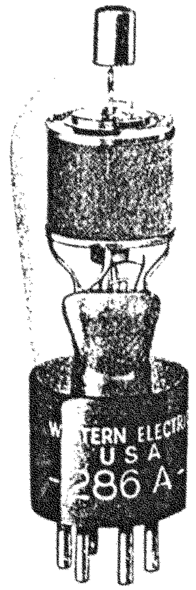
Western Electric

286A Vacuum Tube



Classification—Variable-mu, voltage-amplifier, suppressor-grid pentode with indirectly heated cathode

Each of the three grids of the 286A tube is connected to a separate terminal.

Applications

High-frequency voltage amplifier, especially in circuits in which the amplification is varied by changing the control-grid bias.

Audio-frequency voltage amplifier.

Shielded modulator.

Dimensions—Dimensions, outline diagrams of the tube and base, and the arrangement of the electrode connections to the base terminals are shown in Figures 1 and 2.

Base—Medium, six-pin base. Small, metal cap control-grid terminal at the top of the bulb.

Socket—Standard, six-contact type, such as the Western Electric 144B socket.

Mounting Positions—The 286A tube may be mounted in any position.

Average Direct Interelectrode Capacitances

Control grid to plate	0.004 μμf.
Suppressor grid to plate	1.7 μμf.
Plate to heater, cathode and screen grid	12.2 μμf.
Control grid to suppressor grid	0.06 μμf.
Control grid to heater, cathode and screen grid	6.3 μμf.
Suppressor grid to heater, cathode and screen grid	7.0 μμf.

Heater Rating

Heater voltage	2.0 volts, a.c. or d.c.
Nominal heater current	1.60 amperes

The heater element of this tube is designed to operate on a voltage basis and should be operated at as near the rated voltage as is practicable.

Cathode Connection—Preferably direct to the heater. If voltage must be applied between the cathode and heater, it should be kept as low as possible and should never exceed 90 volts.

Characteristics—Plate current and screen-grid current characteristics of a typical 286A tube are given in Figures 3 and 4, respectively, as functions of plate voltage for a screen-grid voltage of 75 volts, zero suppressor-grid voltage, and several values of control-grid voltage. A typical characteristic showing plate current as a function of control-grid voltage is given in Figure 5 for a plate voltage of 180 volts, a screen-grid voltage of 75 volts, and zero suppressor-grid voltage. The corresponding transconductance characteristic is shown in Figure 6. For other plate voltages between 135 and 250 volts, the transconductance of a typical tube for values higher than 5 micromhos does not differ by more than ± 2 per cent from its value at 180 volts. Amplification factor and plate resistance characteristics are shown in Figures 7 and 8, respectively, as functions of control-grid voltage for a screen-grid voltage of 75 volts, zero suppressor-grid voltage, and several values of plate voltage. Plate current and screen-grid current characteristics are shown in Figures 9 and 10 as functions of plate voltage for a screen-grid voltage of 75 volts, a control-grid voltage of −1.5 volts, and several values of suppressor-grid voltage. Corresponding amplification factor, plate resistance, and transconductance characteristics are given in Figures 11, 12, and 13, respectively.

Typical Operating Conditions

Plate Voltage	Screen-Grid Voltage	Suppressor-Grid Voltage	Control-Grid Bias	Plate Current	Screen-Grid Current	Amplification Factor	Plate Resistance	Transconductance
Volts	Volts	Volts	Volts	Milliamperes	Milliamperes		Ohms	Micromhos
135	75	0	−1.5	6.1	1.7	475	400,000	1190
180	75	0	−1.5	6.2	1.6	850	700,000	1200
*250	75	0	−1.5	6.3	1.5	1275	1,050,000	1210
**135-250	75	0	−45	—	—	—	—	5

*Maximum operating conditions
**Nominal cut-off

Less severe operating conditions should be selected in preference to maximum operating conditions wherever possible. The life of the tube at maximum conditions may be shorter than at less severe conditions.

Microphonic Noise—With a plate voltage of 180 volts, a screen-grid voltage of 75 volts, zero suppressor-grid voltage, a control-grid voltage of −1.5 volts, and a load resistance of 100,000 ohms, the mean microphonic noise output level of the 286A tube, measured in a laboratory reference test set, is 17 db below 1 volt. The range of levels of individual tubes extends from 0 to 34 db below 1 volt. Since microphonic noise level depends on the type and intensity of the mechanical disturbance which produces it, the values given here are useful chiefly for comparison with the levels of other types of tubes which have been tested in the same way.

Special Features—By virtue of its variable-mu characteristic, the 286A tube is particularly well adapted to amplifier or modulator applications where the sensitivity is controlled by varying the grid bias. As the control grid is made more negative, the transconductance and plate current approach zero gradually rather than sharply, so that distortion is relatively small at all values of grid bias.

In addition to its amplifier applications, the tube is also effective as a shielded modulator. Due to the low capacitance between the first and third grids, separate inputs may be applied to these elements without appreciable interaction. Both of these grids are negative for such use, so that the power required to drive them is negligible. The operating conditions suggested in the table on page 2 are appropriate except that a negative bias numerically equal to about ⅛ of the plate voltage should be applied to the suppressor grid.

Circuit Requirements—In order to make use of the high gain per stage of which the 286A tube is capable when used as a voltage amplifier, suitable precautions must be taken, especially where high frequencies are involved, to avoid undesired feed-back in the circuit. It is usually necessary to use a close-fitting shield around each tube, to shield each stage of the amplifier circuit, to connect a low-impedance condenser between each screen-grid and its corresponding cathode, to filter each battery lead to each tube, and to avoid impedances common to the plate, screen-grid, control-grid, or cathode circuits of two or more tubes. For amplifier applications, each suppressor grid should be connected directly to its corresponding cathode.

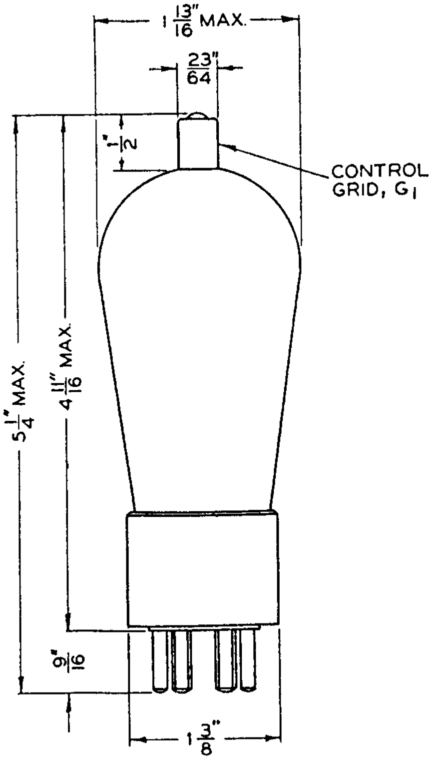


FIG. 1

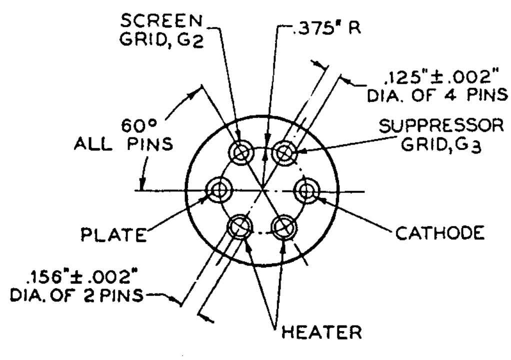


FIG. 2

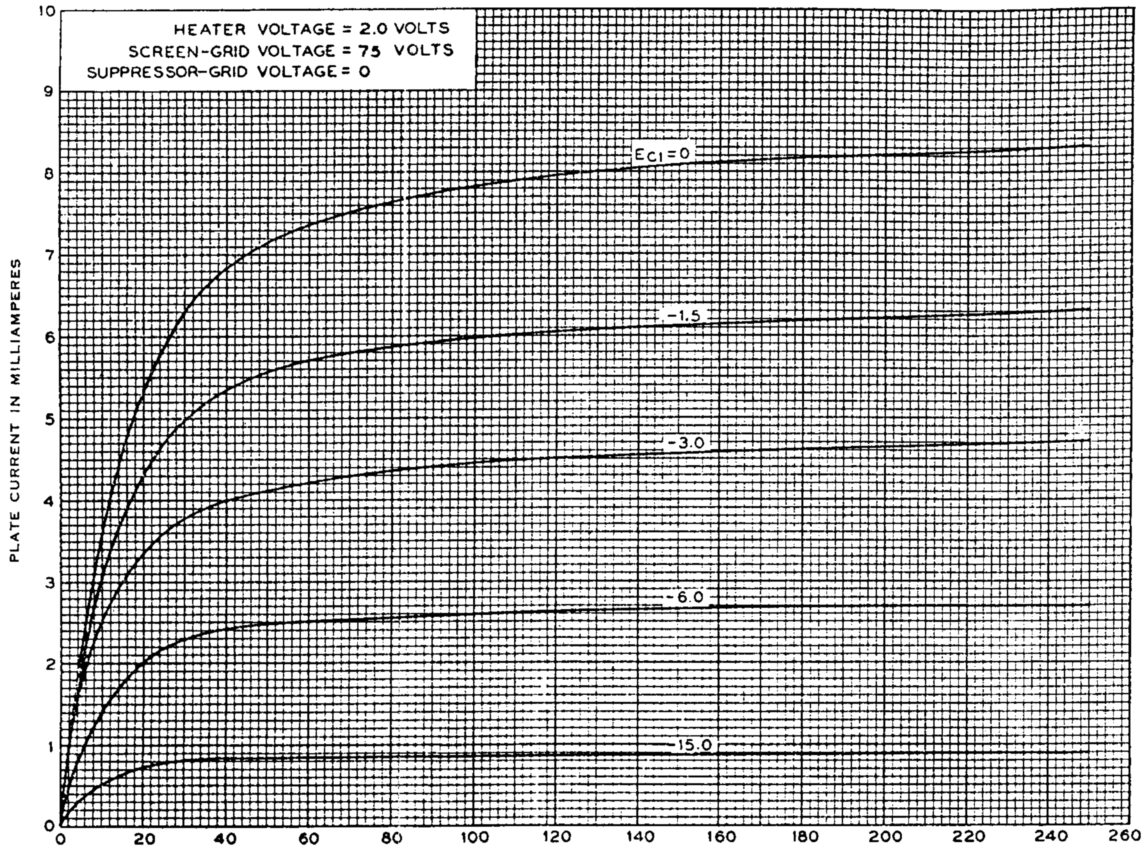

HEATER VOLTAGE = 2.0 VOLTS
SCREEN-GRID VOLTAGE = 75 VOLTS
SUPPRESSOR-GRID VOLTAGE = 0
PLATE CURRENT IN MILLIAMPERES
Ec1 = 0
-1.5
-3.0
-6.0
-15.0
0
1
2
3
4
5
6
7
8
9
10
0
20
40
60
80
100
120
140
160
180
200
220
240
260

FIG. 3

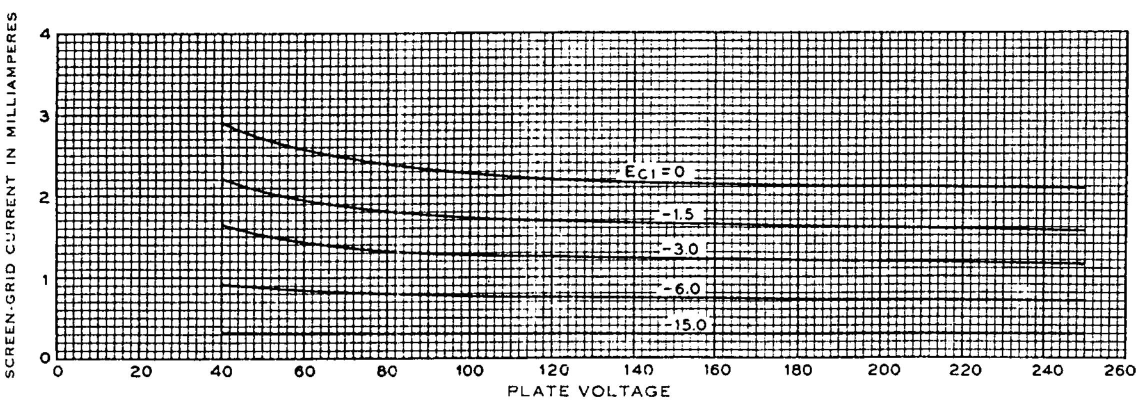
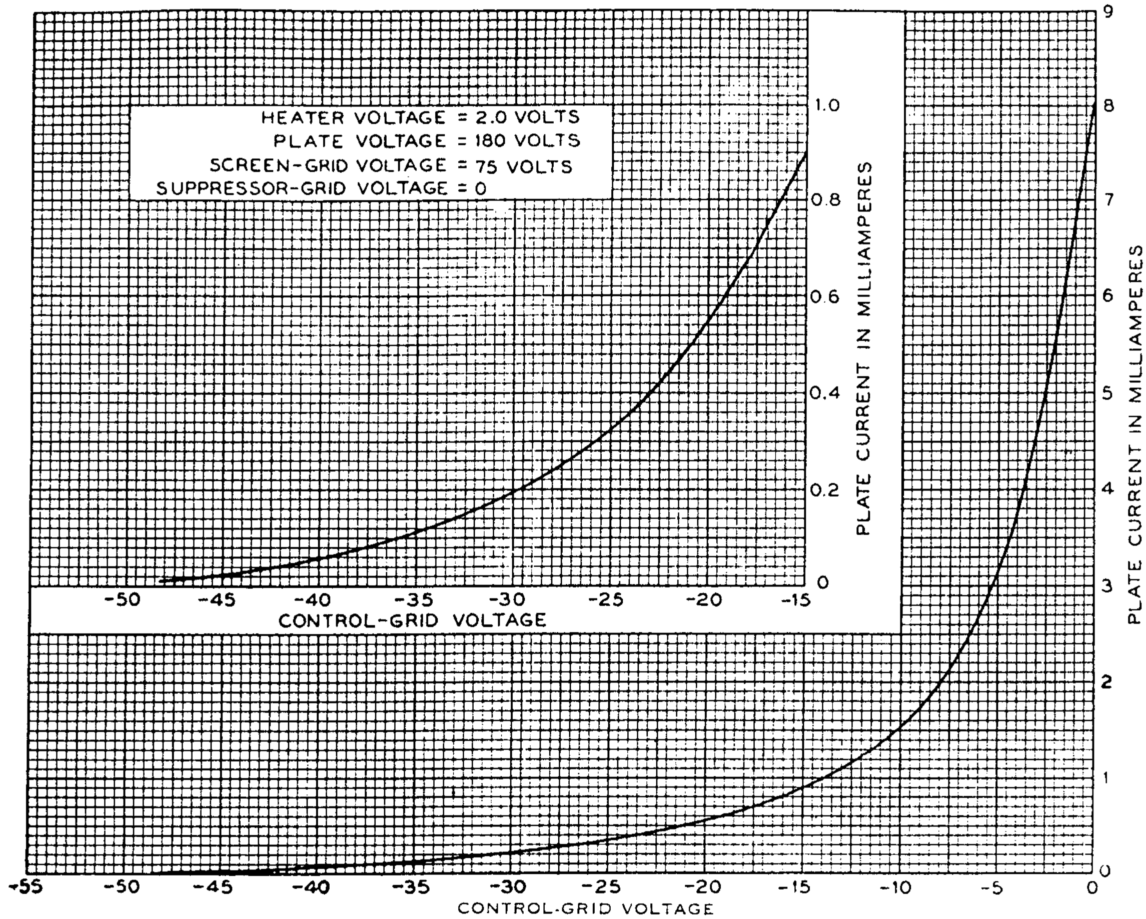
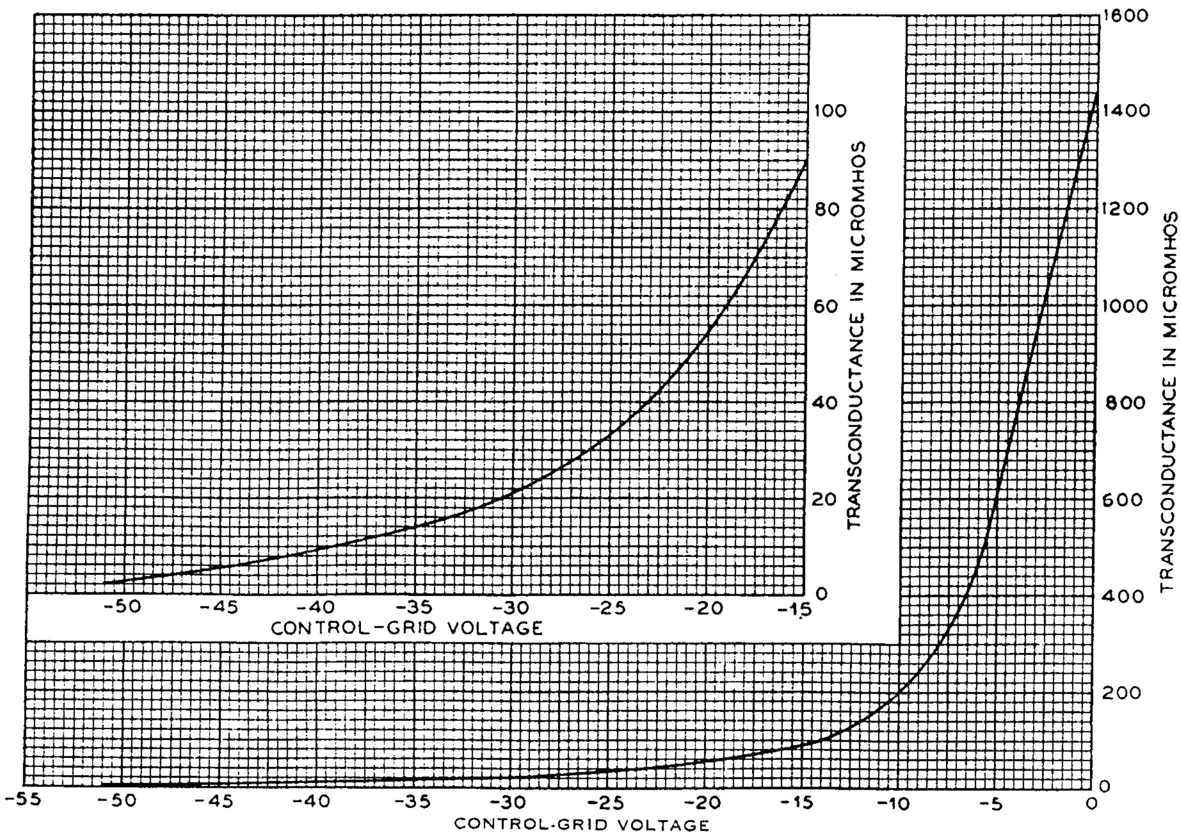

SCREEN-GRID CURRENT IN MILLIAMPERES
Ec1 = 0
-1.5
-3.0
-6.0
-15.0
0
1
2
3
4
0
20
40
60
80
100
120
140
160
180
200
220
240
260
PLATE VOLTAGE

FIG. 4



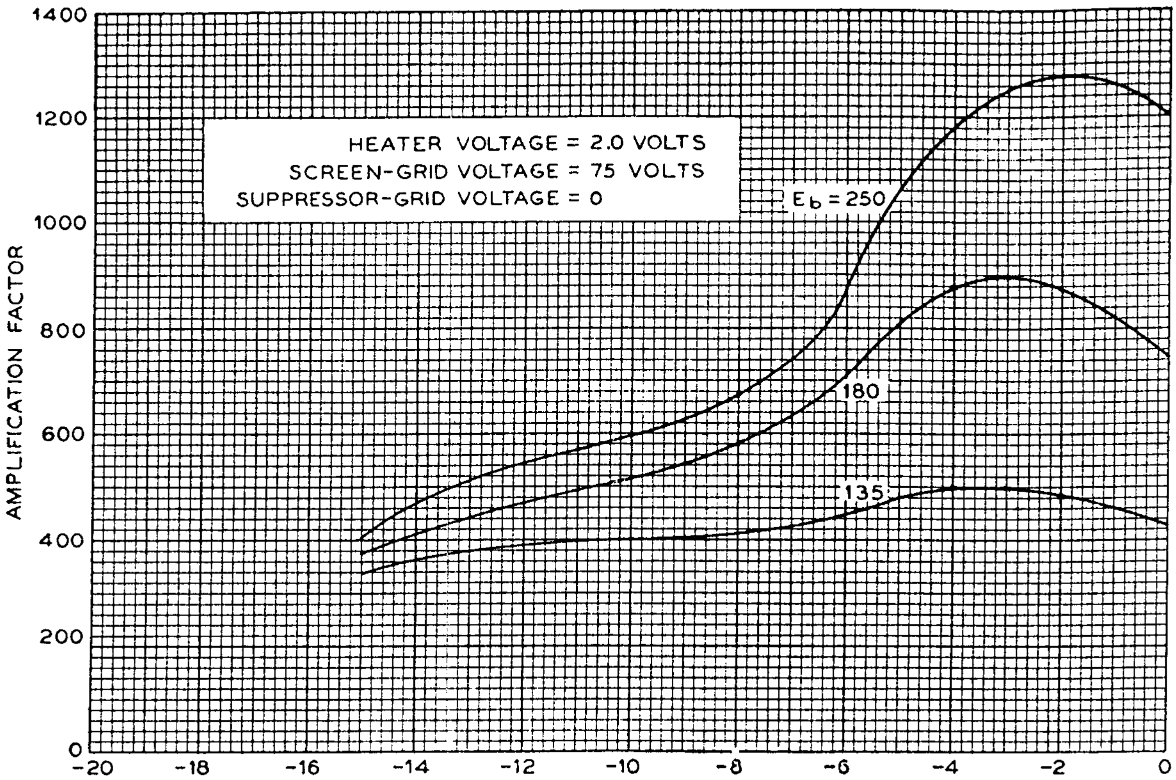
HEATER VOLTAGE = 2.0 VOLTS
PLATE VOLTAGE = 180 VOLTS
SCREEN-GRID VOLTAGE = 75 VOLTS
SUPPRESSOR-GRID VOLTAGE = 0
PLATE CURRENT IN MILLIAMPERES
CONTROL-GRID VOLTAGE
PLATE CURRENT IN MILLIAMPERES
CONTROL-GRID VOLTAGE

FIG. 5



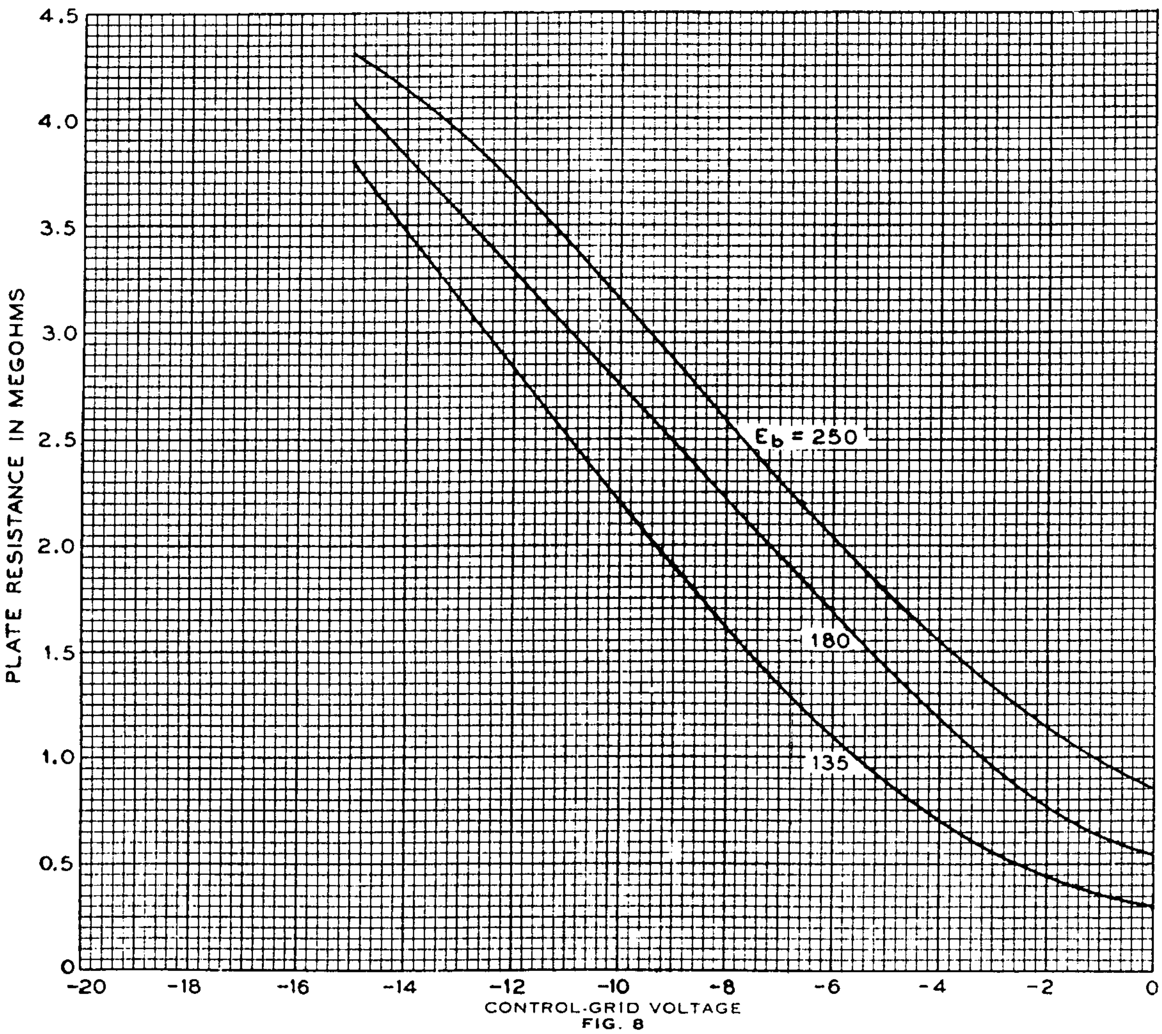
TRANSCONDUCTANCE IN MICROMHOS
CONTROL-GRID VOLTAGE
TRANSCONDUCTANCE IN MICROMHOS
CONTROL-GRID VOLTAGE

FIG. 6



HEATER VOLTAGE = 2.0 VOLTS
SCREEN-GRID VOLTAGE = 75 VOLTS
SUPPRESSOR-GRID VOLTAGE = 0
$E_b = 250$
180
135
AMPLIFICATION FACTOR
1400
1200
1000
800
600
400
200
0
−20
−18
−16
−14
−12
−10
−8
−6
−4
−2
0

FIG. 7



$E_b = 250$
180
135
PLATE RESISTANCE IN MEGOHMS
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0
−20
−18
−16
−14
−12
−10
−8
−6
−4
−2
0
CONTROL-GRID VOLTAGE

FIG. 8

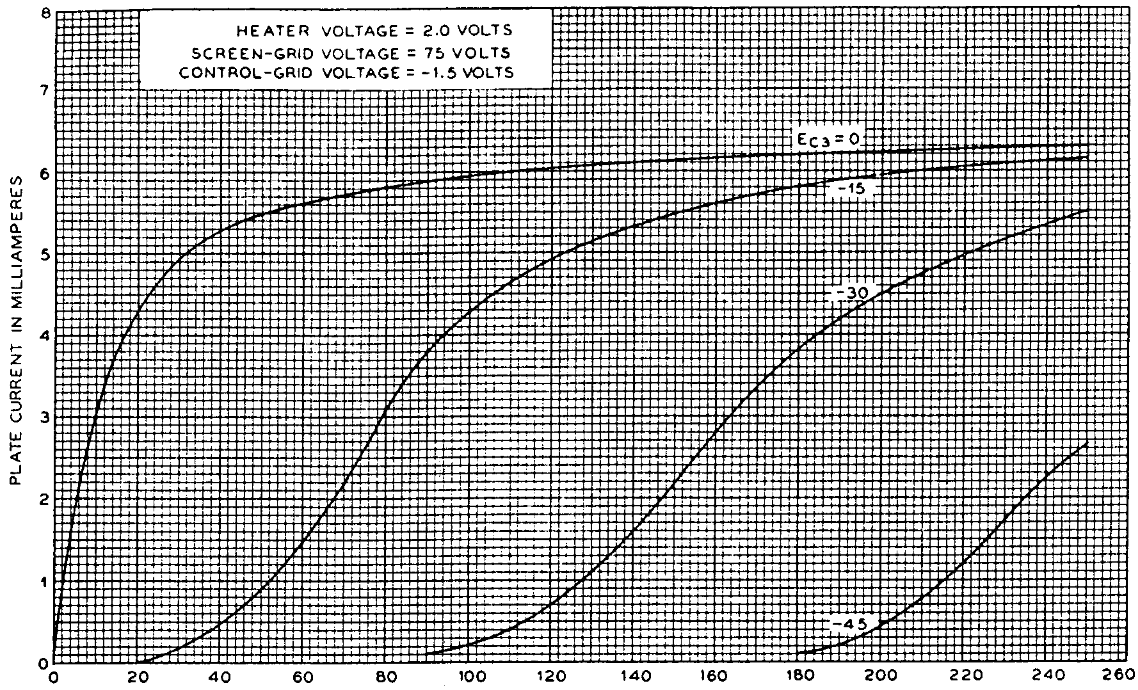

HEATER VOLTAGE = 2.0 VOLTS
SCREEN-GRID VOLTAGE = 75 VOLTS
CONTROL-GRID VOLTAGE = -1.5 VOLTS
$E_{C3}=0$
-15
-30
-45
PLATE CURRENT IN MILLIAMPERES
0
1
2
3
4
5
6
7
8
0
20
40
60
80
100
120
140
160
180
200
220
240
260

FIG. 9

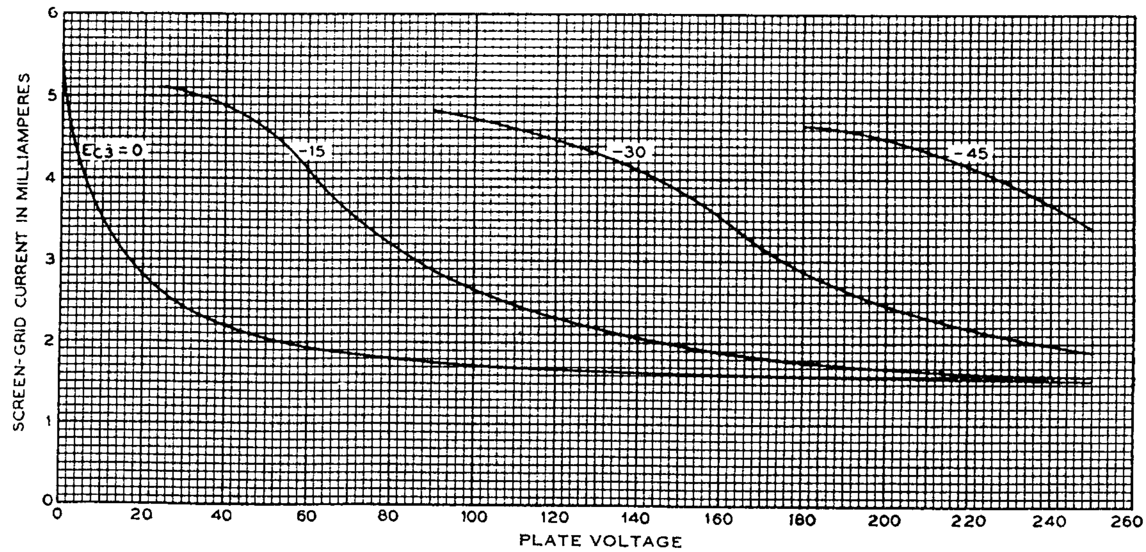

$E_{C3}=0$
-15
-30
-45
SCREEN-GRID CURRENT IN MILLIAMPERES
0
1
2
3
4
5
6
0
20
40
60
80
100
120
140
160
180
200
220
240
260
PLATE VOLTAGE

FIG. 10

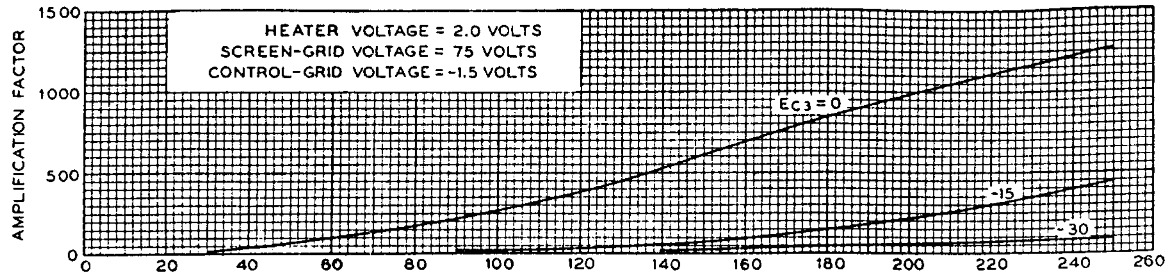


FIG. 11

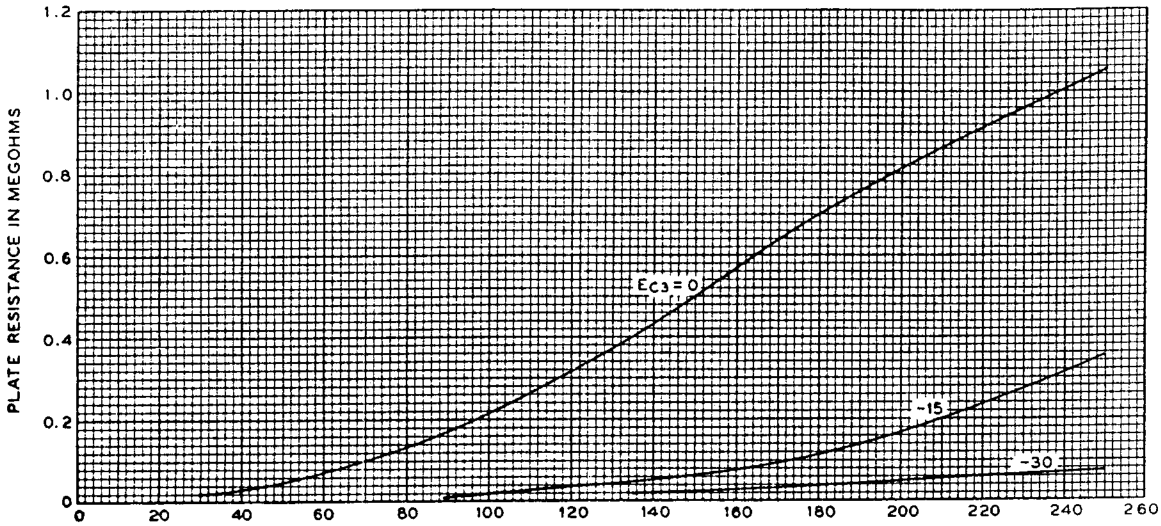


FIG. 12

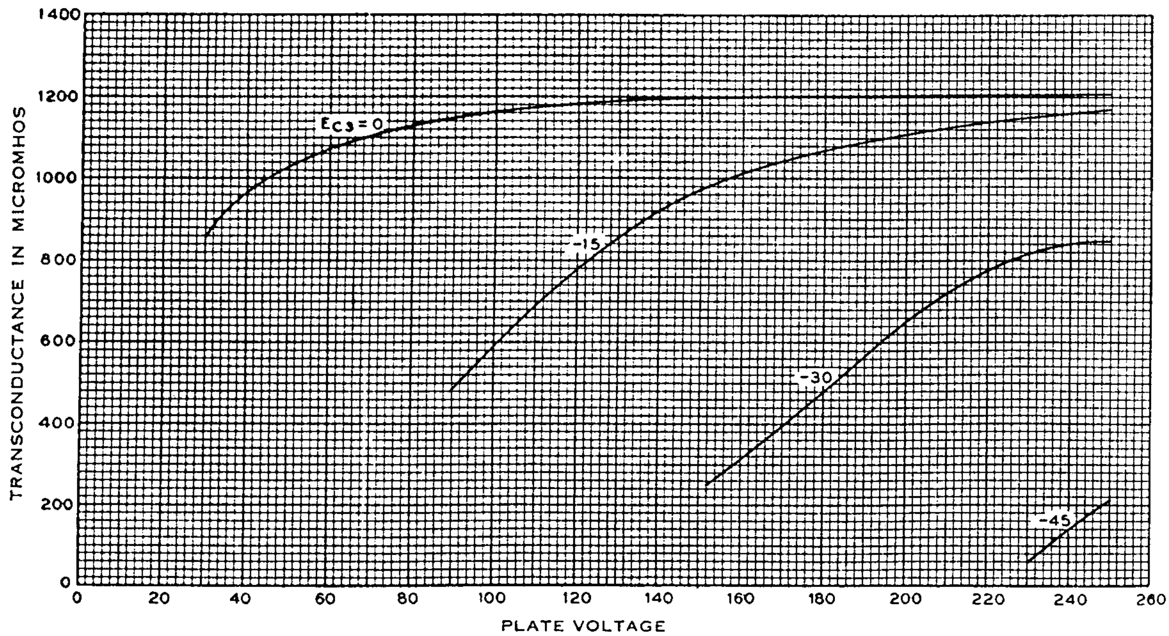


FIG. 13

A development of Bell Telephone Laboratories, Incorporated, the research laboratories of the American Telephone and Telegraph Company, and the Western Electric Company