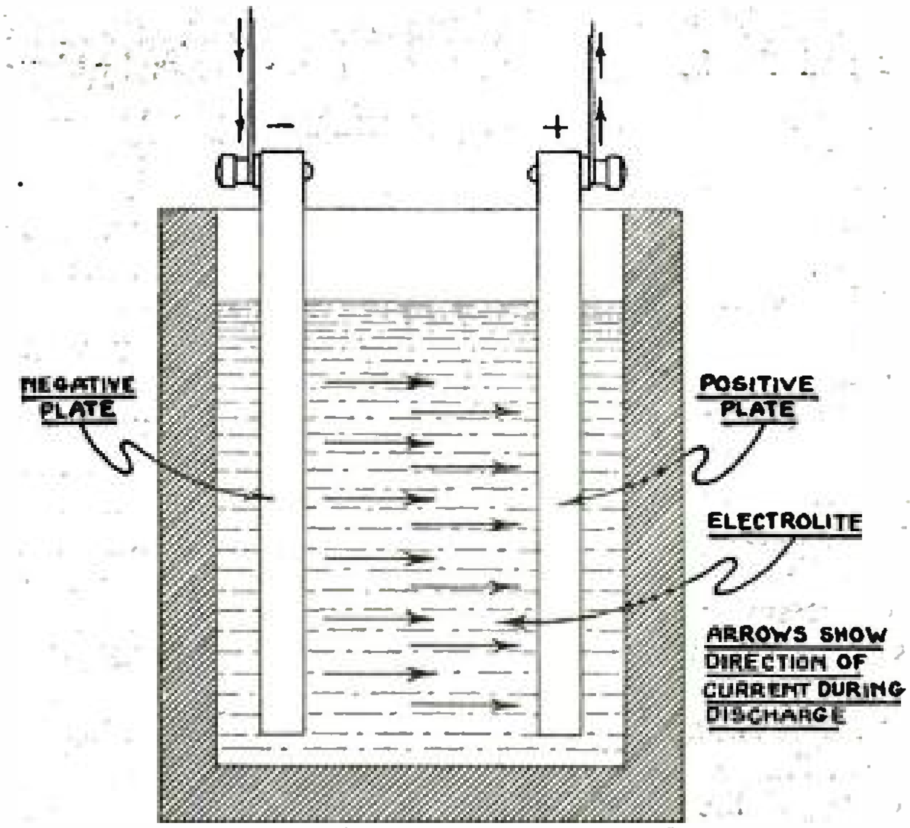


HOW A BATTERY DISCHARGES

FIGURE 1: *When a battery discharges the current flows outside the battery, through the circuit, from the positive terminal to the negative terminal. The flow inside the battery is from the negative to the positive, through the electrolyte, as indicated by the arrows.*

HOW TO MAKE A
Battery Charging Rectifier
At a Cost Ranging from $1.00 to $2.00

By ARTHUR R. NILSON

THE charging of the storage battery is a problem that has to be solved by every radio enthusiast who operates a vacuum tube set. A storage battery may well be compared to a living organism, which soon dies and must be discarded if it is neglected. On the other hand, a little regular care, water and food—which in the case of the storage battery is water and charging—prolongs its life over a long period.

When a storage battery is discharging, the acid in the electrolyte (liquid) mixes and combines with the active material of the plates. For this reason the specific gravity of the electrolyte, which depends entirely upon the ratio of acid to water, varies as the battery becomes charged and discharged. When the battery has completely discharged most of the acid has gone from the water and combined with the plates, leaving an electrolyte that consists largely of water.

When the battery is charged the reverse action takes place; the acid is driven out of the plates back into the water. If all of the acid is not thus driven out, the battery is not completely charged. If this happens a number of times the acid tends to clog up the porous active material (spongy lead) of the plates and the battery becomes sulphated.

It is seen that the route taken by the acid is either into or out of the plates and that this direction of movement is controlled by the direction in which current flows in the battery. When a battery is discharging, the direction of the internal e.m.f. between the plates is from negative to positive as shown in Figure 1, and that during charge the flow is in the opposite direction. It is necessary, therefore, that the charging current flow in one direction only; in other words, that direct current be used. An alternating current cannot be used because the direction of flow changes periodically. This is shown in the oscillogram in Figure 2.

In this diagram the electromotive force takes a positive direction for 1/120th of a second and a negative direction the next 1/120th of a second; 1/60th of a second is necessary for a complete reversal of current. Such a current is a 60-cycle current; it is the kind supplied to most lighting circuits.

If a rectifier or some other method of eliminating one direction of flow is introduced in the circuit the pulsating direct current that is shown in Figure 3 results. The lower or negative side of the curve shown by dotted lines is the flow eliminated by the rectifier.

While it is true that the rectified current does not maintain a steady value while flowing, it is uni-directional and therefore suitable for the charging of storage cells.

There are many ways of rectifying an alternating current. Some of the most commonly used and efficient pieces of apparatus are the mercury-arc lamp rectifier, the Kenotron and the Tungar rectifiers, the mechanical rectifier, and the type of rectifier to be described in this article, called the electrolytic rectifier.

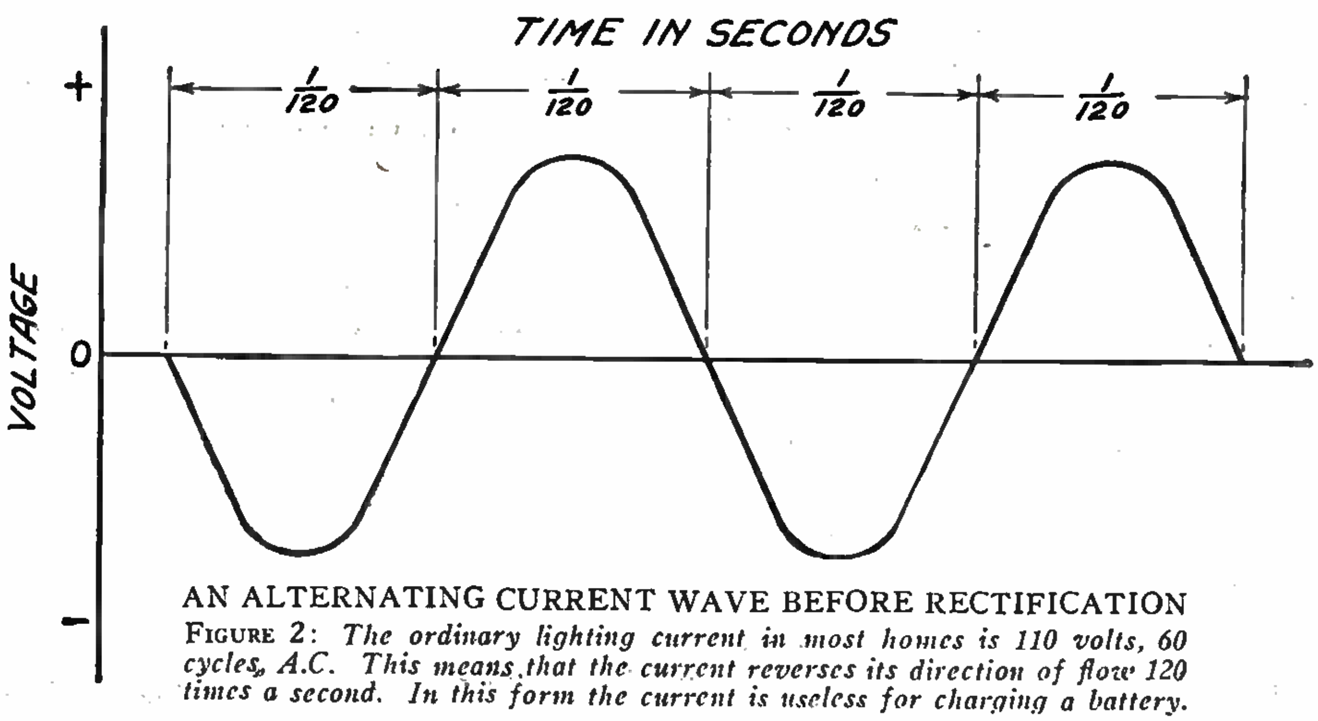
How to Build the Rectifier

The electrolytic rectifier is perhaps the one most easily made by an experimenter who has only a few tools. A photograph of the completed rectifier and resistance is shown in Figure 4. The following materials are necessary:

- 2 mason fruit jars—pint size;
- 2 strips of aluminum; size—6 inches by 1 inch by ⅛ inch;
- 2 strips of lead, size—6 inches by 1 inch by ⅛ inch thick;
- A few ounces of borax;
- 4 terminal posts.

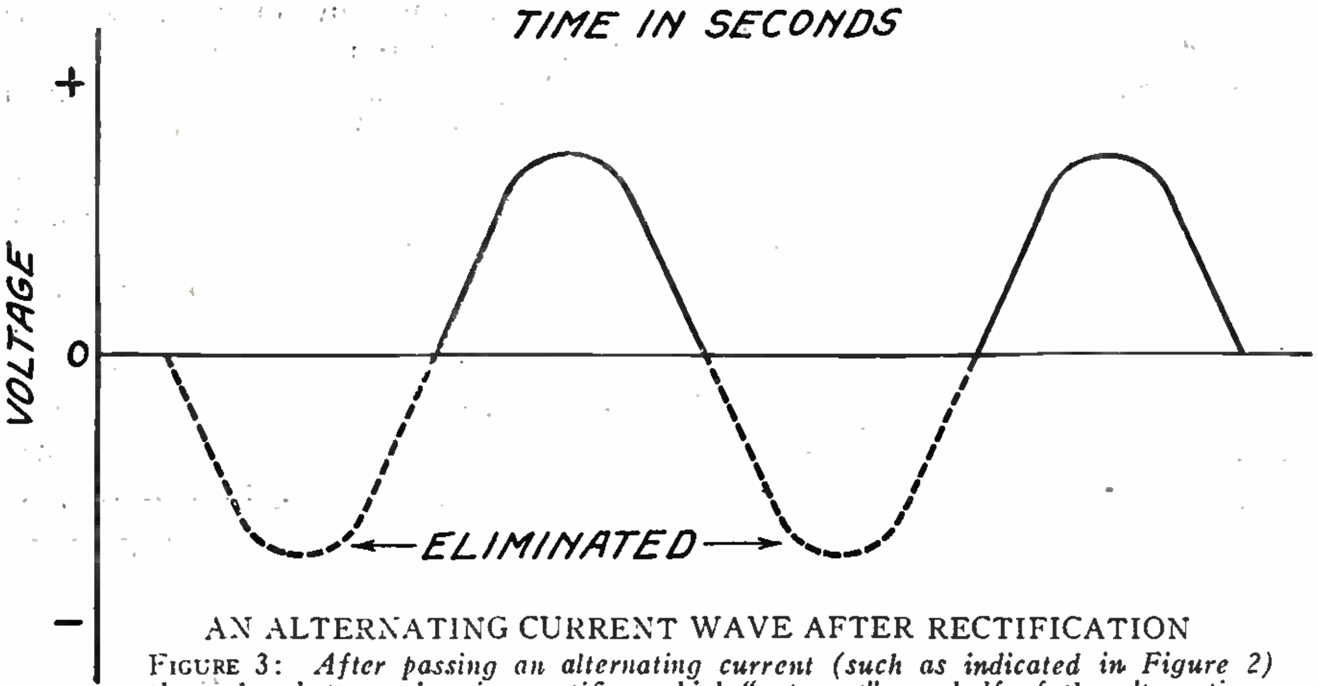
The construction is so simple that a lengthy explanation is unnecessary. A close study of the photograph will show that the two strips are bent and hung over the edge of the jar into the electrolyte.

The electrodes as noted in the list above



AN ALTERNATING CURRENT WAVE BEFORE RECTIFICATION

FIGURE 2: *The ordinary lighting current in most homes is 110 volts, 60 cycles, A.C. This means that the current reverses its direction of flow 120 times a second. In this form the current is useless for charging a battery.*



AN ALTERNATING CURRENT WAVE AFTER RECTIFICATION

FIGURE 3: *After passing an alternating current (such as indicated in Figure 2) through a battery charging rectifier, which "cuts out" one-half of the alternations, a pulsating direct current is left which can be used to charge a storage cell.*

are of lead and aluminum, cut to the sizes given in the list.

The electrolyte consists of two pints of water to which has been added about three heaping teaspoonfuls of borax. A new electrolyte should be prepared and substituted every few weeks. This is necessary because the electrolyte becomes saturated with aluminum particles which come off the positive plate and mix with the electrolyte, thereby lowering its resistance. The lead plate does not wear away.

The jars used are the pint size mason fruit jars which may be purchased in any hardware or grocery store.

The terminal posts should be one-inch round head brass machine screws with two nuts. Their size should be 8/32 or 10/32 thread.

The jars should be set into a wooden rack as shown in the photograph. A rack such as the one shown can be made of whitewood and stained any desired color.

How to Operate the Rectifier

While in operation the rectifier "boils" due to the heat produced by the current that flows through the electrolyte between the lead and aluminum electrodes. The water is therefore evaporated and it is necessary to add water to take the place of that lost by evaporation. It is not necessary to add more borax; this element does not reduce itself by evaporation.

A connecting lead-wire to hook the rectifier up to the lighting circuit is necessary. This should be as long as required and should have a screw plug fitted to one end so that it may be screwed into a light socket. Spring clips should be soldered to the other ends for clipping it onto the rectifier and resistance terminals as indicated in Figure 5.

A double-pole double-throw switch to change the battery from charge to discharge will be found convenient and may be connected as in Figure 5.

It is important that the two sets of aluminum plates and the two sets of lead plates be connected together, with the jars paralleled and also that the aluminum strip electrode of the rectifier be connected to the positive terminal of the storage battery. If the polarity is not marked on the battery it may be determined in any of the following ways:

1. Cut a potato in half, and insert the two leads from the battery; a green formation will take place around the positive terminal.
2. A direct current voltmeter will read correctly only if connected positive to positive and negative to negative. Get a reading on the voltmeter and note the markings on the connecting posts.
3. Dip the terminals of the battery into a glass of water into which a little salt has been dropped, being careful not to let them touch; bubbles will appear at the negative terminal.
4. Use a polarity indicator; this may be purchased in any electrical supply store.

The rectifier and storage battery should be installed in the cellar near the electric meter. This, of course, will necessitate running two wires up to the radio set but it removes the possibility of any of the sulphuric acid coming in contact with furniture and carpets.

If the battery is installed in any place where it may injure fabrics or furniture, it should be kept scrupulously clean. It is well, any way, to keep the lead connectors and terminals coated with vaseline. Always unscrew the caps while the battery is on charge so as to allow the gases which are generated to escape.

The generation of gas (shown by bubbling) in the electrolyte while the battery is being charged indicates that the battery is nearing the full charge point. After this has been going on for four hours it is safe to assume that the battery is fully charged.

How to Make the "Resistance"

It is necessary to insert a resistance in the line; such a resistance may be a 100-watt lamp or a water rheostat, made as shown in Figure 6.

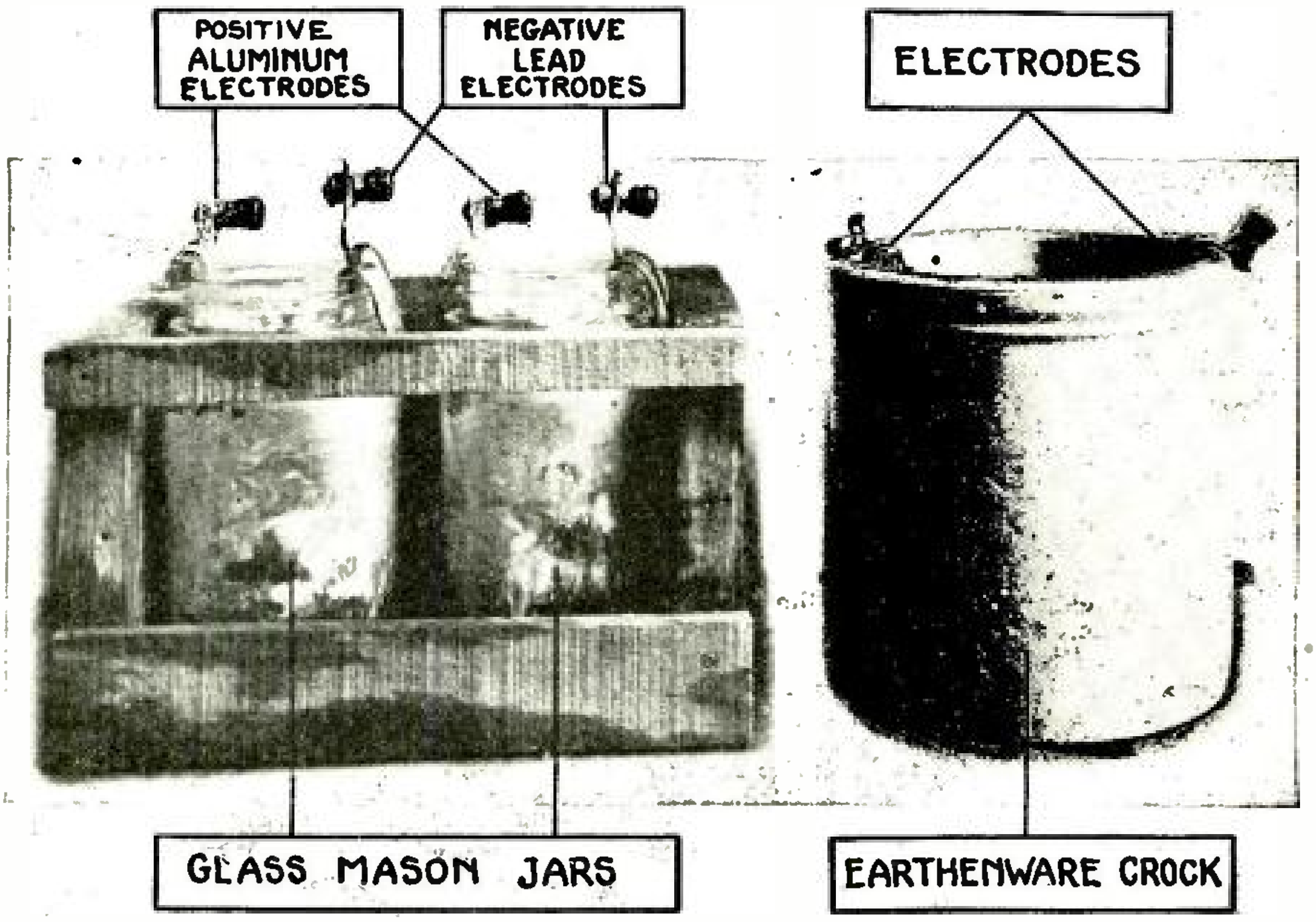
The jar for this should be 6 inches by 8 inches in size. The electrodes should be lead and carbon. Connect the lead to the negative side of the line. The electrolyte should consist of pure water to which has been added a half teaspoonful of salt.

Practical application has shown that only two rectifying jars are necessary for the ordinary 40 or 60 ampere-hour battery. If, however, a battery of larger capacity is to be charged, three jars in parallel may be used to cut down the time necessary for charging. Two jars may be used in any case, but the higher the capacity of the battery the longer the time that is necessary for charging.

Before the completed rectifier is put into use it should be connected across the lighting circuit line for several hours until the plates have taken on a crust or deposit. The plates are then said to be "formed."

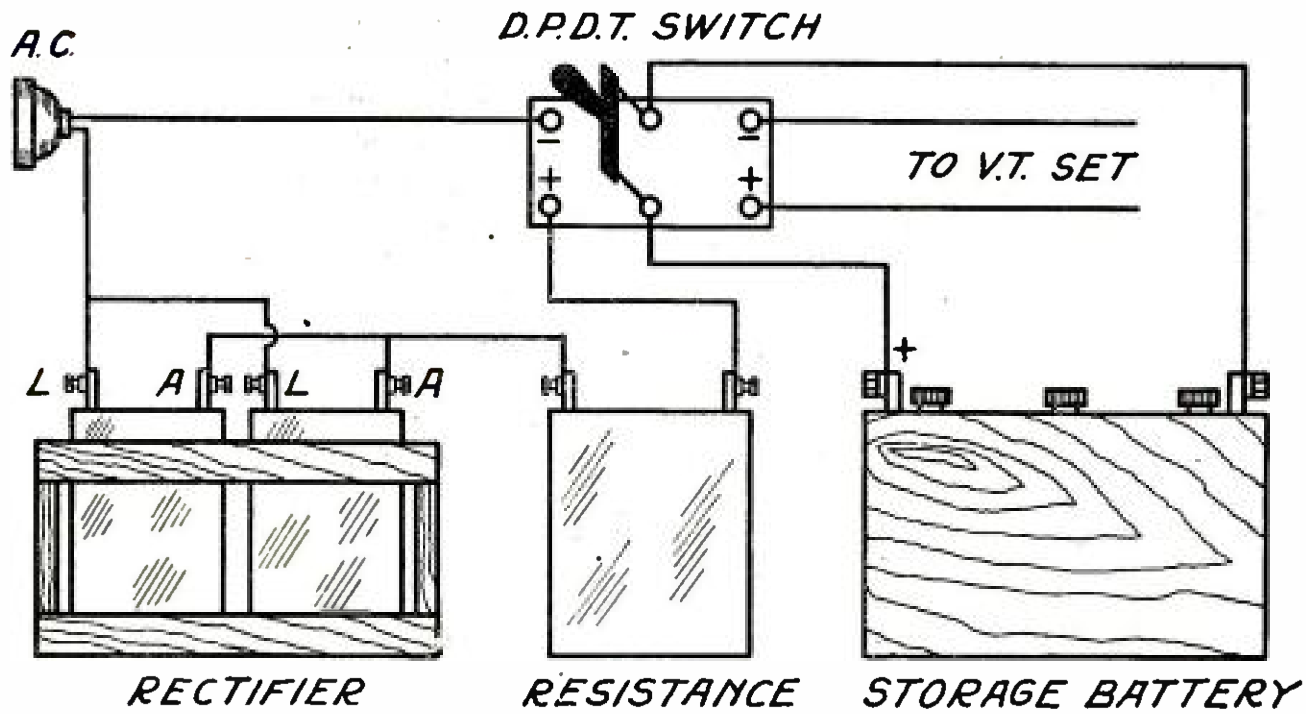
This is necessary because the rectifier, when it is first connected to an alternating current line, acts only as a resistance, and if it were connected to the battery without first having the plates formed, it would allow alternating current to flow through the battery.

In other words, the rectifying action of this type of cell depends on the chemical action which takes place in the thin crust or deposit on the aluminum plates, and if the plates are not first formed they will not rectify efficiently.



THE COMPLETED RECTIFIER AND WATER RHEOSTAT

FIGURE 4: *The rectifier jars are set up in a wooden rack, and an earthenware crock is used to hold the electrodes of the water rheostat. With these two units the radio fan may charge his own batteries at home from the A.C. lighting mains at small cost.*



HOW TO WIRE UP THE CHARGER

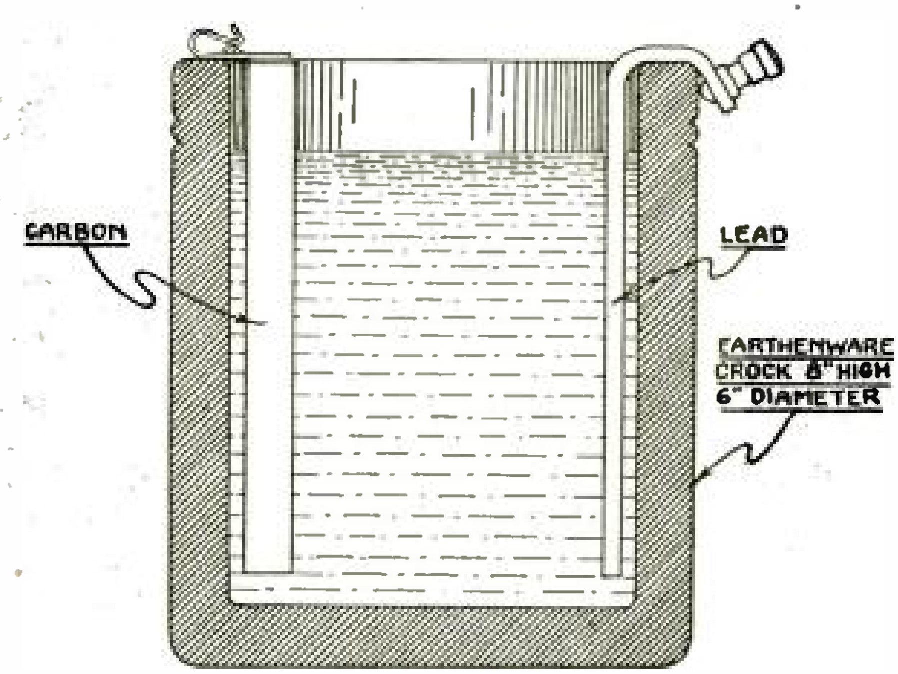
FIGURE 5: *The circuit diagram for connecting up the rectifier, the rheostat, the storage battery and the change-over switch. By throwing the switch to the left the battery is put on charge and by throwing it to the right the battery is connected to the vacuum tube receiving set.*

The only part that has to be replaced in the cell is the aluminum plate, which eats away after a period of usage.

The above type of rectifier has been used for many months by the writer, and it has given him uniformly excellent results and the cost per charge has been extremely low.

HOW THE WATER RHEOSTAT IS PUT TOGETHER

FIGURE 6: *The rheostat consists of an old earthenware crock which is filled with water to which has been added a half-teaspoonful of salt. The lead and the carbon electrodes are then immersed in the liquid on opposite sides of the crock.*



How to Build a Simple Honeycomb Receiver

In the next issue of POPULAR RADIO—for October—will appear a complete detailed description of a home-made set that may be built by any radio novice who is handy with tools at a cost of about $15.