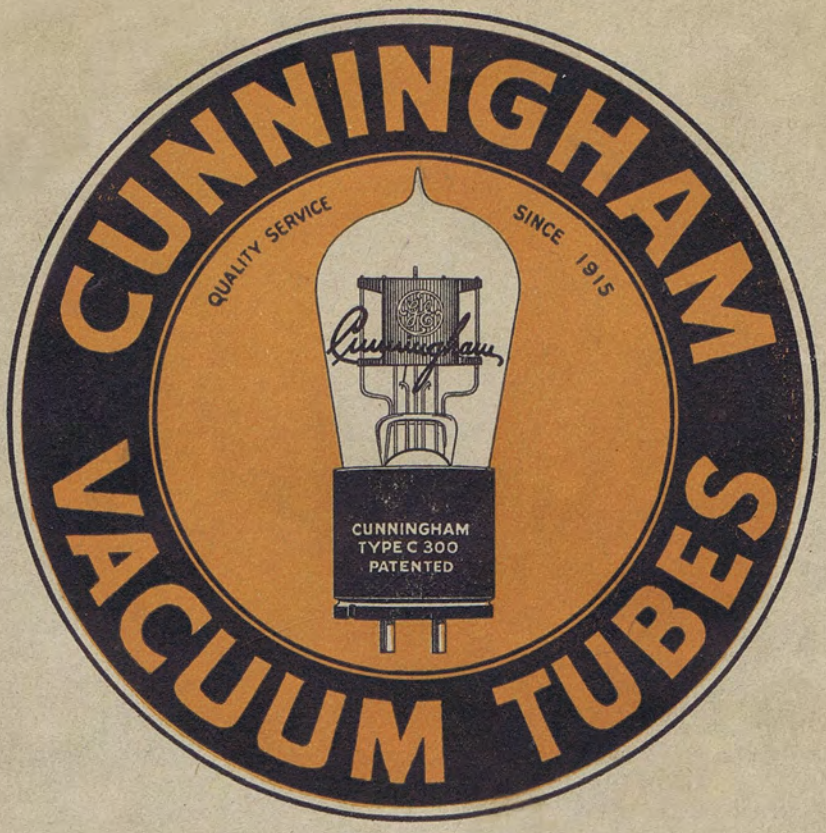

E. J. Cunningham

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February 2015

TCA extends thanks to Col. Larry Daniel, K2MYV, for providing this material.

CUNNINGHAM VACUUM TUBES

1922-1923

PATENT NOTICE

Cunningham tubes are covered by patents dated

11- 7-05, 1-15-07, 2-18-08,
4-12-10, 2-27-12, 4- 2-12,
12-30-13, 7-28-14, 5-18-15,
10-31-16, 6- 4-18, 7-23-18,
12-17-18, 2-18-19

and others issued and pending. Licensed only for amateur or experimental use in radio communication. Any other use will be an infringement.

E. J. Cunningham

Head Office
248 First Street
San Francisco, Calif.

Central and Eastern Sales Office
154 W. Lake Street
Chicago, Illinois.

CUNNINGHAM VACUUM TUBES

Cunningham Tubes are the result of a national demand for tubes that meet the latest and most exacting requirements for all makes of home receiving sets. These quality tubes are manufactured in the great General Electric Laboratories.

When you buy Cunningham Tubes you KNOW that the reputation of one of the world's greatest scientific laboratories is behind them—you KNOW that the highest human and manufacturing skill is combined to insure clearness of reception of all radio messages.

Without thought of expense, the smallest detail is carried out that could possibly improve the quality of these tubes. The remarkable results that are obtained through the use of Cunningham Tubes comes as the result of the extraordinary care and skill that is used in their manufacture.

The trademark GE is the guarantee of these quality tubes. Each tube is built to most rigid specifications in the factories of the General Electric Company.

INTRODUCTION

IN PREPARING this catalog it has been our aim to make it a complete information book regarding the operating characteristics of Cunningham Tubes. For this reason much space has been devoted to graphic illustrations of vacuum tube action. The graphs were prepared in the Research Laboratories of the General Electric Company and each is the average result obtained from tests made with five Cunningham Tubes. In the graphs pertaining to amplification the term "miles" has been used. If a tube is said to have an amplification of 25 miles it means that it would take 25 miles of standard No. 19 gauge telephone cable to reduce the signal to its normal value.

A careful study of these graphs will prove of great value to the operator in obtaining maximum results and maximum life from Cunningham Tubes.

GENERAL INSTRUCTIONS FOR THE CARE AND OPERATION OF CUNNINGHAM TUBES

ALL CUNNINGHAM TUBES are the result of years of research and experimental work by engineers in the great Research Laboratories of the General Electric Co. Each of the five models of Cunningham Tubes as illustrated in this catalog has been designed to give maximum efficiency for a definite use.

The type C-300 is a Gas Content Detector Tube of extreme sensitiveness. It is the most satisfactory tube for use as a detector in both straight and regenerative circuits. The applied filament voltage and the plate voltage are very critical in their adjustment for maximum signal strength as illustrated by the curves in Fig. 3 and Fig. 4. For this reason it is desirable to use a rheostat of low resistance (about 2 ohms) in series with a six-volt storage battery for filament lighting. Such a rheostat will be found to give very fine adjustment over the critical range of the tube. The use of an "A" battery potentiometer, for plate voltage control, as illustrated in Figs. 1 and 2 provides the most satisfactory means of adjusting the plate voltage. A fixed grid condenser of .00025 mfds. capacity and a grid leak of approximately 2 megohms should always be used to obtain maximum efficiency from the C-300 detector tube.

In operating the C-300, set the plate voltage at any value between 18 and 23 volts and gradually increase the filament

temperature until signals are heard, then adjust the tuner and plate voltage for maximum signal strength. Now readjust the filament temperature for maximum signal strength and remember that burning the filament too bright will decrease the audibility of the incoming signals (as illustrated by the curve in Fig. 3) and will greatly decrease the life of the tube.

Figs. 1 and 2 show the two standard types of regenerative receiving circuits most generally used.

The C-301 is a high vacuum amplifier tube of rigid operating characteristics and does not require close adjustment of plate voltage. Any voltage between 40 and 100 volts may be used. When using the higher voltage with a high filament current more amplification is obtained but the life of the tube is shortened due to the higher filament temperature required. This point is well illustrated in Fig. 11. With forty volts on the plate 22 miles of amplification is obtained with a filament potential of 4 volts. With 100 volts on the plate it is necessary to have a filament potential of 4.55 volts to obtain 22 miles of amplification. However, the maximum amplification obtainable at 40 volts is a little less than 25 miles and at 100 volts it is 28.5 miles.

The proper filament current under any conditions is obtained by adjusting the filament rheostat for maximum signal audibility after all other adjustments have been made. When using radio frequency amplification the C-301 will be found to give excellent results as a detector. A possible circuit for such an arrangement is shown in Fig. 9.

The C-302 is a five watt power tube for use as an oscillator

or modulator in a low power transmitter. It may also be used for power amplification in the last stage of an audio frequency amplifier. The filament current should be supplied from an 8 volt storage battery and is normally 2.35 amps. at 7.5 volts. The normal plate potential is 350 volts and in no case should over 450 volts be used. As in the case of the receiving tubes the life of a transmitting tube will be much longer if the tube is consistently operated at the lowest filament temperature at which good results may be obtained.

The C-303 is a 50 watt power tube having a normal filament current of 6.5 amps. at 10 volts. A 12 volt storage battery should be used for filament current supply. The normal plate voltage is 1000 volts. To obtain long life this value should not be exceeded. A study of Fig. 21 will show that there is practically no radiation gained by using over 10 volts at the filament terminals. Always remember that the use of the lowest possible filament current tends to prolong the life of the tube.

The C-304 is a 250 watt power tube designed for long distance transmission. The high plate potential (2000 volts) used with this tube necessitates a special mounting having the plate lead at the opposite end of the tube from the filament and grid leads. Alternating current should be used for lighting the current, which draws 14.75 amperes at 11 volts.

The same operating instructions and precautions outlined for other Cunningham power tubes apply to this tube also.

Cunningham
C-300

Gas Content Detector

THE type C-300 Gas Content Tube is the most satisfactory for use as a detector in both straight and regenerative circuits. The result of years of experimental work by the engineers of the General Electric Company's research laboratories, it represents the high mark of detector tube efficiency. The customary hissing or bubbling has been practically eliminated resulting in a completely quiet receiver in the absence of incoming signals.

For telephone broadcast reception without speech distortion—for obtaining maximum signal strength in long distance work and as a tube having uniform characteristics—the C-300 cannot be surpassed.

SPECIFICATIONS.

Dimensions (over-all)	1¾" x 4 5/16"
Base	4 Prong Standard
Filament Terminal Voltage	5 V.
Filament Supply Voltage	6 V.
Filament Current	1.0 amp.
Plate Voltage	18 to 25 V.
Plate Current	¼ to 1 milli. amps.
Output Impedance	10,000 ohms at 20 volts

Price **$5.00**

Amplifies as It Detects

Short Wave Regenerative Receiving Circuit Range 175 to 700 Meters

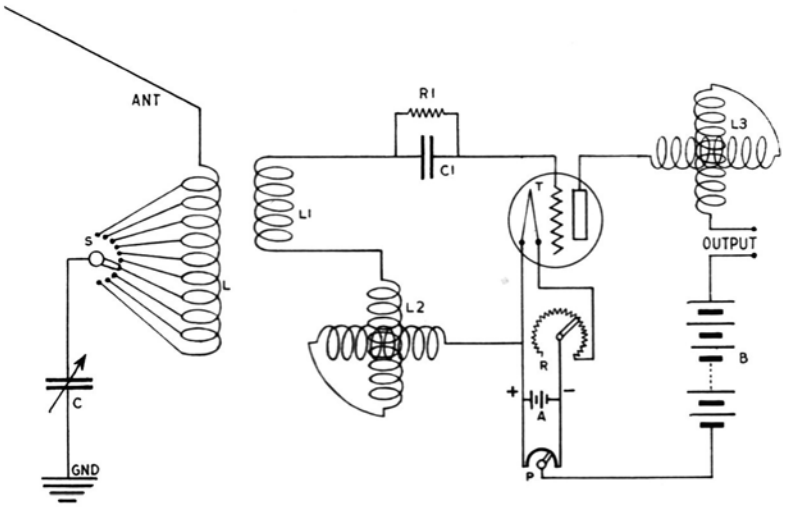


Fig. 1—Variometer type Short Wave Receiver

ONE of the most efficient circuits for telephone broadcast and short wave telegraph reception using the Cunningham C-300 Detector Tube is the vario-coupler variometer type as illustrated in Fig. 1. This type of circuit is the most simple and efficient one to use for telephone broadcast reception but is limited in wave length range. When constructed with standard variometers and vario-couplers the wave length range will be approximately 175 to 700 meters.

PARTS REQUIRED.

T—Cunningham C-300 Detector Tube.
L and L1—Primary and Secondary of vario-coupler.
L2—Variometer.
L3—Variometer.
R—Two ohm rheostat.
A—6 volt storage battery.
B—22½ volt dry battery.
P—"A" battery potentiometer for plate voltage control.
C—Variable condenser of .0005 mfds. cap.
C1—Fixed grid condenser .00025 mfds. cap.
R1—Grid Leak.

Short and Long Wave Regenerative Receiving Circuit Range 150 to 25,000 Meters

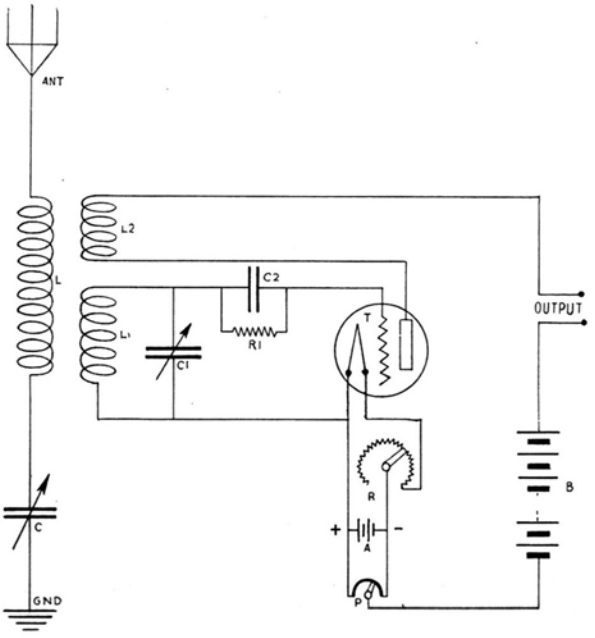


Fig. 2—Universal Receiving Circuit using Compact Inductance Coils

WHEN it is desired to construct a set with the Cunningham C-300 Detector Tube that will be equally efficient on all wave lengths the circuit illustrated in Fig. 2 may be used. This circuit employs the use of three unit inductance coils in a standard 3 coil mounting. The tuning is done with two variable condensers and the sets of coils used may be easily changed for different ranges of wave lengths.

PARTS REQUIRED.

T—Cunningham C-300 Detector Tube.
L1
L2 Compact inductance coils mounted in a standard
L3 3 coil mounting.
C } Variable condenser of .001 mfds. capacity.
C1 }
A—6 volt storage battery.
B—22½ volt dry battery.
R—2 ohm rheostat.
P—"A" battery potentiometer for plate voltage control.
C2—Fixed grid condenser of .00025 mfds. cap.
R1—Grid Leak.

C-300
Audibility versus Filament Voltage

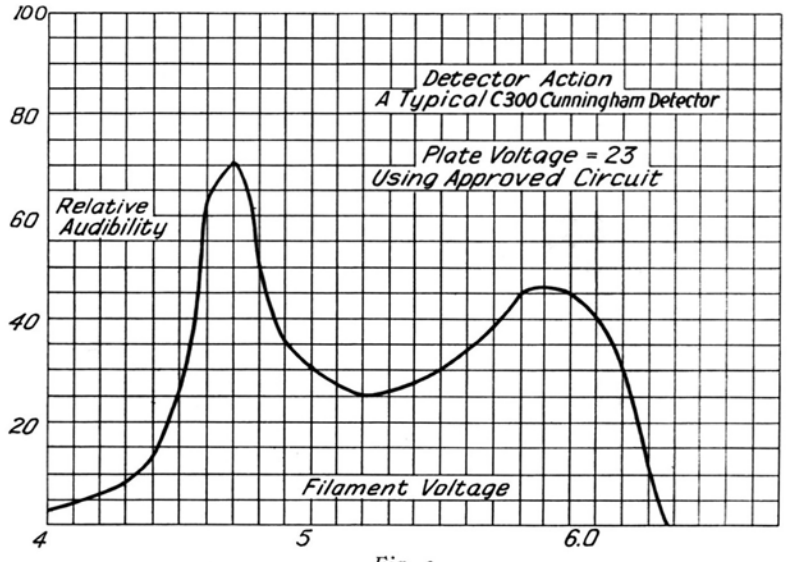


Fig. 3

The above is a graphic illustration of the relative audibility of a C-300 Detector Tube with a varying filament voltage. Note that when using 23 volts on the plate the use of more than 4.7 volts in the filament circuit causes a decrease of audibility.

Audibility versus Plate Voltage

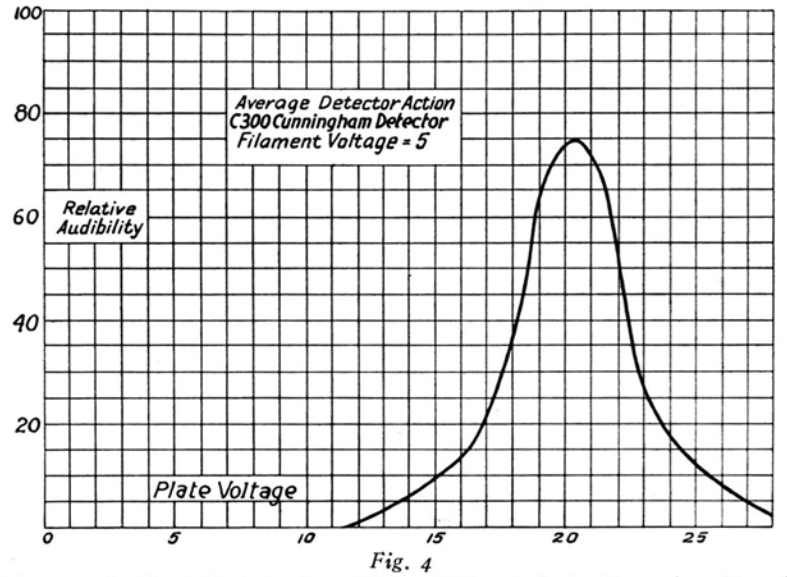


Fig. 4

The curve in Fig. 4 illustrates the relative audibility obtained with varying plate voltage. Note that when using 5 volts in the filament circuit maximum audibility is obtained at a plate potential of 20.5 volts and that slight variations either way cause a considerable decrease in audibility. For this reason the use of an "A" battery potentiometer for plate voltage control is highly recommended.

C-300
Plate Current versus Grid Voltage

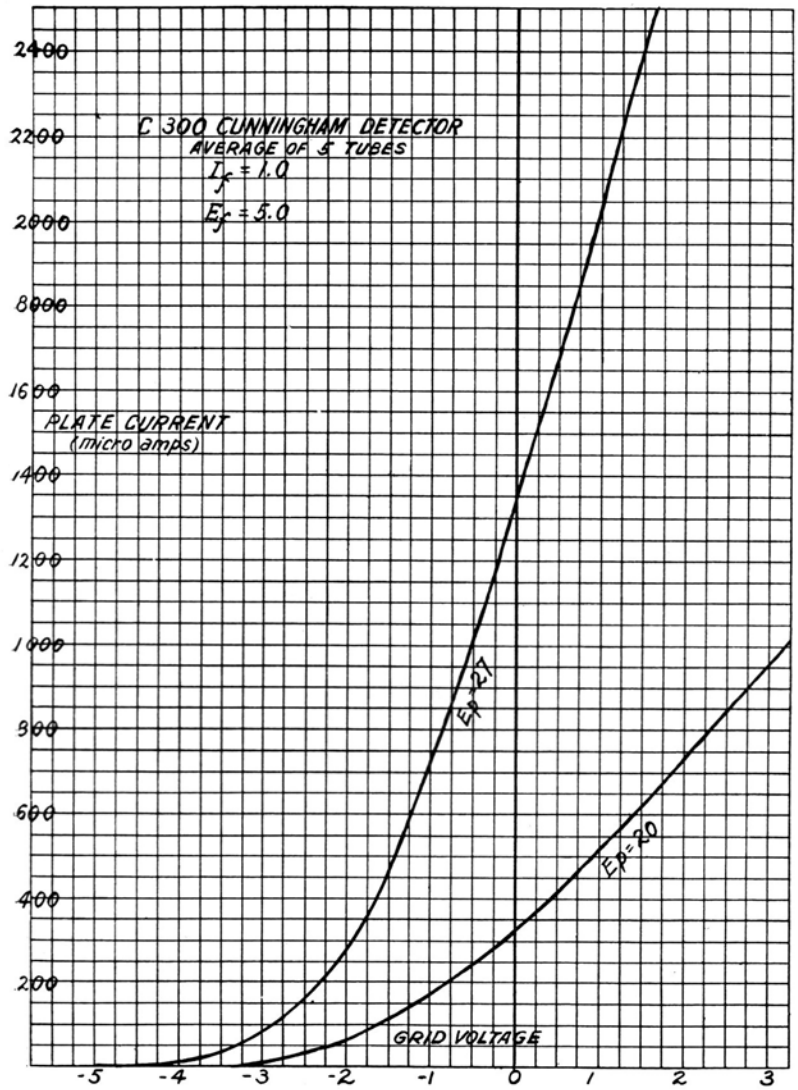


Fig. 5

The curves in Fig. 5 show variations of plate current with variations in grid potential at two fixed values of plate voltage. Note that the point where equal variations of grid voltage cause the greatest difference of plate current variations is several volts negative. The use of a grid condenser and grid leak keep the grid potential at this proper value for detector action.

C-300
Plate Impedance versus Plate Voltage

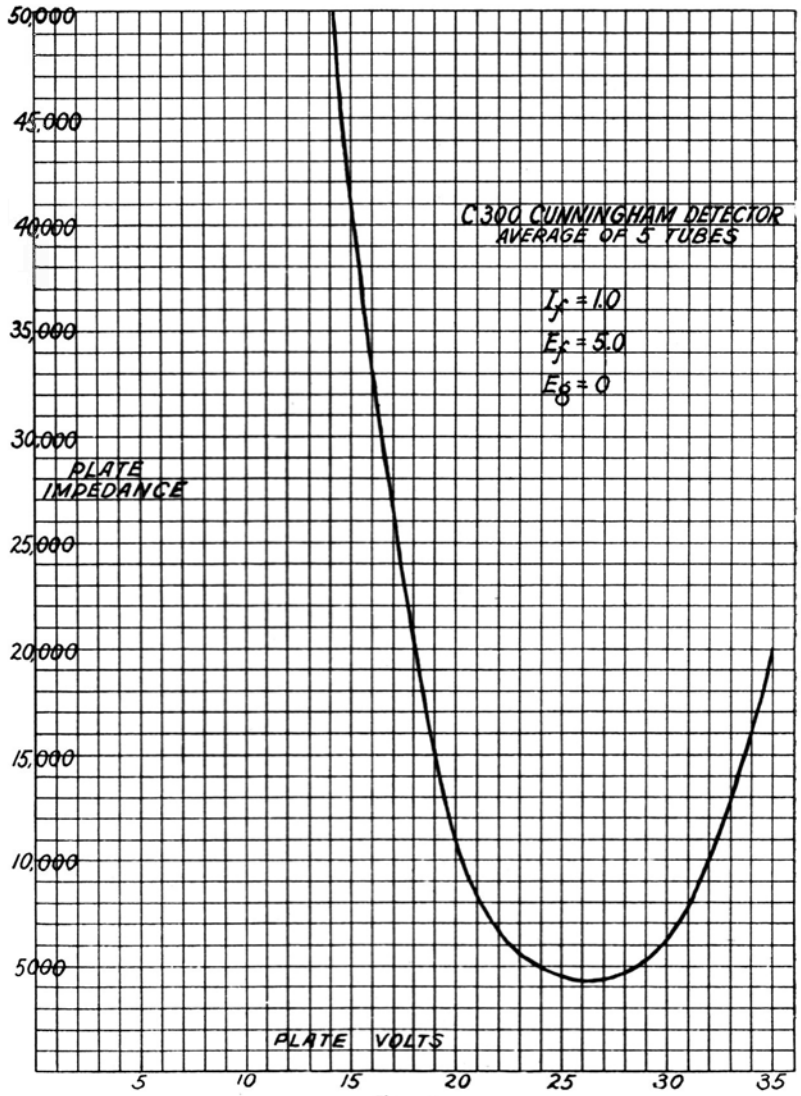


Fig. 6

This curve shows the variations of plate impedance of the C-300 with variations of plate voltage.

C-300
Amplification versus Grid Voltage

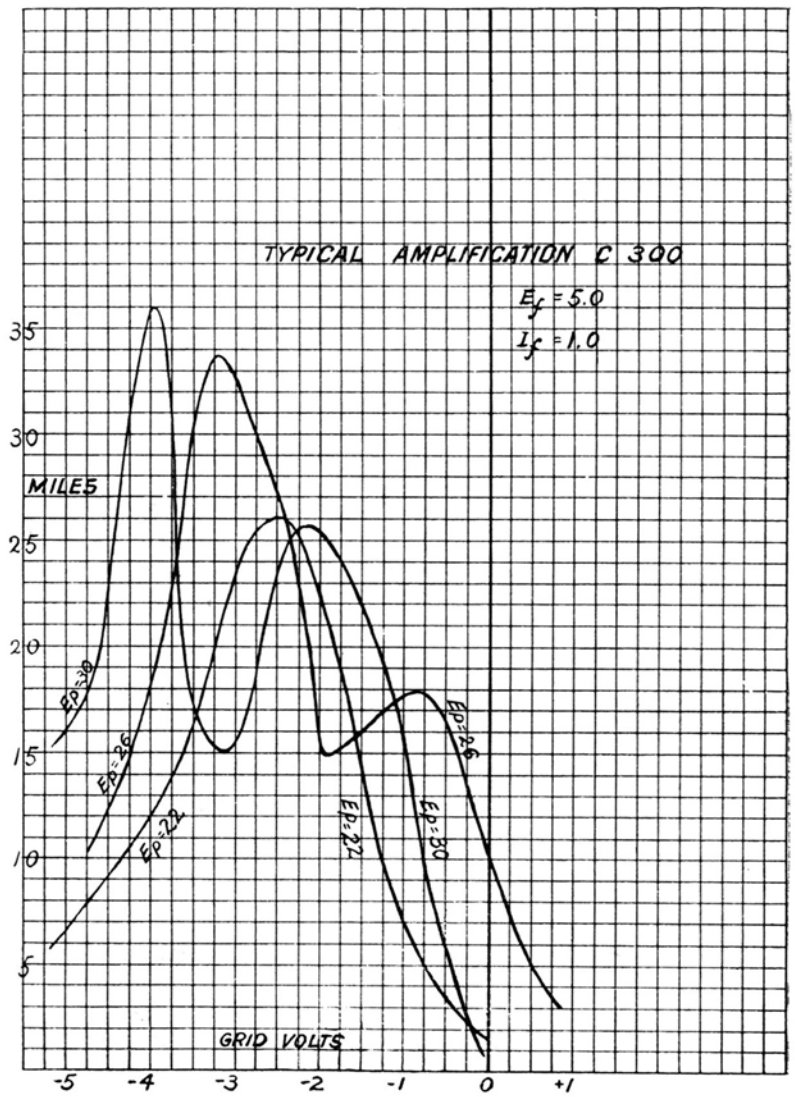


Fig. 7

The three curves in Fig. 7 illustrate the amplification in miles obtained with varying grid voltage of the C-300 Detector Tube for three different fixed values of plate potential.

Cunningham
C-301

High Vacuum
Amplifier

THE Cunningham C-301 High Vacuum Amplifier embodies every qualification necessary to insure quiet operation, a high amplification constant and a long filament life. Designed by General Electric engineers and built in that company's factories to the most rigid specifications, the Cunningham C-301 represents the most efficient type of amplifier tube on the market today.

SPECIFICATIONS.

Dimensions (over-all)	1¾" x 4 5/16"
Base	4 Prong Standard
Filament Terminal Voltage	5 V.
Filament Supply Voltage	6 V
Filament Current	1.0 amp.
Plate Voltage	40 to 100 V
Plate Current	1 to 5 milli. amps.
Output Impedance	21,000 ohms at 40 volts; 14,000 ohms at 100 volts
Amplification Constant	6.5 to 8 at 40 V.; 8 to 10 at 100 V.

Price **$6.50**

Amplifier Circuits

THERE are two kinds of amplifiers in general use—radio frequency and audio frequency. The audio frequency amplifier amplifies the audio frequency current in the plate circuit of the detector tube. This type is suitable for all ordinary purposes and is the one most generally used. Fig. 8 shows the circuit diagram for a two step-transformer coupled audio frequency amplifier. When using loop antenna or receiving signals from distant stations the incoming signal may be too weak to efficiently operate the detector tube. In this case a radio frequency amplifier should be used. Fig. 9 shows a possible wiring for a complete receiving set with a two step, transformer coupled, radio frequency amplifier and a detector, using three C-301 amplifier tubes. The output terminals of this circuit may be connected to either head phones or the input terminals of an audio frequency amplifier such as illustrated in Fig. 8.

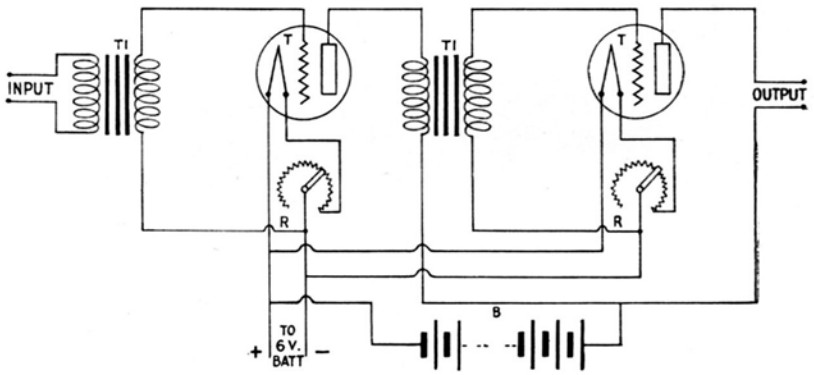


Fig. 8—Two-Stage Audio Frequency Amplifier

PARTS REQUIRED.

T—Cunningham C-301 amplifier tube.
T1—Audio frequency transformer.
R—2 ohm rheostat.
B—40-100 volt dry battery.

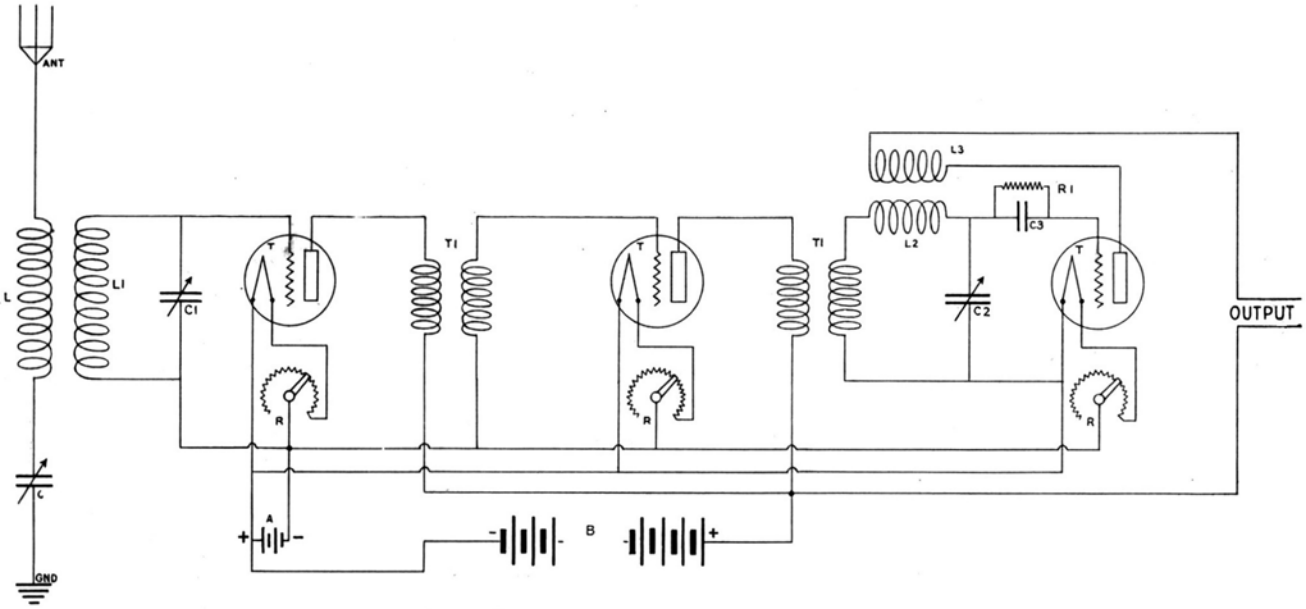


Fig. 9—Two Stage Radio Frequency Amplifier

LC and L1 C1 are the primary and secondary of any receiving circuit. T1 are air core radio frequency amplifier transformers. The inductance L2 and the condenser C2 are of values such as to tune the grid circuit of the detector tube to the incoming wave. The inductance L3 is the usual tickler coil. The three tubes used are all type C-301 and the plate potential may be supplied from a single dry battery of from 40 to 100 volts.

C-301
Plate Current versus Grid Voltage

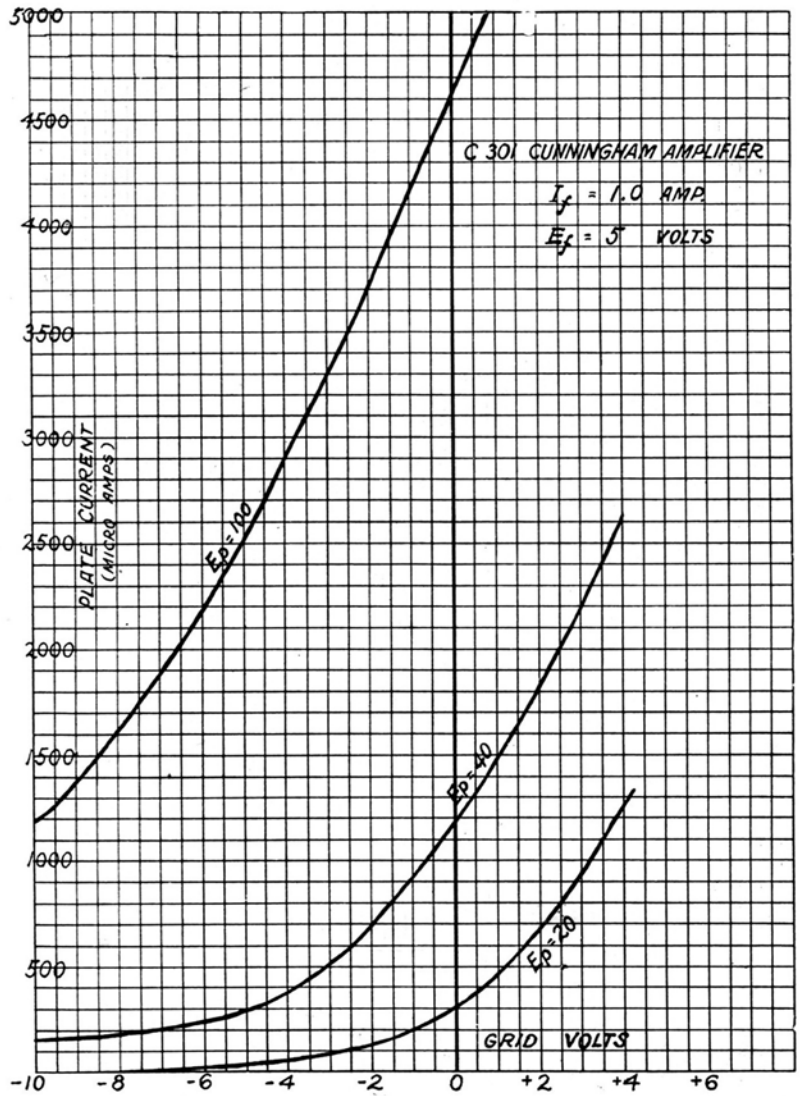


Fig. 10

The three curves in Fig. 10 illustrate variations of plate current with varying grid potential at three different values of fixed plate voltage.

C-301
Amplification versus Filament Voltage

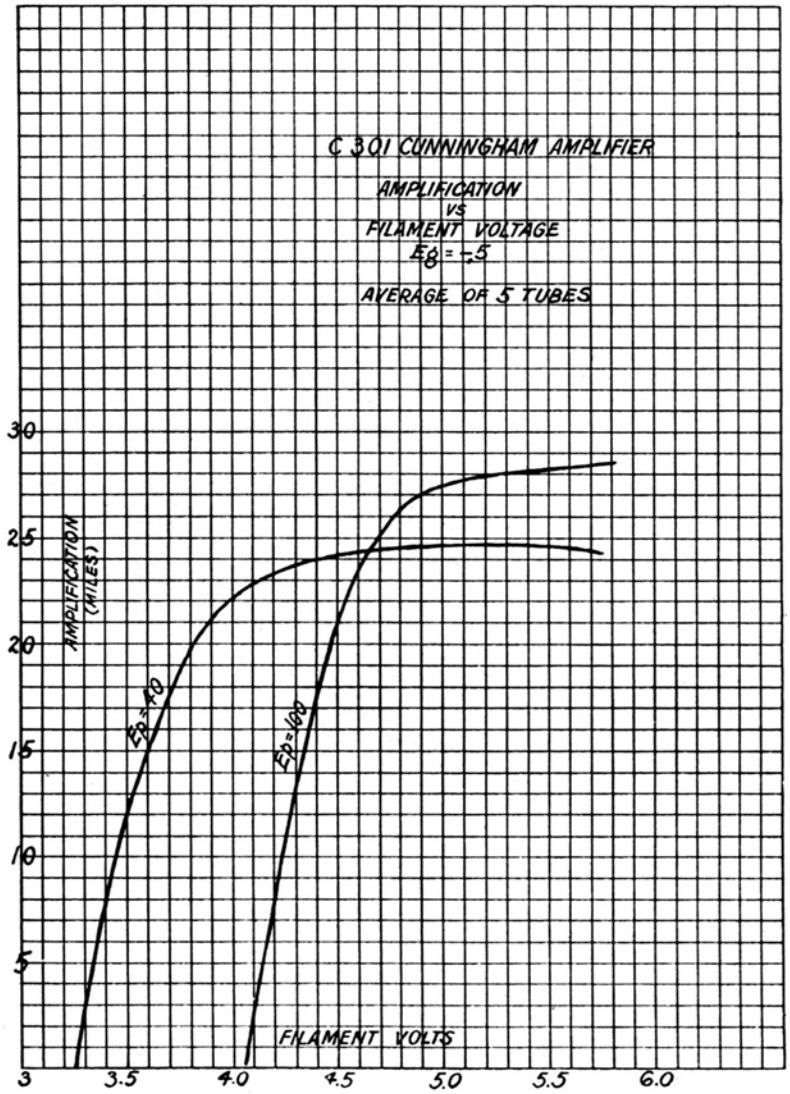


Fig. 11

The curves in Fig. 11 show the amplification in miles with variations of filament voltage at two fixed values of plate voltage. Note that practically no increase of amplification is obtained by using over 4.5 volts in the filament circuit when using 40 volts on the plate or over 5 volts in the filament circuit when using 100 volts on the plate.

C-301
Amplification versus Plate Voltage

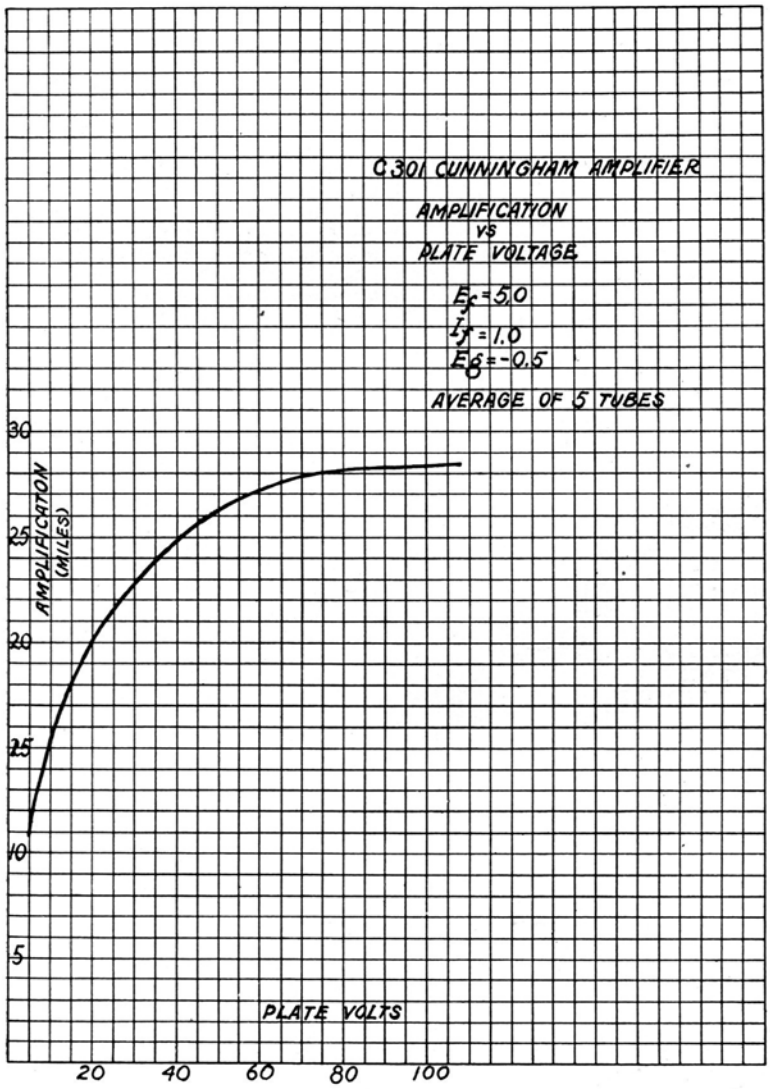


Fig. 12

The curve in Fig. 12 shows the amplification in miles obtained with variations of plate voltage. Note that there is little to be gained by using more than 70 volts on the plate, and that almost as much amplification is obtained at 45 volts.

C-301
Plate Impedance versus Plate Voltage

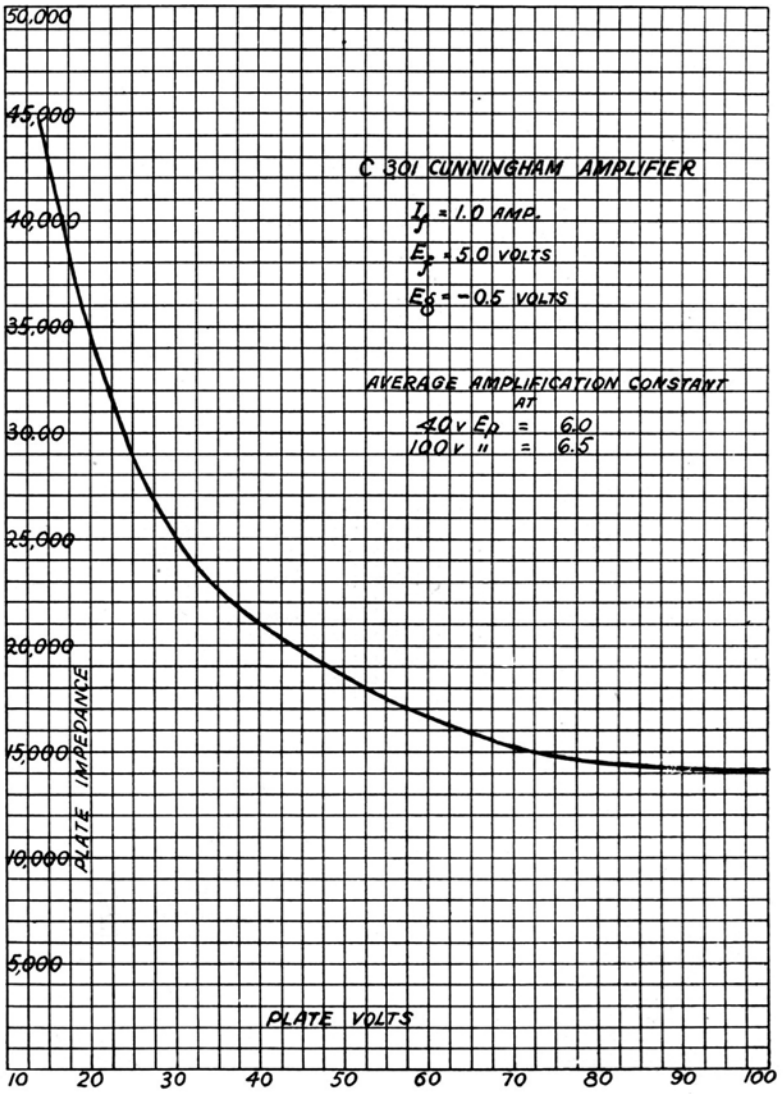


Fig. 13

The curve in Fig. 13 shows the plate impedance of the C-301 at various plate voltages.

Cunningham
C-302

FIVE WATT

POWER TUBE

THE Cunningham C-302 5 watt power tube makes telephone and telegraph transmission within the reach of everyone. Low initial cost, low operating cost and long life make this tube ideal for low power transmission. Two or more tubes may be used in parallel when increased power is desired.

The trade mark G. E. is your guarantee that the Cunningham C-302 was designed by leading vacuum tube engineers and built in the most modern vacuum tube factories in the world.

SPECIFICATIONS.

Dimension (over-all)	2⅛"x5¼"
Base	4 Prong Standard
Filament Terminal Voltage	7.5 V.
Filament Supply Voltage	8 V.
Filament Current	2.35 amp.
Plate Voltage	350 V. normal
Plate Current	.045 normal
Output Impedance	4,000 ohms.
Amplification Constant	7.5
Watts Output	5 normal

Price **$8.00**

C-302
Filament Current versus Filament Voltage

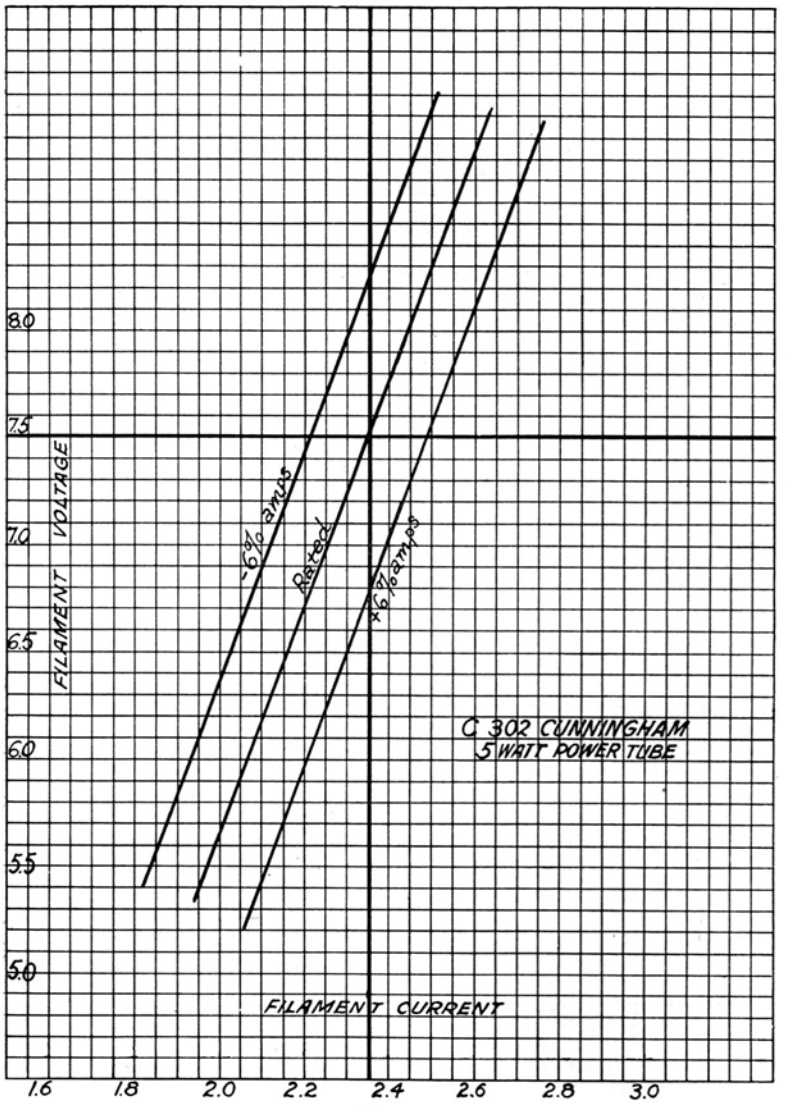


Fig. 14

The filament resistance of power tubes often varies slightly from the rated value. The curves in Fig. 14 illustrate the variations of filament current with variations of filament voltage in a tube having a filament of rated resistance and two tubes with filament 6% above and 6% below the rated resistance.

C-302
Plate Current versus Grid Voltage

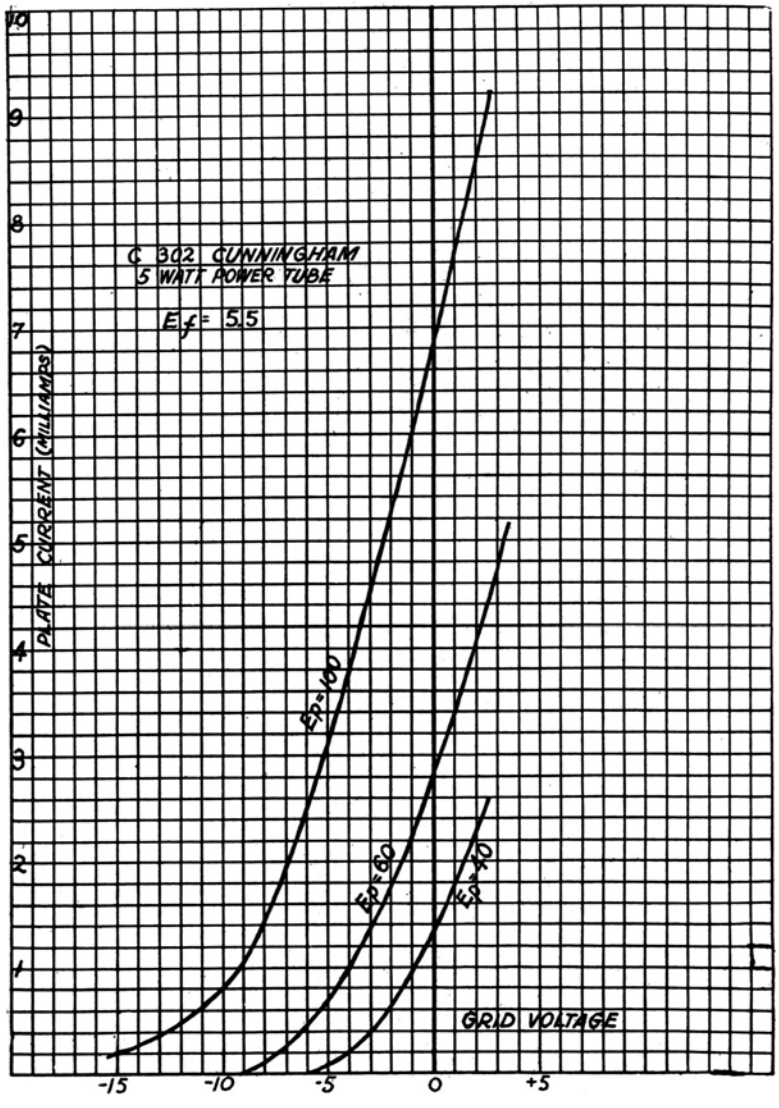


Fig. 15

The curves in Fig. 15 show the values of plate current with varying grid voltage at three different fixed values of plate voltage. These low values of plate voltage are used only when the C-302 is used as an amplifier.

C-302
Plate Current versus Grid Voltage

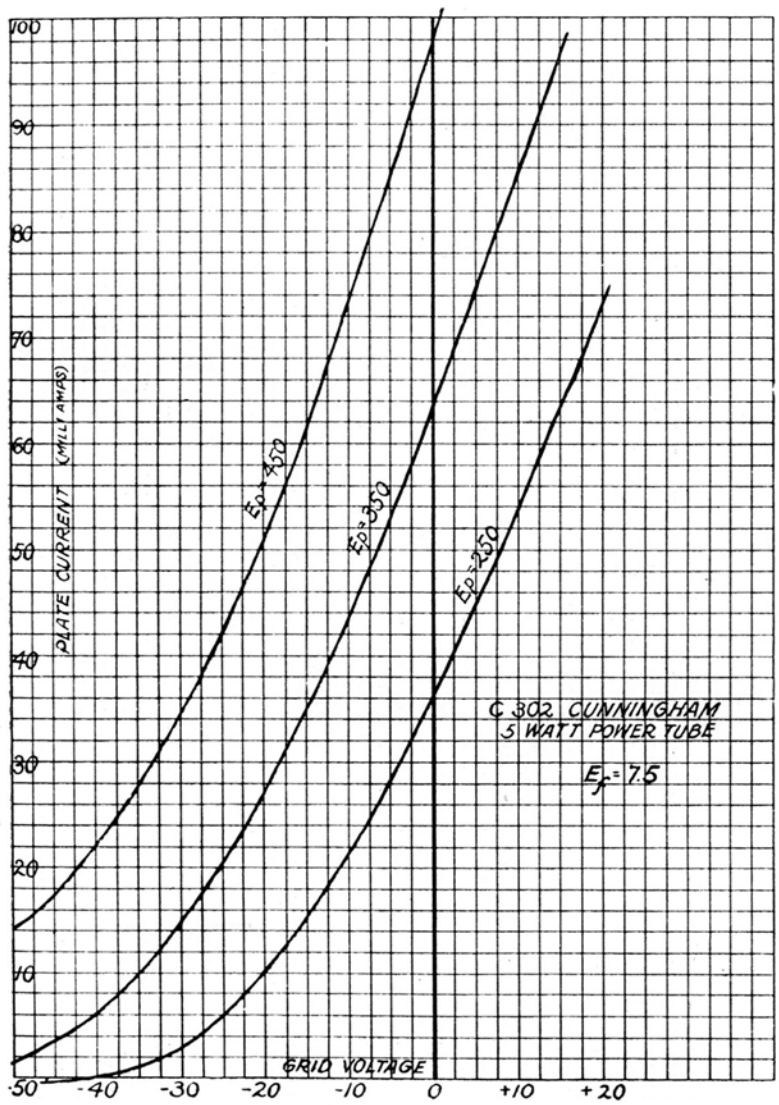


Fig. 16

Fig. 16 illustrates the same effect as Fig. 15 with three higher values of plate voltage such as are used for C. W. or phone transmission.

C-302
Amplification versus Filament Voltage

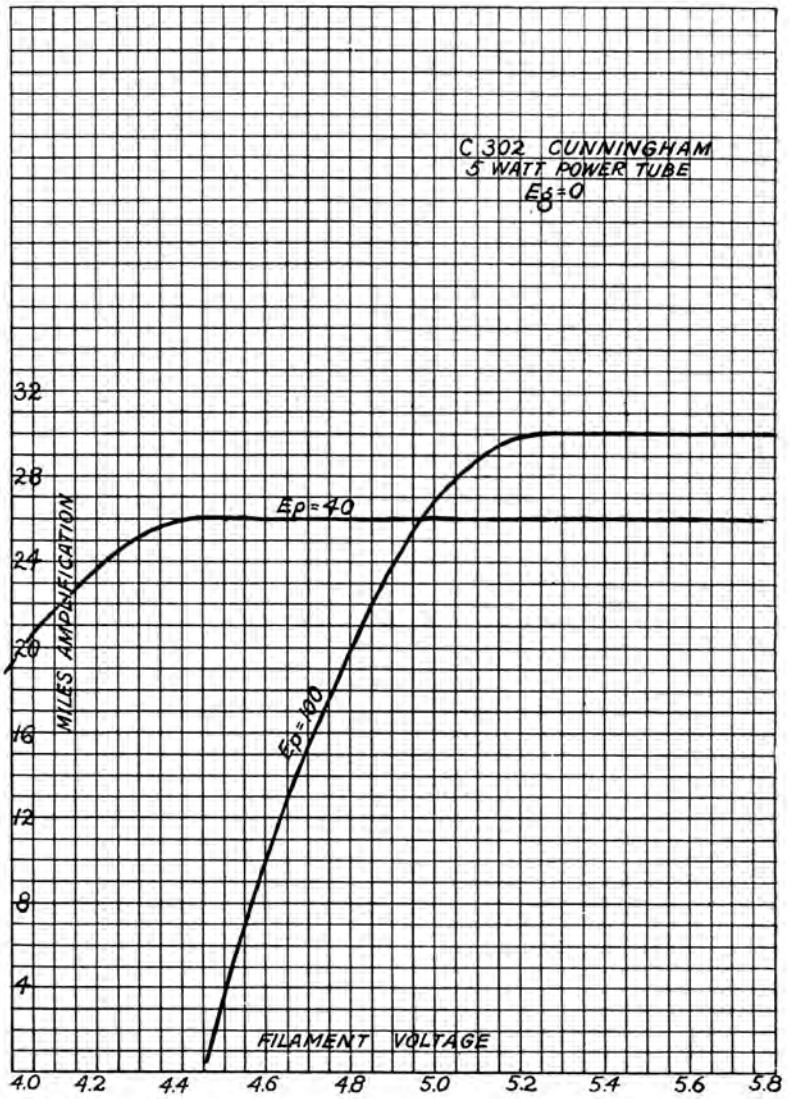


Fig. 17

The two curves of Fig. 17 show the amplification in miles obtained with varying filament voltage at two fixed values of plate voltage. Note that amplification cannot be increased by using more than 4.4 volts in the filament circuit when using 40 volts on the plate or more than 5.25 volts in the filament circuit when using 100 volts on the plate.

C-302
Plate Impedance versus Plate Voltage

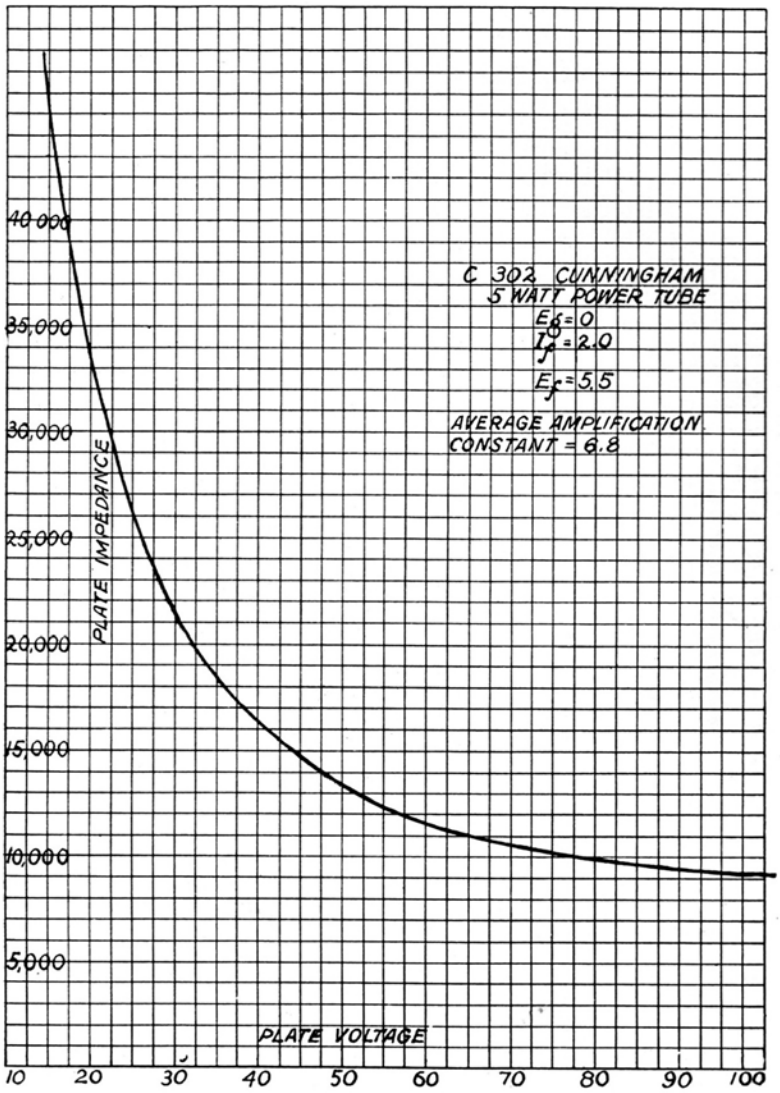


Fig. 18

The curve in Fig. 18 shows the variations of plate impedance with a varying plate voltage.

Cunningham
C-303

FIFTY WATT

POWER TUBE

THE Cunningham C-303 50-Watt Power Tube has been especially developed by the General Electric Company for use in long distance telephone and telegraph transmission. It is the result of years of investigation by scientists in that company's great research laboratories. Every precaution of design and manufacture has been taken to make it equally efficient as an oscillator and modulator.

For perfect modulation with exact reproduction of every tone quality as well as for long distance transmission this tube is not surpassed by any tube of equal input power.

SPECIFICATIONS.

Dimensions (over-all)	2"x7½"
Base	4 Prong Special
Filament Terminal Voltage	10 V.
Filament Supply Voltage	12 V.
Filament Current	6.5 amp.
Plate Voltage	1000 V. normal
Plate Current	.15 amp.
Amplification Constant	10
Watts Output	50 normal
Price	**$30.00**

For Long Distance Transmission

C-303
Filament Current versus Filament Voltage

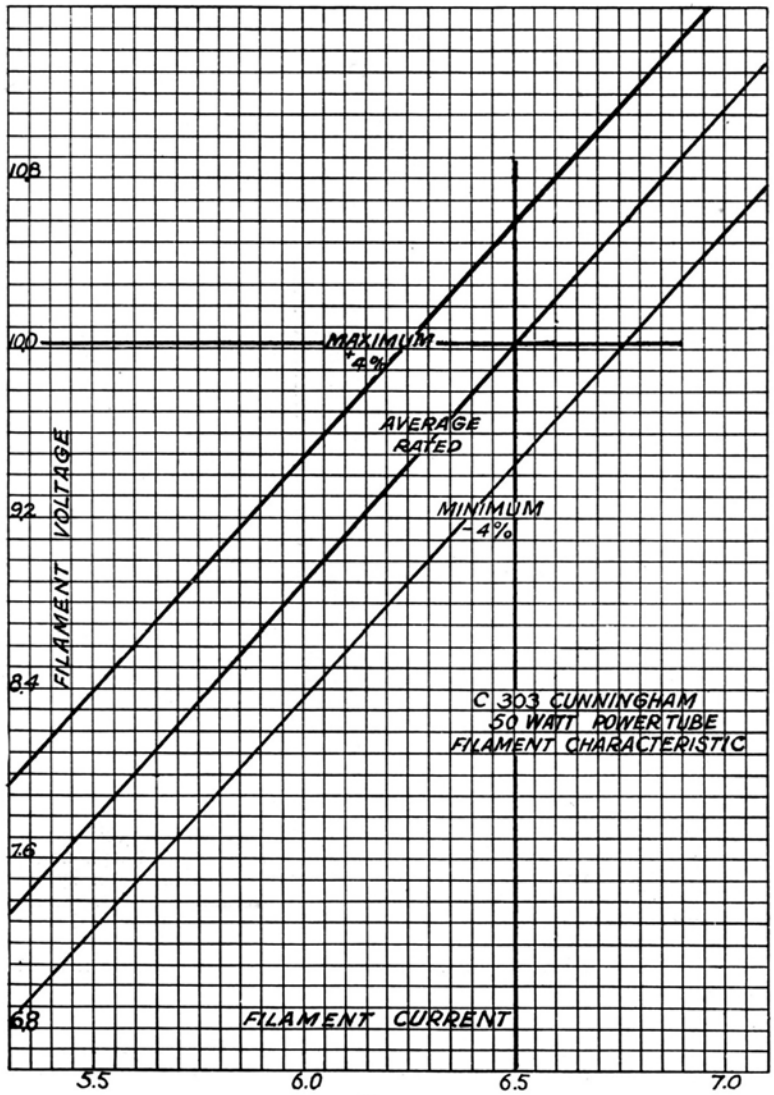


Fig. 19

The filament resistance of power tubes often varies slightly from the rated value. The curves in Fig. 19 illustrate the variations of filament current with variations of filament voltage in a tube having a filament of rated resistance and two tubes with filaments 4% above and 4% below the rated resistance.

C-303
Plate Current versus Grid Voltage

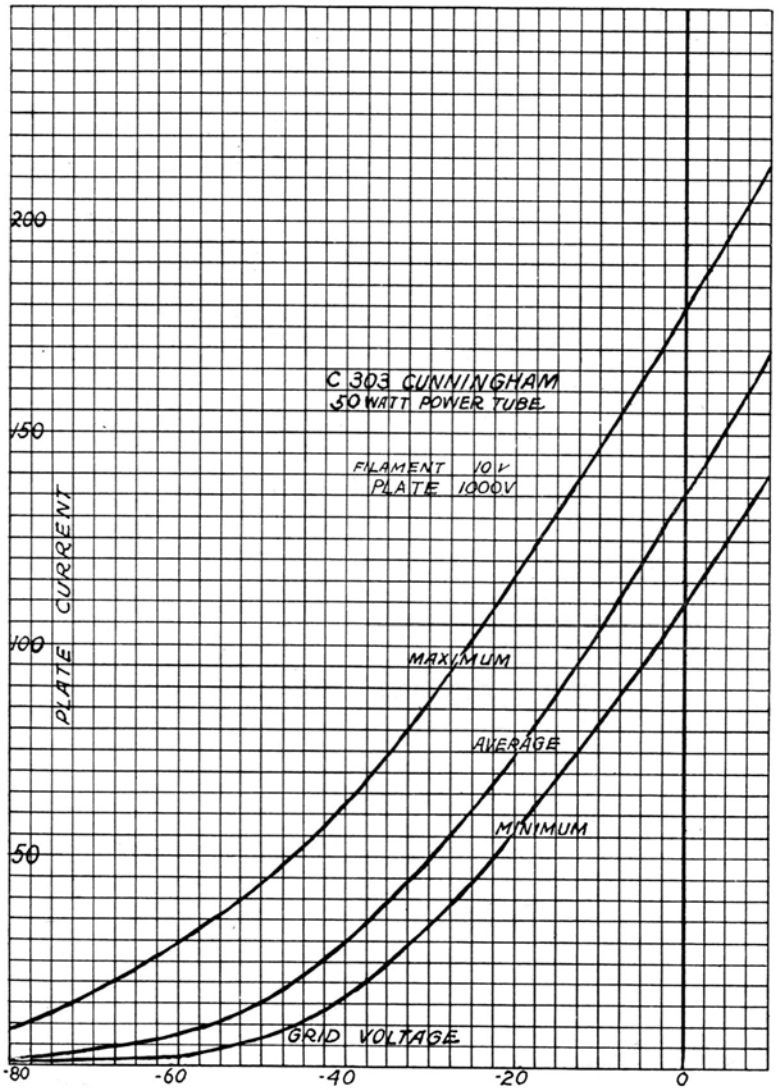


Fig. 20

The three curves in Fig. 20 illustrate variations of plate current with varying grid voltage for three different tubes. In each case the plate potential is constant at 1000 volts and the filament potential is constant at 10 volts.

C-303
Antenna Current versus Filament Voltage

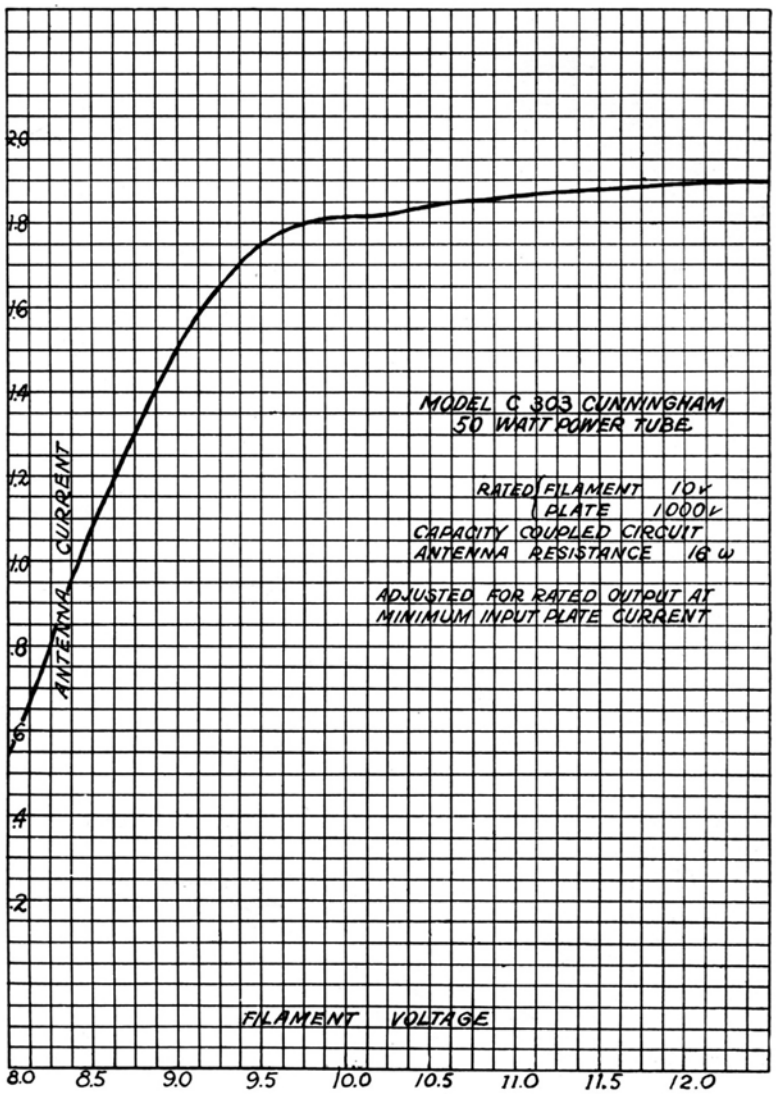


Fig. 21

The curve in Fig. 21 shows values of antenna current in amperes with varying filament voltage. Note that there is very little increase in radiation with increases in filament voltage above 10. The use of a low filament voltage tends to prolong the life of the tube.

C-303
Plate Current versus Plate Voltage

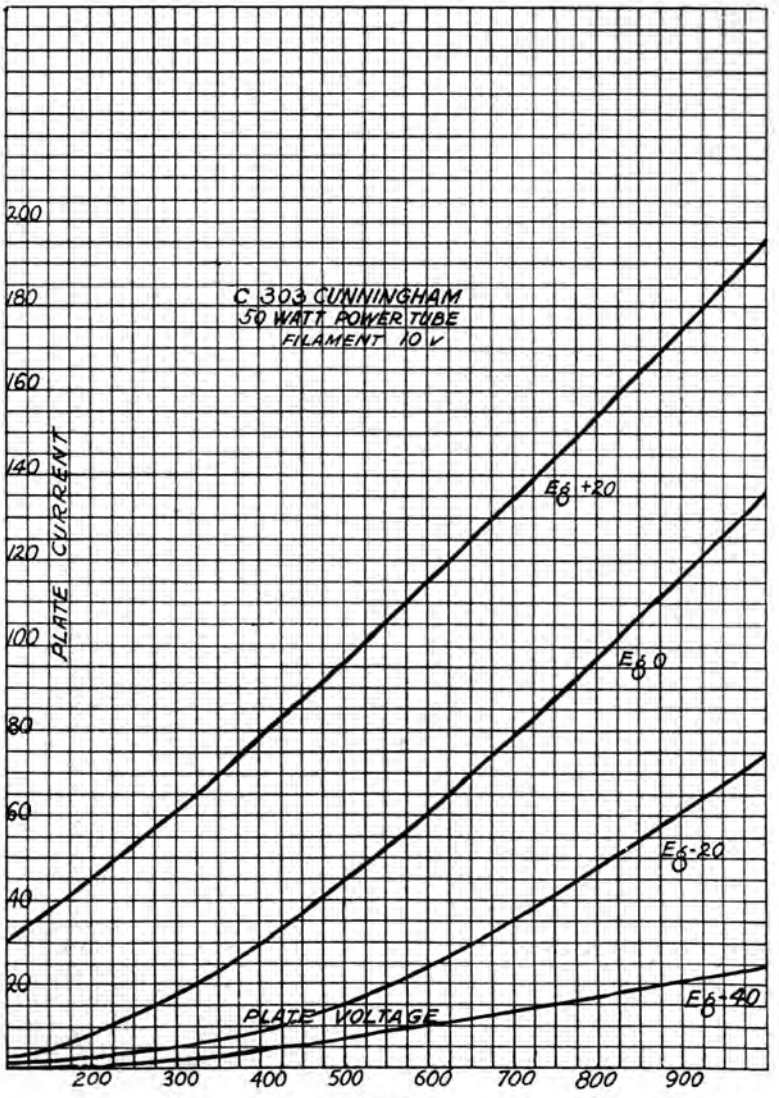
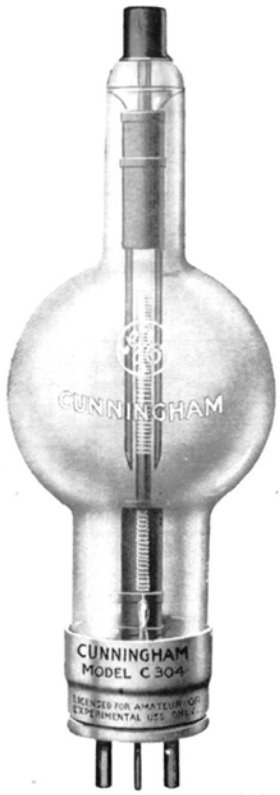


Fig. 22

The curves in Fig. 22 show values of plate current with a varying plate voltage for four different values of fixed grid potential.

Cunningham
C-304

250
WATT



POWER
TUBE

FOR the extremely high power amateur transmitting station—for the radio experimenter—and for use in the laboratories of educational institutions, this tube cannot be surpassed. As in the case of all other Cunningham Tubes the C-304 was designed by General Electric engineers.

The trade mark G. E. guarantees that these Cunningham Tubes were built by skilled workmen to the most rigid specifications in the world's greatest vacuum tube factory.

SPECIFICATIONS.

Dimensions (over-all)	5"x14½"
Base	Special Mounting
Filament Terminal Voltage	11 V.
Filament Supply Voltage	12 V.
Filament Current	14.75 amp.
Plate Voltage	2000 V. normal
Plate Current	.25 amp.
Output Impedance	6,000 ohms.
Amplification Constant	25
Watts Output	250 normal
Price	**$110.00**

High Power Transmitting Tube