Condensers and Liquid Rectifiers in 1923 Page 1

This first article was extracted and edited from **Australasian Wireless Review June 1923**.

The conversion of alternating currents into uni-directional current (called DC now days) of small amperage is most easily effected by means of the electrostatic converter - a combination of rectifiers and condensers.

This type of converter is so easily and cheaply constructed that it is surprising it is not more popular, especially among radio enthusiasts.

A strip of aluminium and a strip of iron are immersed in a solution of sodium phosphate and connected to an alternating current circuit, a microscopically thin film of oxide forms on the aluminium strip. This film has the peculiar property of allowing current to flow through in one direction, but not in the other direction. The current will flow from the solution through the film to the aluminium strip but not from the aluminium strip through the film to the solution. This makes the active element a simple and very reliable rectifier. (The original semiconductor diode)

Another important feature about the rectifying film is its high electrostatic capacity. The film it so thin it forms an excellent condenser dielectric, for storing up an electric charge. The capacity of one square inch of this film is about 0.09 microfarad.

A simple condenser of large capacity, that can stand up to 150 volts can be made by immersing an aluminium plate and an iron strip into a solution of sodium phosphate; the aluminium plate constitutes one side of the condenser and the electrolyte constitutes the other side. The iron strip is merely a electrical connection to the electrolyte.

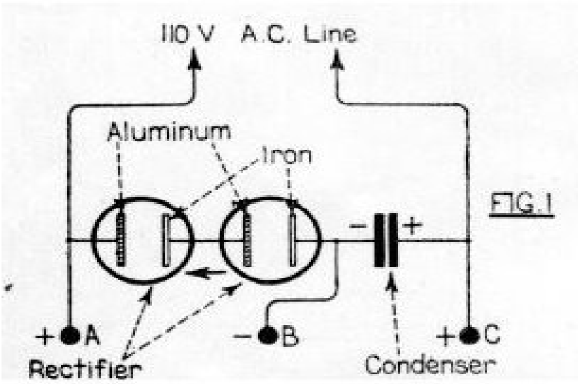
The aluminium plate of six inches by six inches the condenser will have a capacity of about 6 microfarads. The aluminium plate is connected to the positive side line, the iron strip to the negative side of the line. if used in a DC circuit. If the condenser is to connected to an alternating current line two aluminium plates are used in place of one aluminium plate and one iron strip.

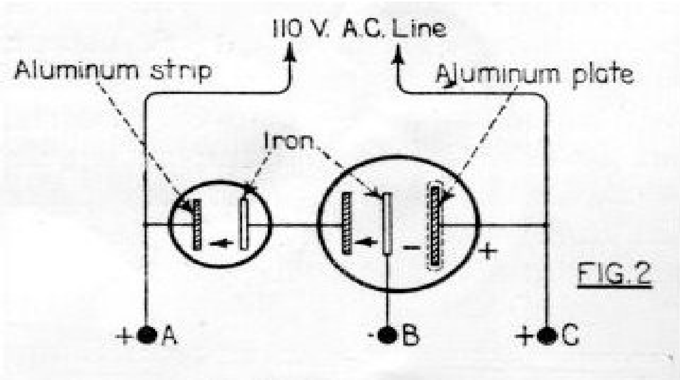
Figure one shows the simplest form of electrostatic converter. This converter consists of a rectifier and a condenser, and they are connected in series to an alternating current line, with terminals brought out at A, B and C. The direct current may be taken from either terminals A and B or terminals B and C.

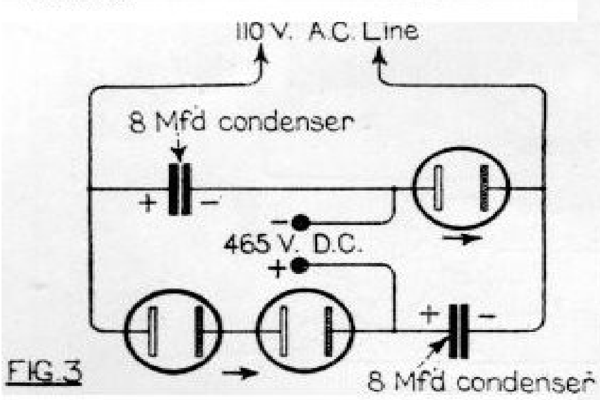
The voltage across terminals B and C is equal to maximum value of the alternating current voltage, neglecting losses; and is the capacity of the condenser is large and the amount of current withdrawn is small, the potential will be practically constant. The voltage across A and B is pulsating , the maximum value of which is is equal to twice the maximum voltage of the alternating current voltage, and the minimum is equal to zero.

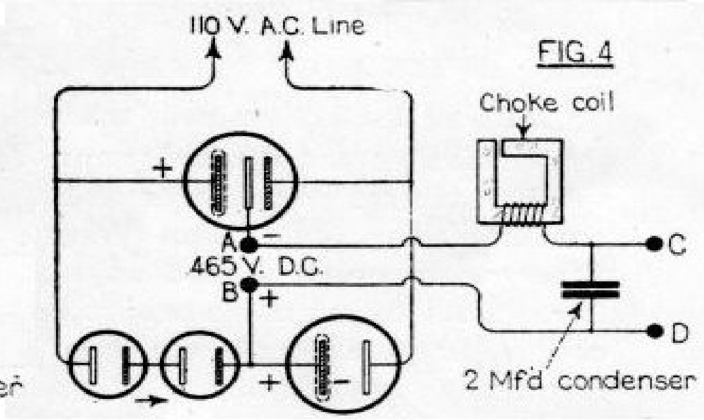
The action of this converter may be explained as follows: Suppose the converter is connected to a 110 Volt A.C. line, and the current of the first half cycle flows down the right hand wire. This will charge the condenser to the maximum value of the A.C. voltage which in the case is 110 x V2 or 155 Volts. The current of the next half cycle flows down the left hand wire, but this current cannot flow through the rectifier from the solution to the aluminium opposite the direction indicted by the arrow, so the current flows from terminal A through the external circuit to terminal B, and then through the condenser to the other side of the A.C. line.

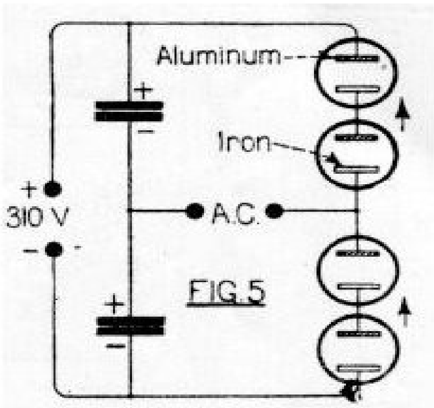
Condensers and Liquid Rectifiers in 1923 Page 2

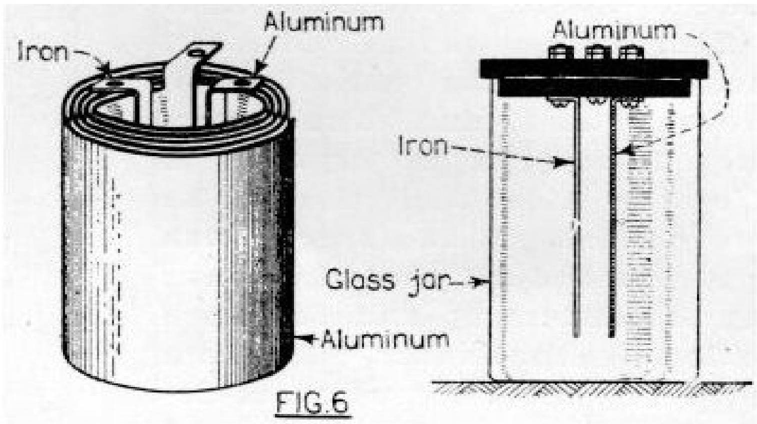












Therefore the condenser, which is charged to 155 Volt, is discharged through the external circuit in series with the A.C. line whose maximum voltage is 155, so that every other half cycle the voltage across terminals A and B is 2 x 155 or 310 Volts. The polarity of the terminals will be as indicted.

The actual D.C. voltage is about 87% of the theoretical value, the losses are due to the resistance of the electrolyte in the rectifiers and to current leakage through the rectifiers, as the oxide film is not a perfect insulator.

The aluminium and iron strips of the rectifier are each quarter inch by six inches long. The solution is made by dissolving sodium phosphate in hot water after which the solution is allowed to cool before using. The condenser should be several microfarad, two, two microfarad paper telephone condensers in parallel will be sufficient if the current withdrawn is small.

The converter is to be connected to an alternating current line in series with a 110 volt lamp. At first

Condensers and Liquid Rectifiers in 1923 Page 3

the lamp will light up brightly, and as the rectifying film forms on the aluminium electrodes the lamp will gradually go out. (The electrolytic capacitor has been "formed")

The converter shown in figure two will give the same D.C. voltage and the action is identical. The only difference is instead of using paper condensers advantage is taken of the electrostatic capacity of the rectifier itself for storing up charge. The small rectifier is made similar to the rectifiers in figure 1. The other rectifier and electrolytic condenser are made as shown in figure 6.

They consist of a strip of iron and a strip of aluminium, each quarter inch by 6 inches long, which form the rectifier, and an aluminium plate which forms one side of the condenser, the other side if which is the electrolyte.

An aluminium plate of 6 inches by 24 inches will give a capacity of about 26 microfarads. This plate may be wound in a spiral, as shown in figure 6.

The converter shown in figure 3 will give a D.C. voltage equal to three tiles the maximum value of the A.C. voltage neglecting losses. The condensers used are made from paper telephone condensers in parallel.

Figure 4 uses electrolytic condensers in place of the paper condensers and these are made in a similar way to the one in figure 2. The choke coil and paper condenser smooth out the resulting pulsations thus making the D.C. voltage constant for use in power amplifiers or radio telephone transmitting sets.

The Electrolytic Rectifier Or how to produce a low cost high voltage rectifier, 1923 style. **From The Australasian Wireless Review October 1923.**

Most experimenters have to economise in the matter of space to accommodate their various pieces of apparatus, especially when both transmitting and receiving are done. For transmitting purposes, some method of rectifying the convenient A.C. Current must be resorted to and the choice lies between tubes of the Fleming two-electrode valve and an electrolytic rectifier. The latter day two-electrode valves are known as "Kenotron" tubes, and these are now readily procurable. Two such tubes would be required and would cost five or six pounds. Further, a special transformer is necessary, one having s third winding for the filaments of the Kenotron valves, that is if the transmitting valves are to be lit from the same transformer, as well.

Without doubt, the Kenotron furnishes the most stable means of rectification, but the electrolytic rectifier is so satisfactory that it will continue to be employed by amateurs for along time to come.

Fig.1 below shows the two strips on top of each other; the dotted line is where the first bend is made. Fig.2 the first bend is ready to be flattened down with the hammer. Fig.3 the next step is the double bend over, this is also hammered down and the sides of the bends tapped down to splay the lead. Fig.4 shows the complete unit containing two rectifiers, assembles ready for use.

The electrolytic rectifier need not be an unwieldy affair, and a compact yet serviceable type will be described. This compact unit will appeal to those to who economy of space is a consideration.

A "Monopole" cigar box, made to contain 100 cigars as outside dimensions of 81/4 by 51/4 by 41/4 inches, and it makes an ideal container, when the bottom is knocked out and the top nailed up to

Condensers and Liquid Rectifiers in 1923 Page 4

form a stout bottom..
With ample provision for waxed cardboard separators between the test tubes, it will hold just 28 flat bottomed one inch test tubes, procurable from any large chemist's suppliers.

Paraffin wax should be melted in a dish on the top of a saucepan of boiling water, and the box well brushed with the molten wax inside and out. It is then put in the gas oven for a few minutes to allow the wax to permeate the wood.

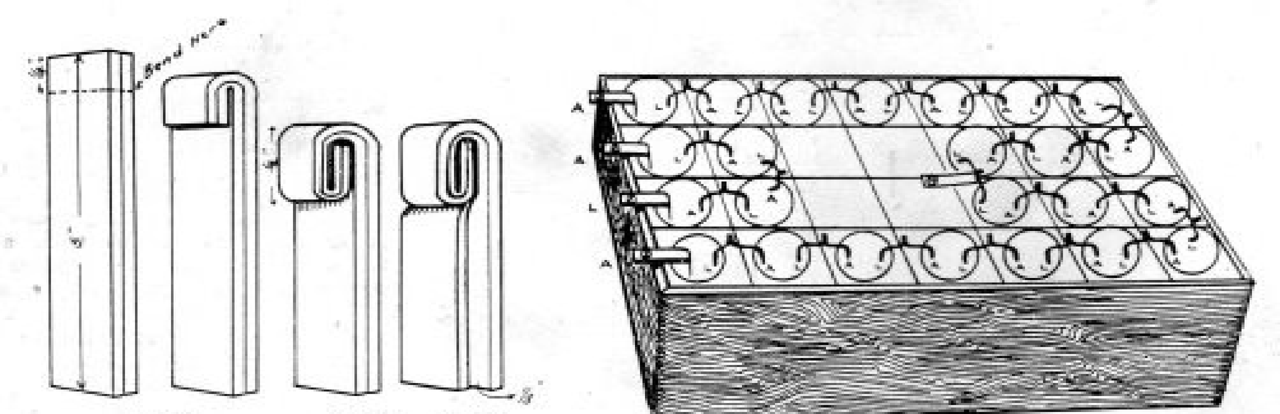


Fig 1 Fig 2 Fig 3 Fig 4

When it is cool, wax is poured in to a depth of one-eight of an inch and allowed to set. At the same time , the corners of the box are again brushed over to seal all joinings to render the container waterproof, and free from leakage. Strips of thin cardboard are cut 71/2 by 4 inch, three will be required. Starting one inch from one end, a slot is cut at each inch distance until six slots have been made, the slots to be just half the width of the cardboard strips.

Six other strips, 41/4 by 4 inches are cut and similarly slotted. The whole is then immersed in paraffin wax and allowed to drain. When set the long and short strips are connected together to form one inch squares, by means of the slots. Two dozen one inch flat bottomed test tubes complete the containing element.

Aluminum of number No 18 or 20 gauge and lead of 1/16th inch will be required for the electrodes. The aluminum and lead are cut into half inch strips with a pair of plumber's snips. The strips require to be five inches in length.

Assuming the middle tap of the transformer gives a potential of 500 volts (1000 volt on the outside terminals), ten cells will be used on each side of the line, as about 50 volts are all that each cell can take care of properly. For ten cells in each line, eighteen aluminum-lead combinations will be needed, two single aluminum strips for connecting to the outer terminals of the transformer and two single lead strips are bolted together at the negative line tap.

Usually the lead and aluminum strips are bolted together by small bolts or switch studs may be used for the purpose. This is unnecessary, however as the two strips may be secured together without the trouble of boring and fitting bolts and nuts and the easy way is just as satisfactory as the more troublesome one.

Having cut the strips to the 5 inch length, a lead strip is laid on top of and aluminum strip and holding them firmly together, one quarter of an inch of both is bent over as shown in Fig. 1 and is

Condensers and Liquid Rectifiers in 1923 Page 5

then well hammered down on flat iron surface, the ordinary house hold iron serving well in this capacity. The first bend is again turned over, this time making a half inch bend, as shown in Fig 2. This second bend is hammered down and a tap or so given on the side to splay the lead into the aluminum.

The two strips are now separated with a piece of cigar box wood pushed up between them to the bent over portion and when the wood is right up as far as it will go, the two strips are pinched in at the top of the wood, with a pair of pincers, leaving the two strips fixed with thickness of the wood as the distance between them, as shown in Fig 3. This is to allow for the space separating two of the test tubes, as one aluminum and one lead leg of each combination will go into every two test tubes as shown in Fig. 4 above.

The rectifier or rectifiers as described are the very acme of compactness and are so easily constructed that both can be knocked together in less than an hour. There has been a great deal of controversy as to what forms the best electrolyte. Ammonium phosphate, sodium phosphate and borax are most commonly used. Borax is the cheapest and works without an trouble, but is a bad "starter".

To work effectively as a rectifier a film of oxide must be formed on the aluminum electrode, and this takes quite a time with borax unless some preliminary forming is done. The preliminary forming is done by immersing the electrodes in very weak solution of caustic soda, just a grain or so of the crystal in a quart of cold water, just enough to give the characteristic "feel" of caustic in water. About ten minutes immersion will be sufficient, and then rinse in running water.

Note Ordinary borax will not serve, but the kind Americans call "20 mule teams borax" or calcium borax, is the correct thing and should be used at a strength of one ounce to 11/4 pints of water.

Today we could make a replica of one of these but be vary careful of the high voltages involved. Electrical safety was non existent in the 1920's.

You could use two "sides" of six cells and power it from a typical power transformer from a mantle radio. Be very careful, put a Perspex top over the finished assembly so no one can come in contact with the high voltage and do not apply power until it is finished and protected. Also, the output voltage could be lethal and that is why I have suggested to power it from a mains transformer from an old radio so the output is isolated from earth (ground).

Remember if you do build an electrolytic rectifier the plates must be formed by connecting the assembly to the voltage source via a suitable lamp and letting is pass current until the lamp extinguishes. If you use a 60mA transformer from an old radio a 15 Watt 240 volt pilot lamp would be ideal.

In the original article the device was connected to the 110 Volt AC mains and there were on such things as Safety Switches/ECLB's in the electrical distribution network

Build it at your own risk, death is permanent and an electrical shock from experimenting with a device like this will most likely kill you.