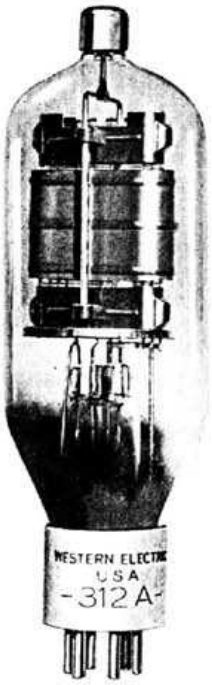
Western Electric

312A Vacuum Tube



Classification—Filamentary air-cooled pentode

This tube is intended primarily for use as a radio-frequency power amplifier, modulator, oscillator, suppressor-grid modulated amplifier or harmonic generator at intermediate power levels.

Dimensions—Dimensions and outline diagrams are shown in Figures 1 and 2. The overall dimensions are:

Maximum overall length	7¾″
Maximum diameter	2 5/16″

Mounting—Standard 6 pin ceramic base, for use in the Western Electric 144B or similar socket. The tube may be mounted in either a vertical or horizontal position. If mounted horizontally, the plane of the filament, which is indicated in Figure 2, should be vertical.

Filament—Thoriated tungsten

Filament voltage	10 volts, a.c. or d.c.
Nominal filament current	2.8 amperes
Average thermionic emission	1.0 ampere

Average Direct Interelectrode Capacitances

Plate to grid (maximum)	0.15 μμf.
Grid to filament, screen and suppressor grids	15.5 μμf.
Plate to filament, screen and suppressor grids	12.3 μμf.

Characteristics—Performance data given below are based upon a typical set of conditions. Variations can be expected with different circuits and tubes. Figures 3 to 8, inclusive, give the static characteristics of a typical tube plotted against grid and plate voltages. All data are based on alternating current operation of the filament, with grid voltages referred to the center tap of the filament.

Average Characteristics at 1000 volts direct plate potential and 50 watts plate dissipation (E_{c2} = 500 volts, E_{c3} = 0 volts, I_b = 50 milliamperes):

Amplification factor (approximate)	1100
Grid to plate transconductance	3800 micromhos
Plate resistance	290,000 ohms

Operation

Maximum Ratings

	CLASS C AMPLIFIER OR OSCILLATOR		
	*Unmodulated	**Plate Modulated	**Suppressor-Grid Modulated
Max. direct plate voltage	1250	1000	1250 volts
Max. direct plate current	100	100	60 milliamperes
Max. plate dissipation	50	35	50 watts
Max. plate input	125	100	75 watts
Max. direct screen-grid voltage	500	500	500 volts
Max. direct screen-grid current	50	50	55 milliamperes
Max. screen-grid dissipation	20	12	20 watts
Max. direct suppressor-grid voltage	50	50	−200 to +50 volts
Max. direct suppressor-grid current	15	15	15 milliamperes
Max. direct control-grid current	15	15	15 milliamperes
Max. r-f control-grid current	5	5	5 amperes
Max. frequency for above ratings	20	20	20 megacycles

*For intermittent service.
**Carrier conditions for use with 100% modulation.

Class C Radio-Frequency Power Amplifier—Suppressor-Grid Modulated
Carrier Conditions:

Direct plate voltage	1000	1250 volts
Suppressor-grid bias (approx.)	−70	−85 volts
A-F suppressor-grid voltage (approx.)	70	85 peak volts
Control-grid bias (approx.)	−50	−50 volts
R-F control-grid voltage (approx.)	85	85 peak volts
R-F control-grid excitation	0.55	0.55 watts
Direct plate current	47	50 milliamperes
Direct screen-grid current	39	42 milliamperes
Direct control-grid current	5	5 milliamperes
Screen-grid resistor	17,500	22,000 ohms
Nominal carrier power output for use with 100% modulation	17	23 watts

Class C Radio-Frequency Power Amplifier or Oscillator—Unmodulated

Direct plate voltage	†1000	†1000	1250	1250 volts
Suppressor-grid bias	0	20	0	20 volts
Screen-grid bias	350	300	350	300 volts
Control-grid bias (approx.)	−50	−55	−50	−55 volts
R-F control-grid voltage (approx.)	85	100	85	100 peak volts
R-F control-grid excitation (approx.)	0.55	0.7	0.55	0.7 watts
Direct plate current	94	95	100	100 milliamperes
Direct screen-grid current	39	33	37	36 milliamperes
Direct control-grid current	5	5.5	5	5.5 milliamperes
Nominal power output	65	70	85	90 watts

†May be used for continuous service.

Class C Radio-Frequency Power Amplifier—Plate Modulated Carrier Conditions:

Direct plate voltage	1000 volts
Suppressor-grid bias	40 volts
Control-grid bias (approx.)	−40 volts
R-F control-grid voltage (approx.)	90 peak volts
R-F control-grid excitation (approx.)	1 watt
Direct plate current	95 milliamperes
Direct screen-grid current	35 milliamperes
Direct control-grid current	7 milliamperes
Control-grid bias resistor	6000 ohms
Screen-grid resistor	22000 ohms
Nominal carrier power output for use with 100% modulation	65 watts

Operating Precautions

Mechanical—Figures 1 and 2 show the overall dimensions and basing arrangement for the tube.

The tubes should not be subjected to mechanical shock or excessive vibration. Mechanical vibration may cause breakage of the thoriated tungsten filaments.

A free circulation of air must be provided to insure adequate cooling of the glass during operation.

Electrical—Overload protection should always be provided for the plate circuit. A suitable fuse or circuit breaker should remove the plate and screen-grid voltages if the plate current exceeds 150 milliamperes. Although the tube is sufficiently rugged to withstand momentary overloads, a prolonged overload caused by inefficient adjustment of the circuit may damage the tube. When adjusting a new circuit, reduced plate voltage or a series resistance of 1,000 to 5,000 ohms in the plate circuit should be used until it is operating properly.

The filament should always be operated at the rated voltage, measured at the tube terminals. A 5% decrease in filament voltage reduces the thermionic emission approximately 25%.

In cases where severe and prolonged overload has temporarily impaired the electronic emission of the filament, the activity may be restored by operating the filament at 30% above normal voltage for 10 minutes, with all other voltages off, followed by a longer period at normal filament voltage.

The center tap of the filament is connected to a separate pin in the base. When alternating current is used for heating the filament, the grid and plate returns may be connected to this point instead of to a center tap of the filament heating transformer secondary. If direct current is used for heating the filament, the plate and grid circuit returns should be connected to the negative filament terminal. When the tube is used in circuits at very high frequencies, the center tap should be connected through low-impedance by-pass condensers to the two end points of the filament in order to minimize the effective filament inductance.

The voltage for the screen grid may be obtained from a separate source or from a potentiometer or series resistor in the plate supply. The screen-grid voltage should *not* be applied without the plate voltage. The screen-grid dissipation, which is the product of the direct screen-grid current and the direct screen-grid voltage when the screen grid is adequately by-passed, should never be permitted to exceed the maximum rating given above. This dissipation corresponds to a dull red color of the screen grid.

The voltage for the suppressor-grid may be obtained from any source of constant direct voltage. In types of operation where the suppressor draws current, the source of the suppressor-grid voltage should have good regulation.

In certain applications, special shielding and separation of the input circuit from the output circuit are necessary. In such cases, the housing containing the input circuit may be arranged to enclose the lower part of the tube to the level of the circular shielding disc located below the plate inside the tube. Clearance between the shield and the glass bulb should be at least $\frac{1}{8}$".

Radio-Frequency Oscillator or Power Amplifier

Class C—Grid bias below cut-off.

Suppressor-Grid Modulated

This type of operation is suitable for telephony. To modulate the carrier output completely, less than one watt of audio power is required, which is lower than for any other recommended method of modulation. For outputs which do not require that the suppressor be driven positive, the audio power may be less than 1/10th watt.

It is recommended that the screen-grid voltage be obtained from the plate voltage by inserting a resistance in series with the screen grid and the plate voltage, and that part of the control-grid bias also be obtained from the voltage drop produced by the control-grid current flowing through a resistance. With this arrangement, using suitable values of resistance, the output power is almost independent of carrier input over a wide range of carrier input voltages, the distortion of the signal wave is minimized, and the risk of damaging the tube by overload while making circuit adjustments is reduced.

A radio-frequency output current characteristic of a typical 312A tube is shown in Figure 9 as a function of suppressor-grid voltage for a constant impressed radio-frequency control-grid voltage. Corresponding plate current, screen-grid current, control-grid current, and suppressor-grid current characteristics are given in Figure 10.

Unmodulated

This type of operation is suitable for telegraphy, or the production of a continuous flow of radio-frequency power for purposes other than communication.

Plate Modulated

This type of operation is for use when the modulating voltage is superimposed on the plate supply voltage and to obtain good quality the output power should vary as the square of the plate voltage. For complete or 100% modulation, the plate voltage varies from zero to twice the applied direct value during a cycle of the audio frequency. With no modulation applied, the plate voltage is, of course, the direct value, and the carrier power output is one-fourth of the peak power output under 100% modulation. In this case, since the plate voltage varies with modulation, the direct value must be rated lower than for other types of operation.

With this type of operation, the screen-grid voltage as well as the plate voltage should be modulated. When a series resistor is used to obtain direct screen-grid voltage from the plate supply, this may readily be accomplished by connecting the resistor to the modulated plate supply. No by-pass condenser is used across the screen resistor in this case so that the actual modulating voltage applied to the screen grid is somewhat lower than that applied to the plate. The by-pass condenser between the screen grid and filament should be as small as practicable to avoid by-passing the higher modulating frequencies.

High Frequency Ratings

The tube may be used at full ratings up to 20 megacycles. When operating at higher frequencies, the dielectric losses, charging currents and lead-in heating may be increased to an excessive degree. Accordingly, the plate voltage, and consequently the plate input must be reduced 50% at 70 megacycles, and in proportion at frequencies between 20 and 70 megacycles. In order to obtain maximum output and proper operation at these frequencies, special attention should be given to shielding and to the by-pass circuits.

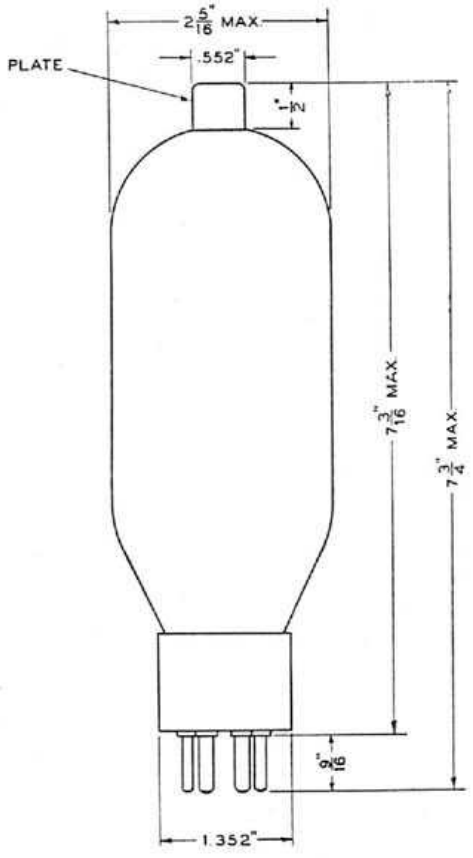


FIG. 1

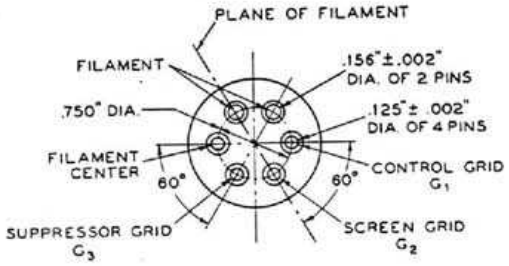


FIG. 2

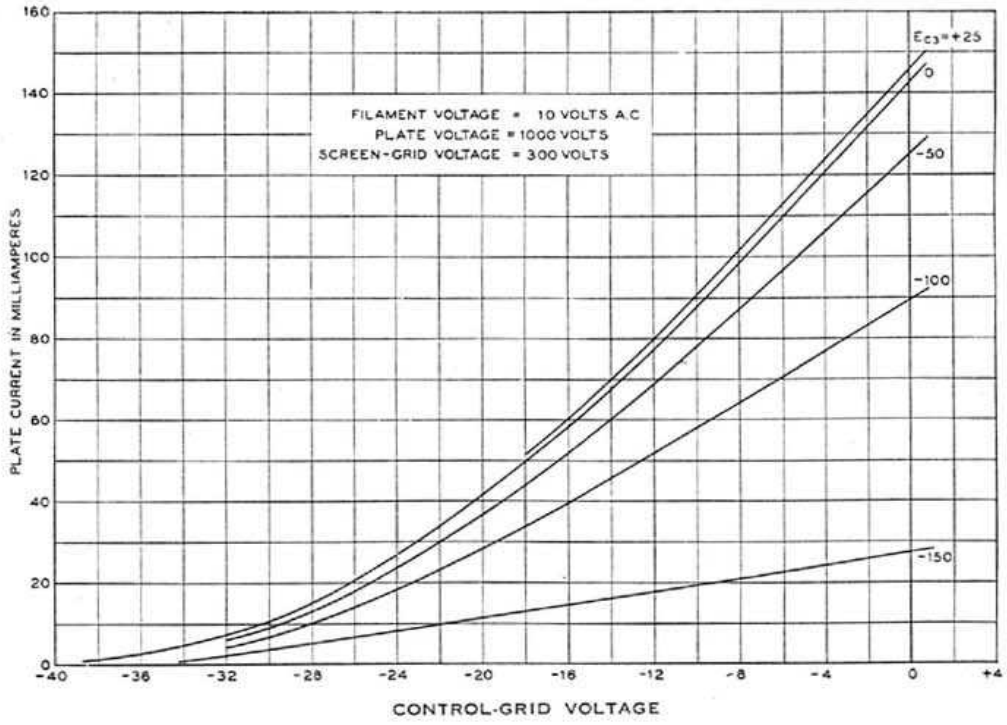

FILAMENT VOLTAGE = 10 VOLTS A.C.
PLATE VOLTAGE = 1000 VOLTS
SCREEN-GRID VOLTAGE = 300 VOLTS
E_{c3}=+25
0
-50
-100
-150
PLATE CURRENT IN MILLIAMPERES
CONTROL-GRID VOLTAGE
160
140
120
100
80
60
40
20
0
-40
-36
-32
-28
-24
-20
-16
-12
-8
-4
0
+4

FIG. 3

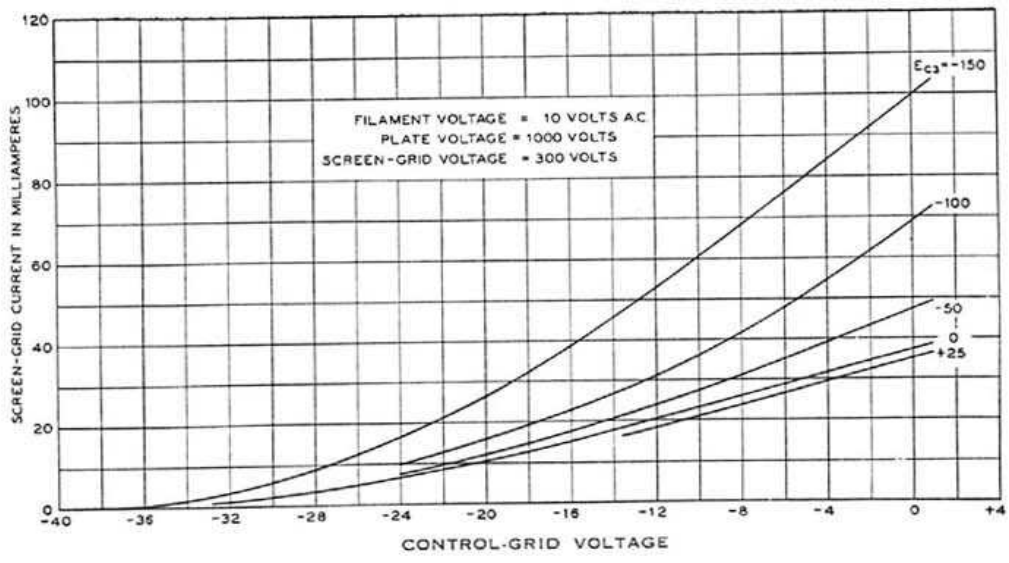

FILAMENT VOLTAGE = 10 VOLTS A.C.
PLATE VOLTAGE = 1000 VOLTS
SCREEN-GRID VOLTAGE = 300 VOLTS
E_{c3}=-150
-100
-50
0
+25
SCREEN-GRID CURRENT IN MILLIAMPERES
CONTROL-GRID VOLTAGE
120
100
80
60
40
20
0
-40
-36
-32
-28
-24
-20
-16
-12
-8
-4
0
+4

FIG. 4

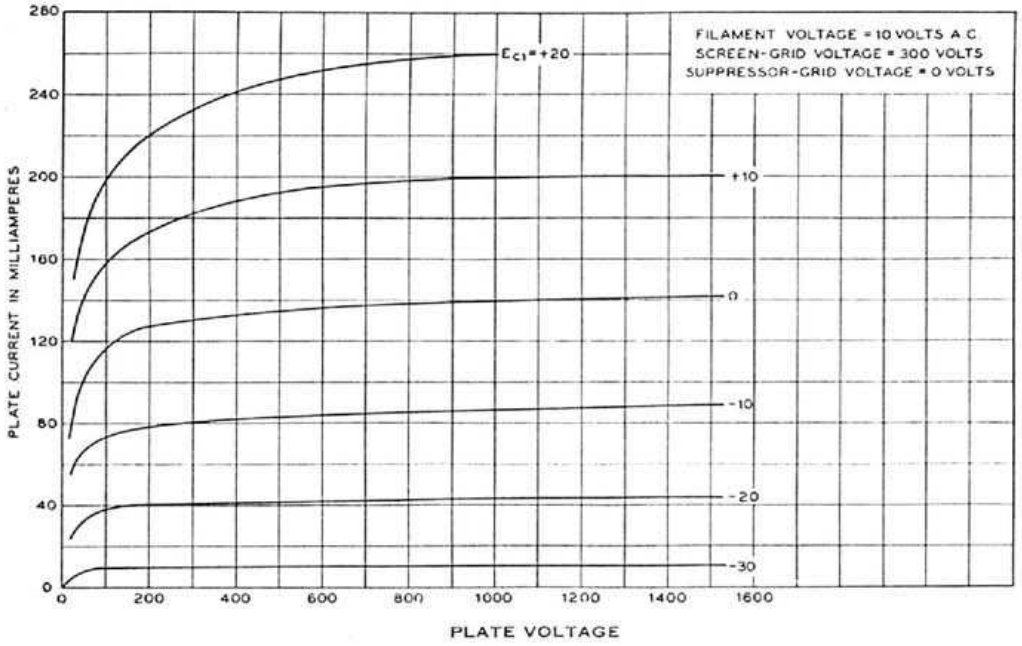

FILAMENT VOLTAGE = 10 VOLTS A.C.
SCREEN-GRID VOLTAGE = 300 VOLTS
SUPPRESSOR-GRID VOLTAGE = 0 VOLTS
E_{c1} = +20
+10
0
-10
-20
-30
PLATE CURRENT IN MILLIAMPERES
PLATE VOLTAGE
0
40
80
120
160
200
240
280
200
400
600
800
1000
1200
1400
1600

FIG. 5

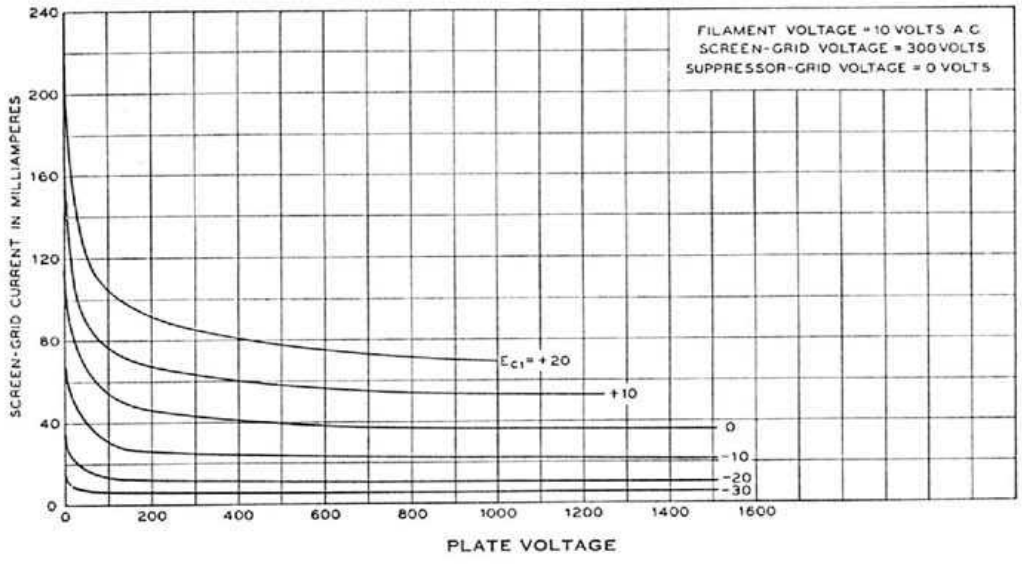

FILAMENT VOLTAGE = 10 VOLTS A.C.
SCREEN-GRID VOLTAGE = 300 VOLTS
SUPPRESSOR-GRID VOLTAGE = 0 VOLTS
E_{c1} = +20
+10
0
-10
-20
-30
SCREEN-GRID CURRENT IN MILLIAMPERES
PLATE VOLTAGE
0
40
80
120
160
200
240
200
400
600
800
1000
1200
1400
1600

FIG. 6

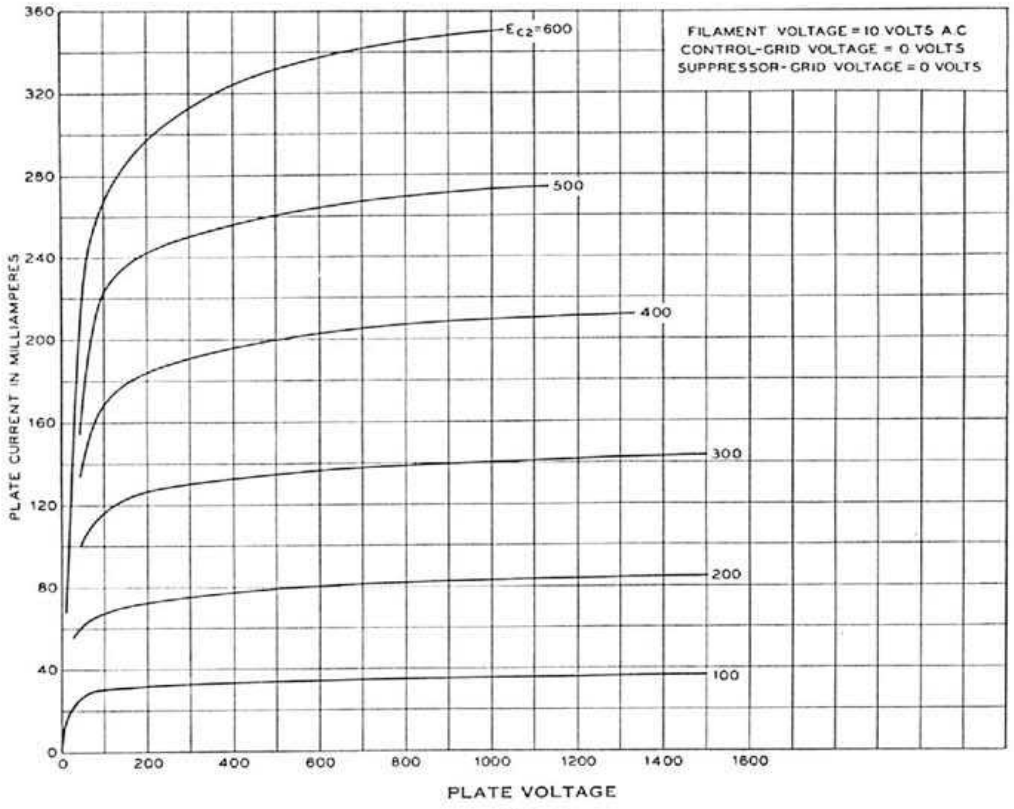

FILAMENT VOLTAGE = 10 VOLTS A.C
CONTROL-GRID VOLTAGE = 0 VOLTS
SUPPRESSOR-GRID VOLTAGE = 0 VOLTS
E_{c2}=600
500
400
300
200
100
PLATE CURRENT IN MILLIAMPERES
PLATE VOLTAGE
0
40
80
120
160
200
240
280
320
360
0
200
400
600
800
1000
1200
1400
1600

FIG. 7

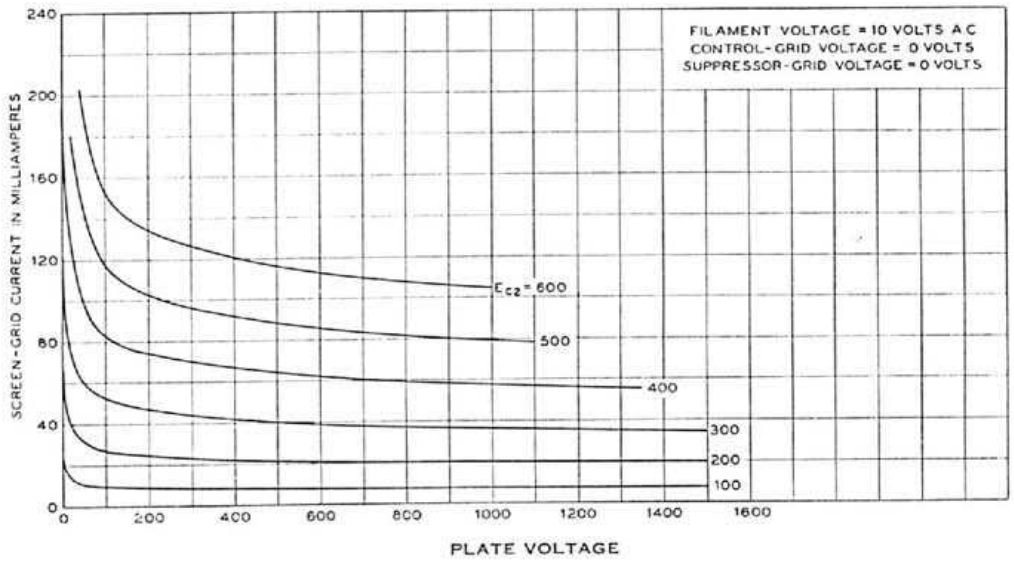

FILAMENT VOLTAGE = 10 VOLTS A.C
CONTROL-GRID VOLTAGE = 0 VOLTS
SUPPRESSOR-GRID VOLTAGE = 0 VOLTS
E_{c2}=600
500
400
300
200
100
SCREEN-GRID CURRENT IN MILLIAMPERES
PLATE VOLTAGE
0
40
80
120
160
200
240
0
200
400
600
800
1000
1200
1400
1600

FIG. 8

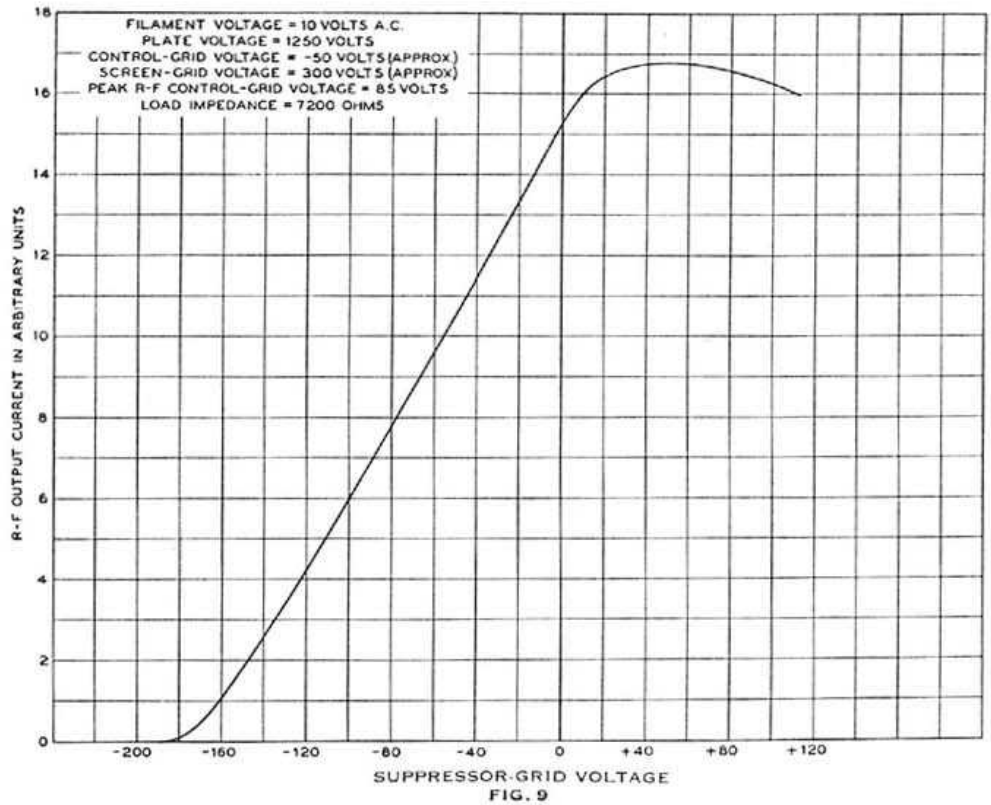

FILAMENT VOLTAGE = 10 VOLTS A.C.
PLATE VOLTAGE = 1250 VOLTS
CONTROL-GRID VOLTAGE = -50 VOLTS (APPROX.)
SCREEN-GRID VOLTAGE = 300 VOLTS (APPROX.)
PEAK R-F CONTROL-GRID VOLTAGE = 85 VOLTS
LOAD IMPEDANCE = 7200 OHMS
R-F OUTPUT CURRENT IN ARBITRARY UNITS
0
2
4
6
8
10
12
14
16
18
-200
-160
-120
-80
-40
0
+40
+80
+120
SUPPRESSOR-GRID VOLTAGE

FIG. 9

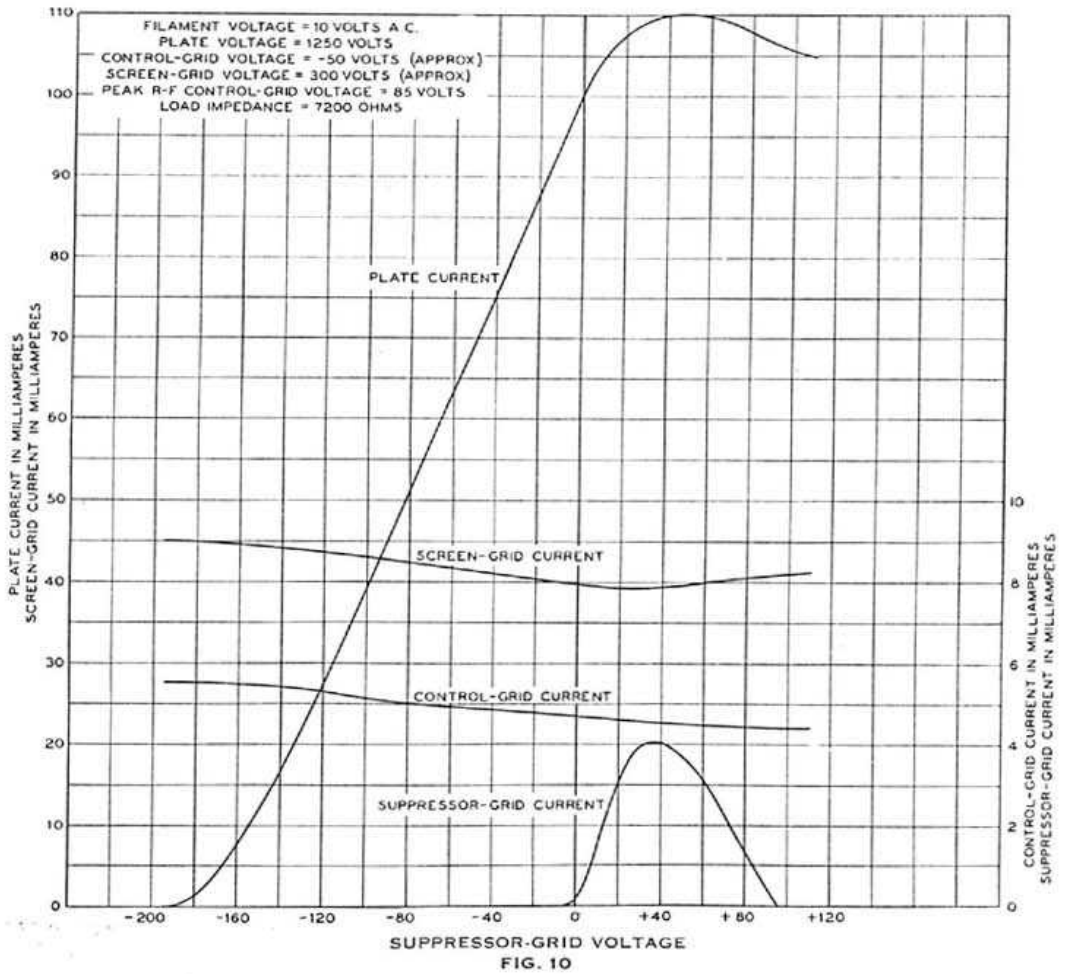

FILAMENT VOLTAGE = 10 VOLTS A.C.
PLATE VOLTAGE = 1250 VOLTS
CONTROL-GRID VOLTAGE = -50 VOLTS (APPROX.)
SCREEN-GRID VOLTAGE = 300 VOLTS (APPROX.)
PEAK R-F CONTROL-GRID VOLTAGE = 85 VOLTS
LOAD IMPEDANCE = 7200 OHMS
PLATE CURRENT
SCREEN-GRID CURRENT
CONTROL-GRID CURRENT
SUPPRESSOR-GRID CURRENT
PLATE CURRENT IN MILLIAMPERES
SCREEN-GRID CURRENT IN MILLIAMPERES
CONTROL-GRID CURRENT IN MILLIAMPERES
SUPPRESSOR-GRID CURRENT IN MILLIAMPERES
0
10
20
30
40
50
60
70
80
90
100
110
0
2
4
6
8
10
-200
-160
-120
-80
-40
0
+40
+80
+120
SUPPRESSOR-GRID VOLTAGE

FIG. 10