

The UV-861

A Screen-Grid Tube for the High Power Amateur Transmitter

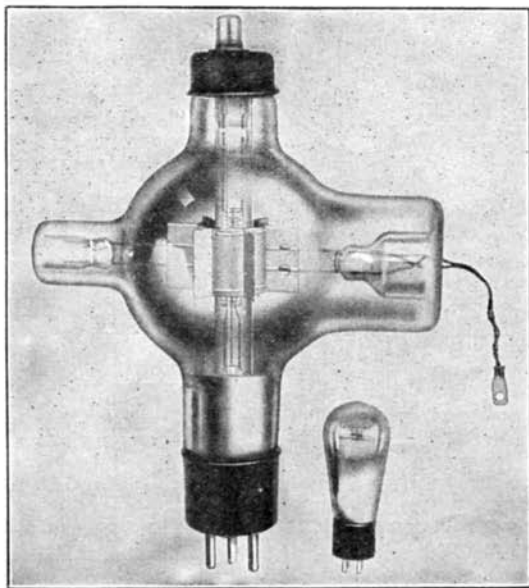
By Harold P. Westman, Technical Editor

SOME months ago we described a 75-watt screen-grid power amplifier tube known as the UX-860. The UV-861 has in relation to this tube been correctly designated for most assuredly it goes the 860 one better—and a good one at that! To begin with, its rated output is 500 watts, seven times that of the 860 and its size dwarfs practically all other glass-envelope air-cooled tubes with which the amateur is familiar. Even the 204-A, long considered a Jumbo, seems but a trifle by its side.

The 861 is designated primarily for use as a radio frequency power amplifier in transmitting circuits. As such it requires no neutralization to prevent self oscillation because the employment of the fourth element, a screen-grid, reduces the effective capacity between the control-grid and plate to but 0.50 μ fd. For stable operation though the external circuit capacity should be kept as low as possible.

As can be seen from the photograph of the tube, it partakes of the appearance of both the 860 and the 204-A. In addition to the three large arms such as is found on the 860, there is a fourth arm of somewhat smaller proportions which acts as a support for the plate assembly. The two opposing large arms are based much as is the 204-A although the circuit connections are not the same as for that tube. The two horizontal arms support the plate which is mounted upon four metal rods. Two of these rods are sealed into a stem in each of the arms. Neither of these arms is based

and the plate lead which is made up of two heavy twisted wires is taken through a seal in the larger arm. These plate leads should be twisted to prevent heating in one. This type of tube construction allows separate stems and seals to be employed upon which the various elements are mounted. The result of this greater spacing is shown in the very low capacity and high insulation resistance between the elements which makes the structure so suitable for high frequency operation.



THE UV-861

The tube alongside of it is not a 204-A as one might suppose; it is a UX-210. A further idea of its size might be realized when it is considered that this tube is several inches too long to be accommodated in the mounting for a 204-A. It truly is a he-man affair!

FILAMENT

As in practically all the power tubes being manufactured today, a thoriated tungsten filament is employed. For normal operation a current of 10 amperes at 11 volts is required to heat it to the proper temperature. It is recommended that it be operated at a constant voltage as under this condition maximum operating life will be obtained. The running of the tube with less than normal voltage is not desirable as it may result in a loss of emission because the electrons are being absorbed at a faster rate than they are being

supplied to the surface of the filament from its interior. The use of too high a filament voltage will cause a rapid reduction in its diameter and the life will be ended by burn-out.

The filament is supported by a single centrally located rod and because it is constructed in the shape of a double spiral or helix, it requires no tension spring whatever. This obviates the necessity of an additional support from the opposite end of

the tube in the stem of which is mounted the control grid. Such an additional support, if needed, would tend to increase the capacity between the two elements as well as reduce the resistance between them.

REACTIVATION

Fig. 1 shows the current vs. voltage characteristics of the filament. Two other curves taken for values of $+5\%$ and -5% are also shown. In Fig 2 values are plotted for the emission and filament efficiency.

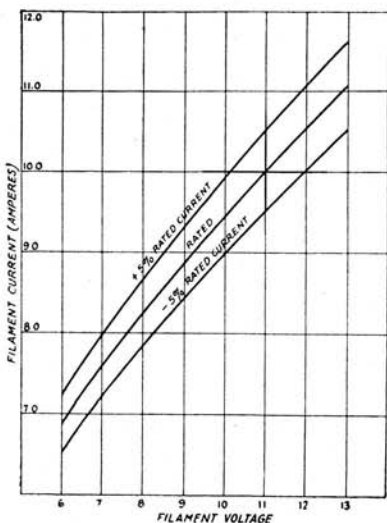


FIG. 1. FILAMENT CHARACTERISTICS ARE GIVEN FROM WHICH THE FILAMENT CURRENT FOR ANY FILAMENT VOLTAGE MAY BE OBTAINED

For convenience in calculation, curves are shown for a 5% increase and 5% decrease from the rated values.

The total emission at the rated voltage is approximately 10 amperes and the efficiency at this point is roughly equivalent to 100 milliamperes plate current per watt of filament power.

A loss of emission may be the result of an overload, insufficient filament voltage or such abuse and if no large amount of occluded gas has been driven out of the elements, it is possible to reactivate the filament by operating it at the rated voltage for ten minutes with the other electrodes free. The reactivation process may be hastened by raising the voltage to 13. Under no conditions should higher voltages be employed. The tube should be so mounted that the filament is in a vertical position; either end may be uppermost.

Whenever possible, alternating current should be used for filament heating with plate and grid returns made to a center tap on the filament heating transformer.

If it is absolutely necessary to operate the filament from a direct current supply, the plate and grid returns should go to the positive leg of the filament. The filament terminates in the two prongs of a mounting similar to a 204-A grid base which caps the lower arm of the tube.

CONTROL GRID

The control grid is cylindrical and surrounds the filament. It is mounted upon four longitudinal rods and is of a comparatively coarse mesh. The effect of the control-grid voltage upon plate current for various values of plate voltage is shown in Fig. 3. From this curve it may be seen that the plate current changes but slightly for large changes in plate voltage. In Fig. 4, the effect of the control-grid voltage upon the plate current is shown for several values of screen-grid voltage and a plate voltage of 3,000. In operation the control-grid bias may be obtained by means of either a biasing battery or grid leak resistor. The control-grid terminates in what would be the plate terminal of a 204-A base.

PLATE

The plate is circular and is equipped with six generous fins or wings which allow rapid dissipation of heat and in consequence, a

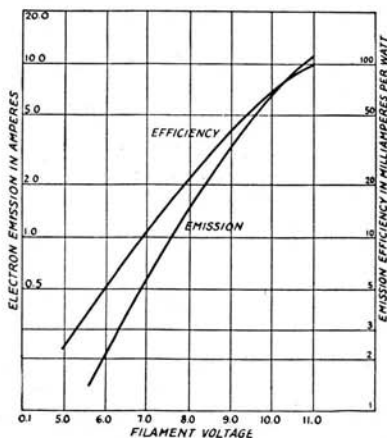


FIG. 2. THESE CURVES SHOW THE AMOUNT OF EMISSION AND THE EFFICIENCY OF THE FILAMENT AS AN EMITTER FOR VARIOUS VALUES OF FILAMENT VOLTAGE

At the operating voltage the total emission is about ten amperes, the efficiency being equivalent to 100 milliamperes of plate current for each watt of heating energy.

greater output rating than could be obtained with a plain plate. The plate dissipation should never exceed 400 watts which corresponds to a cherry red coloring. While the normal plate voltage is 3,000, it may be operated at as high as 4,000 volts

when used as an oscillator that is not being modulated. The plate dissipation under these conditions remains the same and no coloring brighter than a cherry red should be considered as indicative of proper operation. Due to the high allowable dissipation, free circulation of air about the tube is essential. When being overloaded, the use of forced ventilation is recommended to increase the factor of safety against breakdown. The tube should never be mounted in a cabinet or box restricting ventilation nor should it be placed in contact with anything or be subjected to spray or drops of liquid.

SCREEN-GRID

The screen grid is mounted just within the plate and consists of a cylindrical helix of wire supported upon four rods fastened to collars that are clamped to the stems of the base arms. The screen runs the full length of the tube, effectively shielding the plate from the other elements. It terminates at the grid pin of the 204-A base. A high capacity between the filament and

The d.c. screen voltage should be kept as low as practical and is normally about a quarter of the plate voltage. It is desirable

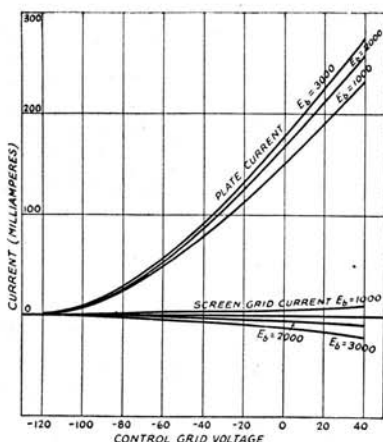


FIG. 4. THESE CURVES WERE OBTAINED WITH A PLATE VOLTAGE OF 3,000 AND SHOW THE EFFECT OF THE CONTROL-GRID VOLTAGE UPON PLATE AND SCREEN CURRENT FOR THREE VALUES OF SCREEN POTENTIAL.

As may be seen, the screen voltage has much more effect upon the plate current than has the plate voltage, curves for which appear in Figure 3. The screen current is extremely small or negative over the range of control-grid voltage plotted.

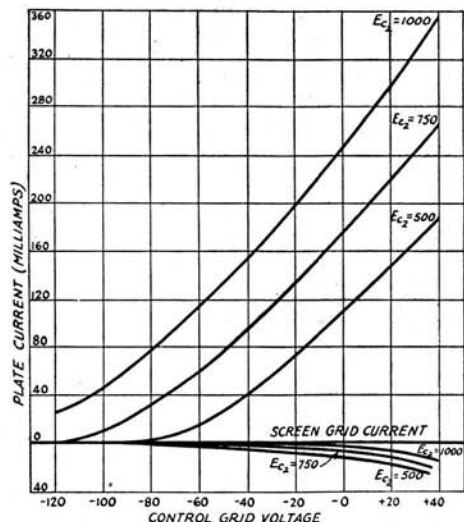


FIG. 3. THE EFFECT OF THE CONTROL-GRID VOLTAGE UPON THE PLATE CURRENT FOR THREE VALUES OF PLATE VOLTAGE IS SHOWN HERE

These curves differ from those obtained with a triode chiefly in that the increase of plate voltage has but a small effect upon the plate current. The screen voltage in all cases was 750 and a negative screen current is obtained at plate voltages of 2,000 and 3,000 for all values of control-grid voltage less than about 100 volts negative.

screen grid is desirable and a large by-pass condenser should be connected across these elements close to the tube. The screen should be at ground potential as far as radio frequency currents are concerned.

that this voltage be obtained from the plate supply. A potentiometer arrangement will be most satisfactory. Under no conditions should the plate voltage be removed while the screen voltage is still applied as the screen will then act as the plate of a three-electrode tube and the screen current will increase greatly resulting, perhaps, in its destruction. The amount of energy dissipated in the screen should never exceed 35 watts which, as in the case of the plate, corresponds to a cherry red coloring. Figs. 3, and 5 show values of screen current under various conditions; those proper for normal operation give little or no current in this circuit.

A tabulation of the general characteristics is as follows:

Filament volts	11.
Filament amperes	10.
Normal plate volts (d.c.)	3,000.
Max safe screen dissipation	35. watts.
Max safe plate dissipation	continuous
	400. watts.
Rated output	750. watts.

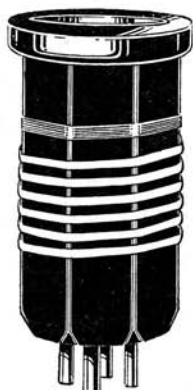
With a filament voltage of 11, a plate voltage of 3,000, a screen voltage of 750 and a control-grid voltage of 0, these values are obtained:

Amplification constant	300.
Plate impedance	133,000. ohms.
Mutual conductance	2.25 ma/v

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with the ungrounded side of the filament circuit, the flashlight lamp will blow for "about twenty cents worth," instead of four nine tubes for "ten or fifteen dollars worth."

In concluding it may be said that, although the receiver has so far been given only a brief test, it promises to live up to the reputation set by Mr. Hull's original model.

The UV-861

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The direct interelectrode capacities measured according to I.R.E. definition are:

Plate to control-grid (filament and screen together) 0.05 μ fd.

Control grid to filament and screen 17. μ fd.

Plate and filament to screen 13. μ fd.

To the man who is desirous of employing all the power the law will allow and

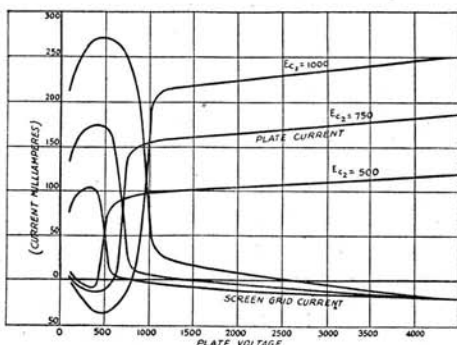


FIG. 5. THIS FAMILY OF CURVES SHOWS THE EFFECT UPON PLATE AND SCREEN CURRENT OF VARIATIONS IN PLATE POTENTIAL.

They show the characteristic dynatron kinks where the plate voltage is lower than the screen voltage.

who is using crystal control or some other form of oscillator-amplifier arrangement, this tube should prove a boon. The main requirement will be for a husky power supply from which to run it!

An Examination of A. C. Plate Supply

(Continued from Page 27)

condition of precise adjustment. The advent of the new mercury vapor rectifier tubes, of course, has introduced an important factor into the case. By avoiding the particular difficulties of adjusting the self-rectified to the standard of performance required at present, the installation of such rectifiers may be the more practical solution to the plate supply problem at all times. In the past, self rectification for the higher voltage tubes was justified by the scarcity and high cost of suitable rectifiers. We sincerely hope that we are correct when we say that this condition no longer exists.