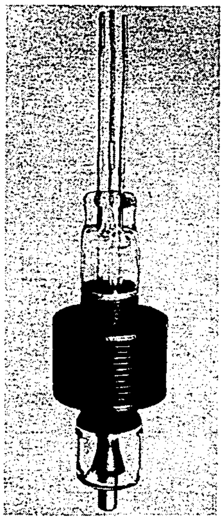
from RMA release # 454, Nov. 20, 1945

6C24

POWER TRIODE

Radiator Type
Forced-Air Cooling

Full Ratings up to 160 Megacycles
Plate Dissipation up to 600 Watts



RCA-6C24 is a compact power triode capable of delivering one kilowatt in class C amplifier and oscillator service at frequencies as high as 160 megacycles. Its small size, center-tapped filament, low interelectrode capacitances, and efficient radiator for forced-air cooling all contribute to the exceptionally good high-frequency performance.

For the usual transmitter applications, the maximum plate dissipation is 400 watts, but this rating can be increased to 600 watts by the use of increased air-flow through the radiator. For applications such as are encountered in electronic heating equipment where it is desirable to hold tube and circuit efficiencies to moderately low values, this higher dissipation rating provides reserve capability for conservative operation of the 6C24.

GENERAL DATA

Filament	Thoriated Tungsten		
Voltage (AC or DC)	11.0	..	Volts
Current	12.1	..	Amperes
Starting Current: The filament current must never exceed, even momentarily, 24 amperes.			
Resistance (Cold)	0.13	...	Ohms
Amplification Factor	30		
Direct Interelectrode Capacitances (Approx.):			
Grid to Plate	4.4	...	μμf
Grid to Filament	4.6	...	μμf
Plate to Filament	3.2	...	μμf
Terminal Connections	See *Outline Drawing*		
Radiator	Integral Part of Tube		
Mounting Position	Vertical, Filament or Grid End Up		
Mounting	See Drawing, page 7		

Cooling: See page 3 for cooling methods. Under any circumstances, sufficient air must be supplied to the radiator so that the rated maximum radiator temperature of 180°C will not be exceeded. In addition, a small amount of air is required on the filament and grid seals to limit their temperature at the hottest part to 150°C. Air flow must start before the application of any voltages.

AF POWER AMPLIFIER & MODULATOR — Class B

	Cooling Method I	*Cooling Method II*	
Maximum CCS* Ratings, *Absolute Values:*			
DC PLATE VOLTAGE	3000 *max.*	3000 *max.*	Volts
MAX.-SIG. DC PLATE CUR.**	400 *max.*	400 *max.*	Ma.
MAX.-SIG. PLATE INPUT**	1200 *max.*	1200 *max.*	Watts
PLATE DISSIPATION**	400 *max.*	600 *max.*	Watts

Typical Operation:
Unless otherwise specified, values are for two tubes

DC Plate Voltage	3000	...	Volts
DC Grid Voltage#	−95	...	Volts
Peak AF Grid-to-Grid Voltage	470	...	Volts
Zero-Signal DC Plate Current	75	...	Ma.
Max.-Signal DC Plate Current	800	...	Ma.
Effective Load Resistance (plate-to-plate)	8600	...	Ohms
Max.-Signal Driving Power (Approx.)	30	...	Watts
Max.-Signal Power Output (Approx.)	1640	...	Watts

RF POWER AMPLIFIER — Class B Telephony

Carrier conditions per tube for use with a maximum modulation factor of 1.0

	Cooling Method I	*Cooling Method II*	
Maximum CCS*Ratings, *Absolute Values:*			
DC PLATE VOLTAGE	3000 *max.*	3000 *max.*	Volts
DC PLATE CURRENT	250 *max.*	250 *max.*	Ma.
PLATE INPUT	600 *max.*	600 *max.*	Watts
PLATE DISSIPATION	400 *max.*	600 *max.*	Watts

Typical Operation:

DC Plate Voltage	3000	...	Volts
DC Grid Voltage#	−95	...	Volts
Peak RF Grid Voltage	130	...	Volts
DC Plate Current	200	...	Ma.
DC Grid Current (Approx.)##	5	...	Ma.
Driving Power (Approx.)##°	16	...	Watts
Power Output (Approx.)	210	...	Watts

PLATE-MODULATED RF POWER AMPLIFIER — Class C Telephony

Carrier conditions per tube for use with a maximum modulation factor of 1.0

	Cooling Method I	*Cooling Method II*	
Maximum CCS* Ratings, *Absolute Values:*			
DC PLATE VOLTAGE	2500 *max.*	2500 *max.*	Volts
DC GRID VOLTAGE	−500 *max.*	−500 *max.*	Volts
DC PLATE CURRENT	400 *max.*	400 *max.*	Ma.
DC GRID CURRENT	150 *max.*	150 *max.*	Ma.
PLATE INPUT	1000 *max.*	1000 *max.*	Watts
PLATE DISSIPATION	265 *max.*	400 *max.*	Watts

Typical Operation:

DC Plate Voltage	2500	...	Volts
DC Grid Voltage:			
from a fixed supply of	−350	...	Volts
from grid resistor of	2600	...	Ohms
Peak RF Grid Voltage	620	...	Volts
DC Plate Current	400	...	Ma.
DC Grid Current (Approx.)##	135	...	Ma.
Driving Power (Approx.)##	75	...	Watts
Power Output (Approx.)	810	...	Watts

RF POWER AMPLIFIER & OSCILLATOR — Class C Telegraphy

Key-down conditions per tube without modulation ¢

	Cooling Method I	*Cooling Method II*	
Maximum CCS* Ratings, *Absolute Values:*			
DC PLATE VOLTAGE	3000 *max.*	3000 *max.*	Volts
DC GRID VOLTAGE	−500 *max.*	−500 *max.*	Volts
DC PLATE CURRENT	500 *max.*	500 *max.*	Ma.
DC GRID CURRENT	150 *max.*	150 *max.*	Ma.
PLATE INPUT	1500 *max.*	1500 *max.*	Watts
PLATE DISSIPATION	400 *max.*	600 *max.*	Watts

Typical Operation:

DC Plate Voltage	3000	...	Volts
DC Grid Voltage			
from fixed supply of	−250	...	Volts
from grid resistor of	1700	...	Ohms
from cathode resistor of	400	...	Ohms

RCA VICTOR DIVISION
RADIO CORPORATION OF AMERICA, HARRISON, NEW JERSEY

6C24-9-45
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Peak RF Grid Voltage.	520	. . .	Volts
DC Plate Current.	500	. . .	Ma.
DC Grid Current (Approx.)##	150	. . .	Ma.
Driving Power (Approx.)##	75	. . .	Watts
Power Output (Approx.).	1100	. . .	Watts

* CCS = Continuous Commercial Service.

** Averaged over any af cycle of sine-wave form.

\# Grid voltages are given with respect to mid-point of filament operated on ac or dc.

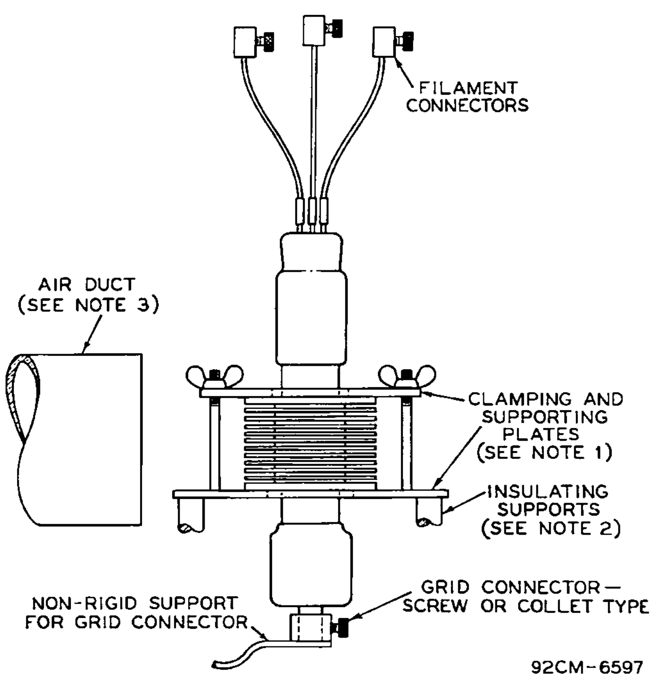
\#\# Subject to wide variations depending on the impedance of the load circuit. High-impedance load circuits require more grid current and driving power to obtain the desired output. Low-impedance circuits need less grid current and driving power, but plate-circuit efficiency is sacrificed. The driving stage should be capable of delivering considerably more than the required driving power.

o At crest of af cycle with modulation factor of 1.0.

¢ Modulation essentially negative may be used if the positive peak of the af envelope does not exceed 115% of the carrier conditions.

INSTALLATION

In *transportation and storage* of the 6C24, care should be taken to protect the tube from rough handling that would damage the metal-to-glass seals or other parts. Each tube is suspended within its shipping carton so that it will



NOTE 1: SUPPORTING PLATE AND CLAMPING PLATE HAVE HOLES LARGE ENOUGH TO PERMIT PASSAGE OF THE GLASS BULBS OF THE TUBE.

NOTE 2: TWO OR MORE INSULATORS MAY BE USED. INSULATORS MUST BE PLACED SO AS TO NOT INTERFERE WITH AIR FLOW ONTO GRID TERMINAL.

NOTE 3: AIR DUCT MUST BE HORIZONTAL AND MUST BE DIRECTED AT CENTER OF RADIATOR.

Fig. 1 - Suggested Mounting for Cooling Method I.

not come in contact with the sides of the carton during shipment. The tube should preferably be stored in a vertical position in the carton and should be protected from moisture and extreme temperature changes. The weight of the tube is 13 ounces.

It is recommended that the tube be tested upon receipt in the equipment in which it is to be used. Before the tube is placed in operation, any foreign material clinging to the tube should be removed.

The *mounting* for the 6C24 requires a clamp support for the radiator (plate connection), a connector for the grid terminal, and three con-

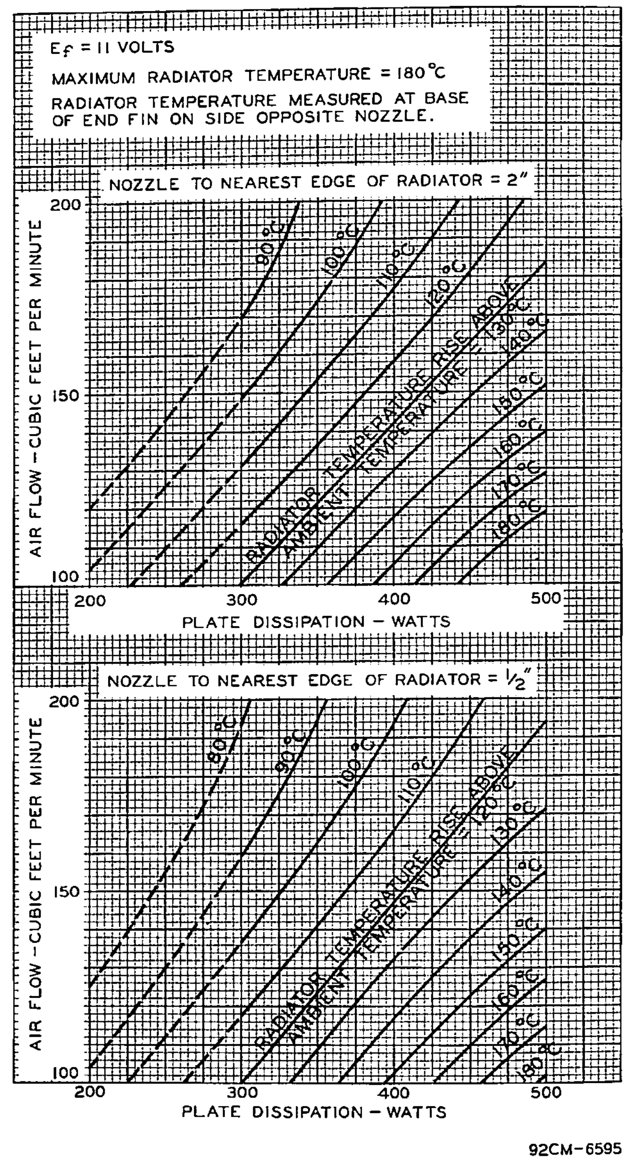


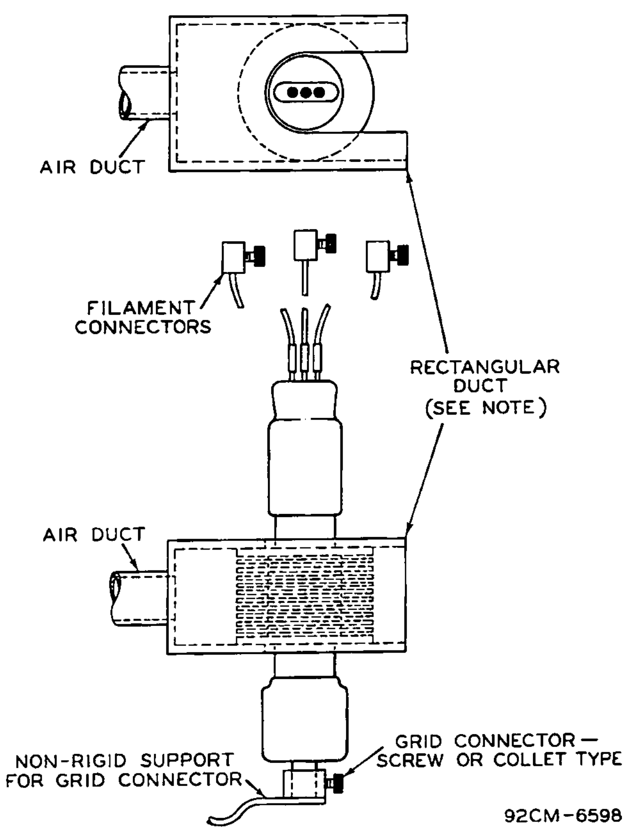
Fig. 2 - Cooling Requirements for Method I.

nectors for the filament leads. Because mounting and cooling arrangements are closely associated, refer also to *Cooling*.

The tube should be supported in a vertical position with either the filament or the grid end up. If the tube is subjected to considerable vibration or shock in service, it is advisable to support the mounting by means of a spring suspension. The installation of all wires and connections must be made so that they will not be close to or touch the glass parts. This precaution is necessary to prevent almost certain puncture of the glass from corona discharge. Suggested mounting devices are shown in Figs. I and 3.

Connections to the grid and filament terminals must be kept flexible in order not to put strain on the glass-to-metal seals. None of the terminals should be used to support circuit parts.

Cooling of the 6C24 is accomplished by passing a blast of air through the radiator. The tabulated data indicate two cooling methods which are illustrated in Figs. I and 3. The drawing of Fig. I, showing a suggested way of mounting the tube for *Cooling Method I*, indicates a two-and-one-half inch duct directed horizontally at the center of the radiator. The air flow for two spacings of duct to radiator plotted against plate dissipation for several values of radiator temperature rise are shown in the curves of Fig. 2. *Cooling Method II* applies to those applications where, because low overall circuit efficiency is



NOTE: AIR DUCT MAY BE PART OF HIGH-FREQUENCY TRANSMISSION LINE. UPPER AND LOWER FACES OF RECTANGULAR DUCT HAVE SLOTS TO PERMIT PASSAGE OF TUBE. MEANS SHOULD BE PROVIDED TO LOCK TUBE IN POSITION.

Fig.3 - Suggested Mounting for Cooling Method II.

desired, the plate dissipation is high. In this method, the tube is placed in the end of a rectangular duct so that all the air supply must pass through the radiator. Fig.3 is a drawing illustrative of this method, and Fig.4 shows the relations between rate of air flow vs plate dissipation, for various values of temperature rise of the radiator. This figure also indicates the air pressure drop through the radiator vs the rate of air flow.

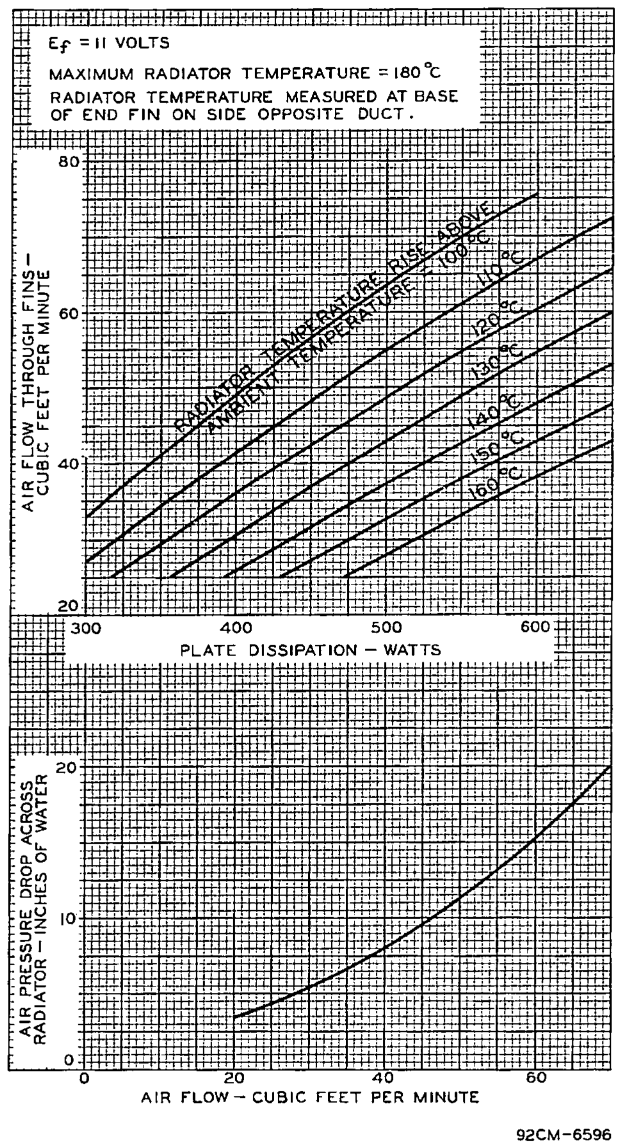


Fig.4 - Cooling Requirements for Method II.

The cooling system should be properly installed to insure safe operation of the tube under all conditions and for this reason should be electrically interconnected with the filament and plate power supplies. This arrangement is necessary to make sure that the tube is supplied with air before any voltages are applied. Air pressure interlocks which open the power transformer primaries are desirable for protecting the tube when the air flow is insufficient or ceases.

A small amount of cooling air is required on the grid and filament seals, and should be so directed that the glass is cooled. Special attention to glass cooling may be required at the higher frequencies. The temperature of the glass should not exceed 150°C. This air supply should be interconnected with the power supplies as in the case of radiator cooling.

The maximum radiator temperature of 180°C is a tube rating and is to be observed in the same manner as other ratings. The temperature of the radiator should be measured at the base of an end fin on the side away from the air supply. The temperature may be measured either with a thermocouple or with temperature-sensitive paint such as Tempilac. The latter is made by the Tempil Corporation, 132 W. 22 Street, New York in the form of liquid and stick and has an accuracy of 1%.

The *filament* of the 6C24 is of the thoriated tungsten type. Under normal full-load conditions the filament should be maintained at the rated voltage within ±5%; with light loads, reduction of the filament voltage by as much as 5% is permissible. In the latter case, care must be taken that the reduction of the filament voltage and, therefore, of emission is not so great that the peak current requirements cannot be met. It is recommended that, in intermittent service where the standby periods are no longer than 15 minutes, the filament voltage should be reduced to 80% of normal during standbys; for longer periods, the filament voltage should be shut off. The filament should be operated at constant voltage rather than at constant current. The filament must be allowed to reach normal operating temperature before other voltages are applied to the tube.

The filament is center tapped in order to minimize the effect of filament-lead inductance. At the higher frequencies, the grid- and plate-circuit returns should be by-passed for rf to the center lead of the filament. The returns should be made to this common connection in order to avoid rf coupling through common return circuits. It may be advisable to connect rf chokes in these returns to form a filter network. All three filament leads should be connected in parallel through rf by-pass capacitors. The center lead of this parallel connection should be by-passed to the filament transformer or to ground. It should not be returned to these points directly.

A filament starter should be used to raise the filament voltage gradually and to limit the high initial rush of current through the filament when the circuit is first closed. The starter may be either a system of time-delay relays cutting resistance out of the circuit, a high-reactance filament transformer, or a simple rheostat. Regardless of the method of control, it is important that the filament current never exceed, even momentarily, a value of 24 amperes.

The *plate circuit* should be provided with a time-delay relay which will prevent the application of plate voltage before the filament has reached normal operating temperature.

A *protective device*, such as a high-voltage fuse, should be used to protect the plate against overloads. It should remove the high voltage when the average value of plate current reaches a value 50% above normal.

Overheating of the 6C24 by severe overload may decrease the filament emission. The filament activity can sometimes be restored by operating the filament at rated voltage for ten minutes or

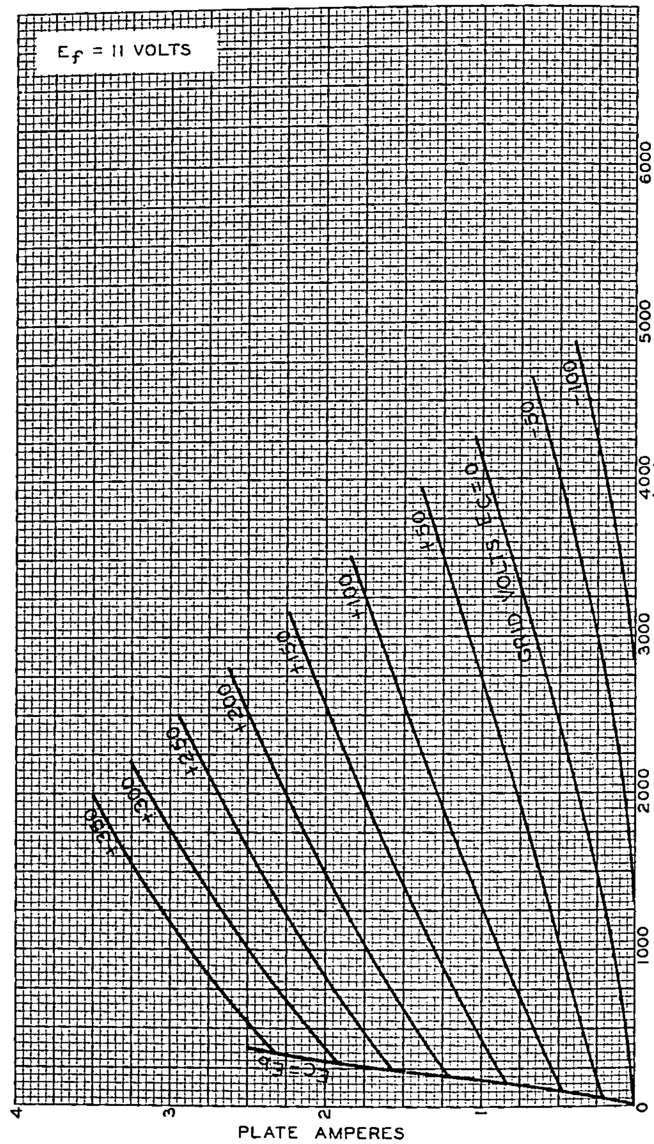


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Fig. 5 - Average Plate Characteristics.

more with no voltage on the plate or grid. This process may be accelerated by raising the filament voltage to 13 volts (not higher) for a few minutes.

In order that the maximum ratings will not be exceeded, changes in electrode voltages due to line-voltage fluctuation, load variation, and manufacturing variation of the associated apparatus must be determined. Average values of plate voltage should then be determined so that under the usual variations the maximum ratings of the tube will not be exceeded.

The rated plate voltage of this tube is high enough to be dangerous to the user. Great care should be taken during the adjustment of circuits, especially when exposed circuit parts are at high dc potential.

When a new circuit is tried or when adjustments are made, the plate voltage should be reduced. The reduction should be in order of 25% to 50% of normal plate voltage.

APPLICATION

In *class B af modulator service*, the 6C24 should be operated with grid bias obtained from a battery or other source of dc voltage of good regulation. It should not be obtained from a high-resistance source such as a grid resistor, nor from a rectifier unless the rectifier has exceptionally good voltage regulation. Each grid circuit should be provided with a separate bias adjustment to balance the grid and plate currents.

In *class B rf power amplifier telephony service*, the 6C24 is supplied with unmodulated dc plate voltage. The grid is excited with rf voltage modulated at audio frequency in one of the preceding stages, and power output is proportional to the square of the grid-excitation voltage. Under these conditions, the plate dissipation is greatest when the carrier is unmodulated. Grid bias is obtained from a battery or other source of dc voltage of good regulation.

In *plate-modulated class C rf amplifier service*, the tube should be supplied with bias from a grid resistor, or from a suitable combination of grid resistor and fixed supply or grid resistor and cathode resistor. The cathode resistor should be by-passed for both audio and radio frequencies. The combination method of grid resistor and fixed supply has the advantage of not only protecting the tube from damage through loss of excitation but also of minimizing distortion by bias-supply compensation. Grid-bias voltage is not particularly critical so that correct adjustment may be obtained with values differing widely from the calculated values.

In *class C rf telegraph service*, the 6C24 may be supplied with bias by any convenient method. When the tube is used in the final amplifier or a preceding stage of a transmitter designed for break-in operation and oscillator keying, a small amount of fixed bias must be used to maintain the plate current and, therefore, the plate dissipation at a safe value. If the 6C24 is operated at the maximum rated plate voltage of 3000 volts, a fixed bias of at least -90 volts should be used.

The grid circuit should be designed and adjusted so that no appreciable voltage can occur between grid and filament at any frequency except the fundamental. This procedure will minimize the occurrence of parasitic oscillations and be simplified if the generation of unwanted harmonic frequencies is avoided. The use of a

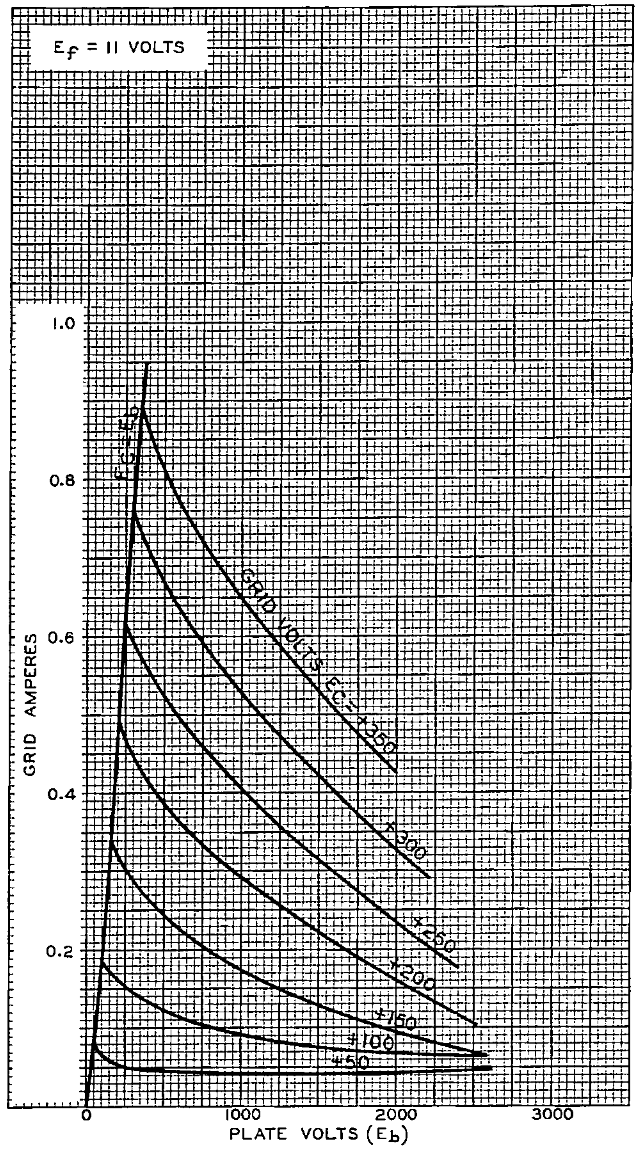

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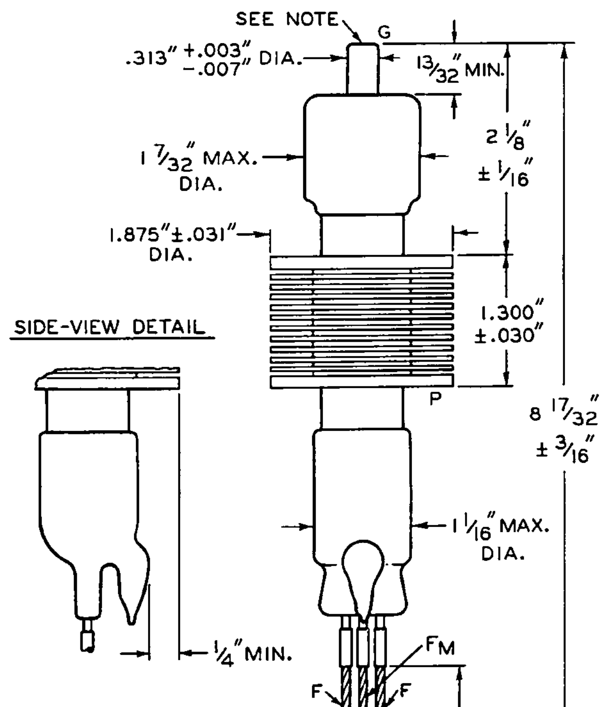
Fig. 6 - Typical Grid Characteristics.

tank circuit having the proper Q and the avoidance of over-excitation are helpful. Link coupling between the driving stage and the power amplifier is useful especially if the Q of the grid tank circuit is high enough to provide good voltage regulation.

Because of the high current carried by the grid lead and its circuit, heavy conductors should be used for these parts. When two or more tubes are used in the circuit, controls should be provided so that adjustment can be made to balance the plate current taken by each tube.

The 6C24 may be operated at maximum ratings in all classes of service at frequencies as high as 160 megacycles.

When more radio-frequency power is required than can be obtained from a single tube, push-pull or parallel circuit arrangements may be used. Two tubes in parallel or push-pull will give approximately twice the power output of one tube. The parallel connection requires no increase in exciting voltage necessary to drive a single tube. With either connection, the driving power required is approximately twice that for a single tube. The push-pull arrangement has the advantage of cancelling the even-order harmonics from the output and of simplifying the balancing of high-frequency circuits. If parasitic oscillations occur in the parallel or push-pull circuits, non-inductive resistors of about 10 to 100 ohms connected in series with each grid lead as close to the tube terminals as possible will often prevent the oscillations.



NOTE: THE GRID TERMINAL WILL FALL WITHIN A 7/16" DIAMETER HOLE CENTRALLY LOCATED IN THE CLOSED END OF A CYLINDRICAL CUP WHICH SLIPS OVER THE RADIATOR AND HAS AN INTERNAL SHOULDER WHICH RESTS SQUARELY AGAINST THE FLAT END OF THE RADIATOR SUPPORTING THE INNER SURFACE OF THE CLOSED END OF THE CUP 1-13/16" FROM THE GRID END OF THE RADIATOR. THE CLOSED END OF THE CUP IS 7/16" THICK.

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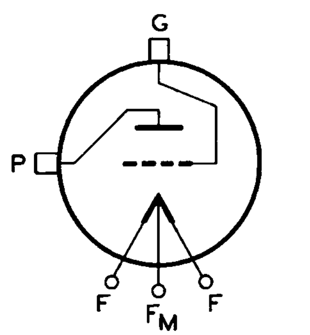
Terminal Connections



F: FILAMENT
FM: FILAMENT MID-TAP
G: GRID
P: PLATE