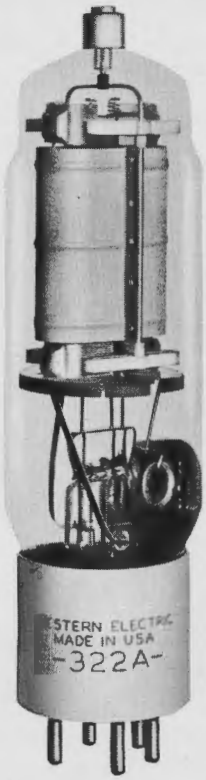
Western Electric

322A and 332A Vacuum Tubes



Classification—Filamentary air-cooled pentodes

The 322A and 332A tubes are identical except that the 332A tube has the suppressor-grid connected directly to the center of the filament within the tube.

These tubes are intended primarily for use as radio-frequency power amplifiers, modulators, oscillators or harmonic generators at intermediate power levels. In addition to the above, the 322A may be used as a suppressor-grid modulated amplifier.

Dimensions and Connections—The outline diagrams of the tube and base giving the dimensions and the arrangement of the electrode connections to the base terminals for the 322A tube, are shown in Figures 1 and 2. Similar information for the 332A tube is given in Figures 1 and 3. The overall dimensions are:

Maximum overall length	9-3/8″
Maximum diameter	2-9/16″

Mounting—These tubes employ large five-pin ceramic bases suitable for use in a large five-pin socket. The tubes may be mounted in either a vertical or horizontal position. If mounted horizontally the plane of the filaments, which is indicated in Figures 2 and 3, should be vertical.

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Filament—Thoriated tungsten

Filament voltage	10 volts, ac or dc
Nominal filament current	5.0 amperes
Average thermionic emission	2.0 amperes

Average Direct Interelectrode Capacitances

Plate to grid (maximum)	0.15 $\mu\mu f$
Grid to filament, screen and suppressor-grids	17.5 $\mu\mu f$
Plate to filament, screen and suppressor-grids	22.0 $\mu\mu f$

Characteristics—Performance data given below are based upon a typical set of conditions. Variations can be expected with different circuits and tubes. Figures 4 to 10, inclusive, give the static characteristics of typical tubes plotted against grid and plate voltages. All data are based on alternating current operation of the filament, with grid voltages referred to the center of the filament.

Average Characteristics at 2000 volts direct plate potential and 125 watts plate dissipation (E_{c2} = 500 volts, E_{c3} = 0 volts, I_b = 62.5 milliamperes);

Amplification factor (approximate)	1400
Plate resistance	350,000 ohms
Grid to plate transconductance	4000 micromhos

Operation

Maximum Ratings

	CLASS C AMPLIFIER OR OSCILLATOR		
	Unmodulated	*Plate Modulated	For 322A only *Suppressor-Grid Modulated
Max. direct plate voltage	2000	1600	2000 volts
Max. direct screen-grid voltage	600	500	600 volts
Max. direct suppressor-grid voltage	500	500	— volts
Max. direct plate current	175	160	110 milliamperes
Max. direct control-grid current	50	50	50 milliamperes
Max. r-f control-grid current	5	5	5 amperes
Max. plate input	350	250	180 watts
Max. plate dissipation	125	85	125 watts
Max. screen-grid dissipation	30	20	30 watts
Max. suppressor-grid dissipation	10	10	— watts
Max. frequency for above ratings	20	20	20 megacycles

*Carrier conditions for use with 100% modulation.

Class C Radio-Frequency Power Amplifier—Suppressor-Grid Modulated

Operating condition for 322A tube only

Carrier Conditions:

Direct plate voltage	1500	2000 volts
Suppressor-grid bias (approx.)	−90	−110 volts
A-F suppressor-grid voltage (approx.)	130	150 peak volts
Control-grid bias (approx.)	−80	−85 volts
R-F control-grid voltage (approx.)	190	170 peak volts
R-F control-grid excitation	3.5	2.5 watts
Direct plate current	100	80 milliamperes
Direct screen-grid current	70	46 milliamperes
Direct control-grid current	16	12 milliamperes
Control-grid bias resistor	5000	7000 ohms
Screen-grid resistor	16,000	35,000 ohms
Nominal carrier power output for use with 100% modulation	50	53 watts

Class C Radio-Frequency Power Amplifier or Oscillator—Unmodulated

	322A		332A	
Direct plate voltage	1500	2000	1500	2000 volts
Suppressor-grid bias	40	40	—	— volts
Screen-grid bias	525	525	550	550 volts
Control-grid bias (approx.)	−75	−75	−75	−75 volts
R-F control-grid voltage (approx.)	170	170	170	170 peak volts
R-F control-grid excitation (approx.)	2	2	2	2 watts
Direct plate current	160	160	150	150 milliamperes
Direct screen-grid current	44	45	50	50 milliamperes
Direct control-grid current	10	10	10	10 milliamperes
Control-grid bias resistor	7500	7500	7500	7500 ohms
Screen-grid resistor	22,000	33,000	19,000	28,000 ohms
Nominal power output	160	210	135	180 watts

Class C Radio-Frequency Power Amplifier—Plate Modulated

Carrier Conditions:	322A	332A
Direct plate voltage	1600	1600 volts
Suppressor-grid bias	100	— volts
Control-grid bias (approx.)	−70	−70 volts
R-F control-grid voltage (approx.)	175	175 peak volts
R-F control-grid excitation (approx.)	4	4 watts
Direct plate current	150	140 milliamperes
Direct screen-grid current	55	55 milliamperes
Direct control-grid current	18	18 milliamperes
Control-grid bias resistor	4000	4000 ohms
Screen-grid resistor*	20,000	20,000 ohms
Nominal carrier power output for use with 100% modulation	155	135 watts

*It is recommended that the screen-grid be fed from the modulated plate voltage through a series resistor.

Operating Precautions

Mechanical—The outline drawings are shown to provide information so that adequate space is provided for mounting 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—Nominal performance data are given in the above tables for a number of typical operating conditions. Less severe operating conditions should be selected in preference to maximum conditions wherever possible. The life of the tube under maximum conditions may be shorter than under less severe conditions.

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 250 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 2,000 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.

When alternating current is used for heating the filament, the grid and plate returns should be connected to the center tap of the filament or filament heating transformer secondary. A filament center tap is provided in the 332A tube only. This is connected to the suppressor-grid within the tube and this connection is brought out to a pin in the base. 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 332A tube is used at very high frequencies the center tap should be connected to low impedance by-pass condensers to the 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.

When using the 322A tube, 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 ⅛″.

Radio-Frequency Oscillator or Power Amplifier

Class C—Grid bias below cut-off.

Suppressor-Grid Modulated (For 322A only)

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 one-tenth 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 322A tube is shown in Figure 10 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 also given in this figure.

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-grid 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 tubes 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.

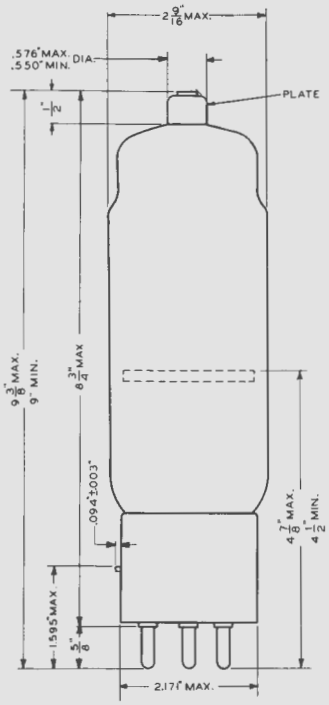
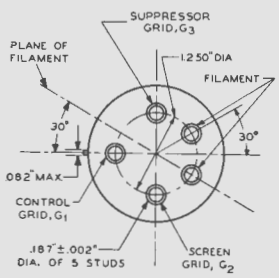
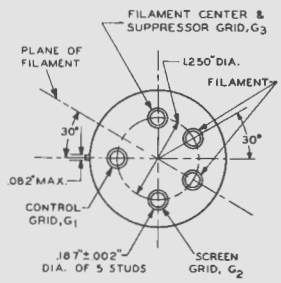


FIG. 1



322 A

FIG 2



332 A

FIG. 3

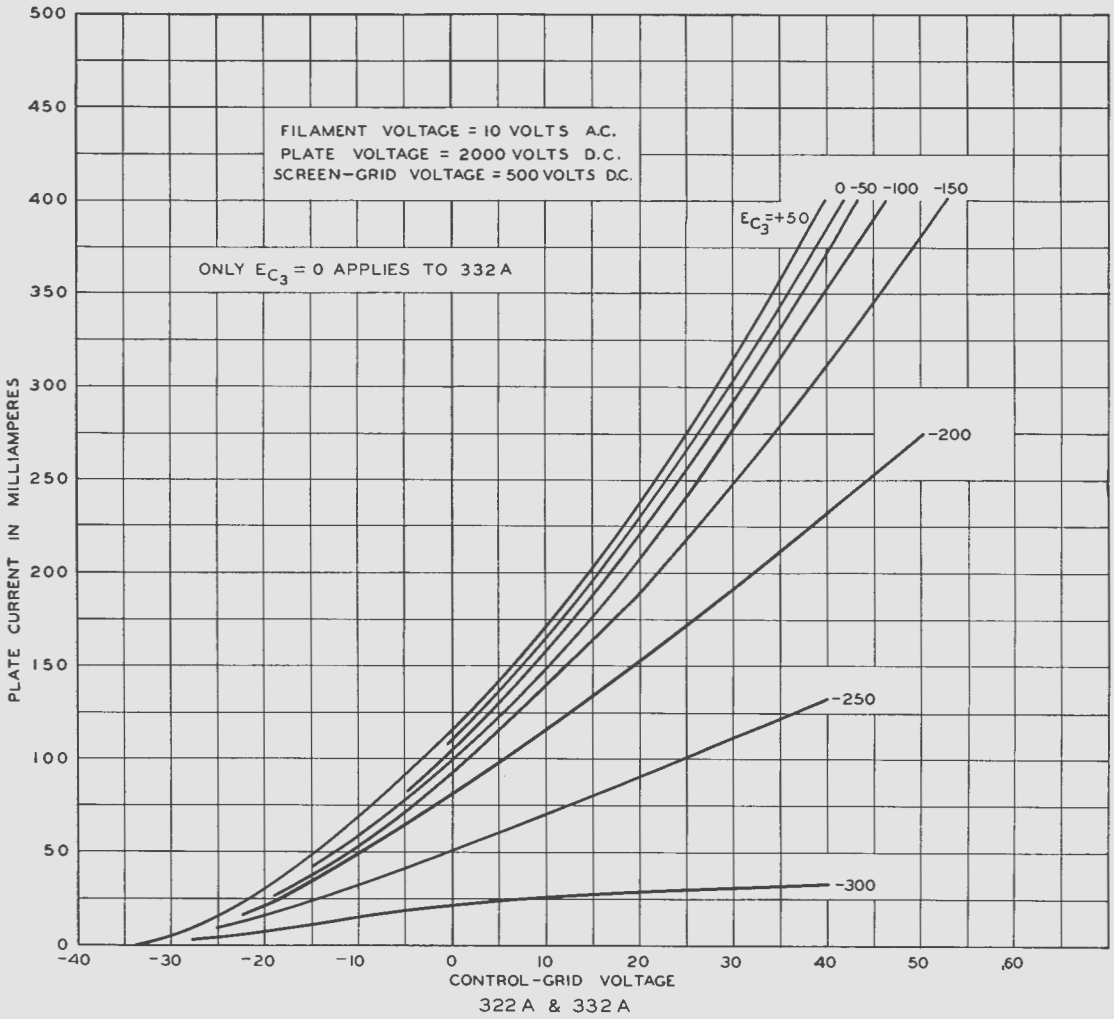

FILAMENT VOLTAGE = 10 VOLTS A.C.
PLATE VOLTAGE = 2000 VOLTS D.C.
SCREEN-GRID VOLTAGE = 500 VOLTS D.C.
ONLY E_{C_3} = 0 APPLIES TO 332 A
E_{C_3}=+50
0 -50 -100 -150
-200
-250
-300
PLATE CURRENT IN MILLIAMPERES
CONTROL-GRID VOLTAGE
322 A & 332 A

FIG. 4

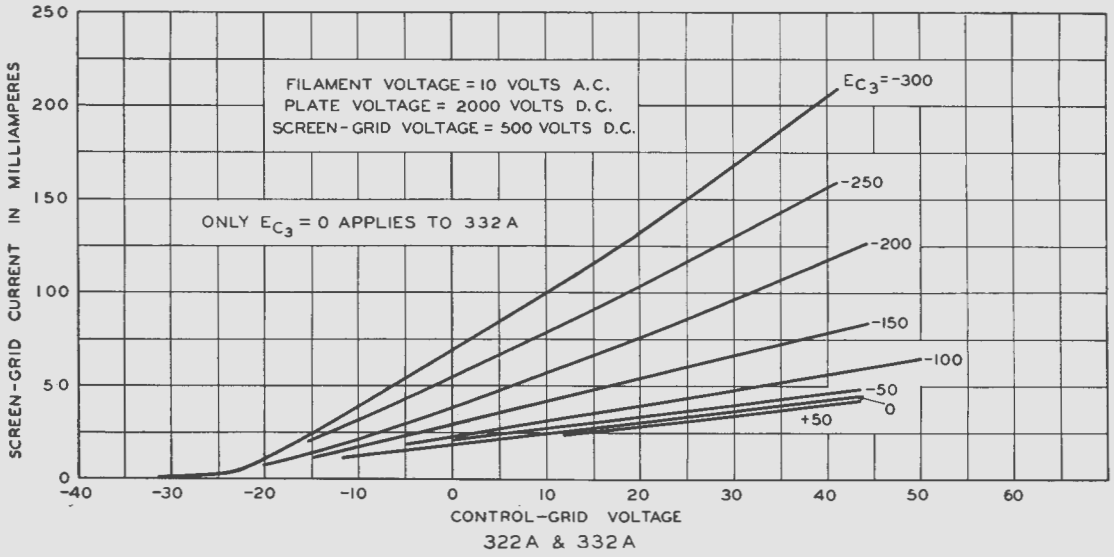

FILAMENT VOLTAGE = 10 VOLTS A.C.
PLATE VOLTAGE = 2000 VOLTS D.C.
SCREEN-GRID VOLTAGE = 500 VOLTS D.C.
ONLY E_{C_3} = 0 APPLIES TO 332 A
E_{C_3}=-300
-250
-200
-150
-100
-50
0
+50
SCREEN-GRID CURRENT IN MILLIAMPERES
CONTROL-GRID VOLTAGE
322 A & 332 A

FIG. 5

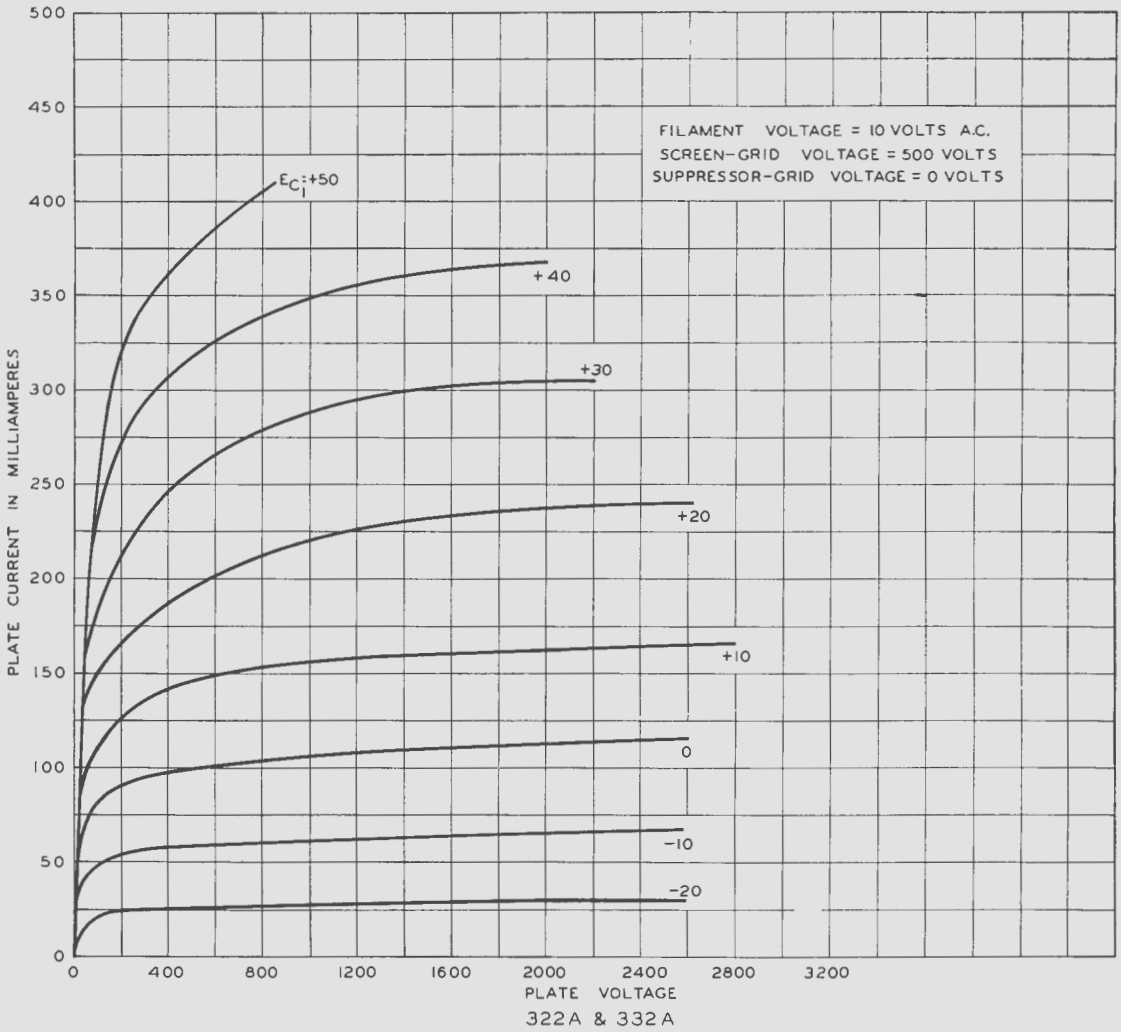

FILAMENT VOLTAGE = 10 VOLTS A.C.
SCREEN-GRID VOLTAGE = 500 VOLTS
SUPPRESSOR-GRID VOLTAGE = 0 VOLTS
E_{C_1}=+50
+40
+30
+20
+10
0
-10
-20
PLATE CURRENT IN MILLIAMPERES
PLATE VOLTAGE
0
50
100
150
200
250
300
350
400
450
500
400
800
1200
1600
2000
2400
2800
3200
322A & 332A

FIG. 6

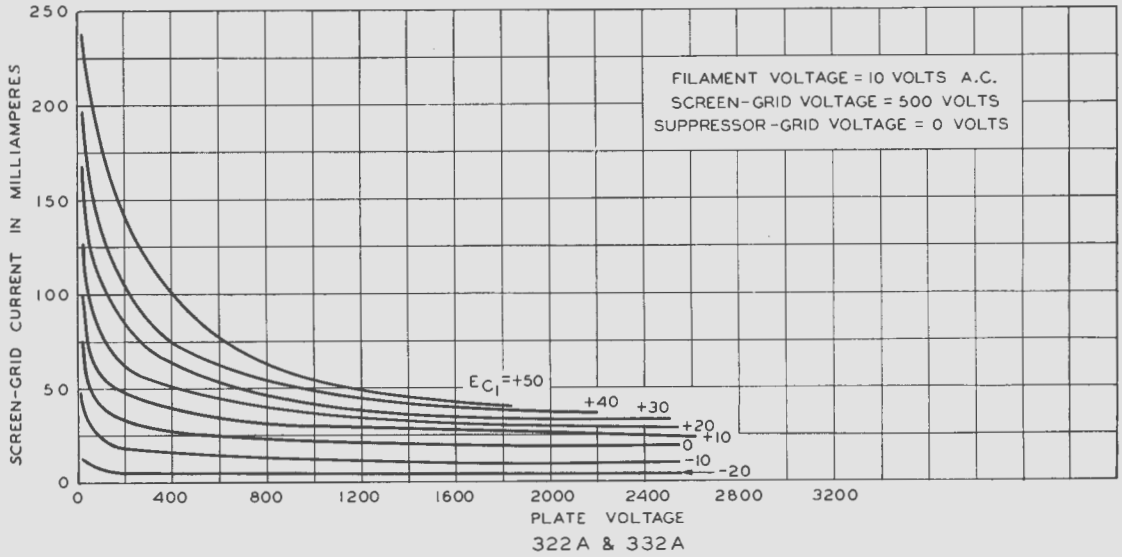
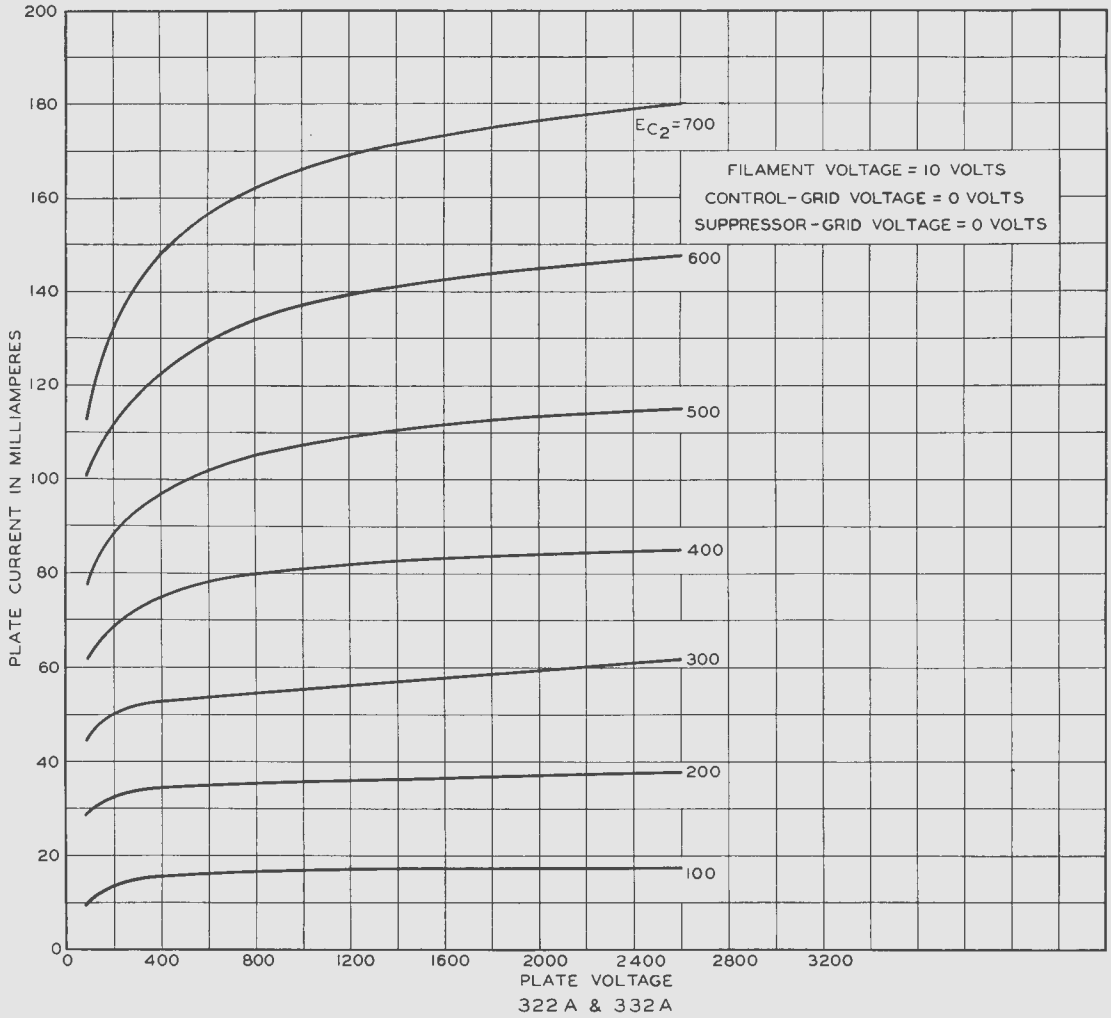
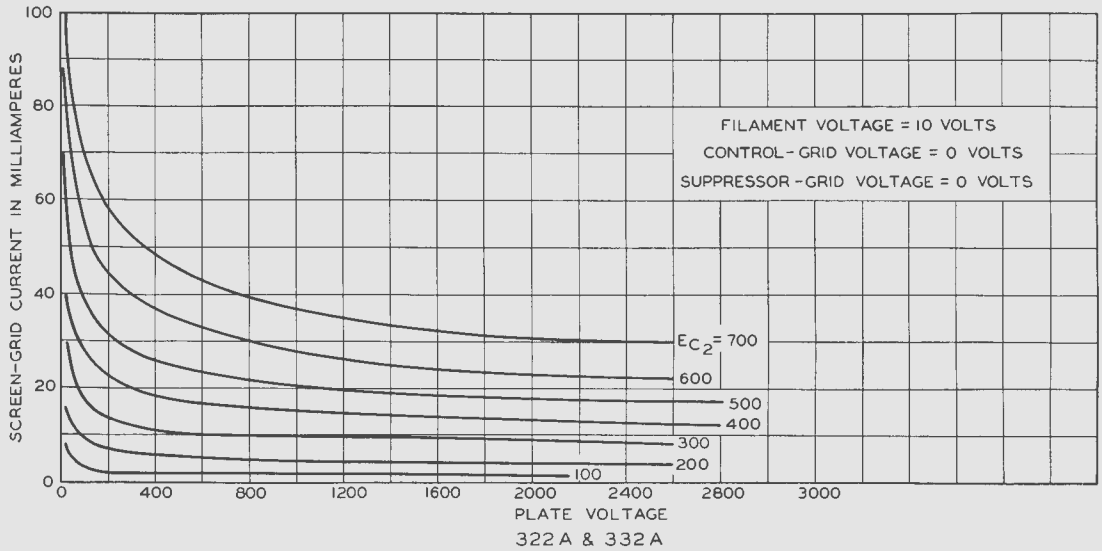

FILAMENT VOLTAGE = 10 VOLTS A.C.
SCREEN-GRID VOLTAGE = 500 VOLTS
SUPPRESSOR-GRID VOLTAGE = 0 VOLTS
E_{C_1}=+50
+40
+30
+20
+10
0
-10
-20
SCREEN-GRID CURRENT IN MILLIAMPERES
PLATE VOLTAGE
0
50
100
150
200
250
400
800
1200
1600
2000
2400
2800
3200
322A & 332A

FIG. 7



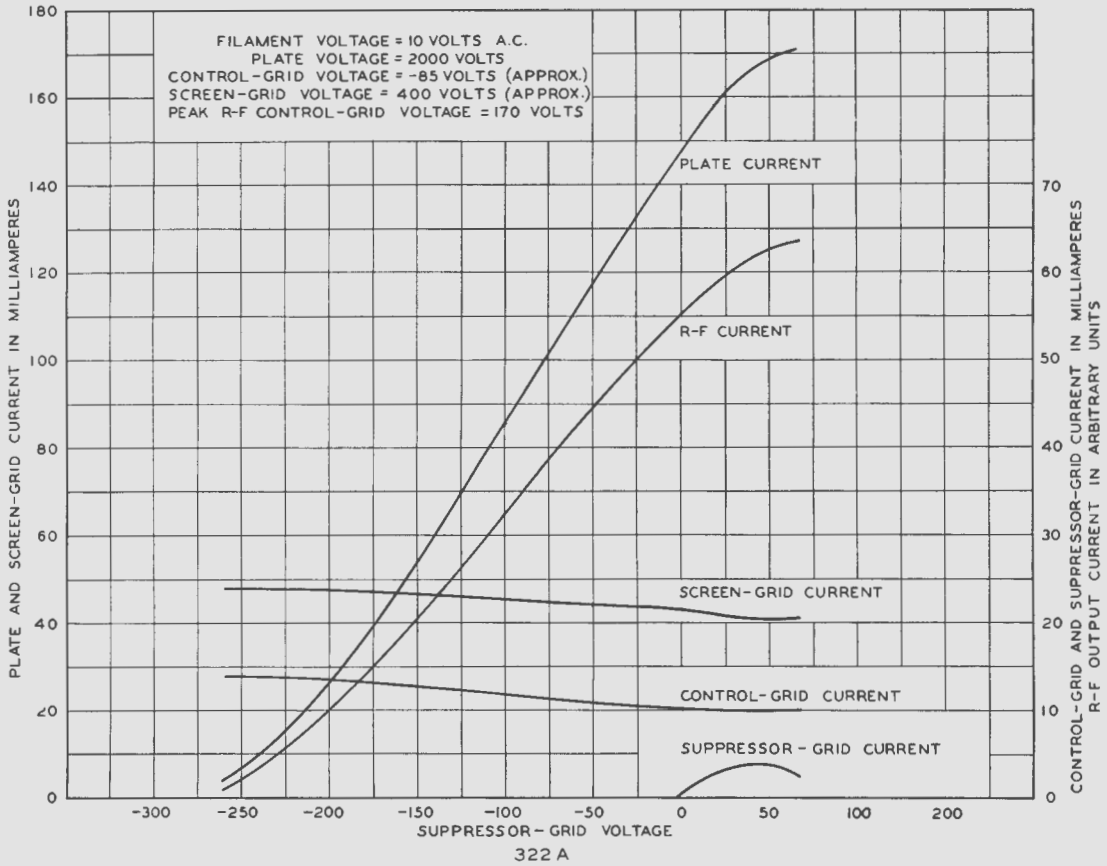
322 A & 332 A

FIG. 8



322 A & 332 A

FIG. 9


FILAMENT VOLTAGE = 10 VOLTS A.C.
PLATE VOLTAGE = 2000 VOLTS
CONTROL-GRID VOLTAGE = -85 VOLTS (APPROX.)
SCREEN-GRID VOLTAGE = 400 VOLTS (APPROX.)
PEAK R-F CONTROL-GRID VOLTAGE = 170 VOLTS
PLATE CURRENT
R-F CURRENT
SCREEN-GRID CURRENT
CONTROL-GRID CURRENT
SUPPRESSOR-GRID CURRENT
PLATE AND SCREEN-GRID CURRENT IN MILLIAMPERES
CONTROL-GRID AND SUPPRESSOR-GRID CURRENT IN MILLIAMPERES
R-F OUTPUT CURRENT IN ARBITRARY UNITS
SUPPRESSOR-GRID VOLTAGE
0
20
40
60
80
100
120
140
160
180
10
30
50
70
-300
-250
-200
-150
-100
-50
0
50
100
200

322 A

FIG. 10