ENGINEERING FEATURES OF THE UX-245

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THE UX-245 is a power amplifier which has been developed to meet the demand for an output tube which would permit the manufacture of broadcast receivers having good tone quality and reasonable volume at a price well within the reach of the average purchaser. Heretofore, the medium-priced receiver has been limited to the use of the UX-112A and UX-171A types of output tubes, and, while the fidelity of reproduction was satisfactory, the volume obtainable with these types was, in many instances, not considered sufficient for all purposes. Receivers utilizing UX-210 or UX-250 tubes are inherently above the middle-priced range so that a gap has always existed between the medium-priced, good-fidelity, low-volume receivers and the high-priced, good-fidelity, high-volume receiver. The UX-245 tube is intended to fill this gap.

The electrical rating of the UX-245 tube is as follows:

Filament volts	2.5
Filament amperes	1.5
Plate volts	250.

Some misunderstanding has existed in the past regarding the voltage ratings of tubes so that a few words in explanation will not be amiss here. The filament voltage rating of a Radiotron, for example, as given in the instruction sheet accompanying each tube, is a normal value, i.e., optimum set performance and life will be obtained when the tube is operated at its rated (normal) value. This means that receiving sets operating on socket power should have transformers or resistors in the filament circuit which are designed to operate the filament or heater at rated value under average line voltage conditions. A reasonable amount of leeway is incorporated in the tube design so that ordinary line fluctuations downward will not cause undue loss of electron emission and appreciable decrease in set performance. In the normal voltage range the filament of the UX-245 tube operates at a dull red color and, with normal plate voltage and grid bias, the sturdy, coated filament gives exceptionally long life performance.

The plate voltage ratings of tubes are maximum values and are so indicated on the instruction sheets. In the case of the UX-245, the 250-volt rating means just what it implies, i.e., the value beyond which it is unsafe to go from the viewpoint of life performance. Several methods of obtaining this voltage regulation are available but their discussion is beyond the scope of this article. In general, however, the amount of voltage fluctuation caused by line-voltage variation, load variation, and manufacturing variations in the apparatus must be determined or estimated and an average design value should then be decided upon so that under the operating variations to be encountered the voltage ratings of the tube will not be exceeded.

Electrical Characteristics

TABLE I gives the electrical characteristics of the UX-245 tube under the two operating conditions which will be used most generally. It should be remembered that the values given are average and that individual tubes may vary somewhat from those stated below.

Table I

AVERAGE CHARACTERISTICS THE UX-245 TUBE

CHARACTERISTIC		
Filament volts	2.5	2.5
Plate volts	250.	180.
Neg. grid volts	50.	33.
Ampl. Factor	3.5	3.5
Plate Resistance (ohms)	1900.	1950.
Mutual Conductance (micromhos)	1850.	1800.
Plate Current (mA.)	32.	26.

In Fig. 2 a family of plate current-plate voltage curves for various grid-bias voltages is shown. These curves are useful in determining the undistorted power output of the UX-245 tube. The method employed has been referred to in an article which appeared on page 329, March, 1929, RADIO BROADCAST ("A High-Power Output Tube—The 250," by K. S. Weaver) and has also been described, among others, by Messrs. J. C. Warner and A. V. Loughren in the I.R.E. *Proceedings*, December, 1926, so that this discussion will not be repeated.

The undistorted output obtainable from UX-245 tube is shown in Table II together with similar data on UX-171A, UX-210, and UX-250 tubes.

Table II

OUTPUT OF VARIOUS POWER RADIOTRONS

	Undistorted power output in milliwatts			
PLATE VOLTAGE	UX-171A	UX-210	UX-245	UX-250
180	720		780	
250		340	1600	900
425		1600		
450				4650

It will be noted that the UX-245 lies between the UX-171A and UX-250 with regard to the undistorted power which it is capable of delivering to a loud speaker, and it has the same output as the UX-210 tube. The advantage of the UX-245 over the UX-210 lies in the fact that the UX-245 delivers the same power as the UX-210 but at about one half the plate voltage required by the latter. This feature is of great importance in connection with set design from the cost standpoint and is one reason for the assured popularity of the new UX-245 tube.

Operation

AS STATED ABOVE, maximum power output from the UX-245 is obtained when it is operated at normal filament potential, 250 volts (maximum) on the plate, and with a negative grid bias of 50 volts.

Filament voltage recommendations for the UX-245 have already been discussed. However, a few remarks concerning the characteristics of this filament may be of interest. The filament of the UX-245 is of the coated-ribbon type and has high thermal inertia which, in addition to the relatively low filament voltage required, insures "humless" operation on alternating current. This type filament is not affected by the presence of small amounts of residual gas and a slight blue glow in the tube is no indication that the tube is defective or that it is improperly operated. The usual midpoint connection to a re-

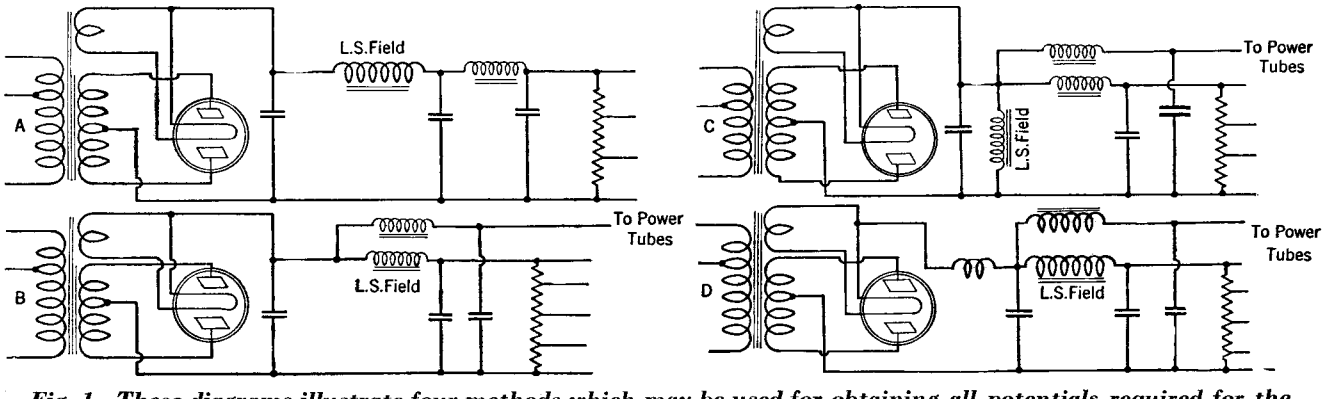

Fig. 1—These diagrams illustrate four methods which may be used for obtaining all potentials required for the operation of a receiver without exceeding the rating of a standard UX-280 full-wave rectifier tube. Each of these power supply systems is designed to supply a receiver of different voltage and current requirements.

sistor placed across the filament terminals or a center-tapped transformer should be used for plate- and grid-circuit return.

The grid swing (50 volts) required to work this tube at its maximum output is easily obtained with sets of present-day sensitivity although when used in "push-pull" circuits the signal input requirement is doubled and this arrangement will call for a set having high over-all gain. When increased power output is desired without increasing the plate voltage supply or grid swing capabilities of the receiver, two UX-245 tubes may be operated in parallel.

The grid-bias voltage for the UX-245 should preferably be obtained by means of a voltage drop across a resistor of proper value placed in the plate-return lead. This is particularly true in resistance-coupled circuits where grid leaks are employed. This "self-biasing" arrangement automatically prevents overloading of the plate and takes care of normal line voltage variation and variations among tubes. When resistance coupling and grid leaks are used it is imperative that the self-biasing connection be used. The grid leak should be made not greater than one megohm so that the grid bias will not be materially reduced in the event that current should flow in the grid circuit.

The plate voltage requirements of the UX-245 are such that the maximum potential (250 volts) may be obtained easily from the type UX-280 rectifier tube. However, the problem of plate voltage supply becomes more involved when two UX-245 tubes are to be supplied in addition to the excitation current for a dynamic loud speaker field and the plate power for the amplifier and detector tubes of the receiver. This condition of use is quite general in this year's receivers and the circuits shown in Fig. 1 will be of interest as they show several methods of obtaining all voltages and currents required without exceeding the rating of the UX-280. This is of particular interest because the use of the UX-280 to supply the plate voltage of a receiver means reduced cost of power pack and reduction in the cost of the receiver.

The rating of UX-280 is as follows:

A.C. volts per anode (r.m.s.) 350 (max.)
D.C. output current 125 mA. (max.)
This gives approximately 350 volts at 125 mA. (d.c.)

Because of the many types of dynamic loud speakers in use no values have been assigned to the various components shown in Fig. 1 since the resistance of the loud-speaker winding and its power consumption determine their values. The following general discussion of the circuits will serve to illustrate the fundamental practice; the set designer can easily fit into his design the constants and select circuit best adapted to this problem.

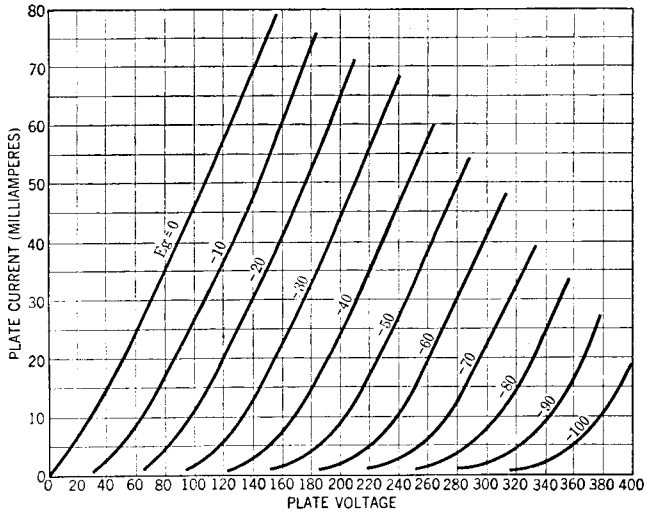

Fig. 2—The undistorted power output available from a UX-245 tube under various operating conditions may be determined easily from the above family of plate current-grid voltage curves.

Four Power Supply Circuits

Circuit A is of use where a considerable voltage drop at a fairly high value of current is permissible; for instance, where the UX-171A, either singly or in push pull, is used as the output tube and UX-226's or UY-227's are used in the rest of the set.

Circuit B is of value where the output power tube requires approximately the full voltage of the rectifier and a considerable voltage drop at a moderate value of rectified current is permissible in supplying the rest of the set. This would be in case the UX-245, either singly or in push pull, is used as the output tube and either UX-226 or UY-227 tubes are used in the rest of the set.

Circuit C is of advantage where the output power tube requires approximately the full voltage output of the rectifier and only a low voltage drop at a low current is permissible in supplying the rest of the set.

Circuit D shows a series reactor-type filter circuit for use under circuit conditions similar to those of circuit B. In this connection, the series reactor decreases the instantaneous peak current through the rectifier and thus permits that tube to work under more advantageous conditions. However, in order to get the full value of rectified current from this arrangement, the voltage on the tube must be increased beyond the present maximum value of 350 volts, and this is not recommended.

The arrangement of loud speaker field as shown in circuit C may be used also in connection with circuit D.

Conclusions

In connection with a discussion of plate voltage supply for the UX-245 it might be well to point out that high plate voltage does not of itself produce appreciably higher volume. It does permit greater volume without distortion provided sufficient signal is available to swing the grid with maximum efficiency. In sets which do not have sufficient overall gain to swing the grid of the UX-245 to its full value (50 volts) it is good practice to reduce the plate voltage, as conservative operation of this tube, as well as other types, considerably prolongs its life. Under all recommended conditions of use a transformer or choke and output condenser should be employed to couple this tube to the loud speaker in order to prevent the plate current of the UX-245 from flowing through the windings of the loud speaker.