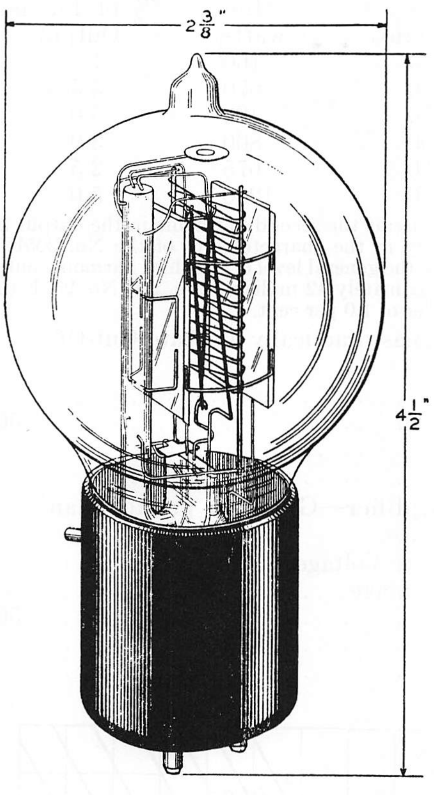
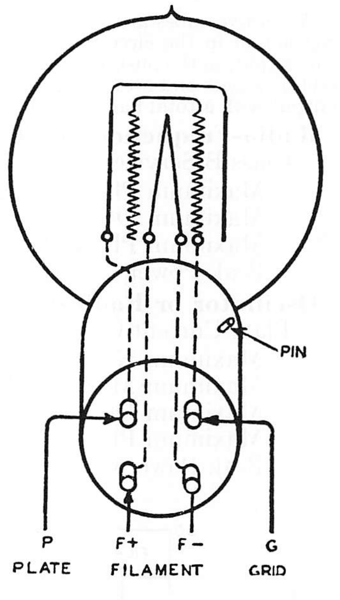
# 205E Vacuum Tube




### Classification

The No. 205E is a three-element filamentary type tube intended for use as a radio-frequency amplifier, oscillator, modulator, and audio-frequency amplifier in output stages when moderate powers are required.

### Base and Socket

The No. 205E Vacuum Tube employs a four-prong bayonet pin type base suitable for use in a Western Electric 100M (front panel mounting), 115B (rear panel mounting), or similar type socket.

### General Ratings and Information

| | |
|---|---|
| Filament Voltage | 4.5 Volts, AC or DC |
| Filament Current | 1.6 Amperes |
| Average Amplification Factor | 7.3 |

Approximate Direct Interelectrode Capacities (measured without socket)

| | |
|---|---|
| Plate to Grid | 4.8 MMF |
| Plate to Filament | 3.3 MMF |
| Grid to Filament | 5.2 MMF |

**Audio-Amplifier or Modulator Rating**—Peak Grid Input Equal to or less than grid Bias—Class A Service.

| | |
|---|---|
| Maximum Plate Voltage | 400 Volts |
| Maximum Plate Current | 50 Milliamperes |
| Maximum Plate Dissipation | 14 Watts |

Typical outputs obtainable within the recommended operating conditions for resistance loads equal to twice the plate resistance and for inputs on the grid equal to the grid bias.

| Plate Volts | Grid Volts | Approx. Plate Current (Milli-amperes) | Approx. Plate Resist-ance Rp (Ohms) | Fundamental Power Output (Milli-watts) | Second Harmonic. % of Funda. Output | Third Harmonic. % of Funda. Output |
|---|---|---|---|---|---|---|
| 250 | —10 | 27.5 | 4000 | 160 | 1.5 | .1 |
| 300 | —24 | 15 | 5000 | 670 | 5.5 | .5 |
| | —18 | 25 | 4150 | 480 | 3.0 | .2 |
| 350 | —22.5 | 30 | 3900 | 800 | 3.0 | .3 |
| | —20 | 35 | 3750 | 675 | 2.5 | .2 |
| 370 | —30 | 21 | 4450 | 1200 | 5.0 | .5 |

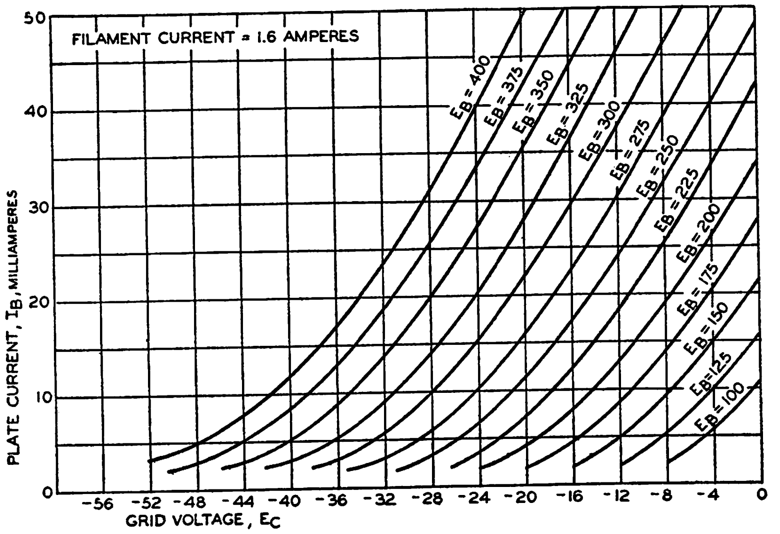
When two tubes are operated in a push-pull circuit the second harmonic in the output is reduced by the balancing action in the circuit. Due to the uniformity in the characteristics of the No. 205E tube the second harmonic output, in the push-pull circuit, is reduced to the general level of the third harmonic output. With a plate voltage of 375 volts and a total plate current of approximately 42 milliamperes, two No. 205E tubes will give 2.4 watts output with a total harmonic content of the order of 1.0 per cent.

**Radio-Frequency Amplifier**—Grid Bias practically at Plate Cut-Off—Class B Service.

| | |
|---|---|
| Maximum Plate Voltage | 400 Volts |
| Maximum DC Plate Current | 50 Milliamperes |
| Maximum Plate Dissipation | 14 Watts |
| Peak Power Output | 12 Watts |

**Oscillator or Radio-Frequency Amplifier**—Grid Bias greater than Plate Current Cut-Off—Class C Service.

| | |
|---|---|
| Maximum Non-modulated DC Plate Voltage | 400 Volts |
| Maximum Modulated DC Plate Voltage | 350 Volts |
| Maximum DC Plate Current | 50 Milliamperes |
| Maximum Plate Dissipation | 14 Watts |
| Peak Power Output | 12 Watts |




**Average Static Characteristics**

The accompanying curve gives the average static characteristics for the No. 205E Tube. These curves have been obtained with the filament operating on direct current and the grid and plate returns connected to the negative ends of the filament.

**General Features**

The No. 205E Tube will operate satisfactorily at or above 30,000 kilocycles if the radio frequency charging current is limited to a value that will not cause excessive heating of lead-in wires or di-electric parts.

It is similar to the No. 205D except that the internal structure is designed to reduce noise disturbance outputs due to variable contacts within the tube. The prongs of the base are equipped with special contact metal tips to prevent noise disturbance due to poor electrical contact with the springs of the socket.

The filament is of a particularly rugged oxide coated type insuring a long tube life.

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# *Western Electric*

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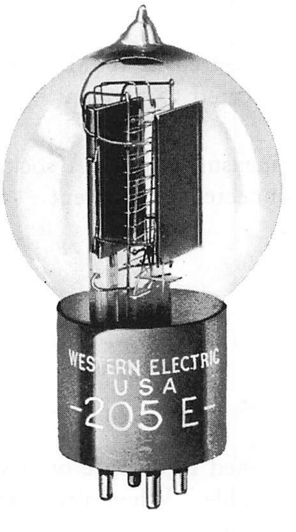


**Classification—Moderate power, filamentary triode**

The 205E tube is similar to the 205D tube except that special precautions have been taken in the 205E tube to minimize sputter noise in the tube and contact noise between the contact pins and the socket.

**Applications**

Audio-frequency amplifier or modulator where power outputs of approximately 1 watt or less are required.

Radio-frequency power amplifier.

Oscillator.

**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, four-pin, bayonet type having special contact metal at the ends of the contact pins. The bayonet pin is offset.

**Socket**—Four-contact, bayonet-slot type, preferably provided with contact-metal contacts, such as the Western Electric 100M for front of panel mounting or 116A for rear of panel mounting.

**Mounting Positions**—Either vertical or horizontal. If mounted in a horizontal position, the plane of the filament, which is indicated in Figure 2, should be vertical.

**Average Direct Interelectrode Capacitances**

| | A | B | C |
|---|---|---|---|
| Grid to plate, $\mu\mu f$ | 4.8 | 4.3 | 4.3 |
| Grid to filament, $\mu\mu f$ | 5.2 | 6.4 | 6.9 |
| Plate to filament, $\mu\mu f$ | 3.3 | 5.2 | 5.5 |

Column A—Based tube without socket.

Column B—Tube alone when measured in 100M socket mounted on metal plate; socket and mounting plate connected to filament.

Column C—Tube alone when measured in 116A socket mounted in metal plate; socket and mounting plate connected to filament.

**Filament**—Oxide-coated

| | |
|---|---|
| Filament voltage | 4.5 volts, a.c. or d.c. |
| Nominal filament current | 1.6 amperes |

The filament of this tube is designed to operate on a voltage basis and should be operated at as near the rated voltage as is practicable. When alternating-current filament supply is used, the grid and plate returns should be connected to a center tap on the secondary of the filament transformer.

**Characteristics**—Plate current charcteristics of a typical 205E tube are shown in Figure 3 as functions of grid voltage for several values of plate voltage. Corresponding amplification factor, plate resistance, and transconductance characteristics are given in Figures 4, 5, and 6, respectively. Plate current characteristics as functions of plate voltage for several values of grid voltage are shown in Figure 7. These characteristics are for direct-current filament supply with the grid and plate voltages measured from the negative end of the filament. When alternating-current filament supply is used, the same characteristics are applicable if 2.6 is added to the numerical value of each grid bias.

**Microphonic Noise**—With a plate voltage of 350 volts, a grid bias of −22.5 volts, and a load resistance of 100,000 ohms, the mean microphonic noise output level of 205E tube measured in a laboratory reference test set is 25 decibels below 1 volt. The range of levels of individual tubes extends from 16 to 33 decibels below 1 volt. Since microphonic noise 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 tubes which have been tested in the same way.

**Sputter Noise**—A particularly disagreeable type of noise, characterized by an unmusical crackling or sputtering sound, occurs in many vacuum tubes, sometimes as a result of slight mechanical agitation. The sputter noise spectrum covers a wide band and may be of appreciable intensity even at radio frequencies. Such noise is usually due either to discontinuously variable insulation leaks between electrodes or to intermittent contacts involving conducting members such as filament supports which, at times of no contact, are insulated from other parts of the tube. Special precautions have been taken in the design of the 205E tube to eliminate this type of noise.

## Limiting Conditions for Safe Operation

| | Class A Amp. | *Class B R-F Amp. | Class C R-F Amp. or Osc. | *Class C R-F Amp. Plate Modulated |
|---|---|---|---|---|
| Maximum direct plate voltage | 400 | 400 | 400 | 350 volts |
| Maximum direct plate current | 50 | 35 | 50 | 40 milliamperes |
| Maximum plate dissipation | 14 | 14 | 14 | 10 watts |
| Maximum direct grid current | — | 10 | 10 | 10 milliamperes |

*Carrier conditions for use with modulation factors up to 1.0.

## Operating Conditions and Output

**Class A**—Amplifier or Modulator

Permissible operating grid and plate voltage for Class A operation are included within the area, ABCD, in Figure 3. Amplification factor, plate resistance, transconductance, and performance data are given in Table I for a number of typical operating conditions represented by selected points within this area. A less severe operating condition should be selected in preference to a maximum operating condition wherever possible. The life of the tube at maximum operating conditions may be shorter than at less severe conditions.

The performance data include the fundamental power output in milliwatts and the levels of the second and third harmonics in decibels below the fundamental for values of load resistance, R, equal to one, two, and in some cases three times the plate resistance, $r_p$. The peak value of the sinusoidal input voltage, $E_{gm}$, which gives the indicated power output, $P_m$, and harmonic levels, $F_{2m}$ and $F_{3m}$, in each case, is numerically equal to the grid bias. For a smaller input voltage, $E_g$, the output and harmonic levels are given approximately by the following relations:

$$P = P_m \left(\frac{E_g}{E_{gm}}\right)^2$$

$$F_2 = F_{2m} + 20 \log_{10} \frac{E_{gm}}{E_g}$$

$$F_3 = F_{3m} + 40 \log_{10} \frac{E_{gm}}{E_g}$$

**TABLE I**

| Plate Voltage | Grid Bias | Plate Current | Amplification Factor | Plate Resistance | Transconductance | Input Voltage | Load Resistance | Power Output | Second Harmonic | Third Harmonic |
|---|---|---|---|---|---|---|---|---|---|---|
| Volts | Volts | Milliamperes | | Ohms $r_p$ | Micromhos | Peak Volts | R | Milliwatts | db | db |
| 200 | −6 | 22.5 | 7.4 | 4000 | 1840 | 6 | $R=r_p$ | 60 | 35 | 65 |
| | | | | | | | $R=2r_p$ | 55 | 40 | 70 |
| 250 | −22 | 9 | 6.9 | 6000 | 1160 | 22 | $R=r_p$ | 500 | 18 | 33 |
| | | | | | | | $R=2r_p$ | 450 | 22 | 40 |
| | | | | | | | $R=3r_p$ | 380 | 26 | 47 |
| 250 | −15 | 19 | 7.2 | 4350 | 1670 | 15 | $R=r_p$ | 310 | 26 | 45 |
| | | | | | | | $R=2r_p$ | 280 | 30 | 55 |
| 250 | −10 | 27.5 | 7.4 | 3800 | 1950 | 10 | $R=r_p$ | 180 | 33 | 60 |
| | | | | | | | $R=2r_p$ | 160 | 38 | 65 |
| 250 | −5 | 37.5 | 7.5 | 3500 | 2150 | 5 | $R=r_p$ | 50 | 40 | 70 |
| | | | | | | | $R=2r_p$ | 45 | 43 | 70 |
| 300 | −30 | 8 | 6.7 | 6700 | 1000 | 30 | $R=r_p$ | 800 | 15 | 28 |
| | | | | | | | $R=2r_p$ | 720 | 20 | 35 |
| | | | | | | | $R=3r_p$ | 600 | 24 | 42 |
| 300 | −24 | 15.5 | 7.1 | 4800 | 1460 | 24 | $R=r_p$ | 750 | 20 | 36 |
| | | | | | | | $R=2r_p$ | 670 | 25 | 45 |
| 300 | −18 | 25 | 7.3 | 4000 | 1830 | 18 | $R=r_p$ | 540 | 27 | 46 |
| | | | | | | | $R=2r_p$ | 480 | 31 | 55 |
| 350 | −22.5 | 29 | 7.3 | 3800 | 1940 | 22.5 | $R=r_p$ | 875 | 26 | 44 |
| | | | | | | | $R=2r_p$ | 800 | 30 | 50 |
| 375 | −30 | 22 | 7.1 | 4300 | 1660 | 30 | $R=r_p$ | 1300 | 20 | 36 |
| | | | | | | | $R=2r_p$ | 1200 | 26 | 45 |
| *300 | −10 | 41 | 7.4 | 3350 | 2220 | 10 | $R=r_p$ | 200 | 37 | 65 |
| | | | | | | | $R=2r_p$ | 180 | 41 | 70 |
| *350 | −20 | 34 | 7.3 | 3600 | 2060 | 20 | $R=r_p$ | 750 | 28 | 50 |
| | | | | | | | $R=2r_p$ | 675 | 32 | 55 |
| *375 | −24 | 32 | 7.3 | 3650 | 1990 | 24 | $R=r_p$ | 1000 | 26 | 44 |
| | | | | | | | $R=2r_p$ | 900 | 30 | 55 |
| *400 | −29 | 30 | 7.2 | 3800 | 1890 | 29 | $R=r_p$ | 1400 | 23 | 39 |
| | | | | | | | $R=2r_p$ | 1300 | 28 | 48 |

*Maximum operating conditions.

**Class B**—Amplifier

Radio telephone applications, particularly the amplification of a modulated carrier wave with a minimum of distortion. Typical carrier conditions for use with a modulation factor up to 1.0 are shown in Table II.

**TABLE II**

| Direct Plate Voltage | Grid Bias | Direct Plate Current | Driving Voltage | | Power Output | | Effective Load Resistance | Peak Driving Power |
|---|---|---|---|---|---|---|---|---|
| | | | Carrier | A-F Peak | Carrier | A-F Peak | | |
| Volts | Volts | Milli-amperes | Peak Volts | Volts | Watts | Watts | Ohms | Watts |
| 350 | −48 | 28 | 69 | 138 | 2.5 | 10 | 3100 | 1 |
| 400 | −56 | 28 | 73 | 146 | 3.0 | 12 | 3700 | 1 |

**Class C**—Amplifier or Oscillator

Radio telegraph or other continuous-wave applications. Typical operating conditions are shown in Table III.

**TABLE III**

| Direct Plate Voltage | Grid Bias | Direct Plate Current | Driving Voltage | Power Output | Effective Load Resistance | Driving Power |
|---|---|---|---|---|---|---|
| Volts | Volts | Milli-amperes | Peak Volts | Watts | Ohms | Watts |
| 350 | − 96 | 45 | 186 | 8.3 | 3750 | 1.3 |
| 400 | −112 | 45 | 202 | 10.0 | 4500 | 1.5 |

**Class C**—Amplifier—Plate modulated

Radio telephone applications. Typical carrier conditions for use with modulation factors up to 1.0 are shown in Table IV.

**TABLE IV**

| Direct Plate Voltage | Grid Bias | Direct Plate Current | Driving Voltage | Power Output | Effective Load Resistance | Driving Power |
|---|---|---|---|---|---|---|
| Volts | Volts | Milli-amperes | Peak Volts | Watts | Ohms | Watts |
| 300 | −120 | 35 | 205 | 6.0 | 4000 | 1.3 |
| 350 | −144 | 35 | 229 | 7.1 | 5000 | 1.7 |

## High Frequency Ratings

If the 205E tube is to be used at frequencies higher than 15 megacycles, the plate voltage and plate dissipation ratings given above should be reduced to avoid excessive high-frequency currents, excessive heating due to dielectric losses, and consequent injury to the tube. At the limiting frequency of 30 megacycles, the maximum ratings should be as follows:

Maximum plate voltage.............................. 300 volts
Maximum plate dissipation.......................... 10 watts
Maximum r-f grid current........................... 3 amperes

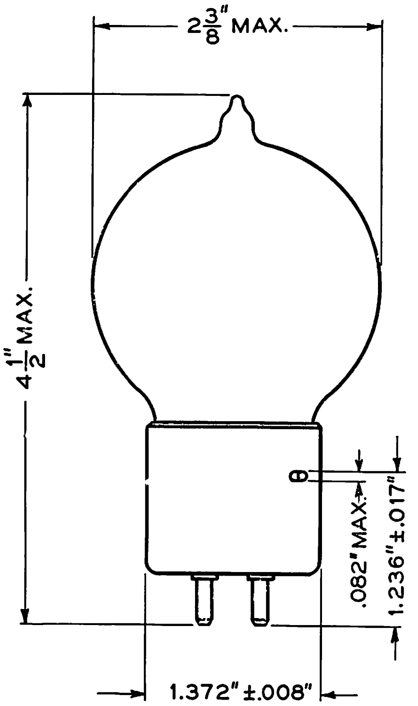


FIG. 1

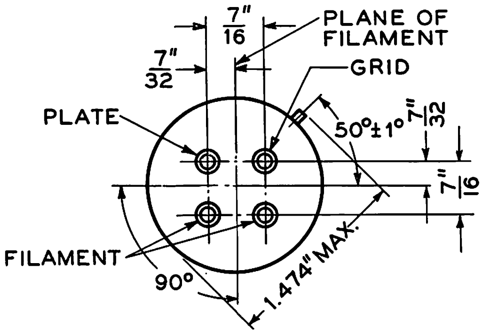


FIG. 2

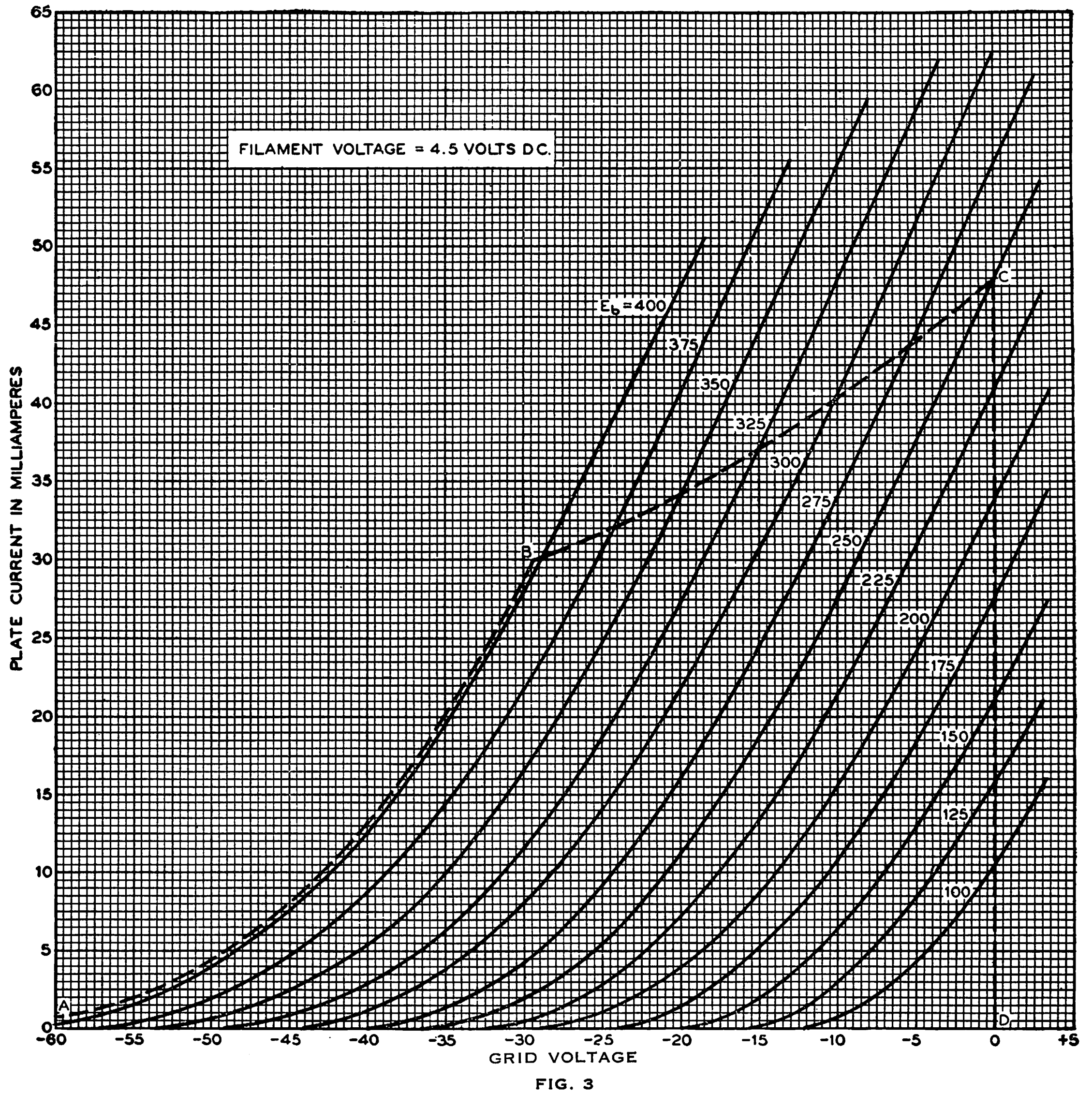


FIG. 3

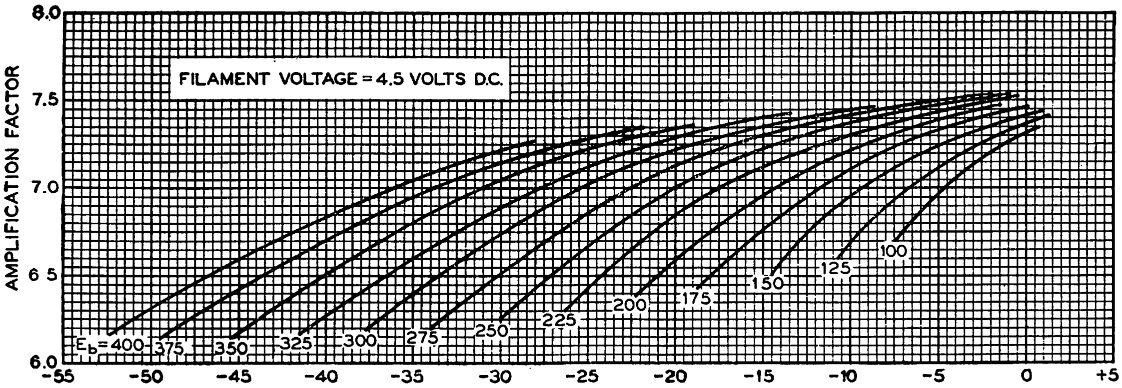

FIG. 4

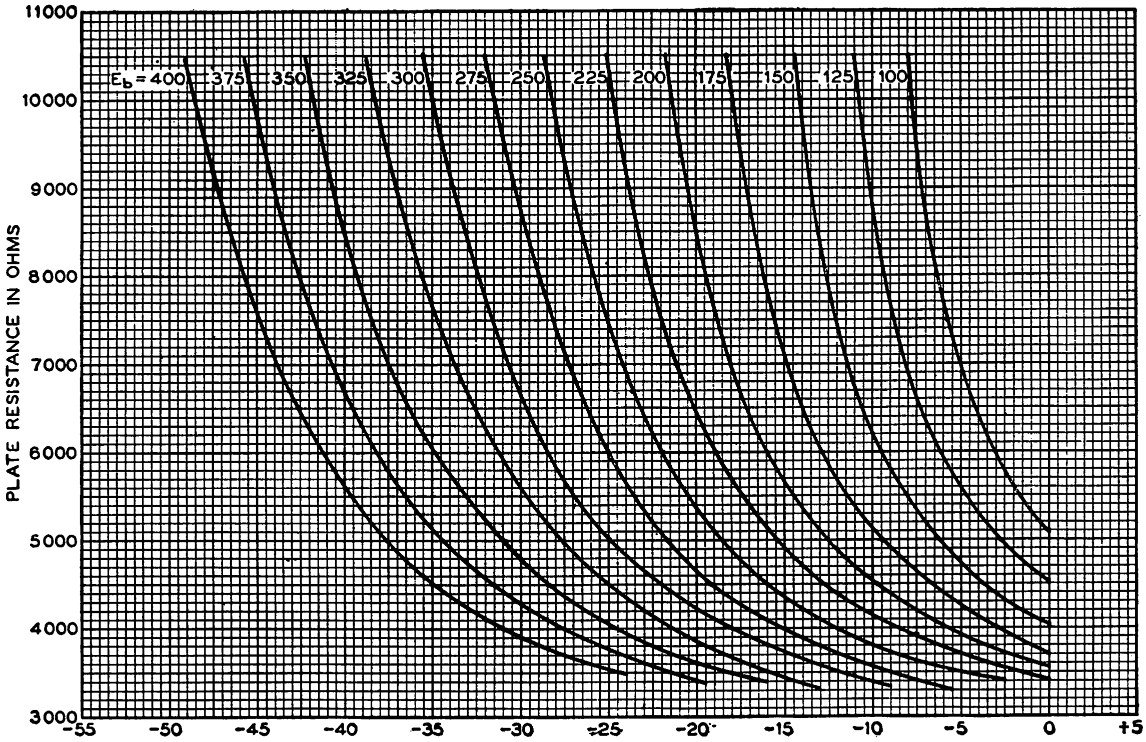

FIG. 5

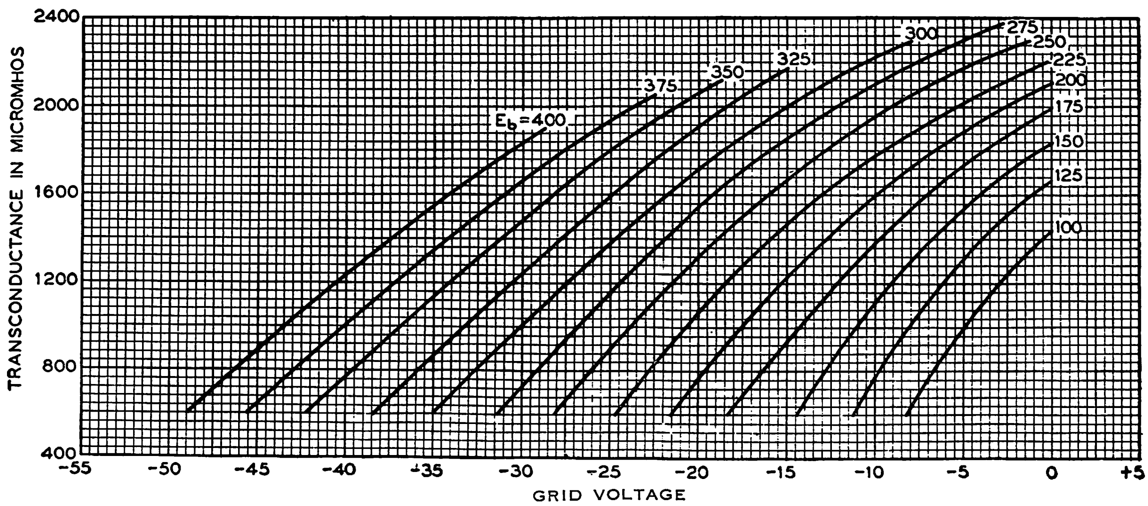

FIG. 6

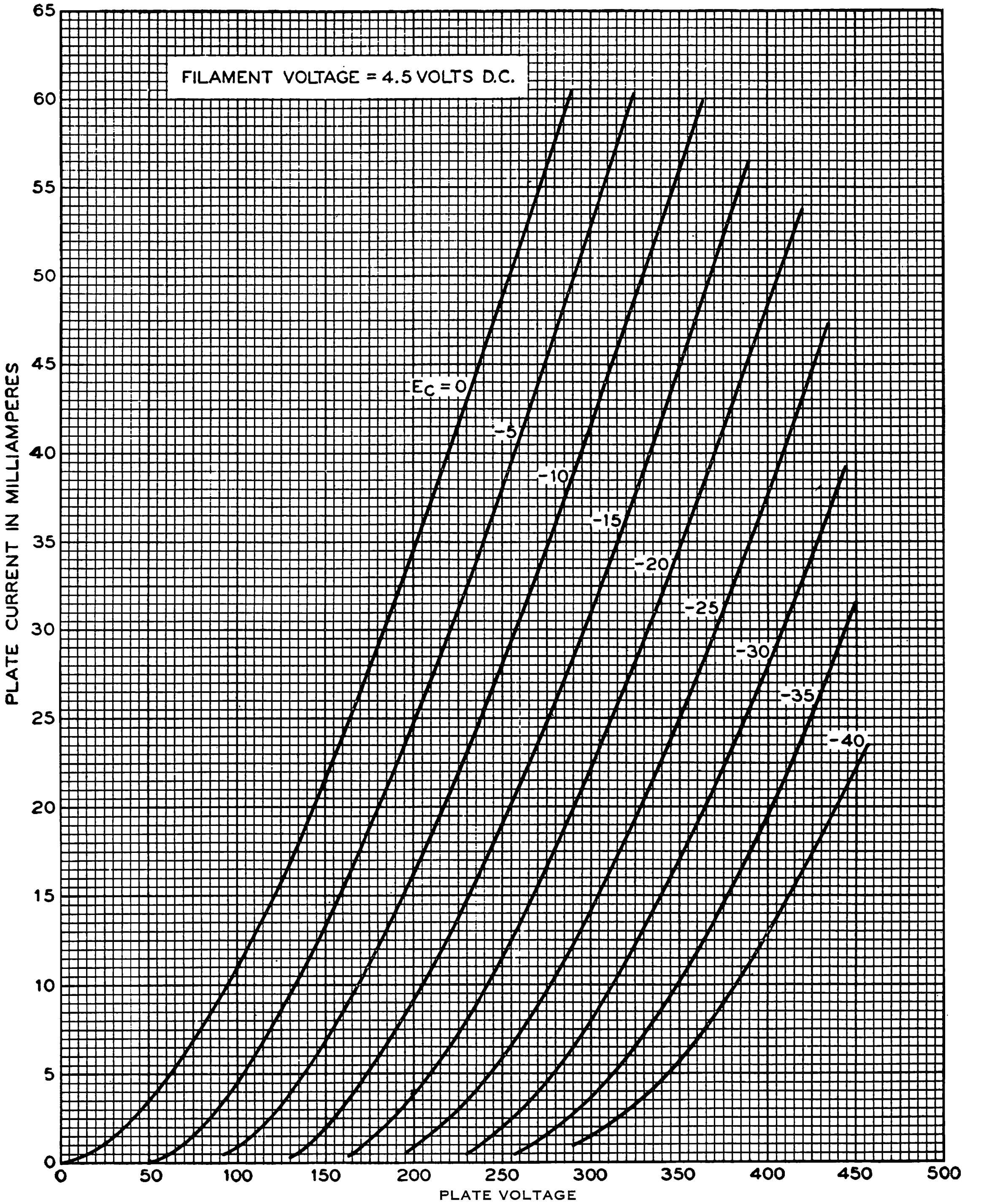


FIG. 7

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