 AND D-55

USE "Exide" BATTERY, TYPE 3-XC-15-1

THE ELECTRIC STORAGE BATTERY CO.

PHILADELPHIA, PA.

FIRST EDITION **JUNE, 1915**

Copyright, 1915, by The Electric Storage Battery Co.

THE ELECTRIC STORAGE BATTERY CO.

GENERAL OFFICES AND WORKS
Allegheny Avenue and Nineteenth Street
PHILADELPHIA, PA.

OFFICES

THE ELECTRIC STORAGE BATTERY CO.

PHILADELPHIA
Allegheny Ave. and 19th St.

NEW YORK
100 Broadway

BOSTON
60 State St.

CHICAGO
Marquette Building

ST. LOUIS
H. B. Marshall, Soliciting Agent
Fullerton Building

CLEVELAND
Citizens Building

ATLANTA
Candler Building

DENVER
George D. Luther, Soliciting Agent
1424 Wazee St.

DETROIT
208 Hayward Building
971 Woodward Ave.

ROCHESTER
44 Cortland St.

WASHINGTON
1828 L St., N. W.

PITTSBURGH
Keystone Building

SEATTLE
Pierson, Roeding & Co.
Colman Building

LOS ANGELES
Pierson, Roeding & Co.
Pacific Electric Bldg.

SAN FRANCISCO
Pierson, Roeding & Co.
118-130 New Montgomery St.

CANADA
The Canadian General Electric Co., Limited
King and Simcoe Sts., Toronto

"Exide" BATTERY DEPOTS

EXIDE BATTERY DEPOTS, INC.

NEW YORK CITY
527 West 23d St.

PHILADELPHIA
Allegheny Ave. and 19th St.

BOSTON
789 Tremont St.

CHICAGO
333 West 35th St.

CLEVELAND
5121 Perkins Ave.

ATLANTA
20 S. Piedmont Ave.

ROCHESTER
44 Cortland St.

DETROIT
Woodward and Garfield Aves.

DENVER
1424 Wazee St.

ST. LOUIS
2038 Walnut St.

KANSAS CITY
1708-10 Main St.

WASHINGTON
1828 L St., N. W.

SAN FRANCISCO
9-13 Minna St.

THIS book is entirely devoted to the care and operation of a storage battery used for automobile starting, lighting and ignition, and has been prepared in such form as to be readily used by the owner of an automobile.

In just a few words, let us first tell you how the "Exide" Battery is particularly adapted to such use and why it will give you the best service at the least expense.

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 13⅝ inches long, 7⅜ inches wide and 9¼ inches high, and weighs only 60 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. Four years ago there arose a demand for storage batteries for automobile starting,

lighting and ignition. This Company, with over twenty 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 there are over 250,000 "Exide" Batteries in service for starting and lighting purposes and many thousands being built 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.

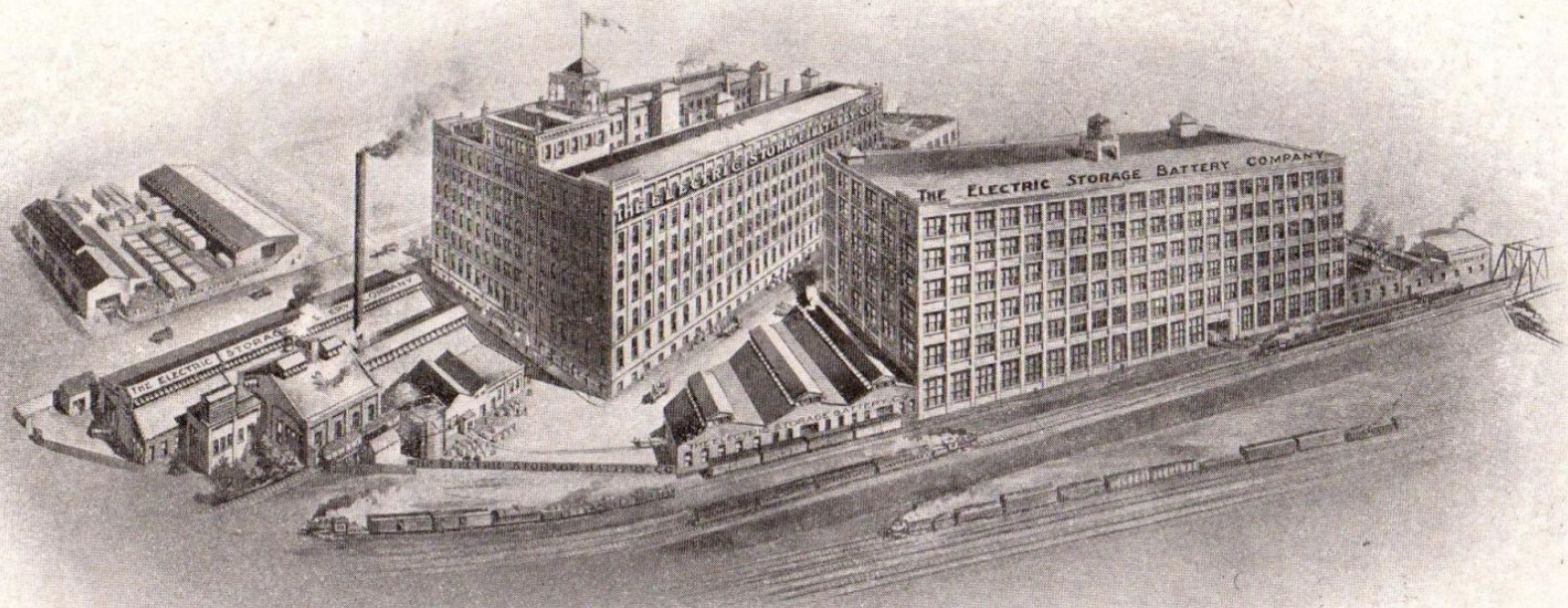
Sixth. **Cases of Improved Construction**—having lock-jointed corners and handles anchored in case ends.

"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 thirteen "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.



THE ELECTRIC STORAGE BATTERY CO.

General Offices and Works

Allegheny Avenue, 18th to 20th Streets

Philadelphia, Pa.

The Largest Storage Battery Manufacturing Plant in the Country

CONTENTS

PAGE

FOREWORD 5

RECEIVING A NEW BATTERY 7

Battery Received Installed on Car 7
Battery Shipped Separately from Car 7
Installing Battery on Car 8

BATTERY IN SERVICE 9

General 9

Adding Water 9
When Necessary 9
How to Add Water 9
Kind of Water to Use 10
Add Nothing but Water 10

Hydrometer Readings 10
Value of Hydrometer Readings 10
When to Take Readings 11
How to Take Readings 11
What Readings Indicate 11

Charging 12
General 12

Special Charging 12
When Necessary 12
How to Charge 12
Indications of Complete Charge 12
Quick Charge 13

Charging Circuit 13
Polarity 13
Resistance Required 14

Cleanliness 14
Necessity 14
Care of Battery Case 15
Care of Connections 15

Battery Not Giving Satisfactory Service 16
How to Locate Trouble 16
Failure to Start 16
Wiring Grounded 16

BATTERY IN NEED OF REPAIRS 17
Packing for Shipment 17

SPECIAL INSTRUCTIONS FOR BATTERIES USED WITHOUT GENERATOR SYSTEM 19

CARE OF BATTERY OUT OF SERVICE 20
Preliminary Charge 20
Freezing 20
Adding Water 20
Periodic Charge 21

GENERAL DESCRIPTION OF BATTERY 22

Plates 22
Grid 22
Material 22
Lug 22
Group 22
Straps 22
Separators 22
Element 23
Electrolyte 23
Jar 23
Cover 23
Vent 24
Case 24
Handles 24
Hold-down Clips 24

ELECTROLYTE 26

Composition 26
Concentrated Sulphuric Acid 26
Preparing Electrolyte 26
Chemically Pure Electrolyte 26
Specific Gravity 26
Temperature Correction 26
Freezing Point 28

HYDROMETER AND ITS USE 30

Type in General Use 30
Hydrometer Syringe 30
Method of Use 30

OUTLINE OF THE ACTION IN A STORAGE BATTERY 32

General 32
Formation of Lead Sulphate 32
Drop in Voltage 32
Drop in Specific Gravity During Discharge 32
Charging 32
Action of Current 32
Object of Charging 33
Gassing 33
Normal Sulphate 33
Abnormal Sulphate 33
High Rates of Discharge 33
Overdischarge 33
Starvation 33
Overcharge 33
Low Temperature 33
High Temperature 34

GLOSSARY 35–37

TABLES OF RATINGS 38, 39

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 owner, chauffeur and garage man to obtain the best results.

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 as follows:

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

2. Keep the battery charged, taking hydrometer readings to determine its condition. If the operation is such that the generator on the car does not give the battery sufficient charge, either modify the operation or give a special charge.

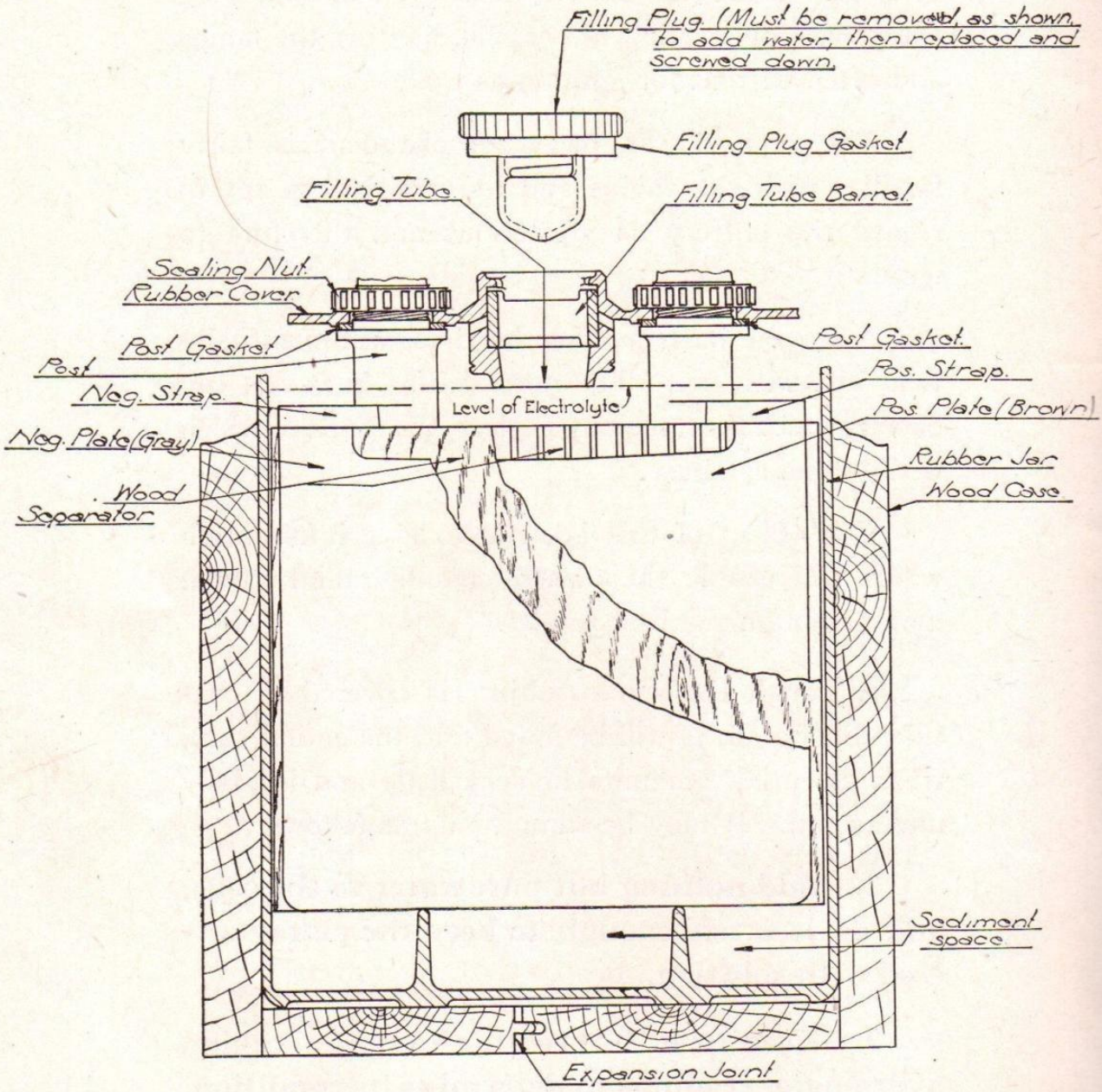


Fig. 1. Section of Battery

RECEIVING A NEW BATTERY

BATTERY RECEIVED INSTALLED ON CAR

Remove filling plugs, and read the specific gravity of the electrolyte in each cell with the hydrometer syringe (page 30).

If the gravity is below 1.250, remove the battery from the car and give a charge from an outside source (page 13).

If the gravity is above 1.250, note the level of the electrolyte. If the level is below the bottom of the filling tubes (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, 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.

BATTERY SHIPPED SEPARATELY FROM CAR

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

After removing the packing material from the top and sides of the battery, remove and discard the soft rubber caps which may be over the filling plugs (Fig. 1).

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 38, 39). 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; 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.

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.

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.

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 gravity 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.

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.

> If temperature is extremely low, start the engine so that the battery is charging before adding water.

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; also 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 30) 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.**

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.

For a large garage, where water is used in quantity, it is worth while to submit a sample of the city supply for test, since this may be of sufficient purity. Sample should not be less than one quart and should be forwarded in a clean glass bottle, carefully packed and marked for identification, and with express charges prepaid, to The Electric Storage Battery Company, 19th Street and Allegheny Avenue, Philadelphia, Pa. The analysis will be made free of charge.

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 (page 7).

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 11).

When battery is used alone (without generator), the hydrometer readings will likewise indicate the state of discharge of the battery and when it is necessary for it to be charged.

When to Take Readings

Take a hydrometer reading of each cell with the hydrometer syringe (page 30) 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.

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 30.

What Readings Indicate

Specific gravity above 1.200 indicates that the battery is more than half charged.

Gravity below 1.200, but above 1.150, 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. If gravity will not rise above 1.200 within a reasonable time, look for trouble in the system.

Gravity of 1.150 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, 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 (page 37), causing the cell to discharge itself, or it may be due to a leaking jar, as a slight leak will allow electrolyte to escape, and if not noticed, the addition of water to replace its loss will lower the gravity.

A short circuited or leaking cell must be attended to at once (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 at all practicable to do so (page 20).

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 should be 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. This is one of the evil effects of adding acid or electrolyte. In such cases, the battery should be charged at once, and the specific gravity reduced to the proper point (page 8).

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.

Connect the battery to the charging circuit (page 13). **The positive terminal of the battery marked "POS" must be connected to the positive wire from the charging source.**

How to Charge

Charge at the rate given in tables (pages 38, 39) for the type of battery in question. If there are batteries of different sizes in the same circuit, the battery having the lowest charge rate should determine the current.

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 replace and tighten the plugs or flooding will result.

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

Quick Charge

To charge a completely discharged battery (gravity 1.150 or thereabout), will require in the neighborhood of 24 hours at the normal rate. If it is very urgent that the battery be charged in quicker time than this, the first part of the charge may be given at twice the normal charge rate, **but great care must be taken to reduce the rate to normal when the cells start gassing;** also the temperature must be watched very carefully and the rate must be reduced when it approaches 110 degrees Fahrenheit. Serious damage may be done by charging a battery at a high rate after the cells are gassing.

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 and there is little or no gassing in one of 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 17).

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.

To Charge One Battery from a Direct Current Circuit

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.

Polarity

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. 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. 2). With

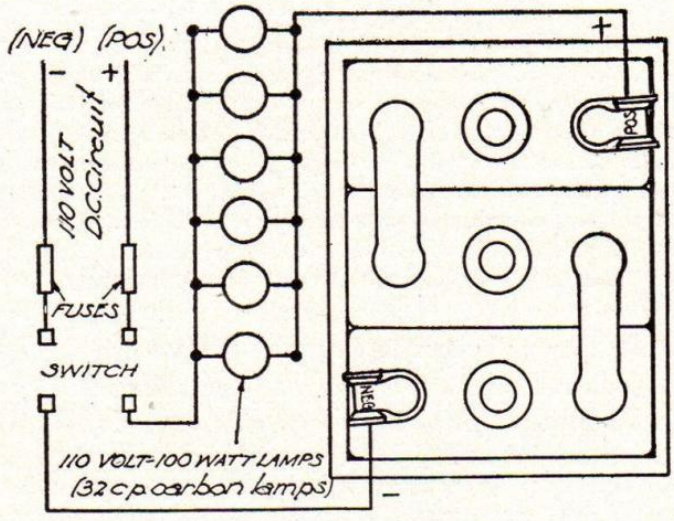


Fig. 2. Charging Connection

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 (tables, pages 38, 39). For instance, for Type XC-15, charge rate 7 amperes, seven 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

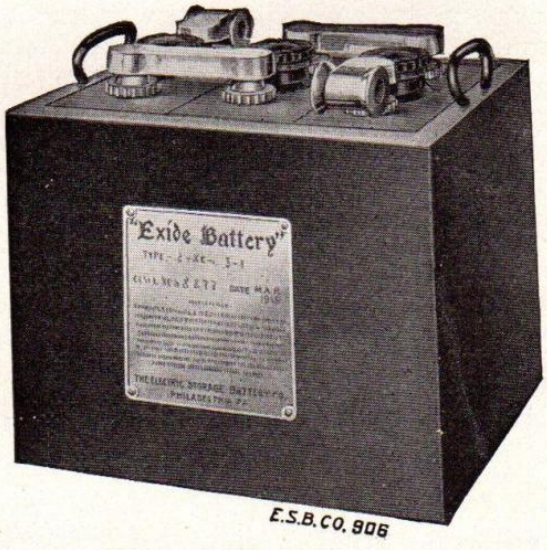
If water or electrolyte is spilled upon the battery or in the compartment, wipe dry with waste. If electrolyte is present in any quantity, use waste moistened with weak ammonia in order to neutralize the acid in the electrolyte. Do not allow electrolyte to collect upon the woodwork as it will cause deterioration.

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 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 or thereabout), give a special charge (page 12).

> 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 17).

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 cell voltage is low (1.80 volts 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 the battery ground wire at the ground plate. Then strike the bare end or terminal of the ground wire against the ground plate; if sparks are noticed, there is a ground in the wiring, which should be looked for and removed.

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).

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 "A" shaped top (Fig. 3) 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.

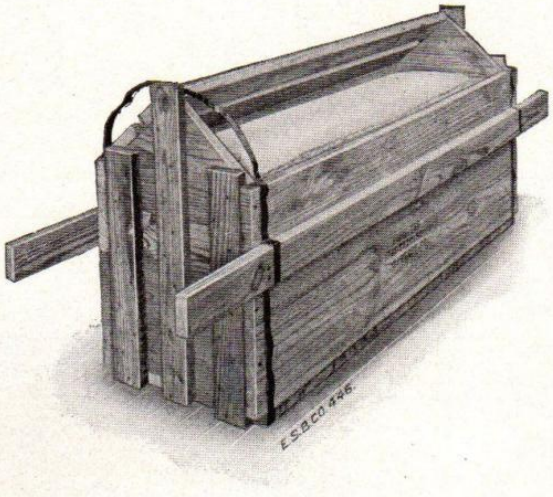


Fig. 3

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.

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. The proper freight classification is "Electric Storage Batteries, Assembled." No railroad caution labels are required.

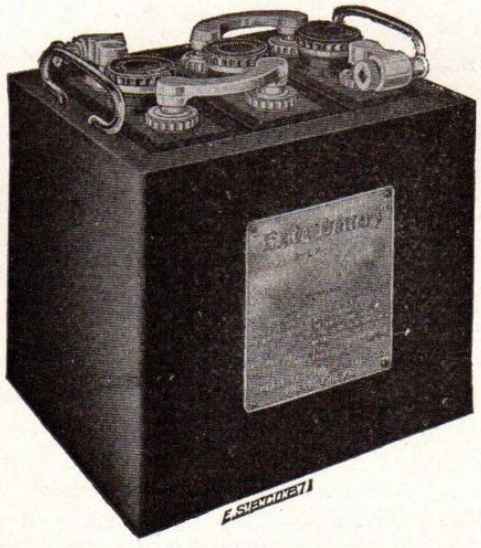
SPECIAL INSTRUCTIONS FOR BATTERIES USED WITHOUT GENERATOR SYSTEM

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.

Frequent hydrometer readings should be taken, however, and when the gravity falls below 1.200, 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 1.150 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

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. 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 the filling plugs and add pure water until the level reaches the bottom of the filling tube. Replace the 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 will result.**

Preliminary Charge

Put on charge at the proper current rate as given in tables (pages 38, 39). If there are batteries of different sizes in the same circuit, the battery having the lowest charge rate should determine the current.

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

The electrolyte in a fully charged battery freezes at something lower than 80 degrees below zero, while in a normally discharged battery it freezes at about 5 degrees above zero. Therefore, if a battery is fully charged before being laid aside, and water is not added except immediately before charging, as directed above, there is no danger of freezing. Should water be added without being followed by a charge, it will not mix with the electrolyte, but, being lighter, will remain on the surface and be subject to freezing. The gassing at the end of charge causes the water to become thoroughly mixed with the electrolyte.

Adding Water

Once every two months during the out of service period, remove the filling plugs and add water, replace the plugs and give the 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.

Periodic Charge

Specific gravity readings, to check against those taken on the preliminary full charge, furnish an additional safeguard, but need not necessarily be taken every time a "freshening" charge is given.

The taking of specific gravity readings occasionally while the battery is standing idle gives a good line on the uniformity of the cells. If the specific gravity in one cell falls materially faster than in the others, there is probably something wrong with this cell, and it should be taken out and inspected by a competent battery man.

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 fifty hours at half normal rate before putting battery into service again.

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 bat-

Grid teries. 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. 4 shows a section through the horizontal ribs and makes clear their staggered relation.

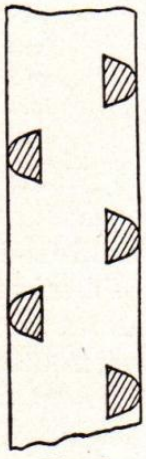


Fig. 4

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. 5 shows the finished positive plate and Fig. 6 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

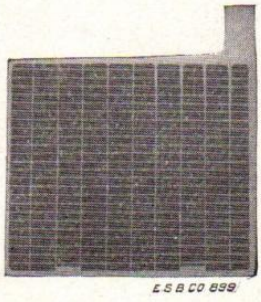


Fig. 5. Positive Plate

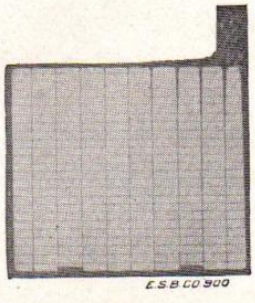


Fig. 6. Negative Plate

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. 7), either positive or negative.

Straps The straps (Fig. 7) 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. 8) are made of tough wood particularly

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

A positive and a negative group, together with the separators, constitute an "element" (Fig. 9). **Element**

The fluid, known as "electrolyte" (page 26), is dilute sulphuric acid. **Electrolyte**

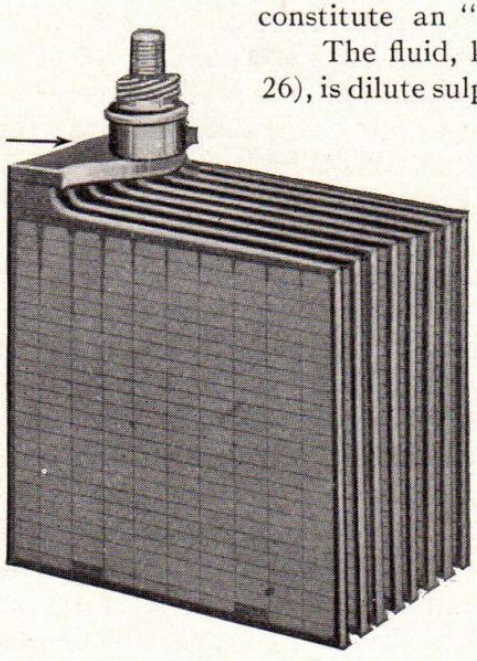


Fig. 7. Group

The cell container is a rubber jar of special composition which will withstand the vibration of the car and any ordinary handling without break- **Jar**

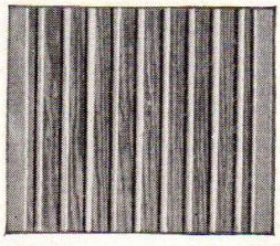


Fig. 8. Separator

age. The plates rest on stiff ribs or bridges in the bottom of the jar (Fig. 1), allowing space for the gradual accumulation of "sediment."

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. **Cover**

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

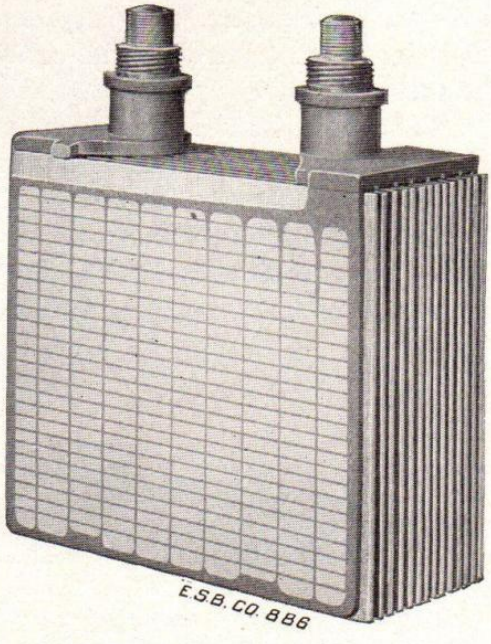


Fig. 9. Element

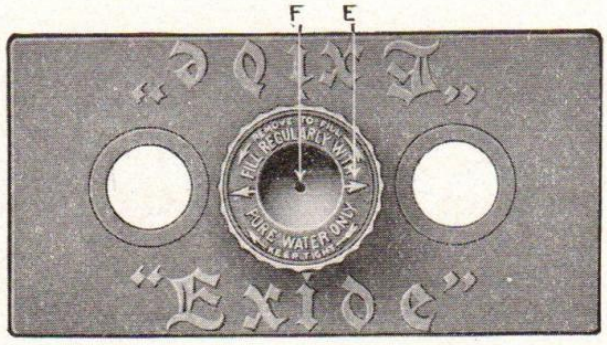
through the cover and the sealing nut clamps the cover tight, the soft rubber gasket underneath giving a very effective seal.

Vent From the illustrations (Fig. 10) 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 over-filling 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 barrel or air lock (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 air lock (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 neck (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 air lock (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.

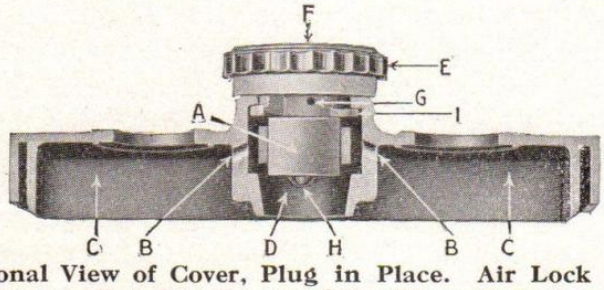
Case The case is substantially built of hard wood thoroughly coated with acid proof paint. The thorough method of sealing adopted prevents electrolyte from splashing or seeping out and keeps the case from becoming weakened and unsightly. So effective is the individual cell sealing that no layer of compound 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.

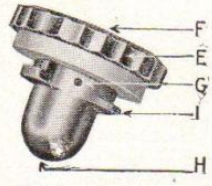
Hold-Down Clips It is **absolutely essential** that the battery be securely held in position on the car, and for this purpose brackets which fit on the case are used. The battery is made fast to the car by means of bolts engaging the hold-down clips.

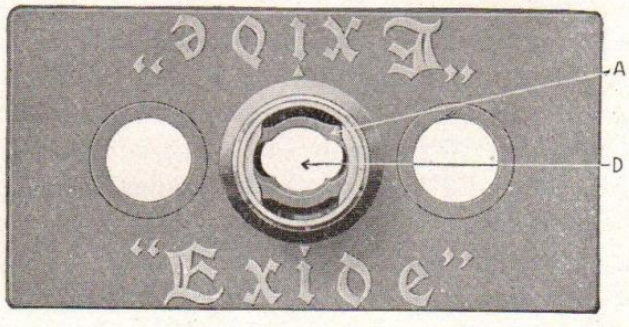


Top View of Cover and Filling Plug, Plug in Place

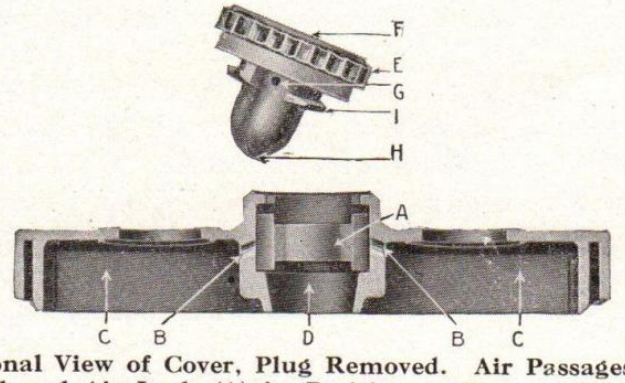


Sectional View of Cover, Plug in Place. Air Lock (A) in Position to Allow Free Escape of Gas Through Passages (BB)





Top View of Cover and Filling Plug, Plug Removed



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

Fig. 10

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 10).

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 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. 11 for the desired specific gravity, taking the following precautions:

Use a glass or earthenware vessel, never metallic.
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.

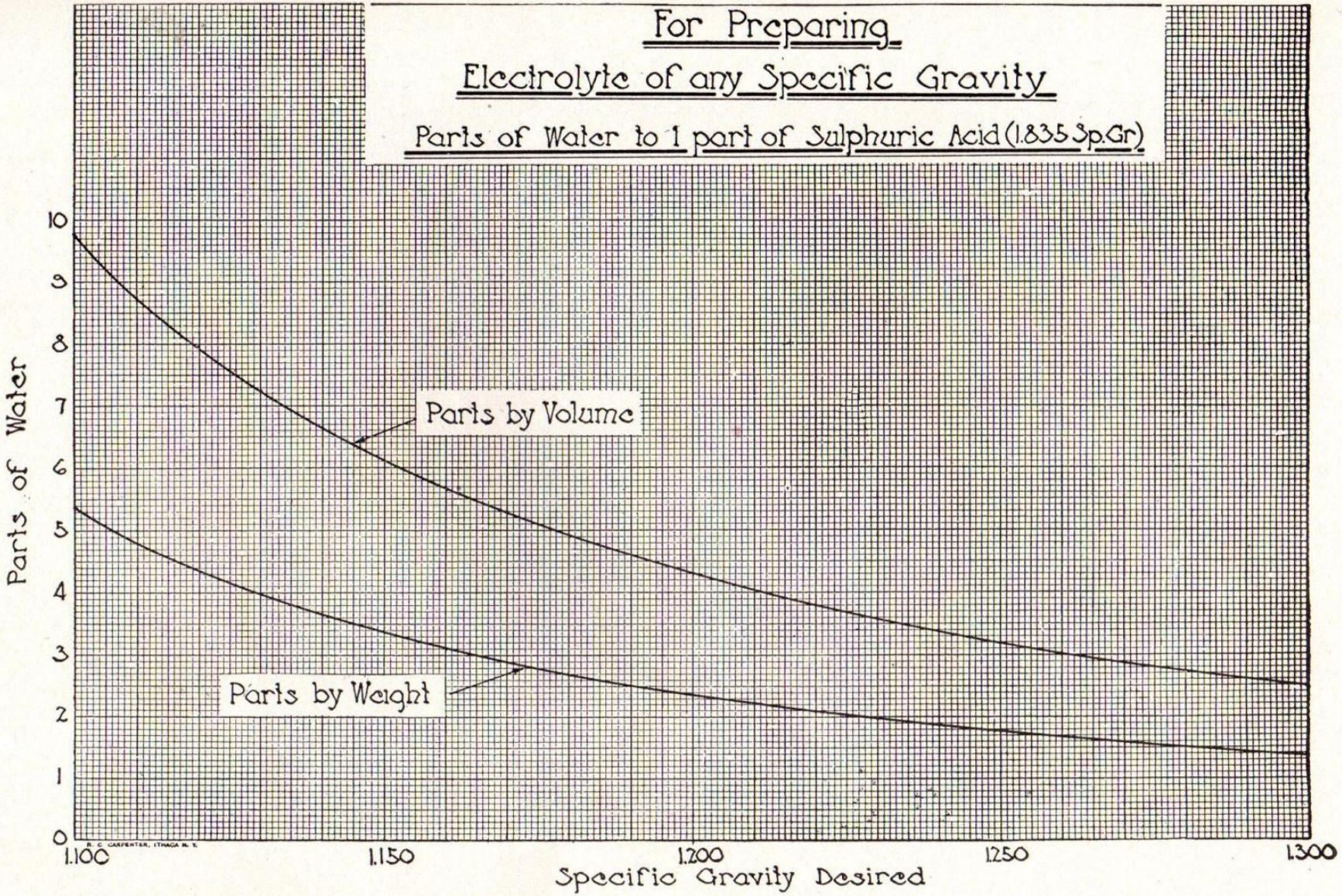
Specific Gravity

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.

Fig. 11


For Preparing
Electrolyte of any Specific Gravity
Parts of Water to 1 part of Sulphuric Acid (1.835 Sp.Gr.)
Parts of Water
0
1
2
3
4
5
6
7
8
9
10
Parts by Volume
Parts by Weight
1.100
1.150
1.200
1.250
1.300
Specific Gravity Desired
R. C. CARPENTER, ITHACA N. Y.

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. 12.

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

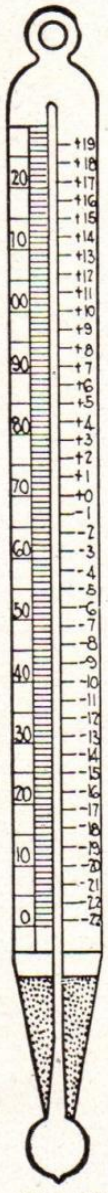


Fig. 12
Thermometer

Freezing Point

The freezing point of electrolyte depends upon its specific gravity. From the curve (Fig. 13) it will be seen that there is little danger of freezing except with a discharged battery.

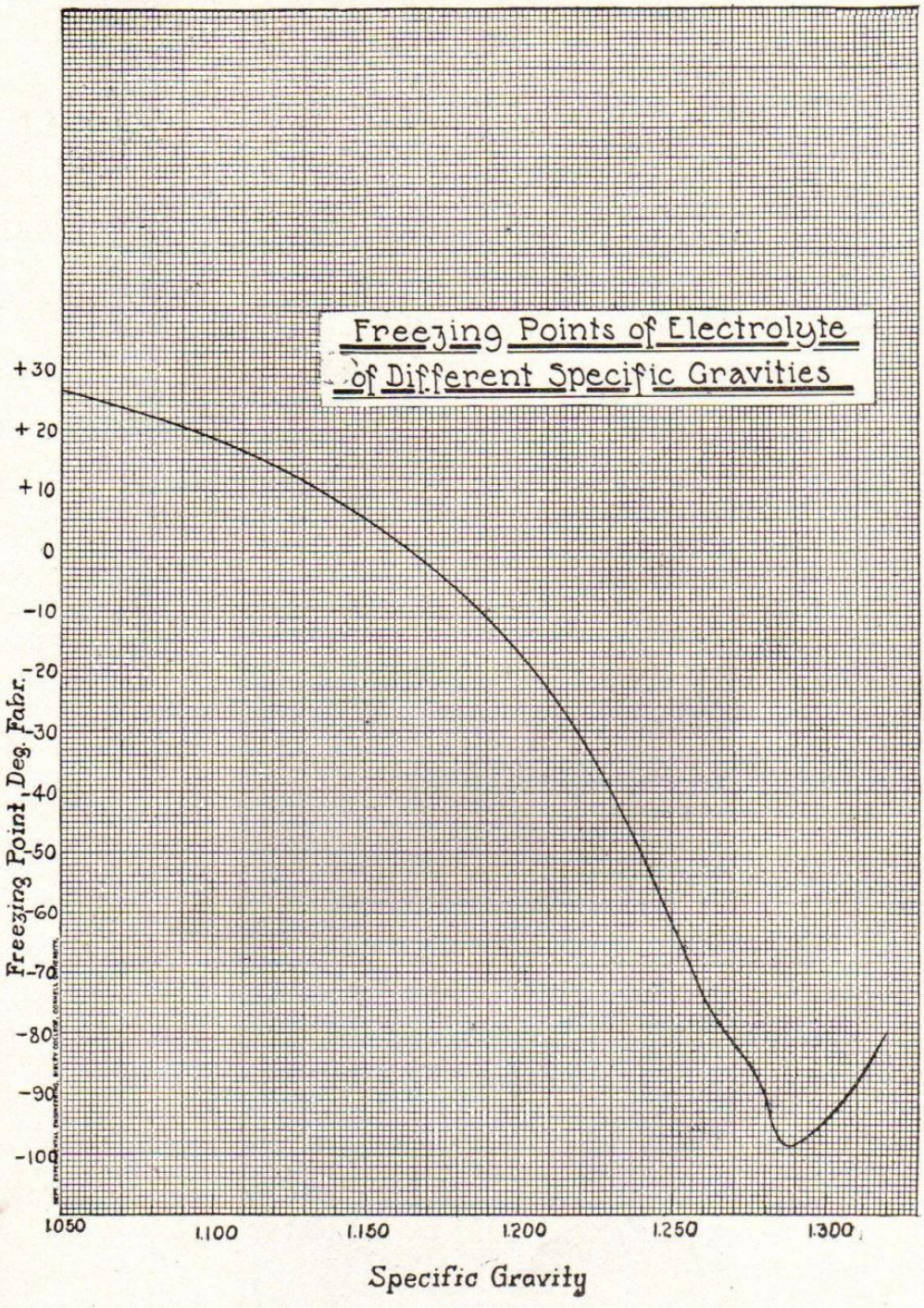

Freezing Points of Electrolyte
of Different Specific Gravities
+30
+20
+10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
Freezing Point, Deg. Fahr.
1.050
1.100
1.150
1.200
1.250
1.300
Specific Gravity

Fig. 13

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. 14), 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. 14 Hydrometer

Hydrometer Syringe

For greater convenience, the hydrometer is usually placed inside of a larger glass barrel provided with a rubber bulb on top and a suitable nozzle on the lower end. This combination is known as the "hydrometer syringe" (Fig. 15).

Method of Use

By squeezing the bulb, inserting the nozzle into the electrolyte and releasing the bulb, electrolyte is drawn up into the glass barrel. Sufficient electrolyte should be drawn up to float the hydrometer clear of the rubber plug in the bottom (Fig. 16).



Fig. 15 Hydrometer Syringe

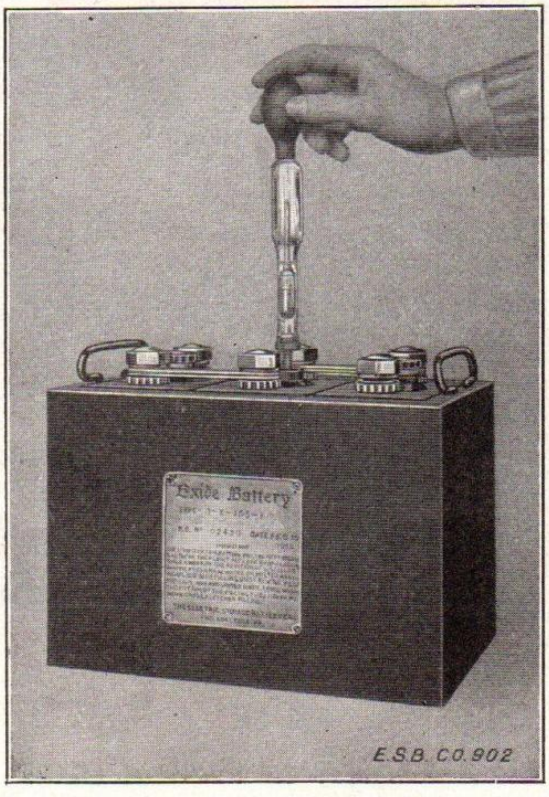


Fig. 16. Taking Hydrometer Readings

To prevent the hydrometer from sticking to the side of the barrel, 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.

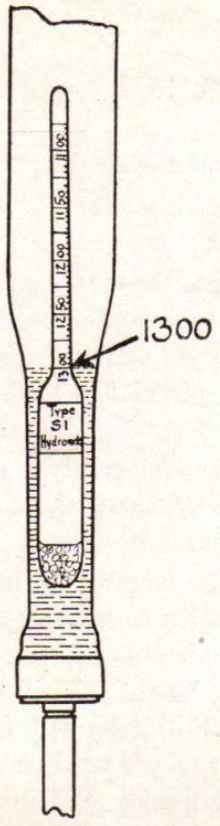


Fig. 17
Hydrometer
Reading, 1.300

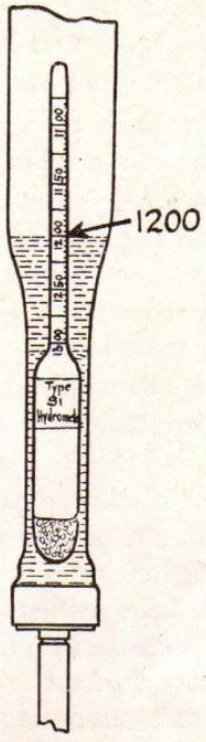


Fig. 18
Hydrometer
Reading, 1.200

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.

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.

Drop in Voltage

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 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, it will, at the end of discharge, be about 1.150. 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

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 over discharged or has had water added without subsequent charging this is liable to occur.

High Temperature

High temperature is to be avoided from the standpoint of life. 110 degrees Fahrenheit 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.

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.

Arc Burning. Making a joint by means of electric current, which melts together the metal of the parts to be joined.

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 cel 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 to 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.

"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
XA-5 XB-5 XC-5 X-55 X-5	2	32½	30	25	22	19	17½
XA-7 XB-7 XC-7 X-75 X-7 JX-7	3	49	45	40	36	33	30
XA-9 XB-9 XC-9 X-95 X-9	4	65	60	57	52	47	44
XA-11 XB-11 XC-11 X-115 X-11 JX-11	5	81½	75	74	67	62	58
XA-13 XB-13 XC-13 X-135 X-13 JX-13	6	98	90	90	84	77	72
XA-15 XB-15 XC-15 X-155 X-15 JX-15	7	114	105	105	100	93	88
XA-17 XB-17 XC-17 X-175 X-17	8	130	120	120	117	109	103
XA-19 XB-19 XC-19 X-195 X-19 JX-19	9	146	135	135	135	125	118
XA-21 XB-21 XC-21 X-215 X-21	10	163	150	150	150	142	134
XA-23 XB-23 XC-23 X-235 X-23	11	179	165	165	165	158	150
XA-25 XB-25 XC-25 X-255 X-25	12	195	180	180	180	176	167
PH-13 PHB-13 PH-135	8	152	160	160	150	140	132
MH-11 MHB-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 1295 X—8-'15—30M

"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 } 3–ZB–5 } ...	1	.....	13¼	10½	9½	8	6¾	.....	.....
3–ZA–7 } 3–ZB–7 } ...	1½	.....	20	17	15½	13½	11¾	.....	.....

