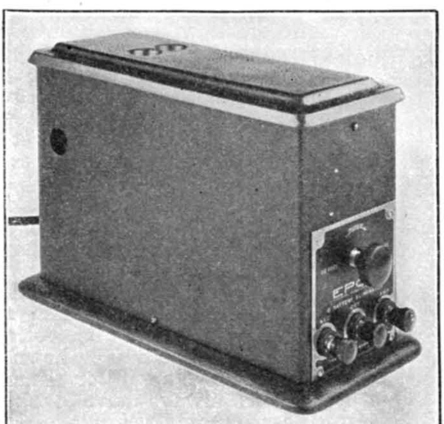
The Epom Rectifier and Filter

By Robert S. Kruse, Technical Editor

THE Epom B battery substitute like the Raytheon device previously described in this magazine[1] makes use of a tube without a filament. While the general principal in the two devices is the same, the Epom device differs in ways which make it worthy of independent discussion from the standpoint of both the receiving man and the low power transmission man.

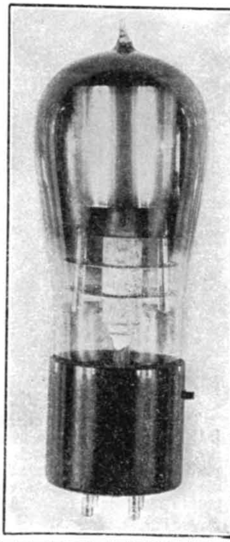
The information in this paper is taken from an interview with Mr. H. P. Donle of the Connecticut Telephone & Electric Company which manufactures the device.[2]

As has been intimated the tube operates without a filament and rectification is due to a peculiarity of the conduction of electricity through a gas at low pressure. Referring to Fig. 1A if the black spot represents a point made of some metal and the large circle represents a cylinder, also of metal, we have the main parts of a gaseous rectifier. It is only necessary to enclose this thing in a glass vessel in which there is present gas at very low pressure. The pressure is in the neighborhood of the one used in the familiar Geissler tube.



A COMPLETE B BATTERY SUBSTITUTE.

In the "Epom" tube the gas happens to be Argon which is used because it breaks down at lower voltages than some of the other gases which can be used. It is important, of course, that the gas be something which is not very active chemically, also its electrical resistance must not be too high. Argon fulfills both requirements pretty well. Returning now to our figure. If we make the little rod at the center positive and the cylinder negative we can easily see that a free electron E is attracted very decidedly in the direction of the arrow. It will start at once with a good deal of speed and will thereby collide with the un-ionized gas with enough violence to jar free some more electrons. The net result is that very promptly the gas becomes ionized and conduction takes place through the tube. At the end of this half cycle the transformer voltage goes down to zero, the gas becomes deionized and we are all ready to try the thing in the reverse direction. If now as in Figure 1B the central rod is made negative and the plate positive we will find that our free electron is attracted in all directions as shown by the arrows. It will move but not with the same speed, and therefore its chances of causing more ionization are so good. The conductivity of the tube in this direction is therefore poor. The practical tube does not use a single rod but uses two rods and one plate as shown in Figure 1C. Here the plate is connected to the positive side of the filter and remains positive during the entire operation of the set. We can therefore think of the voltages as being in Figure 1B. During one-half of the cycle the one point is doubly positive and the other one is at zero (-B) Voltage. During the next half cycle these things are reversed as shown by the dotted symbol.



THE RECTIFIER TUBE, SHOWING THE HEAT DEFLECTORS.

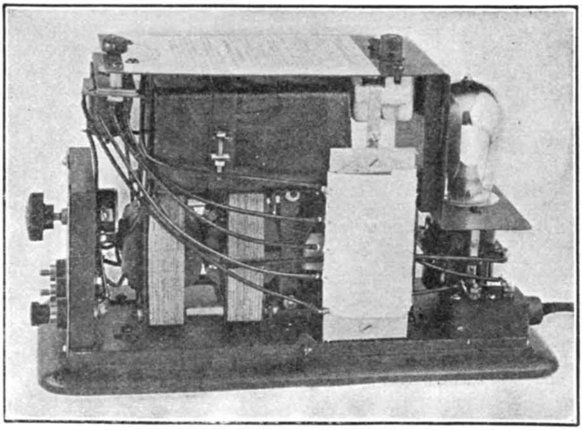
Passing down through the heat deflectors are two glass tubes carrying the plate support, also two fairly large lava tubes carrying the points which project up inside the plate.

Tube Construction

The actual construction of the rectifier tube brings up difficulties not found in the design theory. Very small impurities in

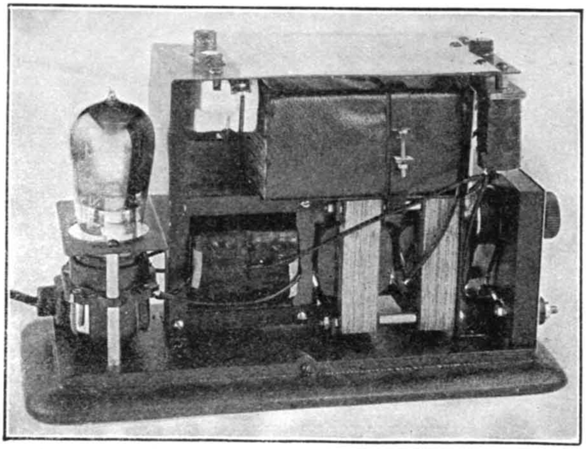
1. Page 38, *QST* for November, 1925.
2. The interview was made possible through very fine cooperation on the part of Mr. H. P. Donle and Mr. E. C. Wilcox of the Connecticut Telephone & Electric Company, as well as Mr. David H. Houghton and Mr. John M. Clayton of the A. R. R. L. organization.

the gas used in the tube are enough to prevent satisfactory operation or to make the tube "go West" in very short order. This not only means that the gas must be very pure but that the parts used in the tube must not give off any gas. As they get fairly hot during operation this means "de-gasing" treatment for all the parts used.



SIDEVIEW OF ONE TYPE OF B BATTERY SUBSTITUTE USING THE "EPOM" TUBE.

The upper panel carries the primary resistance switch at its left end and the line switch at the right. Leads from the primary resistance switch run to the flat resistance card at the right front. The small panel at the left carries the terminals also the detector plate rheostat shown in Figure 4. At the extreme right is the rectifier tube.



The transmitter and filter system is better shown in this view. The large bulk at the top center is the pack of filtering condensers. Just to the right of that is the cylindrical detector feed condenser (C4 in Figure 2).

On the lower level from left to right are the rectifier tubes, the transformer and the two filtering chokes having an inductance of rather more than 30 henries each. Note the ventilating opening around the tube.

If the gas can be kept pure the life of the tube is limited mainly by the life of the glass that is to say the tube will work as long as the glass remains undamaged. Those who have used 5 watt transmitting tubes know that they usually die from electrical leakage through the glass at the stem and that this is caused by overheating and over voltage. If the stem is kept cool the over voltage generally does not harm. In the photograph of the Epom tube will be seen three metal discs which serve the purpose of keeping the heat of the tube away from the stem. It is hard to give definite figures for the life of any vacuum tube but a guarantee of six months' satisfactory operation is regarded as entirely safe in this case. Without the metal disc the life was very much shorter. With no shield at all the temperature of the stem ran to about 210 degrees centigrade. With two shields it ran at 160 and with four (present construction) about 85, which is quite satisfactory. This is when the tube is handling 35 milliamperes at an input voltage of 300.

Transmission Possibilities

Before now it must have occurred to the reader that here was a good plate power supply for the small transmitter. Just what can be expected from the device in this regard can best be seen by inspecting the curves in Figure 3.

When used for transmission less perfect filtering will answer than is necessary where device is used to supply the plate circuits of a receiver. Removal of a part of the filter system will enable one to get higher voltage to the tubes than are shown in Figure 3. The filter should, however, always have a shunt condenser at its *input* end as this will increase the output of the device. This shunt condenser should be on the *rectifier* side of the choke where it does not only serve as a filter capacity but also provides a "starting voltage" which causes the tube to break down more quickly at each half cycle and thereby gives bigger output. Other condensers further along in the filter system may be used as usual. By the way, we will next month present a simplified explanation of filtering action,

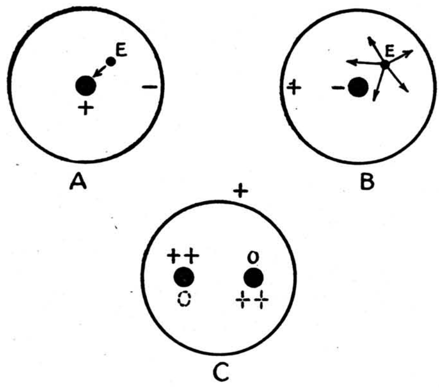


FIG 1

Fig. 1 The theory of the tube.

which accounts for the part played by the various filter condensers.

Why the Gas Tube

Making a satisfactory gas tube is possibly a more delicate job than making a satisfactory kenotron (hot filament and cold plate tube). There are several advantages, however. One naturally thinks of the advantage of having no filament to burn out but that is not the main advantage. Filaments, carefully handled, are likely to last a good many hundred hours and may even get into the thousand class with good design. The regulation of filament tubes leaves something to be desired. This sounds complicated but isn't. If the voltage of the house lighting system drops 10% one naturally has 10% less voltage supplied to the rectifier by the transformer. If the rectifier is a kenotron then the filament becomes dimmer at the same time and there is an additional drop in voltage. The only way to get out of this additional drop is to make the filament so large that its full output of electrons is never required even with the lowest line voltage and the heaviest load. This is perfectly possible but is nevertheless a weakness in this type of rectifier. On the other hand in the gaseous tube there is a sort of "ballasting effect" which tends to counteract the line variation.

The business of regulation is not particularly important when one is dealing with a super-heterodyne or with any kind of a set in which the tubes are operating well below oscillation. When one is anywhere near the oscillating point a change in the output voltage is likely to cause the set to go into oscillation or to go dead suddenly. If the set is being used to supply a small transmitter the note is likely to waver when variations occur.

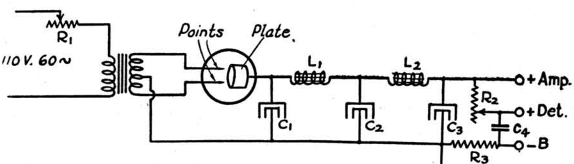


FIG 2

FIG. 2. DIAGRAM OF CONNECTIONS FOR A COMPLETE B BATTERY SUBSTITUTE AND C BATTERY SUBSTITUTE.

C1, C2 and C3, 4 microfarad condensers. C4, detector feed condenser, 1 quarter microfarad. R1, primary rheostat. R2, Detector late rheostat. R3, biasing resistance. This is omitted in some cases. L1 and L2, 30 Henry Chokes.

In addition to this the gaseous tube is not especially likely to be damaged by overloading.

On the other hand one must admit that there is always some leakage directly between the two little rods in the gaseous tube. This consumes some power but not as much as the power used in heating the filament of a kenotron.

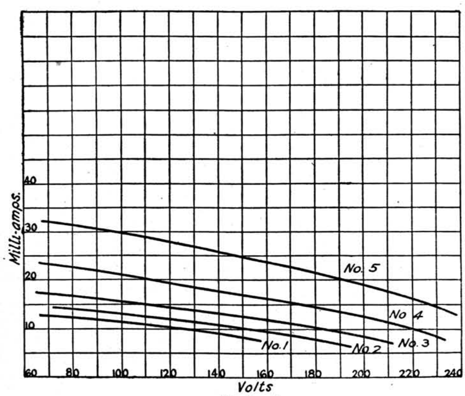


FIG. 3

FIG. 3, OUTPUT OF RECTIFIER AND FILTER AS CONSTRUCTED IN A B BATTERY SUBSTITUTE.

There is one curve for each position of the switch on the primary resistance. The input voltage at the left end of curve No. 5 is 300. This drops somewhat to the right because some primary resistance must be left in. The voltage at the tube is higher than that shown by the curve since there is also some drop through the filter. A transmitting filter would give higher voltages.

Construction of the Complete Device

The wiring of the complete "Epom" device shown in Figure 2. It will be noticed that there is a center-tapped input transformer, a two stage filter and special arrangements for providing a variable detector voltage and a biasing voltage. The scheme for providing the biasing voltage is

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see whether or not the signals, as reported by a man 300 miles away, are clear and clean cut. The receiving operator should be a naturally slow receiver. You are now OK providing you do not make a lot of combinations.

The second means of placing firm signals on the air is to have a relay circuit with contacts large enough to pass the full amount of current on short dots, a thing that is difficult to achieve unless you are good at matching contact points with a contact file.

A good reminder: Don't try to use a fast bug and don't try to "push" a slow bug by jamming letters together, and above all listen to your own sending.

—E. M. Doane.

The Other Side

New York City

Editor, *QST:*

In your issue of November, on page 60, the writer read with much interest your article entitled "Eagle Eyes", signed by Mr. A. H. Morse, R.M., Radio Ltd. It is a simple matter for authors to blame their mistakes on publications, but in fairness to *Radio News* the writer trusts that you will give our side of the story.

Radio News contracted for a series of articles which were prepared for book form, and instead of sending us the usual manuscript, the author sent us the printed pages of the book itself, in their rough form. We enclose, herewith, the page from which the manuscript was set up, and from which you will see that the mistake did not originate with *Radio News*. Of course our proofreader should have known better than to run this, but before making rash statements, Mr. Morse should have looked at his manuscript.

—H. Gernsback,
Radio News.

Standard Waves

Communication for Jan. QST—

Cambridge, Mass.
Nov. 27, 1925.

Dear Editor:

The beginning of u1XM's Standard Frequency Transmissions in January will probably bring an avalanche of QRH?'s from stations working 1XM. Let me explain that our Standard Transmissions are measured at some distance from the transmitter, and special telephonic connections must be established between the Communications Laboratory where the Standard Frequency meter is kept and the radio station. Thus our answer to a QRH? over the air cannot be expected to have an accuracy better than as shown by an ordinarily good meter.

—Killian V. R. Lansingh,
Chairman Standard Frequency Committee.

THE EPOM RECTIFIER AND FILTER

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the same as is used in Western Electric transmitters. The Epom device is also made

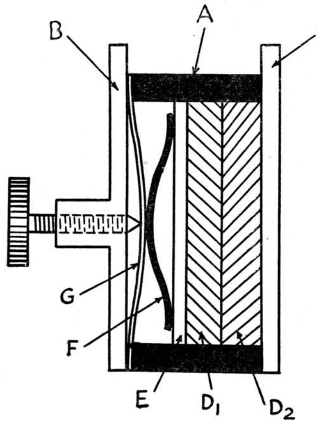

FIG. 4

FIG. 4 THE SPECIAL DETECTOR PLATE RHEOSTAT.

This rheostat is R2 in Fig. 2. Placed in series with a model 1 Weston voltmeter across a 110 volt line this rheostat enables smooth regulation of the voltmeter reading down to values as low as one-half volt. This represents a smooth operating range of better than 50 to 1, a very excellent performance.

A, Insulating shell.

B, Upper plate, forming one terminal and carrying compression screw.

C, Lower plate forming other terminal and having silver-plated contact surface facing resistance material.

D1 and D2, Discs of moulded resistance material.

F, Spring.

E, Silver-plated brass disc.

F, Spring.

G, Fairly stiff spring disc to "give the screw something to work against" and thereby remove slack.

The drawing is not to scale and illustrates the principle rather than the actual construction.

without the B terminal and the resistance R3. For transmission purpose one can as well omit R2, C4 and possibly L2 and C3.

EXPERIMENTER'S SECTION REPORT

(Continued from Page 40)

For large filter condensers the present unit would be used, with no more confusion than when we use yards and miles for calculating distances.

The microhenry is O. K. for size, but why keep the long name for that either? As to the names for these two units, let's take "Max" for one of them; a contraction of the name of our A.R.R.L. President, as Farad is of that of Michael Faraday. A similar contraction of the name of some prominent man of the Bureau of Standards who