The UV-845

A Low Impedance Linear Power Amplifier and Modulator Tube of the 50-Watt Type

This is the second of a series of articles on special-purpose tubes which, although available for amateur and experimental use, are not so well known to either the amateur or engineer. The series will be continued in succeeding issues of QST. — EDITOR.

By James J. Lamb, *Technical Editor*

THE UV-845 is another member of the 50-watt type tube group of which the UV-203-A and UV-211 are the better known, and has as its special purpose utility as an audio frequency power output amplifier and modulator. While it may be used as an oscillator or radio-frequency power amplifier, it has no advantage over the other 50-watt type tubes in such service and has a serious handicap in its extremely low plate impedance. It is therefore not recommended for radio-frequency operation. As an audio-frequency

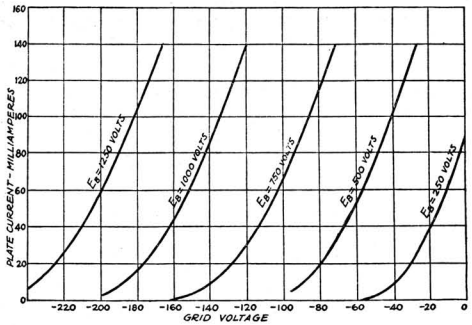

FIG. 1. — THE PLATE-CURRENT GRID-VOLTAGE CURVES FOR THE UV-845 AT VARIOUS VALUES OF PLATE VOLTAGE

power amplifier or modulator, however, it has considerably greater capability than even the UV-211, and it is for this type of service that the tube is intended.

In general appearance and base arrangement the UV-845 resembles the UV-203-A and UV-211. Its filament characteristics are identical with those of the other 50-watt type tubes. Comparative ratings of the UV-845 and UV-211 are given below.

The average grid-voltage plate-current curves for the UV-845 are shown in Fig. 1. In utilizing the plate impedance and mutual conductance curves of Fig. 2 the plate current for given values of plate grid voltage is obtained from Fig. 1. Since these curves of plate impedance and mutual conductance are for small values of input voltage only, some variation from these values

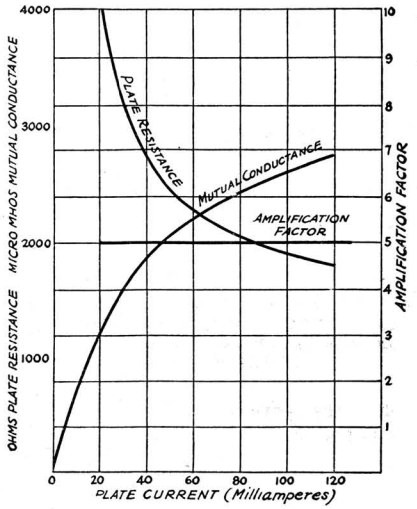

FIG. 2. — PLATE RESISTANCE, MUTUAL CONDUCTANCE AND AMPLIFICATION FACTOR OF THE UV-845 PLOTTED AGAINST PLATE CURRENT

will be found in amplifiers where input voltages are greater than a few volts.

LINEAR AMPLIFIER

When the UV-845 is used as an output linear amplifier in audio systems, it is capable of delivering a maximum of 20 watts of undistorted power under optimum conditions. Although a power output of such magnitude is not often required in any but commercial amplifier systems, the characteristics of the tube when so used are nevertheless interesting to the amateur. The curves of Fig. 3 give the *undistorted* power output, proper grid bias and load resistance for given values of plate voltage. The power output and load resistance are obtained by drawing in the load characteristic for various circuit conditions on the plate-current plate-voltage

curves of Fig. 4 and substituting in the equations for power output and load resistance as described on pages 28 and 29 of July, 1929, *QST*. From Fig. 3 it is seen that with normal plate voltage of 1000 and negative grid bias of 145

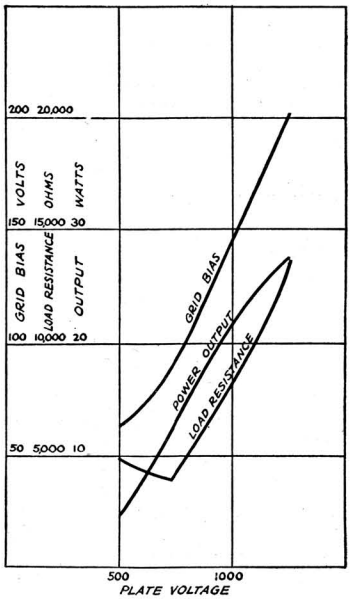

FIG. 3. — POWER OUTPUT, GRID BIAS AND LOAD RESISTANCE PLOTTED AGAINST PLATE VOLTAGE FOR OPTIMUM CIRCUIT CONDITIONS AND UNDISTORTED OUTPUT

volts, the power output, undistorted is 21.5 watts and the load resistance 8150 ohms. These curves are for undistorted output and of course do not hold where distortion is permitted.[1]

[1] A method for locating the load line corresponding to exactly 5% distortion by means of a simple rule will be found in the article, "The Use of the Distortion Rule in Power Output Calculation," in this issue. Since 5% is considered the maximum permissible distortion in practice, the application of this rule in locating the load line greatly simplifies the operation of determining the power output and load resistance as well as calculations for modulator characteristics. The "cut and try" method of locating the load line for various degrees of distortion is given on page 28, July, 1929, *QST*.

At plate voltages below 375 volts the output is not limited by the plate dissipation as with the higher values of plate voltage and the maximum power output is obtained when the load resistance is twice the plate resistance for the particular value of plate current being used.

MODULATOR

The UV-845 has its greatest appeal to the amateur in its capacity as a modulator in the

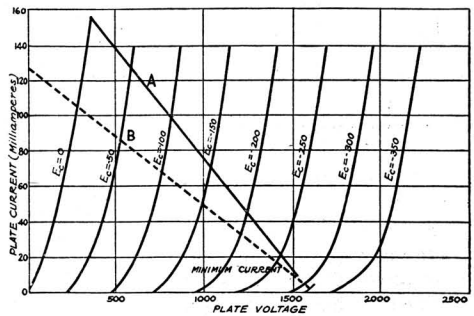

FIG. 4. — PLATE-VOLTAGE PLATE-CURRENT CURVES ON WHICH ARE PLOTTED THE LOAD LINES

"A" is the load line for the UV-845 as a linear amplifier with maximum conditions for obtaining maximum undistorted output. "B" is the load characteristic for the tube used as a modulator with a low value of oscillator or Class C amplifier plate current.

constant current system. It is admirably suited to such use in conjunction with a UV-203-A or UV-211 as the oscillator or Class C modulated radio-frequency power amplifier. With 75 milliamperes at 1000 volts plate input to one of the latter tubes used as a Class C radio-frequency power amplifier, a single UV-845 is capable of modulating better than 60% when the same plate voltage is applied to both modulator and r.f. tube and considerably more when the system using a higher plate voltage on the modulator than on the r.f. amplifier is employed.

	Amplifier or Modulator	
	UV–845	*UV–211*
Filament volts	10	10
Filament amperes	3.25	3.25
Plate voltage	1000 (normal)	1000 (normal)
	1250 (maximum)	1250 (maximum)
Negative grid bias (volts)	150	55*
Safe plate dissipation (watts)	75	75
Amplification constant (μ)	5	12
Plate resistance (ohms)	2100	3400*
Maximum undistorted output as amplifier (watts)	20	10
Oscillator or Class C amplifier input watts for each tube used as modulator (Mod. factor 0.6)	120	45

*When the UV-211 is used as a modulator the negative grid bias should be increased to 70 volts with the normal plate voltage of 1000. Under these operating conditions the plate resistance is approximately 5500 ohms.

As explained in the article on the UX-842 (page 29, July, 1929, *QST*) the load characteristic for the tube when used as a modulator may be plotted on the plate-voltage plate-current characteristics as shown at B in Fig. 4. The load line is extended to the vertical axis and the value of current at this intersection is the sum of the modulator and oscillator plate currents. For the line shown at B, the d.c. modulator plate current chosen is 50 milliamperes, the plate voltage is 1000 and the minimum current is 4 milliamperes. These points fix the operating point and a line is drawn through it and through the intersection of the intersection of the curve for twice the grid bias of the operating point with the minimum current line. The point at which this line intersects the zero plate voltage line (vertical axis) is the sum of the oscillator (or modulated amplifier) and modulator plate currents or 127 ma. The difference between this current and the

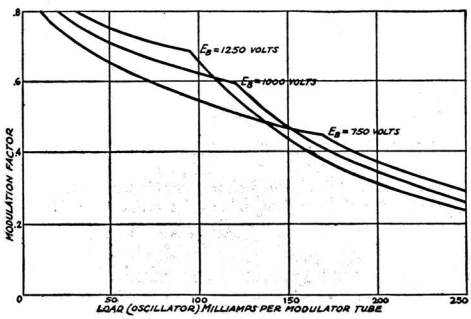

FIG. 5. — CURVES SHOWING THE PERCENTAGE OF DISTORTIONLESS MODULATION OBTAINABLE AT DIFFERENT VALUES OF OSCILLATOR OR CLASS C AMPLIFIER PLATE CURRENT FOR THREE VALUES OF PLATE VOLTAGE

modulator plate current chosen, 50 ma., is the oscillator or amplifier plate current, 77 ma. in this case. The modulation factor is then:

$$M = \frac{E_{max} - E_{min}}{2E_o}$$

where: M = Modulation factor.
E_o = Voltage of operating point.
E_{max} = Voltage at minimum current point.
E_{min} = Voltage at intersection of load line and zero bias line.

$$M = \frac{1600 - 280}{2(1000)} = .66$$ (Percentage of modulation is this value × 100 or 66%.)

The grid bias is seen to be 155 volts and the peak grid swing the same value.

In following the above method it will be seen that the maximum safe plate dissipation of the modulator (75 watts) can be exceeded with high values of oscillator current. It is therefore best to fix the operating point at the safe value of modulator plate current, 75 milliamperes at 1000 volts. A straight line drawn through this point and the sum of a chosen value of oscillator current plus the fixed modulator current on the vertical axis is the load characteristic for the value of oscillator current chosen.

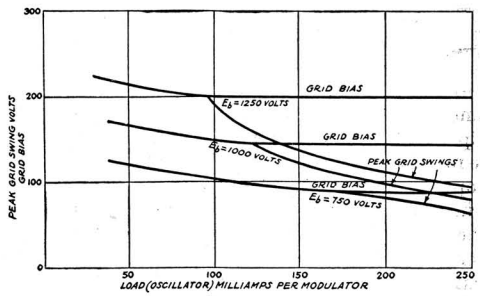

FIG. 6. — PEAK GRID SWING AND GRID BIAS VOLTAGES PLOTTED AGAINST OSCILLATOR OR CLASS C AMPLIFIER PLATE CURRENT FOR THREE VALUES OF PLATE VOLTAGE

Grid bias and grid swing are coincident to the left of the junction points.

Fig. 5 shows the percentage of distortionless modulation obtainable at different values of oscillator current per modulator tube for three different values of plate voltage. From these same curves the number of modulator tubes required to give a desired percentage of modulation with a given value of oscillator or r.f. amplifier plate current can be determined. The same d.c. plate voltage on modulator and modulated rubes is assumed. Irrespective of the number of modulator tubes employed, however, the modulation factor of 1.0 (100%) cannot be obtained unless the d.c. plate voltage of the modulator is higher than that of the oscillator or modulated r.f. amplifier.[1] Fig. 6 shows the peak grid swing and grid bias voltages for the values of plate voltage and oscillator plate current of Fig. 5. In determining these curves the oscillator plate circuit is considered a resistance load in parallel with the plate resistance of the modulator tube, both being supplied from the same source of power through a modulation choke of infinite impedance.

Due to the comparatively low plate impedance of this tube, every precaution should be taken to guard against loss of grid bias, since the excessive plate current drawn under this condition would almost instantaneously wreck the tube. When two or more tubes are operated in parallel or push-pull, a non-inductive resistor should

(*Continued on page 60*)

[1] When a higher plate voltage is applied to the modulator than to the oscillator or Class C amplifier, 100% modulation can be obtained with proper circuit conditions. Transmitters employing this system of modulation have been described in the April and September, 1929, issues of *QST*.

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be connected in the grid lead to each tube. These may have a resistance value of 100 ohms each and should be connected as near to the tube grid terminals as possible. This precaution will preclude the possibility of the tubes oscillating at ultra-high radio frequencies.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912, of *QST*, published monthly at Hartford, Conn., for April 1, 1929.

State of Connecticut } ss:
County of Hartford }

Before me, a Notary Public in and for the State and county aforesaid, personally appeared K. B. Warner, who, having been duly sworn according to law, deposes and says that he is the business manager of *QST* and that the following is, to the best of his knowedge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 411, Postal Laws and Regulations, printed on the reverse of this form, to wit:

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