

Cunningham RADIO TUBES

BULLETIN

Type C-324 Tube

SCREEN GRID AMPLIFIER AND DETECTOR



C-324 is a special purpose tube designed primarily as a radio frequency amplifier and high output bias detector. The design is similar to the design of type CX-322 in that it has a second grid of novel design which extends between the usual grid and plate and is also carried over the outside of the plate to give extremely good shielding between the control grid and the plate. The grid plate capacitance has been reduced to .01 mmfds. maximum allowing high amplification per stage without neutralization.

This tube has a uni-potential cathode heated by means of a heater filament operated on 2.5 volts A. C. requiring a current of 1.75 amperes. This tube has been designed to operate at plate voltages between 135 volts and a maximum of 180 volts. The screen grid voltage should not exceed 75 volts. The control grid is brought out at the top of the bulb as in the CX-322.

BULB

The bulb provided for the C-324 is the standard S-14 bulb having a maximum diameter of 1-13/16". The maximum overall length is 5 1/4" from the end of the base contact pins to the top of the control grid connections base.

BASE

The standard 5 prong base is used for the plate, screen grid, cathode, and two heater connections. This base is similar to the one employed on type C-327. The control grid is brought out at the top of the bulb to a special contact cap having a maximum diameter of .369". The control grid connection is made in this way to allow easy connection by means of a slotted cap which is placed over it. The base connections are shown in Fig. 8.

CATHODE-HEATER

The cathode is made of a small metal cylinder coated with the emission activating material. The heater or filament is placed

inside of the cathode. No connection is made between the cathode and heater in the tube.

ELEMENTS

The control grid is placed next to the cathode in the same way as used in the ordinary three electrode tube. The screen grid is placed between the control grid and plate and also extends on the outside of the plate to give complete plate-control grid shielding. The plate is cylindrical and slightly smaller in diameter than the outer section of the screen grid.

OPERATING CONDITIONS

Heater voltage	2.5	2.5 volts
Heater current	1.75	1.75 amperes
Plate voltage	180	180 volts maximum
Control grid voltage...	-1.5	-3.0 volts maximum
Screen grid voltage....	75	90 volts maximum

AVERAGE TUBE CHARACTERISTICS

Tube characteristics at above operating conditions.

Amplification factor ...	420	400
Plate resistance	400,000	400,000 ohms
Mutual conductance...	1,050	1,000 micromhos
Plate current	4.0	4.0 milliamperes

USE—AS A RADIO FREQUENCY AMPLIFIER

In order to obtain stable operation in circuits designed to give normal gain per stage it is necessary to use shielding to separate the input and output circuits. The internal shielding of the tube makes neutralization unnecessary providing extraneous external couplings are eliminated by means of shielding. Suitable ventilation must be provided through the shielding to prevent excessive tube temperatures. Radio frequency filters should be used in circuits employing more than two stages and also in circuits which are designed to give the maximum amplification per stage. The high plate circuit impedance necessary for obtaining the normal amplification may be obtained either with closely coupled RF transformers or by means of the tuned plate impedance method. At broadcast frequencies a voltage amplification from 50. to 100. per stage can be obtained. To prevent regeneration or oscillation in a two stage radio fre-

quency amplifier, the amplification should not exceed 100. per stage at the highest broadcast frequencies.

The volume of the RF amplifier may be controlled by a potentiometer control on the screen grid voltage so that the screen grid voltage may be varied between zero and plus 75 volts. Control grid voltage adjustment may also be used as volume control providing the control grid bias is always greater than 1.5 volts negative. The negative grid bias maintains high input resistance, resulting in good gain and selectivity of the preceding circuit.

USE—AS A DETECTOR

The C-324 is an excellent bias detector either with small signal or high signal input. The screen grid voltage and control grid bias should be so chosen that the control grid does not swing to a point where grid current is drawn. For small RF signals when a first audio stage is used it is best to operate the screen grid at 35 or 45 volts and the control grid at minus 3.5 or 4.5 volts, respectively. The output under this condition into a 200,000 ohm load choke fed with one volt RMS radio frequency input modulated 22%, is 5.5 volts RMS audio output. With 75 volts on the screen grid and a control grid bias voltage of 7.5 volts the audio output at the point where grid current starts is 49.5 RMS audio voltage output with an input of 4.28 volts RMS with 22% modulation. This is more than sufficient to operate a CX-345 to full output by means of direct coupling; or two CX-345 tubes in push pull by means of a low gain audio stage.

CURVES AND DATA—(Pages 36, 37 and 38)

Fig. 1 shows the filament current and emission variation with filament voltage.

Fig. 2 shows the average plate current over a range of screen grid voltages at various control grid voltages. A curve also of the screen grid current is plotted for the control grid voltage of negative 1.5 volts.

Fig. 3 shows the variation of amplification factor, plate resistance, and mutual conductance for various control grid voltages at screen grid voltages of 75 volts and plate voltage of 180 volts.

Fig. 4 shows the variation of amplification factor, plate resistance and mutual conductance with various screen grid volt-

ages at a control grid voltage of minus 1.5 volts and plate voltage of 180 volts.

Fig. 5 shows the variation of plate current with plate voltage for various control grid voltages at screen grid voltage of plus 75 volts.

Fig. 6 is similar to Fig. 5 except it has been plotted with a screen grid voltage of plus 45 volts.

Fig. 7 shows the detector action in audio frequency volts output against radio frequency input, both measured in RMS volts. The point where grid current starts to flow is noted on each curve. Curve A was taken at a plate voltage of 180 volts, a screen voltage of plus 45 volts and a control grid voltage of minus 4.5 volts. The plate voltage was fed through a high impedance choke and the resistance load so chosen to give a total plate circuit impedance of 200,000 ohms with a power factor of .96. The DC resistance of the choke was 3,000 ohms. Curve B was taken with the same circuit at a screen grid voltage of plus 75 volts and control grid voltage of minus 7.5 volts.

Fig. 8 shows a typical schematic circuit diagram with the C-324 employed as a radio frequency amplifier and detector. One method of shielding the circuits is suggested by the dotted lines.

Fig. 9 and Fig. 10 shows the base and socket connections.

The following are references to some of the articles which have been published describing the performance of the screen-grid tube in radio frequency amplifying circuits:

1. "Some Characteristics and Applications of Four-Electrode Tube," by J. C. Warner, Proceedings of Institute of Radio Engineers, Vol. 16, No. 4, April, 1928.
2. "Application of the Four-Electrode Receiving Tube," by Alan C. Rockwood and B. J. Thompson, Radio Engineering, July, Aug., 1928.
3. "The Screen-Grid Tube," by Keith Henney, Radio Broadcast, Jan., Feb., 1928.
4. "Circuit Analysis Applied to the Screen-Grid Tube," by J. R. Nelson, Proceedings of Institute of Radio Engineers, Vol. 17, No. 2, Feb., 1929.

C-324

AVERAGE CHARACTERISTICS

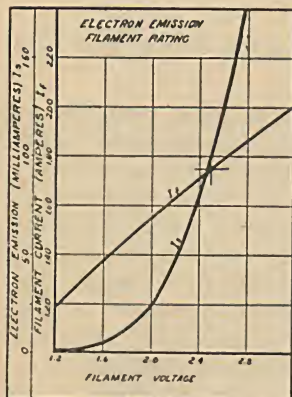


FIG 1

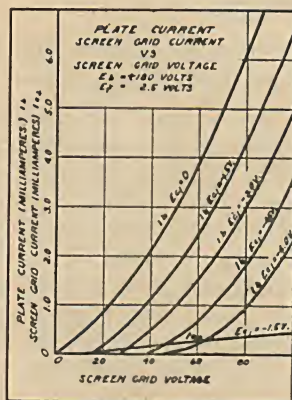


FIG 2

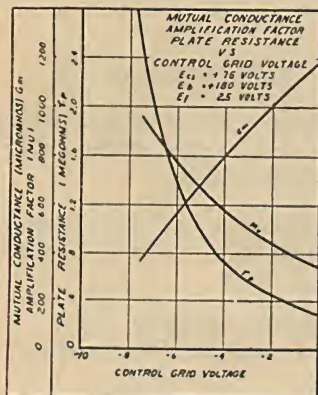


FIG 3

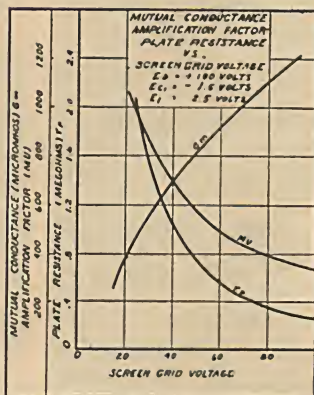


FIG 4

C-324

AVERAGE CHARACTERISTICS

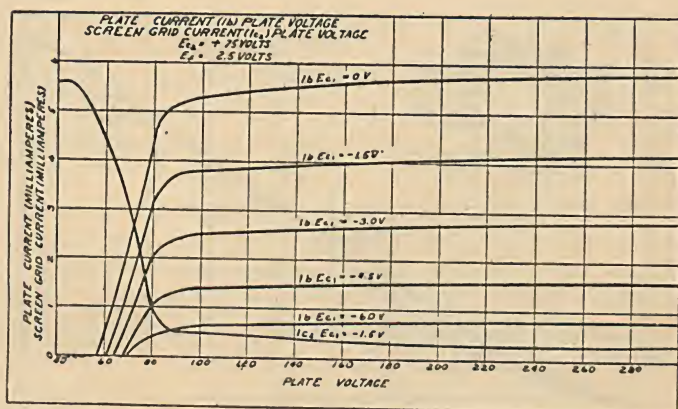


FIG 5

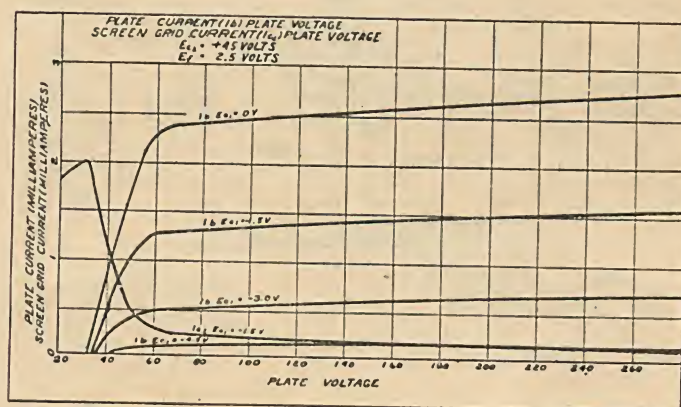


FIG 6

C-324

AVERAGE CHARACTERISTICS

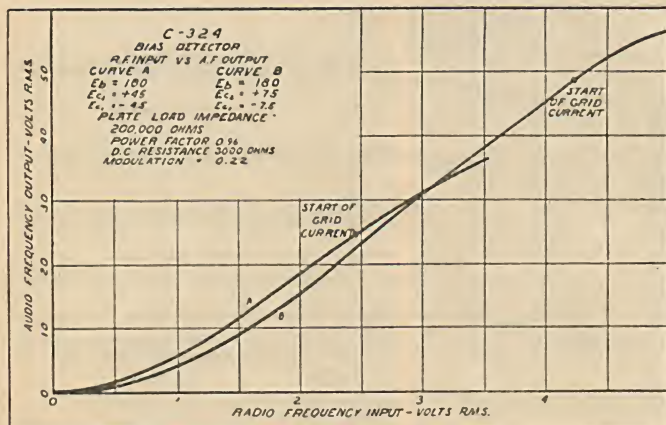


FIG 7

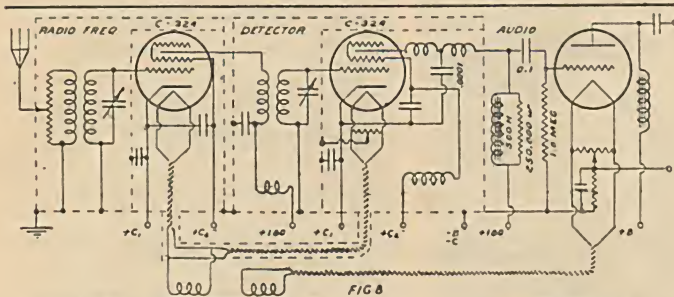


FIG 8

