This Manual is intended for Ford dealers and service stations, and not for the individual owner.

Ford Motor Company
DETROIT, MICHIGAN
Description of a Battery

What is a storage battery? Answer No. 1

A storage battery is simply a device for storing energy at one time for use at another. Energy is put into it in the form of electricity and delivered from it in the same form. The process of putting energy into the battery is termed "charging." When the battery is delivering energy, it is "discharging."

How does a storage battery work? Answer No. 2

The action of a storage battery can be readily understood by contrasting it with that of a primary battery, such as is used for ringing door bells, and with which most battery users are familiar.

Primary batteries consist of two unlike plates in a solution. The solution acts upon the plates in such a way as to give to one of them a tendency to deliver a current of electricity and to the other a tendency to draw in current. When a circuit between the plates is made by connecting them together with a wire, there is a flow of electrical current through the wire, due to the action between the plates and solution. The action gradually changes the plates and solution until the ability to deliver electricity ceases and the plates and solution must then be replaced with new.

The storage battery also consists of two kinds of plates covered by a solution and the action when discharging is similar to that in the primary battery. But the storage battery differs from the primary battery in that, after the action of discharge has taken place, the plates and solution can be restored to their original or charged condition by sending a current of electricity through the battery in a direction opposite to that of the current of discharge and the effect of which is to produce an action within the cell exactly the reverse of that on discharge.

A storage battery may therefore be described as a "restorable" battery; that is, a battery which by means of a charging current may be restored from a discharged to a charged condition.
How is the battery used on the car? Answer No. 3
On cars with an electric starter, it is used as a reservoir from which energy is supplied to crank the engine and light the lamps. The energy so used is automatically restored by the car's generator when the engine is running faster than a certain speed.

What are the essentials of a storage battery? Answer No. 4
The essentials of a storage battery are two unlike plates in a solution. The solution is called "electrolyte" and acts upon the plates in such a way as to give to one of them a tendency to deliver a current of electricity and to the other a tendency to draw in current. The one with the tendency to deliver is called the "positive," the other the "negative."

How are the plates made? Answer No. 5
Both positive and negative plates have as their backbone a cast grid made of a stiff alloy. This consists of a series of light bars running crosswise and strengthened by a series of heavy bars running from top to bottom.

How do positive plates differ from negatives? Answer No. 6
Positive and negative plates differ in the composition of the active material which is brown peroxide of lead in the positives and gray, spongy lead in the negatives. Fig. 2 shows the finished positive and fig. 3 the negative.

What are groups? Answer No. 7
All plates are provided with an extension or lug (fig. 3). Six positive plates are "lead-burned" to an alloy strap forming a positive group (fig. 6). In the same way seven negative plates are formed into a negative group (fig. 4).

What is an element? Answer No. 8
An element (fig. 7) is a positive group assembled with its negative group and provided with separators.

What are separators? Answer No. 9
Separators are very porous sheets of wood (fig. 5) inserted between each positive and negative plate in order to keep...
them from mechanical contact. This is necessary, because if any part of one group should get in contact with the other it would form a short circuit inside the cell just as a wire connected between the terminals forms a circuit outside the cell.

Before being used, the wood separators are specially treated to remove any substances which would be harmful to the plates. They are also grooved on the side which goes against the positive plate.

**What is a jar?**

*Answer No. 10*

A jar (fig. 8) is a container for holding the element and electrolyte. It is made of a special composition of hard rubber and has stiff ridges or ribs in the bottom upon which the element rests, allowing space for the accumulation of sediment which may drop from the plates.

**What is the cell cover?**

*Answer No. 11*

A cover (fig. 9) is a piece of molded hard rubber and is put over the element in the jar. The Ford cover is provided with special flanges to which sealing compound is applied, thus sealing together the jar and cover, and making each cell a complete unit in itself.

Another Ford feature is the method of making a tight seal where the cell posts go through the cover (fig. 10). The post has an alloy collar which supports the jar cover, a soft-rubber gasket being placed between. The post is threaded where it comes through the cover and a sealing nut clamps the cover tight, the soft-rubber gasket underneath giving a very effective seal.

**What are the filling tube and filling plug?**

*Answer No. 12*

Fig. 11 shows the filling plug, together with a section of the cover with the plug out. The filling tube is the opening in the cover through which water may be added to replace evaporation and through which hydrometer readings may be taken. The plug is so arranged as to catch electrolyte spray and return it to the cell, thereby keeping the top of the battery dry. It should always be kept tightly in place, except when adding water or testing.

**What is a cell?**

*Answer No. 13*

A cell (fig. 12) is a complete unit of jar, cover, element and electrolyte all assembled together. It has a nominal voltage of 2 volts and a capacity depending upon the type. Two volts are not enough for automobile work, so several cells are connected in series. For example, a 3-cell battery is a 6-volt battery.
How is the battery case constructed?

The case or container (fig. 13) used for holding the complete cells, is substantially built of hard wood thoroughly coated with acid-resisting paint. Due to each cell being sealed separately, no layer of compound is required over the entire battery. This fact adds greatly to the ease with which the battery can be taken apart. The case is provided with strong loop handles, which are securely anchored without the use of screws or bolts.

What is a complete battery? Answer No. 15

A complete battery consists of 3 cells assembled in a case and connected together (fig. 14).

What are hold-downs? Answer No. 16

It is absolutely essential that the battery be securely held in position on the car, and for this purpose “hold-downs” have been developed. When installing or inspecting a battery, see that the “hold-downs” are tightened properly.

What is a hydrometer syringe? Answer No. 17

A hydrometer syringe is the instrument used for testing the strength of the battery solution or electrolyte. It is one of the most important instruments used in battery repair work.
DESCRIPTION OF A BATTERY

1. Use a glass, china, earthenware, rubber or lead vessel; never metallic, other than lead.

2. Carefully pour the acid into the water; not the water into the acid.

3. Stir thoroughly with a wooden paddle and allow to cool before taking a hydrometer reading of the strength.

Electrolyte, like most substances, expands when hot, affecting the hydrometer reading. To compare different hydrometer readings, therefore, the temperatures should be about the same. It is not necessary, however, to actually bring the temperatures to the same value, because it is a known fact that every 3 degrees increase in temperature decreases the hydrometer reading 1 point, and this fact can be used in estimating what the hydrometer reading would be at a normal temperature. The normal is taken as 70 degrees Fahrenheit. If the hydrometer reading at 100 degrees is 1.270, it would be 10 points more, or 1.280 at 70 degrees. If the reading is 1.290 at 40 degrees, it would also be 1.280 at 70 degrees. Therefore, although the two actual readings differ by 20 points, the difference is all due to temperature, and if the temperatures were the same the readings would be the same. When the temperature is much above or below normal, the hydrometer readings should be "corrected for temperature."

For the convenience of the user, a thermometer (fig. 17) has been designed with a special red ink scale opposite the temperature scale, and a glance at it tells how many points to add or subtract from the hydrometer reading in order to correct for temperature. For
example, an electrolyte temperature of 94 degrees means add 8 points (plus 8) to the actual hydrometer reading.

Why is the electrolyte weaker in tropical climate batteries? Answer No. 19
The electrolyte used in such batteries is purposely made weaker because batteries operated in tropical climates give better results if the solution is weaker than that used in batteries for cooler climates. Places where freezing of water seldom or never occurs are regarded as having tropical climates.

**Capacity of Ford Batteries**

What is the capacity of the battery? Answer No. 20

The ampere hours obtainable from a battery are greater for a long low rate or intermittent discharge than for a short high rate discharge. By an intermittent discharge is meant discharges of a few hours each spread over a period of three days or more.

The following table shows the capacities at different discharge rates for the 13-plate Ford Battery:

- **Cranking Capacity**—98 amperes for 20 minutes.
- **Lighting Capacity**—90 ampere hours if discharged intermittently or at 3 amperes or less.

<table>
<thead>
<tr>
<th>Capacity Type</th>
<th>Capacity Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cranking</td>
<td>98 amperes for 20 minutes.</td>
</tr>
<tr>
<td>Lighting</td>
<td>90 ampere hours if discharged intermittently or at 3 amperes or less.</td>
</tr>
</tbody>
</table>

- 84 ampere hours at 5 amperes
- 77 ampere hours at 7 1/2 amperes
- 72 ampere hours at 10 amperes

**New Ford Batteries**

Upon receipt, what is the first thing to do? Answer No. 21

1. Unpack the battery, keeping the packing case right side up to avoid spilling the battery solution.

2. Examine the battery carefully to see if there is any indication of injury received in transit. If such is found, claim should be made against the carrier.

3. Determine whether the battery has been shipped “charged,” or shipped “unfilled.”

   a. A storage battery shipped “charged” is one which has had solution added and has been given its initial charge at the factory. It leaves fully charged and containing the proper amount of solution and is intended to be put into service shortly after receipt.

   b. A storage battery shipped “unfilled” is one which has never had solution added and, therefore, has not been given its initial charge at the factory. Such a battery may stand a considerable length of time before being put into service. Before being put into service, however, electrolyte of the proper strength must be added and the battery must be given a long initial charge.

If battery has been shipped “charged,” what then? Answer No. 22

1. Remove all the filling plugs and test the strength of the solution by taking a hydrometer reading (fig. 18) in each filling tube.

   a. All readings (figs. 19 and 20) should be more than 1.250 [1.180*]. Add distilled or other “pure” water through each filling tube until the level reaches the bottom of the tube (fig. 1) and replace and tighten filling plugs. In freezing weather, charge the battery for an hour at 6 amperes to mix the water with the solution. If all or some readings are less than 1.250 [1.180*], give the battery a bench charge.

*The reading in brackets applies to batteries used in tropical climates. (Ans. No. 19).*
If battery has been shipped "unfilled," what then? Answer No. 23

1. Store it in a dry, clean location and keep temperature above freezing and below 110 degrees Fahrenheit.

2. No battery that has been shipped unfilled should be allowed to stand for more than one year without being put into service. The process of putting into service will require about five days.

3. If a battery has been allowed to stand more than one year, a cell must be opened up and the separators examined just before putting the battery into service. If the separators are cracked, warped or split, the entire battery must be provided with new separators; otherwise, reassemble the cell and put the battery into service.

How must an "unfilled" battery be put into service? Answer No. 24

1. By filling with electrolyte of the proper strength and giving a long initial charge at the proper rate.

2. To fill, remove filling plugs and pour electrolyte of 1.360 [1.260*] strength carefully into the cells until level with bottom of filling tubes, using china or glass vessels or a rubber syringe. If electrolyte of proper strength is not on hand, it can easily be made as explained in Answer No. 18.

3. After filling, allow battery to stand ten to fifteen hours before starting initial charge. It is important that the full time be allowed.

4. Arrange charging circuit.
   a. Direct current only must be used, never alternating.
   b. The positive terminal of the battery must connect with positive of charging circuit and negative of battery with negative of charging circuit. Battery positive terminal is marked +; negative is marked −.

5. Not sooner than ten to fifteen hours after filling battery with electrolyte, add more electrolyte to restore level if it has

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fallen. Start charging and continue at 4 amperes until battery has received at least 384 ampere hours. If rate is maintained, time required will be ninety-six hours (four days). Initial charge is not complete until the hydrometer reading of every cell goes as high as it will and then remains there for ten hours. Be sure to make the charge absolutely complete, as the entire future of the battery depends upon it.

6. Keep temperature of solution below 110 [125*] degrees Fahrenheit, interrupting charge if necessary.

7. After charge is complete, the strength of solution should be between 1.270 and 1.300 [1.200* and 1.230*]. If it is not these limits, adjust as explained in Answer No. 43.

8. Wipe off top and sides of battery case with rag dampened with ammonia or washing soda to remove any electrolyte that may have been spilled.

9. Just before putting the battery into service, make the high rate discharge test. (Answer No. 91.)

**What care is necessary when installing battery in car?**

**Answer No. 25**

1. In connecting to the car wiring, follow the diagram as given in the Ford Manual. The positive of the battery is always connected to the positive of the system and the negative to the negative.

2. Remove all dirt from the battery and cable terminals and thoroughly clean the surfaces which are to connect together, but do not scrape the lead coating from the cable terminals. Apply a heavy coating of pure vaseline to these surfaces and tighten the connection perfectly, squeezing out the vaseline. Then give the whole connection a heavy coating of vaseline. This is very important in order to prevent connection trouble.

3. Fasten the battery securely in place by means of hold-downs. (Answer No. 16.)

4. If battery is installed in an enclosing box, be sure that none of the ventilating holes are clogged.

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Ford Batteries in Service

**CONDENSED RULES FOR OPERATION**

**What attention does the battery require in service?**

**Answer No. 26**

The battery requires very little attention, but that little is absolutely necessary and vital. Its disregard has resulted in many batteries wearing out in half the time it would have taken if this attention had been given. The attention required may be summed up in the following simple rules:

1. Add nothing but distilled or other “pure” water to replace evaporation. Do this often enough to keep the plates (fig. 1) covered; and in freezing weather do not add it until just before using the battery.

2. Keep the connections tight and covered with vaseline.

3. Keep the filling plugs tight and the battery dry and clean.

4. Take hydrometer readings every month at any time except just after adding water, and be guided by their indications, as follows:

   a. Readings less than 1.225 [1.155*], but more than 1.150 [1.080*], indicate a battery less than half charged at such time the lights and starter should be used sparingly until the readings become more than 1.250 [1.180*].

   b. Readings less than 1.150 [1.080*] indicate complete discharge; in which case the battery should be given a bench charge. This discharged condition may be due to need for adjustment in the system. To determine this, follow the rules in Answer No. 28 and remedy the cause before again running the car.

   c. If the reading of one cell differs from the others by 50 points or more, it indicates loss of electrolyte, wrongful addition of electrolyte or internal trouble in the battery. (Answer No. 27.)

5. If the car is to be laid up for the winter, put the battery into proper storage. (Answer No. 47.)

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*The reading in brackets applies to batteries used in tropical climates. (Ans. No. 19.)
IN CASE OF TROUBLE

What should be done to a battery requiring attention? Answer No. 27

1. Take a hydrometer reading in each filling tube. If all readings are within 50 points of each other and all below 1.200 [1.130*], give the battery a bench charge, following the instructions in Answer No. 42. Locate the cause of trouble and remove it. (Answer No. 28.) If the readings are all above 1.200 [1.130*] or one cell differs from the others by 50 points or more, make the high rate discharge test. (Answer No. 91.) If the solution is too strong, it indicates that acid or electrolyte has been added to the cell. If it is too weak, the cause is sloppage of the battery solution and replacement with water, or else a broken, cracked or leaky jar or internal trouble.

2. Just before replacing battery in service, make the high rate discharge test, to be sure the battery is in good condition. (Answer No. 91.)

How can trouble be located? Answer No. 28

1. Go over all connections. A loose or dirty connection is often the cause of trouble. If the connections between battery and cable terminals are not kept well coated with vaseline, they may corrode, causing a poor connection, or else opening the circuit altogether. If the battery terminal is causing the trouble, remove it and clean the parts thoroughly with weak ammonia. Then remove all dirt, apply vaseline, tighten the connections perfectly and give the whole connection a heavy coating of vaseline.

2. There may be a leak or ground in the wiring. Test for this by turning on all lamp switches and then removing the bulbs from the sockets. Disconnect one of the cables at the battery and in its place tightly hold a file against the battery post, making sure there is good electrical contact between the file and post. Then rub the cable terminal along the file; if sparks are noticed, there is a ground in the wiring, which must be looked for and removed.

*BThe reading in brackets applies to batteries used in tropical climates. (Ans. No. 19.)

3. If engine will not crank, turn on lights and attempt to start in the usual manner. If lights become dim, battery is in poor condition and should be given a bench charge and the cause of trouble investigated and removed. If lights continue to burn brightly, the trouble is elsewhere than in the battery.

4. If the generator of the starting system is not in proper adjustment, the battery will not be kept supplied with the proper amount of current. If the supply is insufficient, the battery will become discharged; if it is too much, the battery solution will become hot (110 degrees Fahrenheit). The generator should be readjusted to deliver more or less current, as the case may require. On all cars, the generator is originally adjusted to supply an amount of current which experience has shown to be the most satisfactory for average running conditions. If the car is run only at nights, more current is naturally required because the lights use a large part of the current which would otherwise go to the battery. If long daylight runs are the rule, the opposite is true because then almost all the current goes into the battery.

ADDGING WATER

What is “pure” water? Answer No. 29

By “pure” water is meant water which contains nothing injurious to the battery, such as distilled water which may be purchased at any drug store or clean rain water that has not been in contact with any metal.

All water for battery use should be kept in clean, covered vessels of glass, china, earthenware, rubber or lead.

Why is it necessary to add water and never anything else? Answer No. 30

The solution in a battery is a mixture of pure water and pure sulphuric acid. Water evaporates; sulphuric acid does not. This is one reason why it is necessary to add water, and also why it is unnecessary to add acid. Another reason is that whenever the battery gasses or bubbles, the action going on changes some of the water into gas which escapes. The acid is not so affected.
How often is it necessary to add water? \( \text{Answer No. 31} \)

Add water often enough to keep the plates covered. There is a certain space above the top of the plates for holding a quantity of solution, and this may be regarded as a reservoir, the object being to keep it from becoming empty or, in other words, to keep the plates from being exposed. Just how long the supply will last depends on several conditions, among which is temperature. Water will be required more frequently in summer than in winter. It is a good plan to add water at least once a week in summer and every other week in winter. When long daylight runs are made, water must be added still more frequently. See answer 65 for other causes of loss of liquid.

When is the best time to add water? \( \text{Answer No. 32} \)

In warm weather, it makes no difference when water is added. In freezing weather, it should be added just before using the car. The reason is that water will remain on top of the solution until it is mixed with it by action of the battery. If not mixed with the solution, it would freeze almost as quickly as outside the battery.

**CLEANLINESS**

Why must the filling plugs be kept tight? \( \text{Answer No. 33} \)

When the battery is in service, the filling plugs must be kept tight, so as to avoid spraying out the solution. Answer No. 12 explains this point.

Is it important to keep the battery dry and clean? \( \text{Answer No. 34} \)

It is very important. Dampness or dirt on the battery permits the electric current to leak away and attracts and holds small quantities of battery solution which in time accumulate sufficiently to corrode terminals and rot the wood case.

If a battery has become wet, before drying it, go over it with a rag dampened with ammonia or soda solution. This will counteract the effect of battery solution.

What about the connections? \( \text{Answer No. 35} \)

Battery connections are made of metal parts, heavily coated with lead to prevent exposure to corrosion. If the coated metal becomes exposed, corrosion may appear. If corrosion should appear, it should be promptly removed and the parts thoroughly cleaned with weak ammonia. Then apply vaseline. Also, be sure the connections are kept tight.

**HYDROMETER READINGS**

Why do hydrometer readings indicate the condition of a battery? \( \text{Answer No. 36} \)

When current is taken from a battery, a certain part of the solution combines with the plates, leaving the solution weaker. When current is put back into the battery, this is returned to the solution, strengthening it again. A measurement of the strength of the solution, therefore, will indicate the condition of the battery, because when the battery is fully charged the solution will be strong and when it is discharged the solution will be weak.

How should hydrometer readings be taken? \( \text{Answer No. 37} \)

Hydrometer readings are taken with an instrument called a “hydrometer syringe” (fig. 15) by inserting the end of the syringe in a filling tube (fig. 18) and drawing up enough solution to float the glass bulb inside the instrument. The reading of the scale at the surface of the liquid (figs. 19 and 20) gives the strength of the solution.

When should hydrometer readings be taken? \( \text{Answer No. 38} \)

Hydrometer readings should be taken at least every month and may be taken at any time except in the interval between adding water and operating the battery. During this interval the water just added has not been mixed with the solution and the hydrometer reading would show but little more than the strength of this water.
Could hydrometer readings give false indications?  

Answer No. 39

Yes; if acid has been added instead of water, it would have strengthened the solution, and a hydrometer reading might incorrectly indicate the battery to be fully charged. A low indication would be shown if the solution had been spilled and spillage replaced with water.

The way to correct false indications of hydrometer readings is to give the battery a bench charge until the hydrometer readings will go no higher and then adjust the strength of the solution to the proper gravity.

**BENCH CHARGING**

What is a bench charge?  

Answer No. 40

A bench charge is a method of restoring energy to the battery from a source outside of the car.

When is a bench charge necessary?  

Answer No. 41

If the car is not equipped with an electric starter, a bench charge will be required periodically, depending on how often and how long the lighting and ignition systems have been used.

If the car is equipped with an electric starter, a bench charge will be necessary only in case of trouble.

How should a bench charge be given?  

Answer No. 42

1. Use direct current only, never alternating.
2. Connect the battery correctly to the charging source, the positive battery terminal to the positive charging wire and the negative battery terminal to the negative charging wire. The positive battery terminal is marked +; the negative is marked —.
3. Limit the charging current to 6 amperes by connecting suitable resistance (Answer No. 57) in series with the battery.
4. Remove filling plugs and add distilled or other “pure” water until the level reaches the bottom of the filling tubes. (Fig. 1.)
5. Charge at 6 amperes rate until all cells are gassing or bubbling freely and evenly and until the hydrometer reading of every cell goes as high as it will. Then charge five hours longer.
6. If, on charge, the hydrometer reading of any cell continues to rise above 1.310 [1.240*], dump the solution, refill with “pure” water and continue to charge at about two-thirds of above rate until the hydrometer reading of every cell goes as high as it will. Then charge ten hours longer.
7. Keep temperature of solution below 110 [125*] degrees Fahrenheit, interrupting charge if necessary.
8. After charge is complete, adjust strength of solution to between 1.270 and 1.300 [1.200* and 1.230*] as explained in Answer No. 43.
9. Just before putting the battery back into service make the high rate discharge test. (Answer No. 91.)
10. How should the strength of solution be adjusted?  

Answer No. 43

It will be unnecessary to adjust the strength of the solution except in the cases called for in this Manual; otherwise harm may result.

To adjust the strength to between 1.270 and 1.300 [1.200* and 1.230*], the simplest procedure is as follows:

1. Be sure the battery is completely charged.
2. Have ready some electrolyte with a strength of 1.285 [1.215*]. This may be prepared as outlined in Answer No. 18.
3. Dump the solution out of the cells and at once fill the cells with the prepared electrolyte. Do not allow the battery to remain empty.
4. Charge for an hour at 4 amperes.
5. If the hydrometer reading is still below 1.270 [1.200*], or above 1.300 [1.230*], adjust again until it is between these limits.

*The reading in brackets applies to batteries used in tropical climates. (Ans. No. 19.)
When charging batteries in series, what precautions are necessary? Answer No. 44

When charging batteries make sure that the positive wire of the charging outfit is connected to the positive (+) terminal of the battery and the negative wire is connected to the negative (−) terminal of the battery. (fig. 21)

![Fig. 21](image)

It is very important that the wires on the charging outfit be properly connected to the battery, otherwise the plates will be injured by the reversed polarity.

FREETING BATTERIES

Can a battery freeze? Answer No. 45

The freezing point of the battery solution depends upon its strength. Fig. 22 gives the freezing points at various strengths. For example, a solution with a strength or specific gravity of 1.250 will not freeze until the extremely cold temperature of 62 degrees Fahrenheit below zero is reached. A strength of 1.150 will freeze at 5 degrees above zero, so it will be seen there is little danger of freezing except with a completely discharged battery. Moreover, at these freezing points, the solution is slushy and does not become hard until the temperature goes still lower.

If water is added to a battery in freezing weather and then not stirred in with the solution by charging the battery, it will remain on top of the solution and may freeze. It is to avoid this possibility that warning is given not to add water in cold weather until just before running the car.

*The reading in brackets applies to batteries used in tropical climates. (Ans. No. 19.)
**Batteries in Storage**

When is it necessary to put batteries into storage?  
*Answer No. 46*

1. When a car is to stand idle for a considerable period.
2. When a car is laid up for the winter.
3. When batteries are kept in stock.

Should it be “dry” storage or “wet” storage?  
*Answer No. 47*

That depends on the condition of the battery.

Any battery which is to be out of commission should, if possible, be put into “wet storage,” providing it will not soon require dismantling, in which case it should be put into “dry storage.”

“Dry” storage requires no attention during the storage period. The battery must, however, be dismantled and reassembled, and if its condition is such that this will soon be required anyway, dry storage is obviously the better method.

How should a battery be put into “dry” storage?  
*Answer No. 48*

1. Provide a dry place for storage, free from dust.
2. Have on hand enough “pure” water to fill all the cells.
3. Empty the battery solution by tilting and turning over the battery and immediately replace the solution with the water.
4. Allow the battery to stand filled with water for approximately ten to fifteen hours.
5. Give the battery a charge, as outlined in the first five items of Answer No. 90.
6. Unseal the cells and pull out of the jars the elements complete with covers, that is, without removing sealing nuts.
7. Remove the separators.
8. Wash the plates by dipping them several times in water.
9. Replace the separators, using new ones. Be sure these are thoroughly saturated (Answer No. 75).
10. Pour the water out of the jars.
11. Put the elements back into the jars and reseal before the negatives dry out.

How should a battery be put into wet storage?  
*Answer No. 49*

1. Provide a bench or shelf in a convenient location and of sufficient size to allow a little air space all around each battery.
2. Place the batteries upon wood strips, in order to keep the bottom of the batteries clear of the bench.
3. Install the necessary wiring, switches and charging resistance, so that batteries can be easily connected up and charged where they stand on the bench.
4. Apply vaseline freely to battery terminals and to exposed copper wires.
5. Batteries may be kept in wet storage by means of either the “trickle charge” or “periodic charge” method.

What is the “trickle charge” method?  
*Answer No. 50*

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, which is so low that gassing is avoided and yet gives enough charge to maintain the batteries in good condition. This charge is termed a “trickle charge,” and in many cases will be found more convenient to arrange for than the “periodic charge.” It has the added advantage of keeping the batteries in condition for putting into use at any time on short notice.
How is the “trickle charge” method applied?  

Answer No. 51

1. Give a bench charge.

2. Connect a tungsten lamp or lamps of appropriate resistance, in series with the cells, across a charging system adapted for continuous charging. Fig. 23 gives an example of connections for “trickle charge,” and the table below gives lamp resistances to provide proper rates for various numbers of cells. (If it is impossible to use the lamps shown in the table, the trickle current should be checked with a low-reading ammeter which has just been calibrated. If this is not done and the ammeter is in error as little as one-fifth of an amperes, which is often the case, the current actually flowing may be sufficient to damage the battery.)

3. Every two months remove filling plugs, add water to bottom of filling tubes, replace and tighten filling plugs and continue “trickle charge.”

Batteries in Storage

Tungsten Lamps for “Trickle Charge”

Lamps rated at 110 volts. Combinations given are to be used in series with batteries across a bus of 105 to 115 volts.

<table>
<thead>
<tr>
<th>Approximate Current 0.10 Amperes</th>
<th>No. cells</th>
<th>25-Watt lamps in series</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3</td>
<td>3</td>
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<tr>
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<td>1</td>
</tr>
<tr>
<td></td>
<td>45</td>
<td>2</td>
</tr>
</tbody>
</table>

What is the “periodic charge” method?  

Answer No. 52

This is a method of wet storage in which the batteries are given charges periodically, and is used where it is not practicable to arrange for the “trickle charge” method.

How is the “periodic charge” method applied?  

Answer No. 53

1. Give a bench charge.
2. Store in a dry, clean location and keep the temperature above freezing and below 110 degrees Fahrenheit.
3. Once every month remove filling plugs, add distilled or other “pure” water to the proper level (fig. 1), replace and tighten filling plugs and charge for five hours at 6 amperes.
4. Before putting battery into service, add “pure” water and give a bench charge.

Charging Equipment

Must alternating current be changed to direct current?  

Answer No. 54

Yes, by means of suitable apparatus. For this purpose, a motor generator set can be used. The size and type depend upon individual conditions. In any case, the manufacturer will want to know:

1. The voltage of the alternating current.
2. Its frequency (cycles per second).
3. Whether it is single-phase or three-phase.
4. The number of 6-volt batteries to be charged at one time.
5. The desired line voltage for charging.
6. The lowest and highest current rate desired.
How can positive of charging circuit be distinguished from negative?  

**Answer No. 55**

1st Method. By a direct current voltmeter. The positive of the meter is marked +. When this is connected to the positive of the circuit and a wire from the negative of the meter is momentarily touched to the negative of circuit, the meter hand will swing in the proper direction. If reversed, the hand will tend to go backward. Be sure the wire is touched only momentarily, because if a reversed connection is not broken instantly, the meter hand may be bent.

2nd Method. Dip the ends of two wires, one from each side of the circuit, into a glass of water into which a teaspoonful of salt has been dissolved, but do not allow the ends of the wires to touch. Fine bubbles of colorless gas will be given off the negative wire.

What is charging resistance?  

**Answer No. 56**

Charging resistance is suitable apparatus inserted in a circuit to retard the flow of current. By varying the resistance, the current can be regulated.

What kind of charging resistance is recommended?  

**Answer No. 57**

The resistance to use depends upon the conditions.

If only one battery is to be charged from a direct current circuit; the most convenient resistance is a combination of lamps of proper size and rating. Fig. 24 shows this arrangement for charging from a 110-volt circuit, the lamps being carbon filament lamps rated at 110 volts and 32 candle power. As shown, they are arranged in parallel with each other and the combination is in series with the battery. With this arrangement, each lamp will allow 1 ampere of charging current to pass through the battery, so that the number of lamps will depend upon the charge rate of the battery. The figure shows six lamps, which will, therefore, allow 6 amperes to flow, suitable for a 13 plate cell.

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.

If 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 or 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.

Is charging resistance always necessary?  

**Answer No. 58**

Yes, except where the voltage of the charging mains is exactly the voltage required to charge the battery or batteries. Within certain limits, a motor generator set can be regulated to deliver the voltage required. Where much charging is done, a motor generator set is more economical in operation than a charging resistance. When inquiring about a motor generator, give:

1. The number of cells to be charged.
2. The highest and lowest charging rate.
3. The voltage of the supply mains. If this is alternating current, give, in addition,
4. The frequency in cycles per second and
5. Whether it is single-phase or three-phase.
Necessary Tools and Equipment for Repairing Ford Batteries

What tools, equipment and spare parts are necessary? Answer No. 59

For the guidance of dealers, we are listing battery repair equipment it will be necessary to procure in order to properly service batteries. The first list represents necessary equipment for those dealers whose battery charging requirements will not exceed 20 batteries at one time. Dealers whose battery charging requirements will exceed this amount should procure the equipment shown in the second list. In deciding which list of material will meet their requirements, dealers should not base their decisions solely upon the amount of battery repair work they are performing at present but should endeavor as far as possible to anticipate their future requirements, as this class of work is bound to increase, and there is no reason why a profitable battery repair business cannot be built up by every dealer.

With the exception of the first four items, which we will briefly describe, the balance of the material shown on these lists can be procured from any Battery Supply House.

The battery rectifier, mentioned in the first list, is the type of outfit generally used for recharging a limited number of batteries. This device is capable of charging ten batteries at a time and this amount can be increased up to twenty batteries by connecting another rectifier.

When more than twenty batteries are to be charged at one time, the motor generator charging outfit, mentioned in the second list, should be used.

A high rate tester is used for testing a battery without the battery being disconnected or removed from car. Each cell of the battery can also be tested separately and it is clearly shown whether the trouble is due to lack of charge or due to a defective cell.

It is also essential to have a low reading portable voltmete r .02-0-2.8 for reading battery and cell voltage.
**List No. 1—Continued**

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
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<tr>
<td>12</td>
<td>Finger cots</td>
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<tr>
<td>2</td>
<td>Battery fillers</td>
</tr>
<tr>
<td>1</td>
<td>Wire brush</td>
</tr>
<tr>
<td>1</td>
<td>Burning rack</td>
</tr>
<tr>
<td>1</td>
<td>Reliable battery filler</td>
</tr>
<tr>
<td>2</td>
<td>Single burner gas plates</td>
</tr>
<tr>
<td>5</td>
<td>Lbs. wire solder</td>
</tr>
<tr>
<td>1</td>
<td>Lead strip mould</td>
</tr>
<tr>
<td>1</td>
<td>Lead scraper</td>
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<tr>
<td>1</td>
<td>5&quot; swivel vise</td>
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<tr>
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<td>End cutters</td>
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<td>10&quot; hack saw</td>
</tr>
<tr>
<td>1</td>
<td>8 oz. ball peen hammer</td>
</tr>
<tr>
<td>1</td>
<td>1/8&quot; center punch</td>
</tr>
<tr>
<td>1</td>
<td>Set steel letter punches</td>
</tr>
<tr>
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<td>1 1/4&quot; putty knives</td>
</tr>
<tr>
<td>2</td>
<td>5 gal. crooks</td>
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<tr>
<td>2</td>
<td>14&quot; gas pliers</td>
</tr>
<tr>
<td>2</td>
<td>Pr. 6&quot; gas pliers</td>
</tr>
<tr>
<td>1</td>
<td>Brace</td>
</tr>
<tr>
<td>1</td>
<td>5/8&quot; drill</td>
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</tbody>
</table>

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

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**List No. 2**

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
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<tbody>
<tr>
<td>1</td>
<td>Motor generator charging outfit</td>
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<tr>
<td>1</td>
<td>High rate tester</td>
</tr>
<tr>
<td>1</td>
<td>Voltmeter .02-0.2.8</td>
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<tr>
<td>2</td>
<td>Sealing nut wrenches</td>
</tr>
<tr>
<td>1</td>
<td>Lead burning outfit</td>
</tr>
<tr>
<td>2</td>
<td>Thermometers</td>
</tr>
<tr>
<td>2</td>
<td>Pyrometers</td>
</tr>
<tr>
<td>20</td>
<td>Lbs. sealing compound</td>
</tr>
<tr>
<td>20</td>
<td>Lbs. burning lead</td>
</tr>
<tr>
<td>1</td>
<td>Gal. battery paint</td>
</tr>
<tr>
<td>1</td>
<td>Set post builders</td>
</tr>
<tr>
<td>1</td>
<td>6&quot; melting pot for lead</td>
</tr>
<tr>
<td>1</td>
<td>4&quot; lead ladle</td>
</tr>
<tr>
<td>2</td>
<td>Service kit boxes</td>
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<tr>
<td>2</td>
<td>Terminal reamers</td>
</tr>
<tr>
<td>1</td>
<td>Pr. cell pullers</td>
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<tr>
<td>1</td>
<td>Separator trimmer</td>
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<tr>
<td>1</td>
<td>8 oz. syringe</td>
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<tr>
<td>1</td>
<td>Post shaper set</td>
</tr>
<tr>
<td>2</td>
<td>Wire brushes</td>
</tr>
<tr>
<td>2</td>
<td>Battery carriers</td>
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<tr>
<td>1</td>
<td>Plate press</td>
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<td>12</td>
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</table>

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**Ford Battery Manual**

**REPAIRING BATTERIES**

1. Sealing compound for resealing cells. (Ford Number M-6022)*
2. Burning strip for lead burning. (Ford Number M-1513)*
3. Electrolyte for replacing actual spillage or loss and never for normal operation. (Ford Number M-1051)*
4. Acid-resisting paint for painting cases.
5. Pure vaseline for terminals to prevent corrosion.

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**LEAD BURNING**

**What is lead burning?**

**Answer No. 60**

Lead joints in a battery 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 a burning outfit.

**What is best lead burning outfit?**

**Answer No. 61**

For a repair station, the use of gas is recommended. Where burning must be done on a job away from the station, the carbondioxide burning outfit is recommended because it is easy to carry.

**What is the best gas for lead burning?**

**Answer No. 62**

There are various good combinations, and the deciding factor is usually the relative cost and availability of the different gases in the particular location in question. Good combinations are:

1. Air and artificial illuminating gas.
2. Air and hydrogen.
3. Oxygen and artificial illuminating gas.
4. Oxygen and natural illuminating gas.
5. Oxygen and acetylene.

Both gases must be under some pressure, the amount depending on the combination used and the distance of the source of supply from the work. Air, oxygen, acetylene and hydrogen may be supplied in separate tanks under pressure.

In all cases, a mixing Y or chamber of some sort must be used, together with a burning tip and sufficient hose to connect the

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*Procurable at nearest Ford Branch.
various parts. Where oxygen is employed, the mixing should be done right at the burning tip, in which case the mixing chamber and burning tip are combined into one piece. The use of oxygen also requires a special valve.

When is the Lead Burning Outfit used?

**Answer No. 63**

Whenever a battery becomes discharged, and is removed from a car and taken into the service department, it is first given a preliminary test and inspection. Then it is placed on the charging rack and connected into the low voltage circuit. Electric current measuring instruments soon show whether or not the battery is properly absorbing the electric current. Very frequently a battery does not take the charge, and it becomes necessary to disassemble it, in order to determine the cause of the trouble.

The lead burning outfit is then used to soften the sealing compound so that the battery jars, plates and separators can be removed. Inspection of these parts shows immediately the reason for the failure to take the charge. Possibly new separators or even new battery plates are required. If new plates are assembled into the battery, the lead burning outfit immediately comes into use, for the reason that these new plates must be burned or welded to the so-called group strap, which like the frame of the plates, is made of lead. Lead sticks made by recasting melted lead scraps, or new lead sticks purchased from us are used as filler rod.

![Fig. 26](image)

![Fig. 27](image)

The battery posts are built up, and the cell connectors are next burned on or welded, and again in both instances the lead stick is used as filler rod. The sealing compound is then "chased" into place, and when it reaches the point of nearest solidification a second light flashing is then given the sealing compound in order to produce an even surface, and the battery is ready once again to go to the charging rack.

A small torch shown in (fig. 26) is used to mix the gases and produce the proper flame for lead burning. This blow pipe with injector type mixer permits the lead burner or operator to use very low pressure on his gases, and through its automatic action after being regulated or adjusted, permits him to continue his work uninterrupted by any attention to the blow pipe or other parts of the lead burning outfit. The gas consumption of the lead burning outfit is extremely low, ranging from two to three cu. ft. of each gas per hour on every storage battery welded.

Lead burning outfits can now be obtained at a price within the reach of every dealer. In Fig. 27 is shown a carbon lead burning outfit which can be used by dealers performing only a small amount of lead burning work. The outfit consists of the following parts: Carbon holder with %- or larger flexible cable; clamp and \( \frac{1}{4} \)" carbon rods. This outfit, however, is not recommended where considerable lead burning work is to be performed, as its only use is for rebuilding terminal posts and cell connectors. A pair of dark glasses should be used with this outfit.

Dealers desiring additional information regarding these outfits should communicate with the nearest Ford Branch.
PRECAUTIONS WHEN USING LEAD BURNING FLAMES

What precautions are advisable when using flames?  

Answer No. 64

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: Remove filler plugs and blow out all gases in the cell, then 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 (fig. 28). 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.

NECESSITY FOR REPAIRS

When are repairs required?  

Answer No. 65

1. A battery terminal or connector warmer than the others indicates a loose or poor connection, which must be repaired.

2. Broken, cracked or leaky jars must be replaced; they cannot be mended.

3. A cell leaking around cover should be resealed. The majority of so-called leaky jars are nothing more than acid syphoning out through cracked compound. Remove old compound and reseal.

4. If the cause of trouble is not apparent, take hydrometer readings and make the high rate discharge test. (Answer No. 91.) If this indicates internal trouble, take the battery or indicated cell apart and inspect it.

TAKING BATTERY APART

How are battery connections removed?  

Answer No. 66

The connectors are solid lead links (fig. 29), and may be removed by taking a \( \frac{3}{8} \) -inch drill or wood bit and boring the connectors \( \frac{1}{4} \) inch deep centrally over each post (fig. 30). 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.
What is necessary before unsealing cells?  
Answer No. 67

Clean any dirt or lead from the top of the battery, taking care that none gets inside the cells.

How are cells unsealed?  
Answer No. 68

1. Remove the filling plugs and gently blow into the filling tubes to remove any gas which may be there and which might ignite later when a flame is brought close. Hand bellows are convenient for this purpose.
2. These cells have the single flange type of cover, which 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 $\frac{1}{4}$ inch for sealing. To unseal, it is not necessary to remove the cell from the case. Heat a thin-bladed knife, such as a putty knife, 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 cover attached can be pulled from the jar. (Answer No. 69.)

How are elements removed from cells?  
Answer No. 69

1. Remove the connections. (Answer No. 66.)
2. Unseal the cell. (Answer No. 68.) It is unnecessary to remove cover from element, although this may be done.
3. Take hold of the two posts with gas pliers and pull the element from the jar. If it should stick, pull the jar along with it and place the cell in very hot water to within an inch or so of the top of the jar. This will soften the rubber and permit the element to be pulled out.
4. Before pulling all the way out, let the element rest a few minutes on the top of the jar at an angle so that the battery solution may drain back.
5. If element is to be used again, place in water or battery solution until ready to use. This prevents the negative plates from drying out and will save considerable time during the charge following reassembly.

How are jars removed from case?  
Answer No. 70

1. Remove the connections. (Answer No. 66.)
2. Note at which corners of the case the battery terminals are placed, so that they will not be put at the wrong place upon reassembling.
3. Unseal the cells. (Answer No. 68.)
4. Remove the elements. (Answer No. 69.)
5. Heat a thin-bladed knife, such as a putty knife and work it down all around the outside of a jar.
6. Lift out the jars. If they stick, empty the solution and fill the cells with very hot water, allowing them to stand a few minutes. Then pull them out with pliers.

How are covers removed from cells?  
Answer No. 71

1. Remove the connections. (Answer No. 66.)
2. Remove the sealing nuts by unscrewing them with the special wrench (fig. 25) designed for the purpose.
3. Unseal the cells as outlined in Answer No. 68 and pull off the covers.

How are elements taken apart?  
Answer No. 72

1. Cover must be removed.
2. Lay the element down with plates on edge.
3. Slightly spread the plates and withdraw the separators one at a time, first separating them from the negative plates by running a thin-bladed knife between.
4. The positive and negative groups can then be separated from each other.
5. If negative plates are to be used again, do not let them dry, but place the group in water or battery solution. This will save time in the length of charge after reassembling.
**NEW PARTS**

**When are new positive plates necessary?**  
*Answer No. 73*

The positive plates should be examined particularly for washing out of material and buckling (warping). If the plates are buckled so much that the element will not go back into the jar, the positives should be discarded. If the plates are only slightly buckled, they can be replaced as they are, since this generally does no harm.

Positive plates are sometimes considered at fault if the cell will not take a charge or show capacity, especially if they seem to be hard. This condition is usually due to new separators which have not been allowed to become saturated with electrolyte before starting the first charge.

**When are new negative plates necessary?**  
*Answer No. 74*

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 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 may be 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 made complete.

**REPAIRING BATTERIES**

**When are new separators necessary?**  
*Answer No. 75*

Unless a battery is 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 battery solution or distilled water.

New separators may be dark, light, hard or soft, according to the kind of wood used. However, none of these qualities affect the value of a separator, which depends on its having been selected and treated properly, so as to have correct porosity and ability to withstand the chemical action of plates and electrolyte.

**What about sediment?**  
*Answer No. 76*

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.

**May the battery solution be used over?**  
*Answer No. 77*

Sometimes impurities get into the solution 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.

When the positive plates are badly disintegrated, it is often 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.
When should a new case be provided? **Answer No. 78**

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-resisting paint.

**ASSEMBLING BATTERY**

How are elements assembled? **Answer No. 79**

1. Slip the positive and negative groups together without the separators.
2. Replace the covers. (Answer No. 80.)
3. Insert the separators. (Answer No. 81.)

How are covers replaced? **Answer No. 80**

1. Heat cover with torch, this makes them somewhat pliable.
2. Wipe the posts with a piece of waste moistened with ammonia, rinse with water and dry thoroughly with clean waste.
3. Place the cover in position, being sure not to omit the soft rubber washers under the cover.
4. Lubricate the sealing nuts with a little graphite mixed to a paste with water; but never use grease or vaseline.
5. Put on the sealing nuts and tighten them, using the special wrench (fig. 25).

How are separators inserted? **Answer No. 81**

1. Place the groups on edge (fig. 32) and insert the separators from the bottom, one at a time. One separator goes between each positive and negative plate with the flat side of the separator against the negative plate. Separators should be so placed that the grooves will be vertical and not crosswise when the element is in the jar.
2. When all the separators are in place, count them to be sure that none are missing.
3. Stand the element up and tap the edges of the wood separators with a wood block until they project equally on each side of the plates.
4. Tighten up the sealing nuts, using the special wrench (fig. 25).

How are elements replaced in jars? **Answer No. 82**

1. Heat jars with torch, this makes them somewhat pliable and less likely to crack under stress.
2. Grip the element near the bottom, in order to keep the plates from flaring out. Take care not to let the outside plates start down over the outside of the jar.
3. The element should fit snugly in the jar. If it does not, place one or more wood separators between the end plates and the jar, taking care that such separators are cut \( \frac{1}{2} \) inch...
narrower than the plate, so as not to throw extra strain on the corners of the jar. The ribs of the separators should go against the jar. Do not, however, crowd the jar so that it bulges.

4. Tighten the sealing nuts again and then lock them. (Answer No. 83.)

How are sealing nuts locked? Answer No. 83
The thread of the post extends slightly above the sealing nut. When the nuts are tight, take a center punch or sharp nail and carefully drive it on the thread in a few spots about each nut, this will slightly upset the thread on the post and prevent the nut from coming loose.

How are the cells sealed? Answer No. 84
If a battery is not sealed properly, it will not give the satisfaction it should. Electrolyte will seep out and shorten the life of the wood trays. Grounds may result, putting an unnecessary drain on the battery. One cell may leak and the others not, ultimately resulting in the cell going back.

To insure good sealing, (1) the jar and cover surfaces must be right and (2) the compound must be applied properly.

1. To have the surfaces right:
   a. Scrape off any old compound or foreign material that may be on the surfaces.
   b. Kill any acid on the surfaces. Sealing compound will never stick where there is any acid, no matter how weak the acid. To kill the acid, wash with strong ammonia and then in turn remove this with water on a rag.
   c. Remove any grease, vaseline or paraffin that may be on the surfaces. Some may have gotten on from the hands while fitting the cover. Gasoline or benzine is suitable for this purpose; kerosene is not.

2. The proper method of applying the compound:
   a. Heat the compound slowly, until just thin enough to pour. Do not drive off part of it as vapor by applying too much heat.
   b. Dry and heat the surfaces to be sealed with a soft burning flame. (Be careful not to burn the rubber nor to deposit any soot).
   c. While jar and cover are warm pour in the compound to one-third the depth. Compound must not be lumpy.
   d. Apply the flame (with practically no oxygen turned on) to the compound until it takes hold of the rubber surfaces. This will be shown by the compound creeping up along the jar and cover to a slight extent.
   e. Then fill the grooves to the top and apply flame again until the compound takes hold of the rubber.

When should cells be filled with electrolyte? Answer No. 85
As soon as the cells are sealed, electrolyte of the proper strength should be added to keep the separators and plates from drying out.

What is the proper strength of electrolyte for filling? Answer No. 86

1. After a complete renewal of plates and separators, fill with electrolyte of 1.360 [1.260*] strength.

2. After a positive plate or separator renewal, or both, fill with “pure” water instead of electrolyte, since batteries received for repair have the plates in a more or less sulphated condition. This filling with water, together with the proper charge after repairing (Answer No. 90), is known as the “water treatment” for sulphated cells.

*The reading in brackets applies to batteries used in tropical climates. (Ans. No. 19.)
How should the filling be done?  
Answer No. 87

1. Use vessels of glass, china, earthenware, rubber or lead; never metallic vessels unless of lead.
2. Carefully pour the liquid through the filling tubes until the level rises in the tubes.

How are cells replaced in case?  
Answer No. 88

1. Be sure to put the cells into the case properly so that two positives or two negatives will not be connected together, and also so that the battery terminals will not come at the wrong corners of the case.
2. The cells should fit tight in the case; pack them in with thin boards if necessary.

How are the connections made?  
Answer No. 89

1. The cells must all be sealed and in the case.
2. Connectors must be lead burned. (Answer No. 60.)
   First see that the posts and eyes of the lead connectors are clean and bright. In all lead burning, absolutely clean surfaces are essential to good workmanship. Lead is soft and very readily cleaned with a knife, file, scraper or wire brush. Place the connectors over the posts, lightly tapping them to a firm seat. Before lead burning, blow into the filling tubes to remove any gas which may be there. Lead burn the joint by first melting the parts to be joined and fusing them together and then immediately melt in burning strip until the joint is flush. Do not melt in burning strip until the parts have fused together nor after the joint has cooled, and do not use any soldering acid or other flux. A little practice may be necessary before a good joint can be made.

What charge is required after repairing?  
Answer No. 90

1. After filling battery with electrolyte or water, as the case requires, allow battery to stand ten to fifteen hours. It is important to allow the full time for standing. Then add more electrolyte or water to restore level if it has fallen.
2. Start charging and continue at 4 amperes, until all cells are gassing or bubbling freely and evenly, and until the hydrometer and voltage readings of every cell go as high as they will. Then charge ten hours longer. Be sure to make this charge absolutely complete.
3. If the hydrometer reading of any cell continues to rise above 1.310 [1.240*], dump the solution, refill with “pure” water and continue to charge at the same rate until the hydrometer reading of every cell goes as high as it will. Then charge ten hours longer.
4. Keep temperature of solution below 110 [125*] degrees Fahrenheit, interrupting charge if necessary.
5. After charge is complete, adjust strength of solution to between 1.270 and 1.300 [1.200* and 1.230*], as explained in Answer No. 43.
6. Wipe off top and sides of battery case with rag dampened with ammonia or soda to remove any electrolyte that may have been spilled.
7. Just before putting battery into service make the high rate discharge test. (Answer No. 91.)

The High Rate Discharge Test

What about the high rate discharge test?  
Answer No. 91

The high rate discharge test is a valuable aid in determining whether batteries or individual cells require repairs or not, particularly in cases where the hydrometer readings give false indications (Answer No. 39); but it must be used in conjunction with hydrometer readings. It may be used to test both battery.
incoming and outgoing batteries, and the method of using it depends upon whether the battery is coming in or going out.

In either case, the test consists of discharging the battery at a fairly high rate and taking the voltage reading of each cell while discharging. A suitable current rate for this test is 25 amperes per positive plate for the usual types of auto starting and lighting batteries. Hold the current for about 15 seconds, and then take individual cell voltage readings. If this cell voltage drops rapidly it indicates internal trouble.

For an incoming battery, first take a hydrometer reading of each cell. If the readings are within 50 points of each other and all below 1.200 [1.130*], most likely all the battery needs is a bench charge with a possible adjustment of the strength of the solution. (Answer No. 43.) If the readings are above 1.200 [1.130*] or one cell differs from the others by 50 points or more, make the discharge test, and if the voltage readings are within 0.10 volt of each other, the battery needs a bench charge with an adjustment of the strength of the solution or else replacement of a leaky jar. If the voltage readings differ by 0.10 volt and the battery is pretty well charged, there is something internally wrong with the cell having the low reading, provided it has not been short circuited in service. It should be opened and examined. With a discharged battery, the difference in voltage will be greater, depending on the extent of discharge, and only experience can guide the battery man in drawing correct conclusions.

For an outgoing battery, just before putting it into service, make the test as a check on the internal conditions, particularly if the battery has been repaired or has stood for some time since being charged. (It is assumed that the battery has the strength of solution properly adjusted.) The battery should not show more than 0.10 volt difference between any two cells, and no cell should read less than 1.75 volts. If every cell reads below 1.75, it is probable that the battery is not completely charged. If one cell is more than 0.10 volt lower than the rest, that cell still needs attention.

Suitable commercial apparatus is on the market for making the high rate discharge test, and particulars will be gladly sent upon request.

Shipping Batteries

How should batteries be packed for domestic shipment? Answer No. 92

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

1. Procure a strong box made with steeple-shaped top (fig. 33) 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 sawdust 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 sawdust 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 “Ford 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.

How are the negative and positive groups prepared for shipment? Answer No. 93

When preparing the negative and positive groups for shipment, extreme care should be exercised to prevent breakage of the plates. A wooden box constructed of 3/8” or 7/8” lumber with a separate compartment for each group should be used. The compartment should be made approximately 4” wider and 4” deeper than the dimensions of the group, so that the group may be entirely surrounded by packing material.

Before packing the group, pieces of corrugated paper or heavy cardboard, approximately 1/8” to 3/4” thick should be inserted between the plates, extending the full length of each plate, after which the group should be wrapped in heavy paper and tied. See Figure 34.

Heavy layers of excelsior shavings at least 2” thick should be placed in each of the compartments in such a manner as to entirely surround the group. See Figure 35. A heavy layer of excelsior should be placed on top of the groups before nailing the cover on the box.

What attention is necessary when shipping rubber jars? Answer No. 94

When packing rubber jars for shipment it is important that they be placed snugly in the box to prevent any movement of the jars while in transit—Rough handling or improper packing invariably results in leaky jars.

In order to utilize space we occasionally hear of parts being placed in jars when a shipment is being prepared. This is extremely poor practice and in nearly every instance results in injury to the jars.

If the above instructions are observed considerable trouble will be avoided when shipping battery material.
Definitions and Descriptions of Terms and Parts

Acid. As used in this book refers to sulphuric acid (H\textsubscript{2}SO\textsubscript{4}), the active component of the electrolyte.

Active Material. The active portion of the battery plates; peroxide of lead on the positive 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 "alters" 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 one-half hour equals one ampere hour.

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

Bucking. 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 "Ford" automatic filling tube, this can usually occur only when a battery is charged with the filling plug out.

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.

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.

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.

Terminal Connectors. 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.

Voltage. Electrical potential or pressure, of which the volt is the unit.
## Condensed Summary of Contents

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- How is the battery used on the car?  
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