Mercury Arc Rectifiers

By Earl D. Smith, 3PZ-3XO

THE mercury arc rectifier, as used in rectification of high voltage and low amperage for radio transmitting tubes, has not been properly used nor have its possibilities been realized.

Mr. C. P. Sweeny, 5KM, has given some good theoretical information* which is of considerable interest. I wish to show how his ideas may be extended to practical amateur radio operation.

The first experiment tried at this station was not successful but indicated the necessity of some menas of continuous vaporization without keeping a load on the tube. In Fig. 1 is shown one of the first circuits tried. This circuit is similar to one of those shown by Mr. Sweeny. The output of the exciting transformer was about 12 volts. This 12-volt transformer creates a vaporizing spark to start the tube. To get this vaporizing spark, we tilt the tube so that the mercury from the large well flows to that of the small well, closing the starter circuit. When the tube is tilted back again the mercury breaks and a short but heavy spark occurs. If the high voltage is turned on at this time the tube will operate for one-half cycle but will then go out because there is no external load to keep it going. To remedy this we will put on a "keep-alive load", the object of which is to keep the tube vaporizing steadily. Unfortunately the load has to be fairly large (500 ohms or less) and absorbs almost the rated power of the tube. Also after a few minutes of operation the load resistance generates a large amount of heat. The efficiency of the arrangement is very low.

This set-up was next connected to the transmitter to determine what sort of D.C. it gave and to find out something about the voltage drop under load. The input was 2000 volts across the two cathode terminals. With the 14-volt drop in the tube a resultant output of 986 volts should have been obtained, but the voltmeter showed it to be only 450. This, therefore, seems to be an impractical circuit, although the output was smoother than had been expected.

A Better Circuit

The next step was to eliminate the load resistance entirely. A high voltage that would *jump* the gap between the two mercury wells was needed. Such a thing would operate without the necessity of putting on a "keep alive load" because the tube would ignite automatically at each half cycle. The Tesla coil was impractical because of the low current output. The most convenient source of high voltage was a one-half kilowatt, 10,000-volt, spark transformer. This was connected across the starting terminals of the tube as shown in Fig.2. The tube was expected to break but instead it worked beautifully and vaporized steadily. The set was now connected up again with the key in the primary of the 2000-volt transformer which was connected to the cathodes. This worked well and the input voltage was raised to 3,000, which gave an output voltage of 1486.

The Concentrating Ring

To get still better operation a flux-concentrating copper ring was placed around the top of the main anode-well and connected to the starting terminal in the smaller well. This arrangement is shown in Fig. 2. This helped to make the mercury

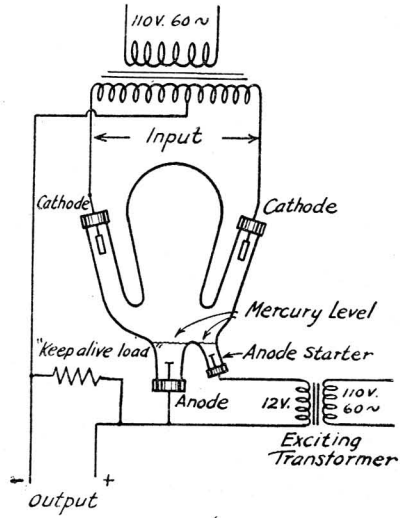

FIG. 1

splatter and to make a more intense exciting arc. The tube worked very steadily then and it was decided to connect it to the transmitter again.

Operation

When our transmitter was operating with 15,000 volts "raw" A.C. the antenna current was 5 amperes. The same wattage applied to the mercury arc and rectified before feeding it to the oscillator raised

*"Phase Multipliers and Mercury Arc Rectifiers", by C. P. Sweeney, Page 16, April, 1924, QST.

this current to 7 amperes; in other words it gave practically twice the antenna energy. The voltage as previously stated was about 1486.

We connected with a southern amateur about 200 miles from Washington who reported that the tone was quite satisfactory.

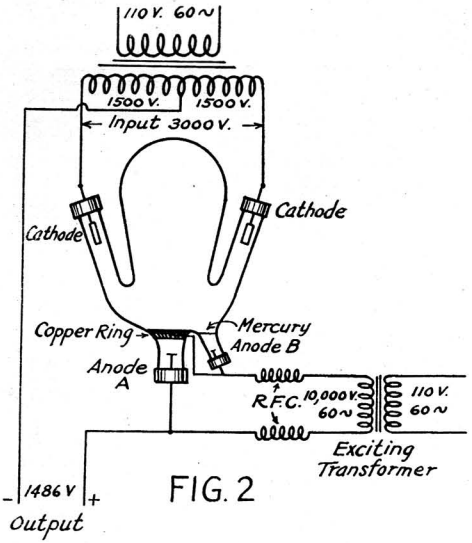

FIG. 2

We then added a filter consisting of an 8-microfarad condenser and two 60-henry chokes. At the distance of 200 miles the tone then was pure D.C., as closely as could be observed. Even nearby the tone was quite pure.

This kind of a rectifier is not recommended for less than a 50-watt transmitting tube; in other words, for a load of less than 125 or 150 watts. The reason for this is that the mercury arc tube works better as more power is drawn. For 250-watt tubes it should work excellently.

The importance of the radio-frequency chokes in the starter secondary must not be overlooked. These chokes prevent radio-frequency damage to the exciting transformer. Two single-layer coils of 250 turns each will suffice.

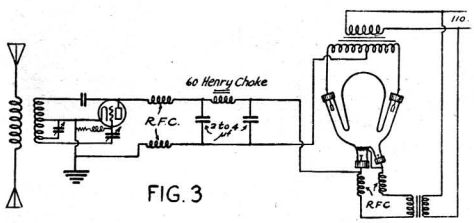

FIG. 3

The only precaution necessary is not to put too high a voltage across the cathodes. This may generate sufficient heat to crack the tube. If the tube is put in an oil bath it will stand a much higher voltage.

The Tube Used.

The Tube used here is a small General Electric tube, rating 10 amperes at 350 volts. At such a small current as used here it will stand very much higher voltages.

Figure 3 is a suggested circuit for use with the transmitter.

I would be glad to receive any suggestions for better operation of the tube and hope that this article will help the transmitting amateur to supply his transmitter with low-priced D.C.

Since this article was received we have been informed that the use of the 10,000 volt "ignition" transformer was suggested by Mr. J. H. Turnbull of 2XQ, the suggestion being tried out by Mr. C. P. Sweeney of 5KM and then passed on to the writer of the present paper.

The scheme has not been a uniform success—several tubes have been cracked by the development of excessive heat at the ridge between the two mercury wells. Larger rectifier tubes seem to stand the heating better than small ones.

Notes on Mercury Arcs

From correspondence with our members

Many of our members have bombarded us with demands for mercury arcs. The idea is fine—but the aim is wrong. Go after Westinghouse and General Electric with special attention to the Charging Equipment Section of the latter firm at Schenectady.

How to Crack Mercury Arcs

There is only one reason for wanting to know how to crack mercury arc tubes—that is to know what **not** to do.

Messrs. Sweeney and Smith have had hard luck in this regard—so have plenty of other members. The trouble is seldom caused by overloading the tube generally it is too sudden heating or else a local arc. Naturally the stunt of using the 10,000 volt transformer to keep the arc going is dangerous; don't use more than **just enuf** power to keep the arc going.

Another good way to crack a tube is to shake it.

In this connection Wm. Snyder of 9BNO points out that mercury arcs are meant to operate **in oil** and should not be used in air.

A rectifier tube that is suitable for amateur use is the G.E., catalogue No. 40525.