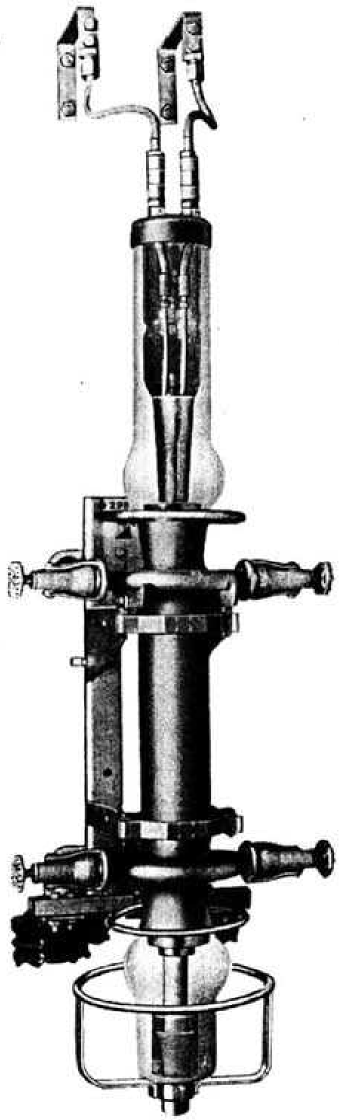
Western Electric

298A and 298B Vacuum Tubes



Classification—Filamentary Water-Cooled Triode

These tubes may be used as audio-frequency amplifiers, or as radio frequency amplifiers, oscillators or modulators. They are identical in construction differing only in the amplification factor.

Dimensions—Figure 1 shows the dimensions and outline diagram.

The overall dimensions are:

Maximum overall length.......................53¾″
Maximum width............................ 9⁹⁄₁₆″

Mounting—The tubes should be mounted only in a vertical position with the filament terminal end up, in a Western Electric socket made in accordance with ESR-613255 or similar type with corona rings to protect seals in case of flashover.

Filament—Tungsten

Filament voltage..............	27 volts, a-c or d-c
Nominal filament current......	225 amperes
Average thermionic emission...	35 amperes

Average Direct Interelectrode Capacitances

	298A	298B
Plate to Grid..................	48	50 mmf.
Grid to filament................	30	31 mmf.
Plate to filament...............	11	11 mmf.

Characteristics—Performance data given below are based upon a typical set of conditions. Variations can be expected with different circuits and tubes.

Figures 2, 3 and 4 for the 298A and Figures 7, 8 and 9 for the 298B give the static characteristics of typical tubes plotted against grid and plate voltages. Figures 5 and 6 for the 298A and for the 298B give the filament resistance and emission characteristics with the normal variation to be expected among tubes. Figure 10 shows the grid current characteristics plotted against plate voltage for the 298B tube.

Average Characteristics

	298A	298B
At plate voltage of 18,000 and plate current of......	4.2	3.0 amperes
Amplification Factor..........................	32	57.5
Plate Resistance..............................	1,450	2,500 ohms
Grid to Plate Transconductance.................	22,000	20,000 micromhos

Note—This combined bulletin supersedes data sheets previously issued for the individual tubes.

Operation

Maximum Ratings

Max. direct plate voltage	20,000 volts
Max. direct plate current	11 amperes
Max. plate dissipation	100,000 watts
Max. grid dissipation	1,000 watts
Max. r-f grid current	75 amperes
Max. frequency for the above ratings	4 megacycles
Max. plate voltage for upper frequency limit of 20 Mc	12,000 volts

Max. plate voltage for frequencies between 4 and 20 Mc in proportion

Class B Audio Amplifier or Modulator for Balanced 2 Tube Circuit

	298A			298B
Direct plate voltage	15,000	12,000	volts	
Grid bias	−350	−250	volts	
Direct plate current per tube,				
No drive	0.70	0.70	ampere	
Max. drive	7.0	7.0	amperes	
Plate dissipation	35,000	28,000	watts	
Load resistance plate-to-plate	2,200	1,600	ohms	
Load resistance per tube	550	400	ohms	NONE
Approx. max. output—2 tubes	140,000	112,000	watts	
Recommended power for driving stage	1,000	800	watts	

Class B Radio-Frequency Amplifier

	298A		298B		
Direct plate voltage	18,000	15,000	18,000	15,000	volts
Direct plate current for carrier conditions	4.2	4.2	4.2	4.2	amperes
Grid bias	−500	−400	−250	−200	volts
Approximate carrier watts for use with 100% modulation	25,000	21,000	25,000	21,000	watts

Class C Radio-Frequency Oscillator or Power Amplifier-Unmodulated

	298A			298B		
Direct plate voltage	18,000	15,000	10,000	18,000	15,000	volts
Direct plate current	6.7	8.0	8.0	9.0	8.0	amperes
Grid bias	−750	−600	−525	−500	−400	
to	−1000	−800	−700	−750	−600	volts
Nominal power output	80,000	80,000	53,000	100,000	80,000	watts
Plate current with zero bias				3.5	2.5	amperes

Class C Radio-Frequency Amplifier-Plate Modulated

	298A		298B	
Direct plate voltage	12,000	10,000	12,000	volts
Direct plate current	5.0	6.0	5.5	amperes
Grid bias	*	*	*	
Max. direct grid current	500	500	1,000	milliamperes
Nominal carrier power output	40,000	40,000	45,000	watts

* It is recommended that the grid circuit for high level modulation be arranged to receive its operating bias from the flow of grid current thru a resistance of from 5,000 to 10,000 ohms. An additional steady state bias voltage of sufficient magnitude to limit the plate dissipation to a safe value with no r-f driving voltage applied to the grid, should be incorporated in the circuit.

Operating Precautions

Mechanical—Figure 1 shows 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 tungsten filaments.

To protect the glass and copper to glass anode seals from being damaged by flashovers external to the tube, corona rings furnished with the W.E. socket are mounted at each end of the anode and at the grid terminal. The approximate locations for these rings are indicated in figure 1. These rings are 8" and 12" in diameter of ½" tubing. The 8" rings are hinged so that they encircle the glass bulb just outside the anode seals when closed. The 12" ring circles the glass bulb adjacent to the grid terminal to which it is directly attached. Old gaskets should be replaced by the new ones supplied with each tube. This tube should not be subjected to unnecessary shock or vibration. No object should touch the bulb and there should be a free circulation of air around the tube.

A free circulation of air must be provided to insure adequate cooling of the glass during operation. No object should touch the bulb.

The cooling water should be of sufficient purity to retard the tendency toward the formation of scale on the anode. Formation of scale would have the effect of insulating the anode from the water and the ineffective cooling of the anode would result in failure of the tube. It is therefore recommended that distilled water be used in the cooling system.

The cooling facilities should be such that the flow of water is not less than 35 gallons per minute and that the temperature of the water leaving each jacket does not exceed 176 F. Sufficient water should be circulated so that the temperature rise of the water through each jacket does not exceed 12 F. Best operation will be obtained if the water leaving the jacket can be maintained above 158 F. in order to eliminate dissolved air. In no case should the tube be operated with a hissing sound present as this indicates either boiling water or dissolved air leaving the water. The minimum length of hose or ceramic coil which can be used to insulate the plate from the water supply which is usually grounded will depend upon the resistivity of the water used and the leakage current that can be tolerated. This length should not be less than 20 feet. The hose connections must always be made so that the water flows upward through the tube jacket.

Provision should be made in the circuit to safeguard against the filament and plate voltages being applied until the cooling water is circulating at the proper rate and temperature, and for the immediate cut-off of the filament and plate voltages if the circulating rate falls below the allowed minimum or the temperature exceeds the allowable maximum. A momentary interruption of the water circulation during operation of the tube may cause immediate failure.

Electrical—Overload protection should always be provided for the plate circuit. A suitable fuse or circuit breaker should remove the plate voltage if the plate current exceeds 13 amperes. 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 or installing a new tube, reduced plate voltage or a series resistance of 1000 to 5000 ohms in the plate circuit should be used until it is operating properly.

The filament should always be operated at the minimum voltage at which satisfactory operation can be obtained. A 5% decrease in filament voltage reduces the thermionic emission approximately 35%. If satisfactory operation can be obtained at lower than the rated voltage, the filament life may be increased considerably. For example, if satisfactory operation can be obtained with a filament potential of 95% of the rated voltage the burn-out life can be approximately doubled. Either direct or alternating current may be used for heating the filament. If direct current is used, the plate and grid circuit returns should be connected to the positive filament terminal. The connections to the filament terminals should also be reversed periodically. If alternating current is used, the circuit should be connected to the center tap of the filament heating transformer winding.

Some provision should be made to limit the initial filament current to less than 500 amperes, when the filament is cold. This may be done by inserting additional resistance in the filament circuit when voltage is first applied or by using a transformer having sufficiently high reactance.

Audio Amplifier or Modulator

Class B—Grid bias practically at cut-off and grid driving voltage higher than the bias.

Two tubes may be used in a balanced circuit. An adequate driving stage and an input transformer with good regulation must be used so that the grid current drawn during positive grid swings does not produce appreciable distortion. The output transformer must transform the load impedance to the proper value for the tubes used. The power output obtainable will be determined by the quality of the transformer used and the amount of distortion which can be tolerated. The output can be increased or the distortion decreased by the use of degenerative feedback.The grid bias must be held constant and therefore cannot be obtained by grid leak or series resistor methods. A battery or other source having good regulation is necessary.

The power required of a modulator for complete modulation of a Class C amplifier is one-half the direct power input to the plates of the Class C amplifier.

Radio-Frequency Oscillator or Power Amplifier

Class B—Radio-Frequency Amplifier—Grid Bias Practically at Cut-Off.

The Class B radio-frequency amplifier is used to amplify a modulated radio-frequency carrier wave without appreciable distortion. It operates similarly to the Class B audio amplifier except that a single tube may be used, the tuned output circuit serving to preserve the wave shape. The push-pull circuit, however, eliminates the even order harmonics and this increases the efficiency slightly.

Class C—Radio-Frequency Oscillator or Power Amplifier—Grid Bias below cut-off.

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.

High Frequency Ratings

The frequency limits specified under maximum ratings are based on the tube being used as an oscillator. The tube may be used at full rating up to 4 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 hence plate dissipation must be reduced to values specified for the upper frequency limit and for frequencies between these two limits the plate voltage should be proportionately reduced. At the higher frequencies, it is desirable to cool the glass next to the anode seals with forced air.

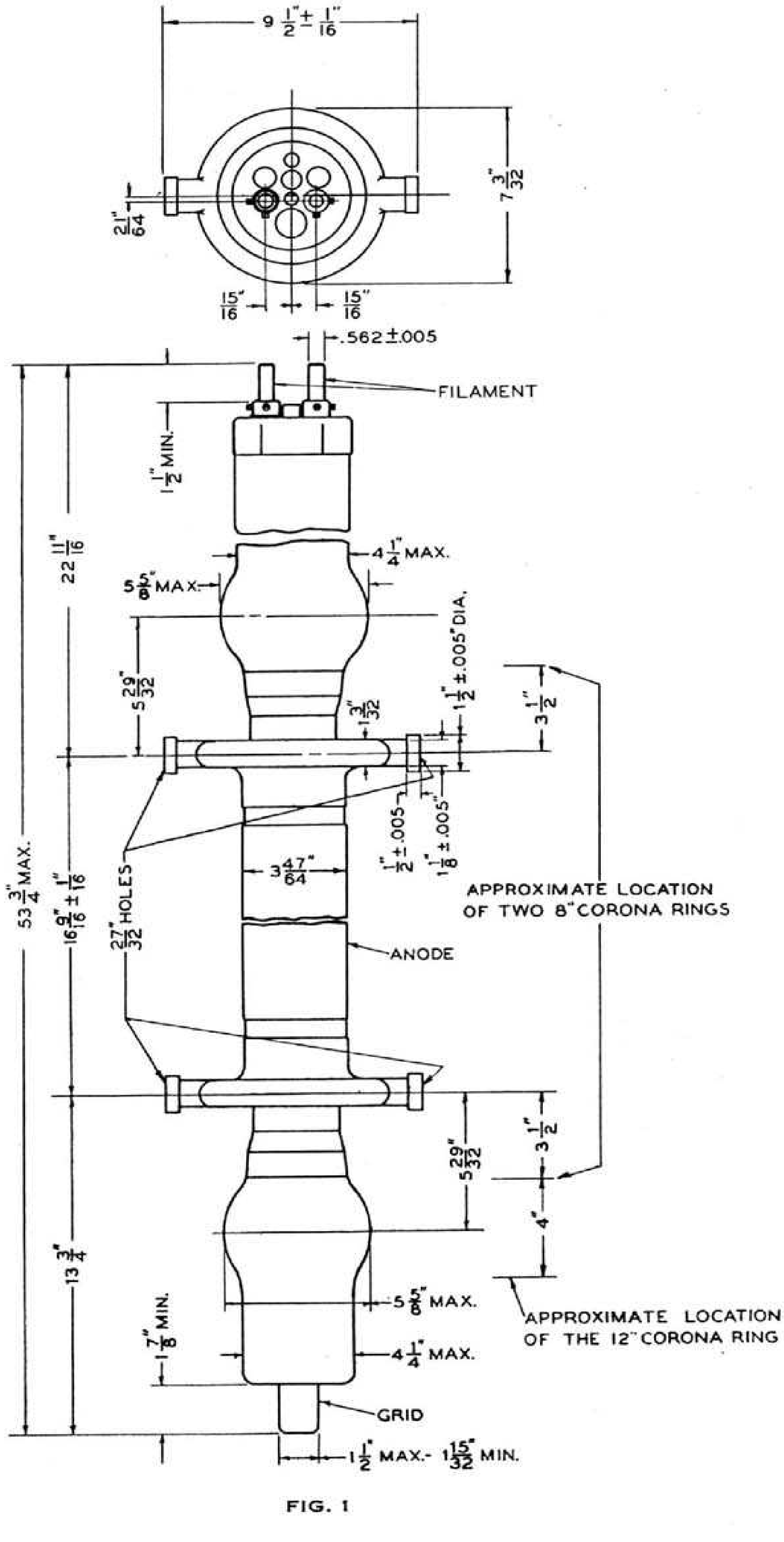

FILAMENT
APPROXIMATE LOCATION
OF TWO 8" CORONA RINGS
ANODE
APPROXIMATE LOCATION
OF THE 12" CORONA RING
GRID
27/32" HOLES
53 3/4" MAX.
.562±.005

FIG. 1

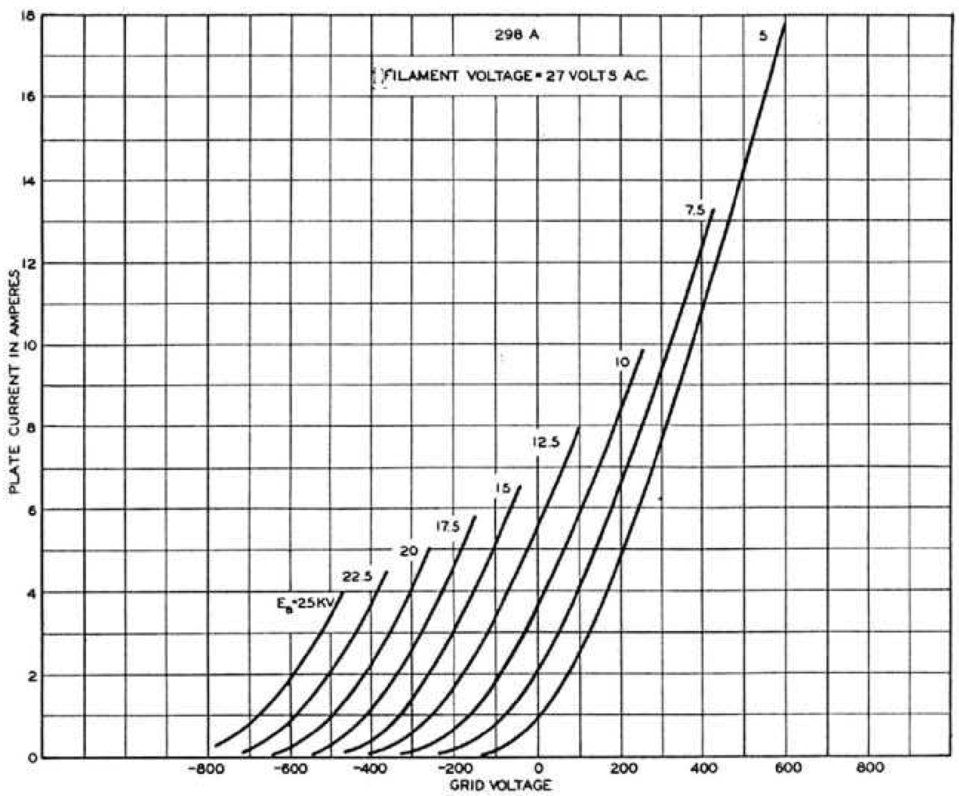

298 A
FILAMENT VOLTAGE = 27 VOLTS A.C.
PLATE CURRENT IN AMPERES
GRID VOLTAGE
E_B=25 KV
22.5
20
17.5
15
12.5
10
7.5
5
-800
-600
-400
-200
0
200
400
600
800
0
2
4
6
8
10
12
14
16
18

FIG. 2

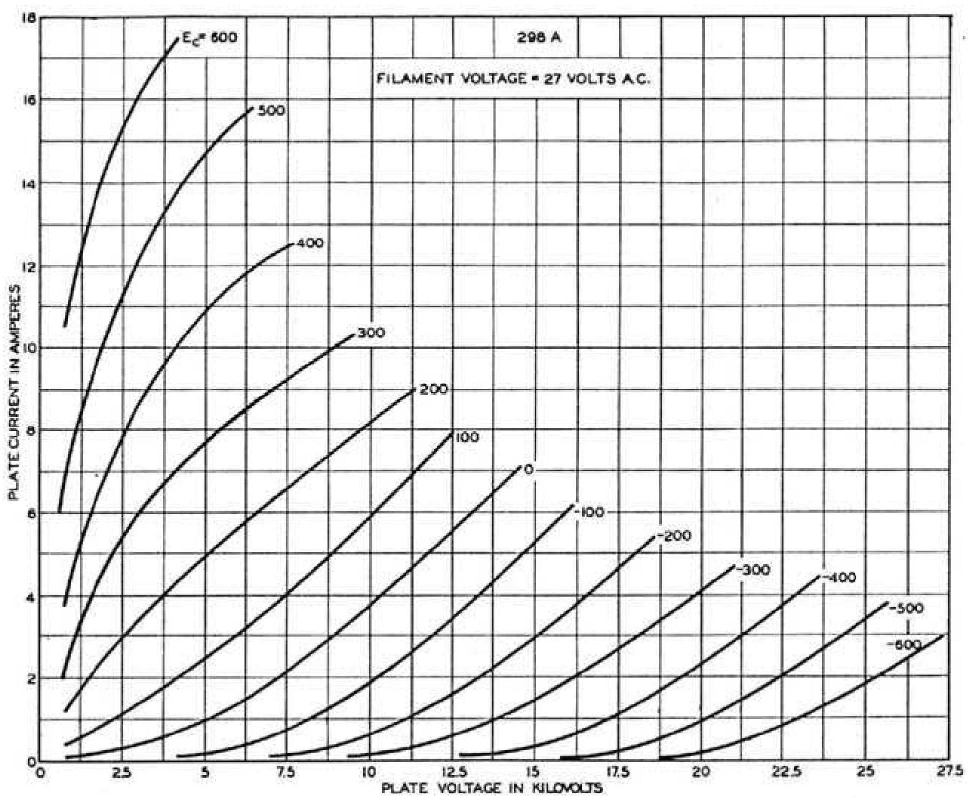

298 A
FILAMENT VOLTAGE = 27 VOLTS A.C.
PLATE CURRENT IN AMPERES
PLATE VOLTAGE IN KILOVOLTS
E_C= 600
500
400
300
200
100
0
-100
-200
-300
-400
-500
-600
0
2.5
5
7.5
10
12.5
15
17.5
20
22.5
25
27.5

FIG. 3

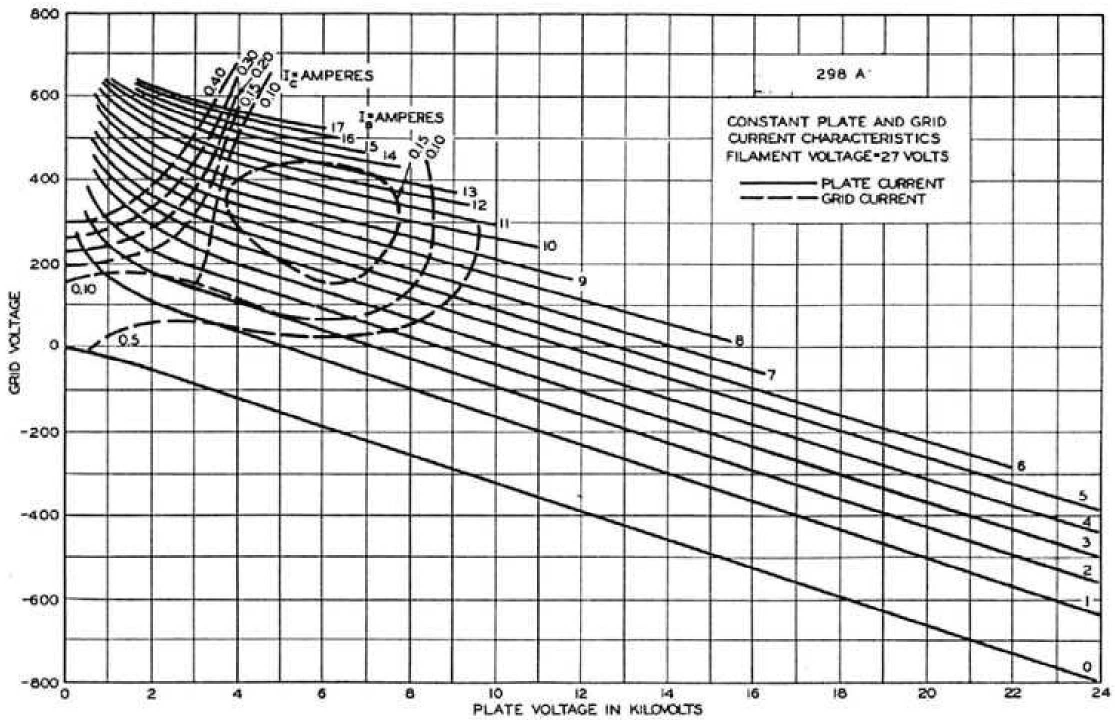


FIG. 4

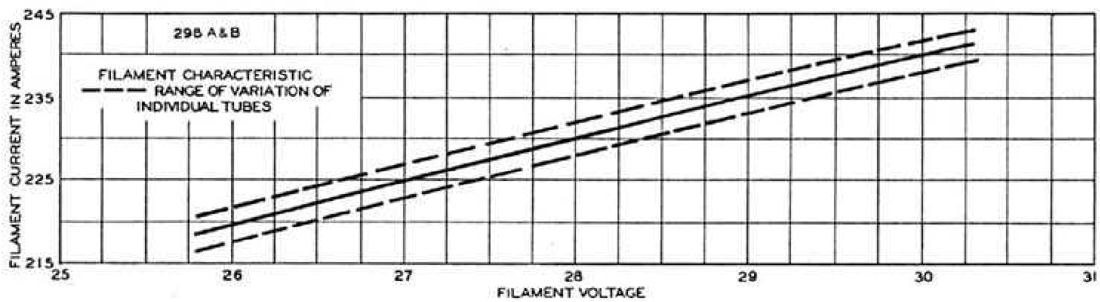


FIG. 5

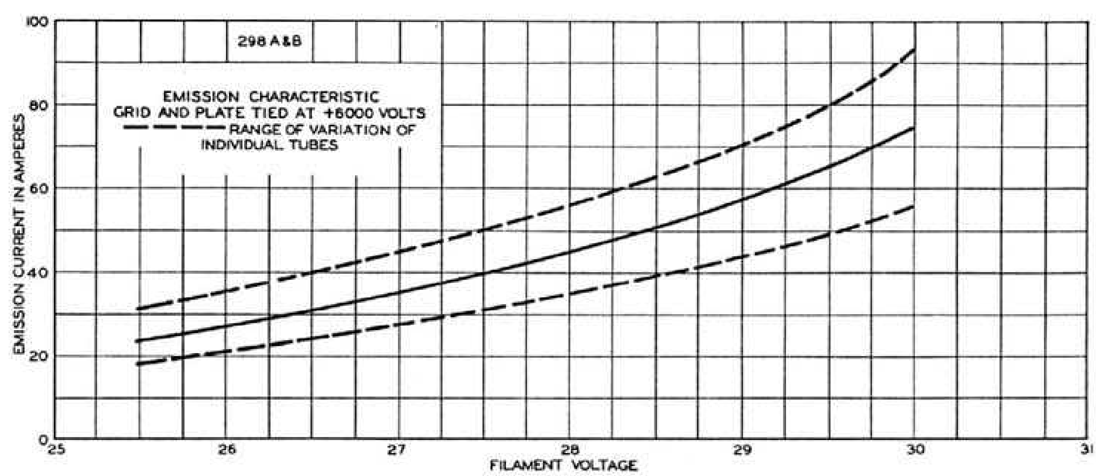


FIG. 6

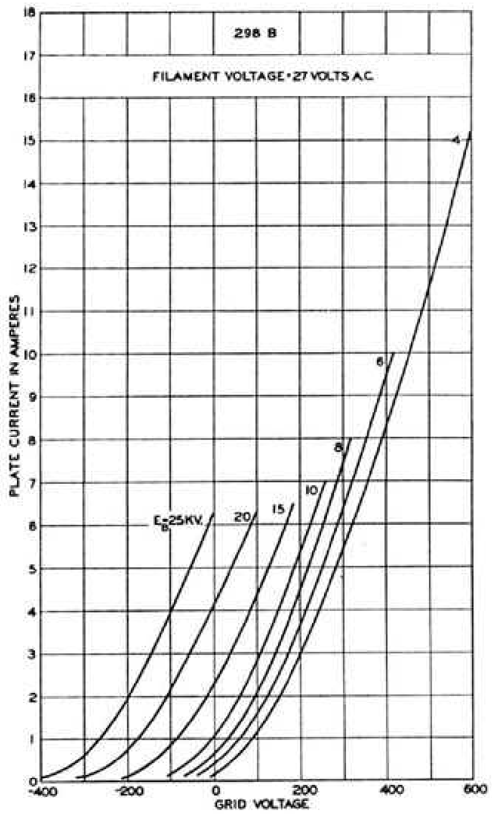


FIG. 7

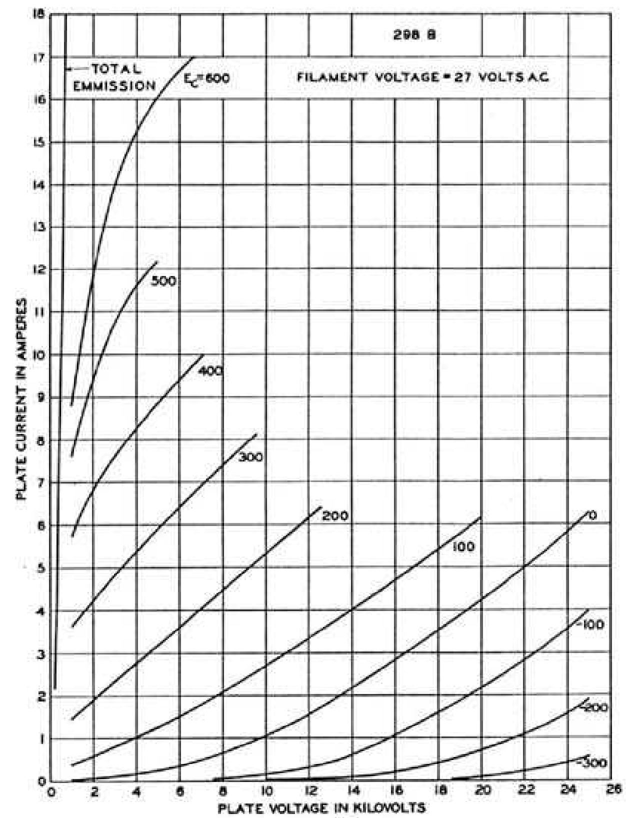


FIG. 8

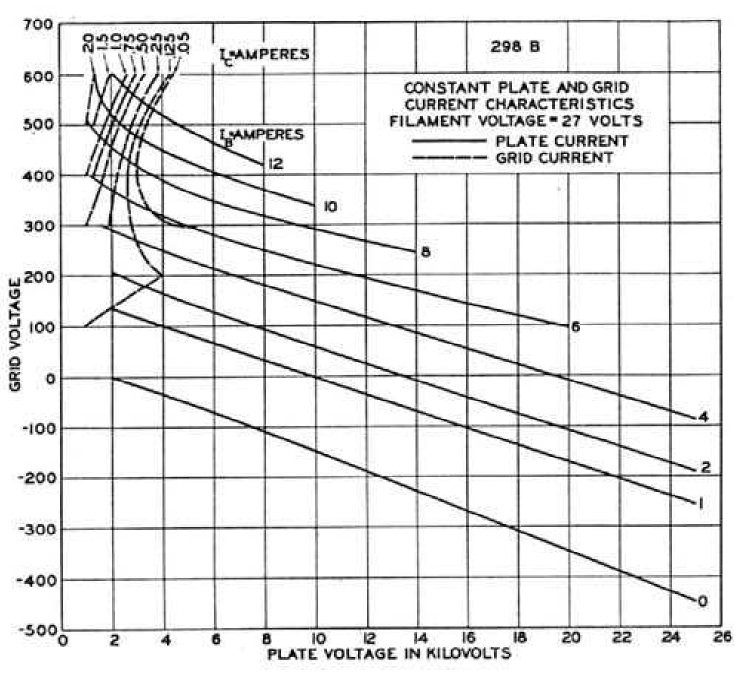


FIG. 9

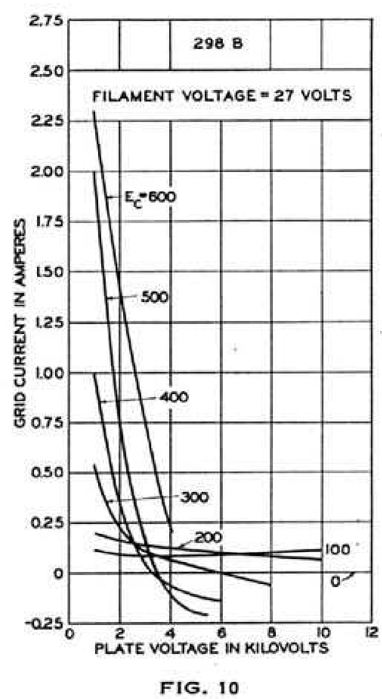


FIG. 10

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