The UX-213 Rectron and the UX-874 Voltage Regulator

By O. W. Pike*

AS is well-known, the problem of supplying d. c. to the plates of a vacuum tube from an a. c. source of power may be divided into three separate parts. It is necessary first to rectify the alternating current, second, to remove the "ripple" which always exists after simple rectification, and, third, in many cases, to provide some means of maintaining the correct output voltage regardless of the output current or variations in the a. c. supply voltage.

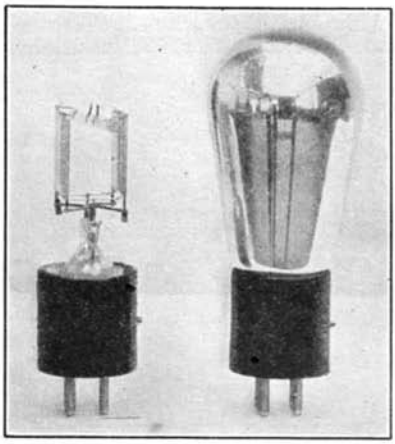

FIG. 1. THE UX-213 RECTIFER TUBE
The tube has two separate plates. Inside of each there is a 5-volt, 2-ampere "XL" tungsten filament. The plates are insulated from each other, the filaments being connected in parallel. Footnote 1 explains the difference between this tube and the similar UV-196.

The rectifiers most widely used for eliminators are of the full-wave type, consisting of a step-up transformer and either two half-wave or one full-wave rectifier.[1] There is available a full-wave vacuum tube rectifier designed for use in "B" eliminators and known as the UX-213 Rectron. This Rectron has two separate plates and two filaments connected in parallel. Externally, the tube is similar to the UX-210 Radiotron. Figure 1 shows the internal and external appearance.

The filament of this tube is of the X-L tungsten type and has a rating of 5 volts, the current being approximately 2 amperes. At first thought, the 10 watts consumed by the filament may seem high, but this power is drawn from the a. c. line, which is an economical source of supply. The high wattage results in long life and ample emission over a variation in filament voltage of from 4.5 to 5.5 volts. The UX-213 has a maximum a. c. supply rating of 440 volts RMS between anodes and a maximum d. c. output rating of 65 milliamperes. This rating is based upon two limiting factors—first, that of the impressed a. c. voltage, which in turn is limited by the insulation between elements and by the effect of positive ion bombardment on the electron emission from the filament—second, that of the d. c. output current which results in anode heating due to electron bombardment. The latter is practically independent of the voltages used.

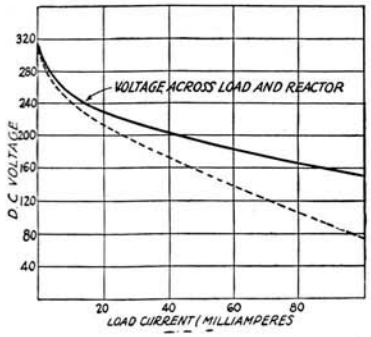

FIG. 2. AVERAGE PERFORMANCE CURVE OF A UX-213 FULL-WAVE RECTIFIER SUPPLYING A FILTER AND LOAD

The applied voltage is assumed to be 220-per-plate and 5 for the filament, all at 60 cycles. The solid curve shows the output voltage of the tube. The dashed curve has been added by the editor to show the voltage that would be available after the output had passed thru a 750-ohm filter. In practice the available voltage would be somewhat higher than this curve, the exact value depending on the filter constants and load. The practical voltages therefore lie between the two curves.

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1. The old "S" tube was a half-wave rectifier of the gaseous discharge type. Two were necessary, "one on each side of the cycle". The little "Raytheon" tube is a small version of the same thing but works on both sides of the cycle—i. e. is a full-wave rectifier. Coming to the kenotrons we have a whole family of half-wave rectifiers of the hot-filament, cold-plate variety. The best known are the 1500-volt, 1/5-ampere, UV-217-A and the "20-watt" UV-216 and UX-216-B. Lately there have been added two small full-wave tubes, the General-Electric (R. C. A.) UX213 and the Westinghouse (R. C. A.) UV-196. The former uses two separate plates but has the "XL" filaments connected together. The latter uses one plate and requires a separate filament transformer secondary for each of the oxide-coated filaments.—Tech. Editor.

The characteristics of the UX-213 tube, when used with a full-wave rectifier connection as described, are illustrated in Figure 2. From this figure it can be seen that with the maximum d. c. load a current of 65 milliamperes at 180 volts is available for filter and load voltage.

Considerable variation is allowable in the design of a filter for a "B" eliminator.

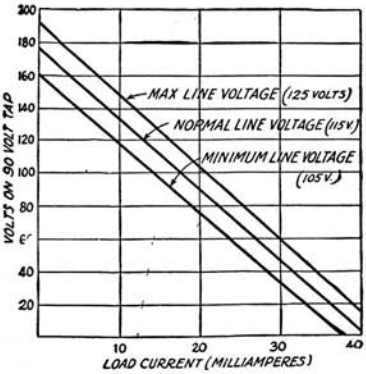

FIG. 3. PERFORMANCE OF A TYPICAL RECTIFIER AND FILTER WITHOUT A STABILIZER

A very satisfactory one consists of two chokes in one side of the line with condensers to the opposite line from both sides of the chokes. It is possible to eliminate one stage of the filter and use only one choke and two condensers, although the inductance of the one choke must be large for equivalent results. The UX-874 voltage

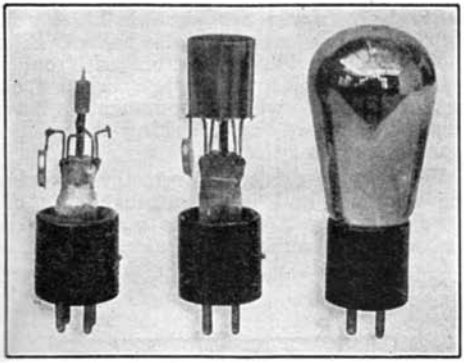

FIG. 4. THE UX-874 REGULATOR TUBE

The view at the left shows the central pointed electrode with its short insulating shield while the central picture shows the plate in place. The tube was discussed in more detail on page 32 of our June issue.

regulator, to be described later, is a considerable aid to filtering.

Unless the filter chokes are made very large, their resistance is usually as great as that of the rectifier itself, and the result is a voltage drop across the filter which is often greater than the drop in the rectifier. Because of this drop in the rectifier, the d. c. output voltage from the filter will vary when the eliminator is to be used with miscellaneous receivers taking different amounts of current. This condition is illustrated by Figure 3 for the 90-volt tap of a typical eliminator with no corrective adjustment. An effective method of overcoming this condition is to use the UX-874 Radiotron.

The UX-874 Regulator

The UX-874 is a voltage regulator tube making use of ionized inert gases at low pressure for the conduction of current between the electrodes. The unique and useful property of this tube is that when placed in series with a resistance the voltage drop across the tube remains *practically constant at 90 volts over a range of current values from 10 to 50 milliamperes.* Approximately 125 volts d. c. is necessary

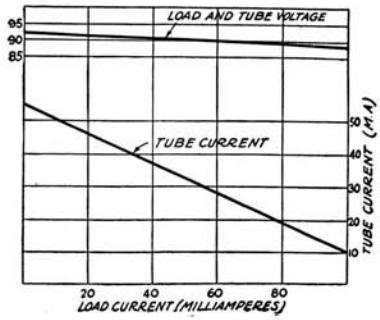

FIG. 5. OPERATING CHARACTERISTICS OF THE UX-874 IN A TYPICAL RECTIFIER-FILTER SYSTEM WITH DIFFERENT LOADS

to *start* the gas discharge after which the voltage drops to the regulation voltage. Fig. 4 shows the appearance of the tube. By arranging the filter so that it has a pair of 90-volt output terminals and connecting the UX-874 across these terminals it is possible to keep this voltage practically constant, the filter supplying the required series resistance. Figure 5 illustrates this condition.[2]

The filter action of the regulator tube is due to the inherent low impedance which is characteristic of the gas discharge tube in

2. Since the regulator is connected to the 90-volt tap, it seems at first sight as if the higher-voltage taps are left free to vary at will. Brief consideration will show that the effect of the tube is to provide the rectifier and filter with a constant-current load-thereby tending to stabilize all the voltages involved. Unfortunately the maximum voltage of the system cannot be run up indefinitely or the device would be excellent for amateur transmitters, tending to remove the wearysome "yoop-yoop" effect from the note of the set.—Tech. Ed.

question. In other words, the UX-874 tends to absorb even the voltage variations due to the a. c. supply and therefore acts somewhat like the condenser in the filter in smoothing out the rectified voltage. In the case of the condenser, one way of explaining the smoothing out effect is to state that it has a very high d.c. resistance and a low a.c. impedance. In this way the d.c. component of rectified voltage is not affected, whereas the a.c. component is practically short circuited and so greatly lowered in value.

In the case of the glow tube, the d.c. resistance is fairly high (1800 to 10000 ohms) while the impedance to changes in voltage (a.c. component) is quite low. The low impedance follows from the fact that there is practically no change in voltage drop across the tube for relatively large changes in current through the tube.[3]

Figure 6 shows the diagram of connections for a suggested built-up "B" eliminator set. The transformer should have a

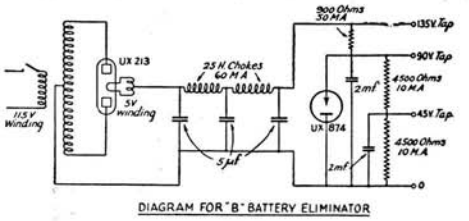

FIG. 6. A CURRENT-SUPPLY SYSTEM SUITABLE TO RECEIVERS

115-volt primary and 440- and 5-volt secondaries, both with center taps. If desired, the return to the 5-volt winding may be to either end rather than to the center. The plate winding should have a current capacity of 40 milliamperes while the filament winding should, of course, carry the two-ampere filament current safely. It may be easier to obtain separate transformers for the filament and plates and just as satisfactory results are obtained by this method.

The filter chokes should have at least 25 henrys inductance and if the total resistance of the two chokes is greater than 750 ohms the capacity of the set will be limited to some extent. If one choke is used this should have at least 50 henries inductance. The condensers should have at least 5 μfd. capacity and be satisfactory for 250-volt operation.

The resistance values shown are calculated for correct voltage distribution with 750-ohm resistance in the two chokes. If chokes of greater resistance are used, the 900 ohms between the 135- and 90-volt taps should be increased, although this will reduce the current output obtainable from the various taps.

As illustrated, the set will deliver 10 milliamperes from the 135-volt tap, 40 milliamperes from the 90-volt tap and detector tube current simultaneously. The UX-874 will maintain the 90 volts practically constant at any load up to 40 milliamperes.

Once constructed and properly adjusted, this set will, within the range of the device, supply the required voltages *without adjustment* regardless of the variations in supply voltage or the current drain of the receiving set supplied.

3. When the device is used for low-power transmission, the filter will be rather less complex than the one shown in Fig. 6, in fact the last condenser, middle condenser and second choke may all be left off, the filtering being good enough with one condenser, one choke and the 874 tube. Even the first condenser need not have a capacity of over 2 microfarads. In addition to this, the 2-microfarad condensers across the resistors may be omitted.—Tech. Ed.

A SHORT-WAVE PRECISION WAVEMETER

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that the rotary plates of the condenser, the condenser shield, the galvanometer and the outside end of the coil are at low potential. The condenser and meter are mounted on a quarter-inch aluminum panel, and are housed in a walnut cabinet which is shielded with sheet copper. Hand capacity effects are, consequently, zero.

The meters are supplied with mounted calibration curves for each coil. A condenser capacity curve can also be had. Each meter is individually calibrated from a standard which, in turn, is checked from quartz crystals whose fundamentals have been determined by checking harmonics from a standard clock.

Where a precision wavemeter covering the amateur and broadcast bands is desired, the type 224L leaves nothing to be desired. Mechanically and electrically it is a *beautiful* job.

—*J. M. C.*

3VX HAS AN ODD HOBBY. HE HAS A SCHOOL OF PET TAME FISH