Western Electric

240B Vacuum Tube

Classification—Filamentary water-cooled triode

May be used as an audio-frequency amplifier or as a radio-frequency oscillator, amplifier or modulator.

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

Maximum overall length	$25\frac{17}{32}''$
Width (Maximum radius $3\frac{23}{32}''$)	$6\frac{7}{32}''$

Mounting—The tube should be mounted only in a vertical position by means of a bracket provided with a clamp to encircle the water jacket between the two water pots. The clamp should be of such design that it will not distort the water jacket or bear on the soldered joint at the center. The anode connections are made through the mounting bracket which should be arranged to contact with a large area of the two annular machined rings indicated in Figure 1.

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Filament—Tungsten

Filament voltage	21.5 volts, a.c. or d.c.
Nominal filament current	41.0 amperes
Average thermionic emission	7.0 amperes

Average Direct Interelectrode Capacitances

Plate to grid	26 $\mu\mu f$
Grid to filament	10 $\mu\mu f$
Plate to filament	5 $\mu\mu f$

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

Figures 2 and 3 give the static characteristics of a typical tube plotted against grid and plate voltages.

Average Characteristics at plate voltage of 10,000 and plate current of 0.64 ampere, $E_c = -50$ volts.

Amplification factor	40
Plate resistance	8000 ohms
Grid to plate transconductance	5000 micromhos

Operation

Maximum Ratings

Max. direct plate voltage	12,000 volts
Max. direct plate current	1.7 amperes
Max. plate dissipation	10,000 watts
Max. grid dissipation	300 watts
Max. r-f grid current	60 amperes
Max. frequency for the above ratings	20 megacycles
Max. plate voltage for upper frequency limit of 40 Mc	6000 volts
Max. plate voltage for frequencies between 20 and 40 Mc. in proportion	

Class B Audio Amplifier or Modulator for balanced 2 tube circuit

Direct plate voltage	12,000	10,000 volts
Grid bias	−225	−170 volts
Direct plate current per tube		
No drive	0.15	0.15 ampere
Max. drive	1.20	1.20 amperes
Plate dissipation	5650	5250 watts
Load resistance plate-to-plate	10200	7920 ohms
Load resistance per tube	2550	1980 ohms
Approx. max. output—2 tubes	17,500	13,500 watts
Recommended power for driving stage	750	750 watts

Class B Radio-Frequency Amplifier

Direct plate voltage	12,000	10,000 volts
Direct plate current for carrier conditions	1.25	1.20 amperes
Grid bias	−250	−200 volts
Approximate carrier watts for use with 100% modulation	5000	4000 watts

Class C Radio-Frequency Oscillator or Power Amplifier—Unmodulated

Direct plate voltage	12,000	10,000 volts
Direct plate current	1.50	1.50 amperes
Grid bias	−450 to −600	−335 to −450 volts
Nominal power output	12,000	10,000 watts
Plate dissipation	6000	5000 watts

Class C Radio-Frequency Amplifier—Plate Modulated

Direct plate voltage	9000	7500 volts
Direct plate current	1.40	1.40 amperes
Grid bias	−450	−400 volts
Max. direct grid current	150	150 milliamperes
Nominal carrier power output	8500	7000 watts

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.

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

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 temperature of the water and rate of flow should be such that there is no tendency for the water to boil, as indicated by a hissing sound, under maximum dissipation. In general, the outlet water temperature should not exceed 75° C. and the rate of flow should be not less than 3 gallons per minute. The minimum length of hose 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 15 feet. The hose connections must always be made so that the water flows in at the bottom port of 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 2 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 rated voltage, measured at the tube terminals. A 5% decrease in filament voltage reduces the thermionic emission approximately 35%. If satisfactory operation can be obtained at lower than the rated voltage an increase in filament life may be obtained, 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 returns should be connected to the center tap of the filament heating transformer winding.

Some provision should be made to limit the initial filament current, 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 A—Peak grid drive equal to or less than the grid bias.

Grid bias may be obtained from the drop across a resistance in the plate current return or from a battery or rectifier supply.

Plate dissipation allowable for this type of service is generally lower than is safe for other uses since the energy is dissipated in the plate in smaller areas due to relatively high voltage drop in the tube.

The plate dissipation is equal to the plate voltage multiplied by the normal plate current. Performance data is based upon the use of a resistance load. Undistorted output is calculated on the basis of 5% second harmonic distortion.

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

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 thus increases the efficiency slightly.

Class C—Radio-Frequency Oscillator or Power Amplifier—Grid bias below cutoff.

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 20 megacycles. When operating at higher frequencies, the dielectric losses, charging currents and lead-in heating are increased greatly. 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.

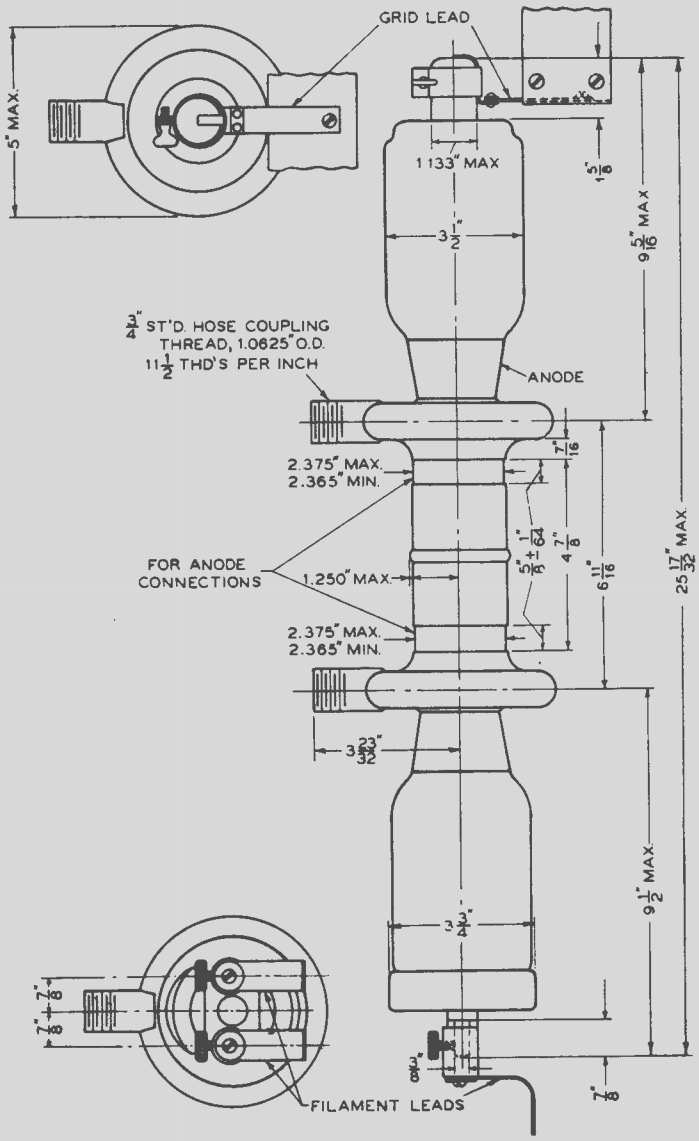

FIG. 1

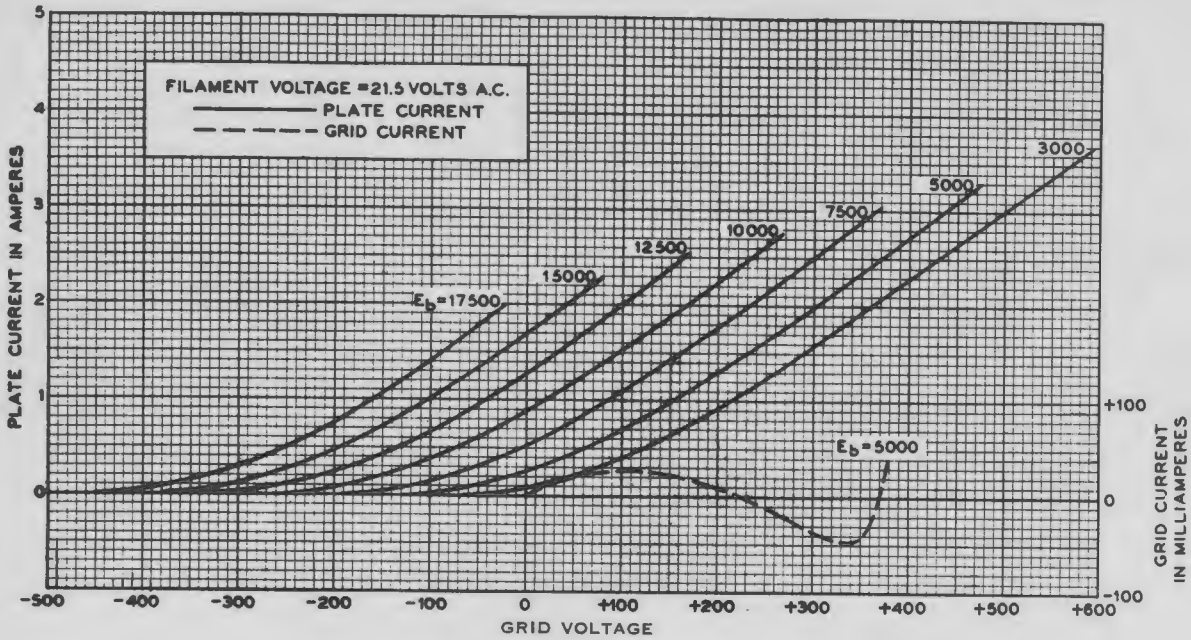
FILAMENT VOLTAGE = 21.5 VOLTS A.C.
PLATE CURRENT
GRID CURRENT
PLATE CURRENT IN AMPERES
GRID CURRENT IN MILLIAMPERES
GRID VOLTAGE
E_b=17500
15000
12500
10000
7500
5000
3000
E_b=5000
-500
-400
-300
-200
-100
0
+100
+200
+300
+400
+500
+600
+100
0
-100

FIG. 2

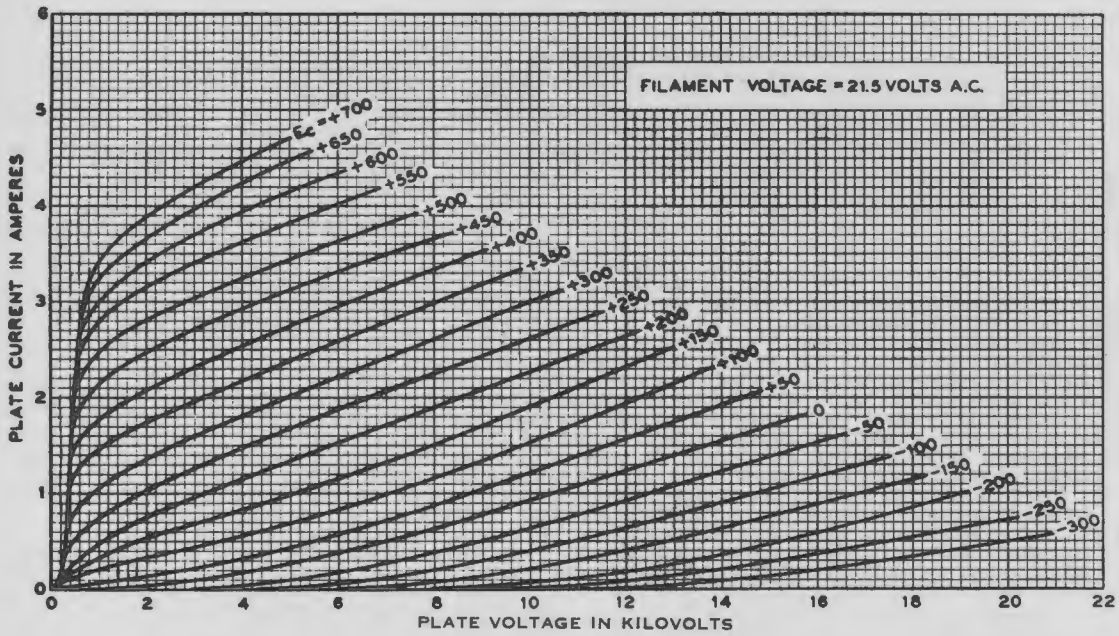
FILAMENT VOLTAGE = 21.5 VOLTS A.C.
PLATE CURRENT IN AMPERES
PLATE VOLTAGE IN KILOVOLTS
Ec = +700
+650
+600
+550
+500
+450
+400
+350
+300
+250
+200
+150
+100
+50
0
-50
-100
-150
-200
-250
-300

FIG. 3