TECHNICAL INFORMATION

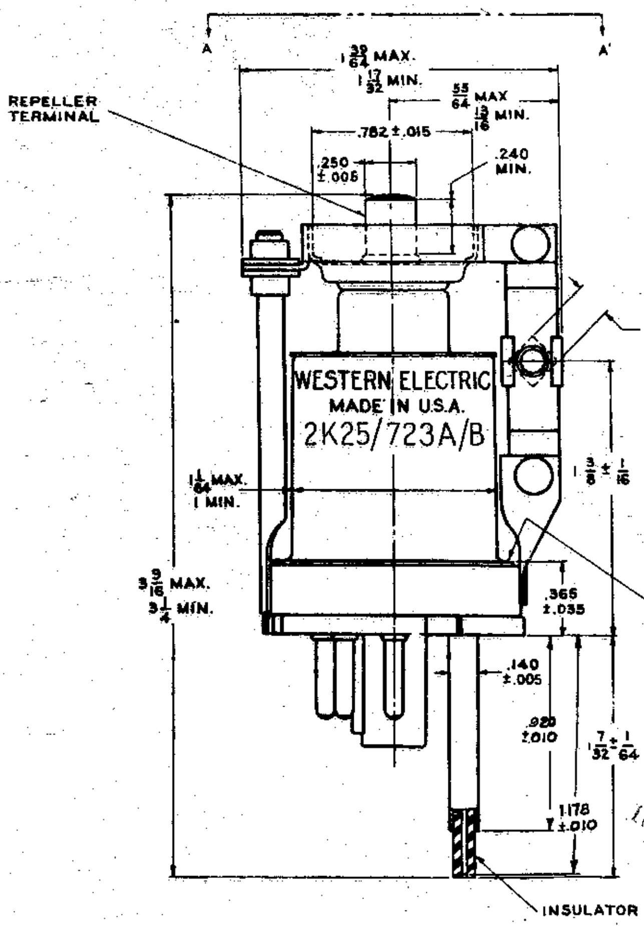
WESTERN ELECTRIC 2K25/723A/B ELECTRON TUBE

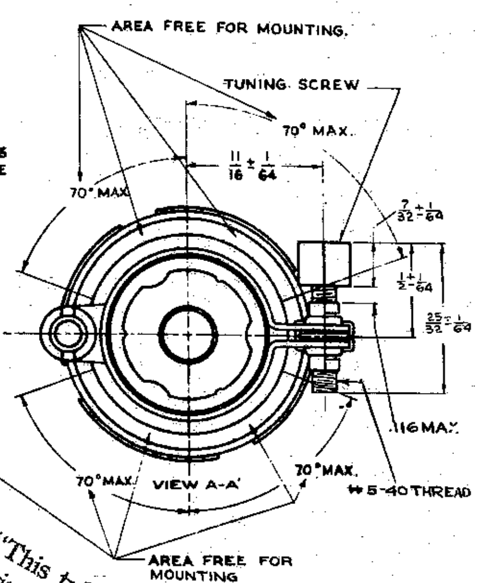
2K25/723A/B
OSCILLATOR
U H F

Note:

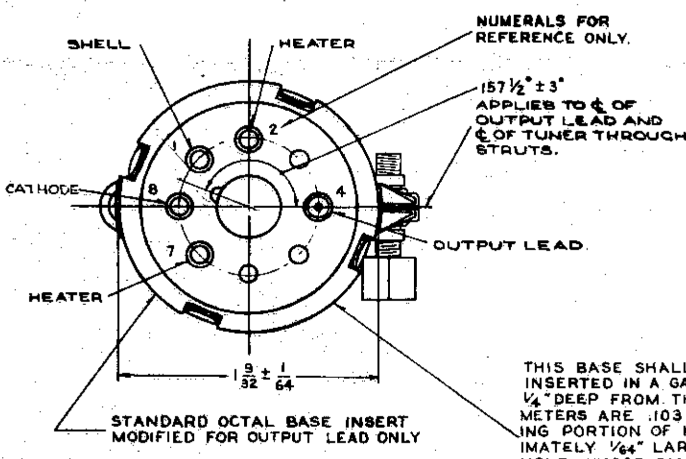
The information contained herein is tentative.

It is recommended that proposed operating conditions for specific applications be discussed with Department 2920 of the Bell Telephone Laboratories.



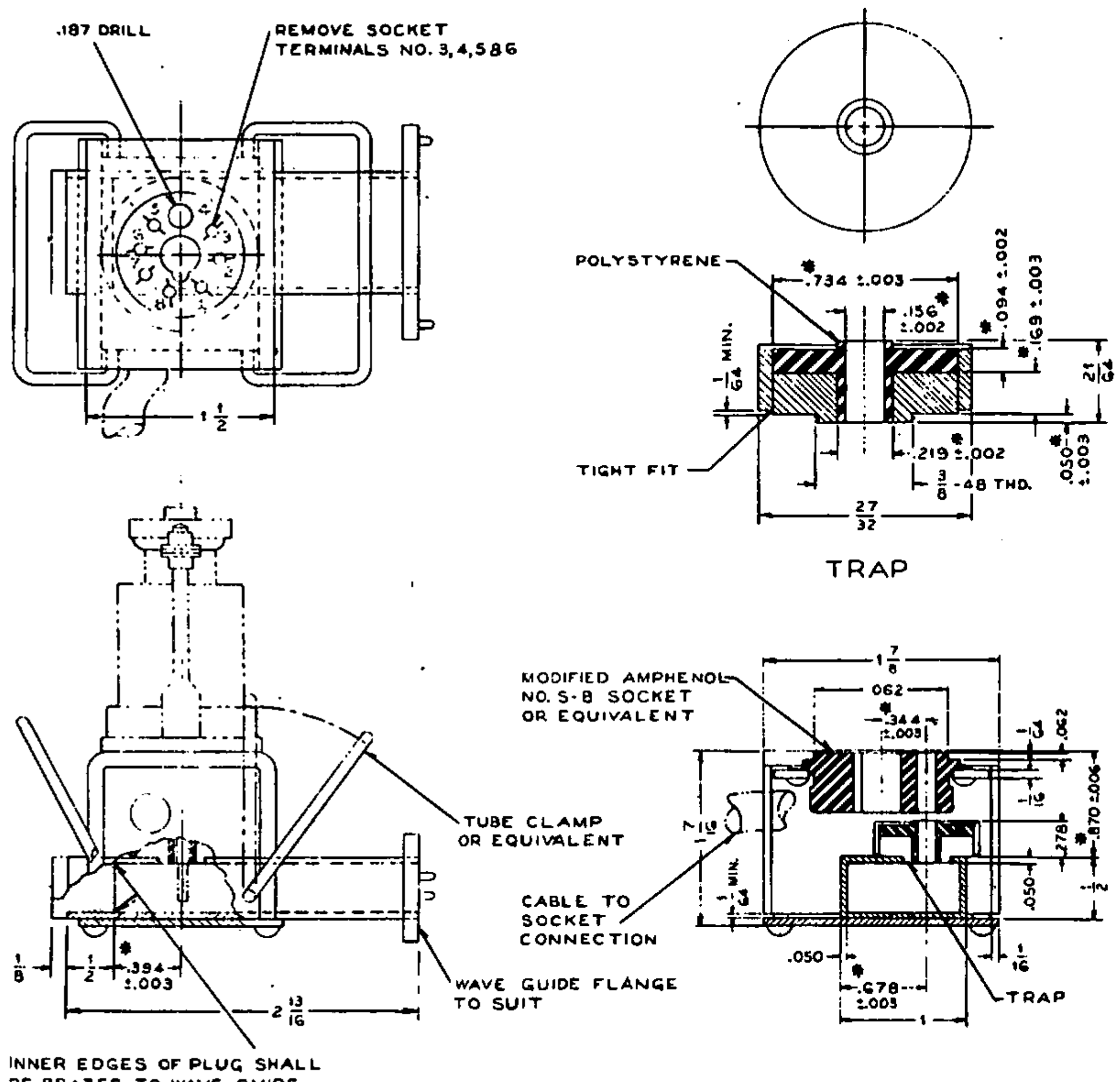


"This tube was sold to the United States Government during the war for Military and Naval purposes and the information contained herein does not at this time constitute an offer by the Western Electric Company, incorporated to sell for commercial use."



THIS BASE SHALL BE CAPABLE OF BEING INSERTED IN A GAGE 1 7/32 THICK HAVING 4 HOLES 1/4" DEEP FROM THE TOP OF GAGE WHOSE DIAMETERS ARE .103" FOR THE CONTACT PINS. REMAINING PORTION OF HOLE TO BE CLEARANCE, APPROXIMATELY 1/64" LARGER IN DIAMETER AND A FIFTH HOLE WHOSE DIAMETER .160" - 1 7/32" DEEP FOR THE OUTPUT LEAD. ALL HOLES LOCATED ON THE TRUE CENTERS. ALSO A CENTER HOLE HAVING THE CONTOUR OF THE PILOT BUT WITH A CLEARANCE OF .002" OVER THE MAXIMUM DIAMETER.

Western Electric



DIMENSIONS INDICATED BY * DETERMINE THE BROAD BAND CHARACTERISTICS OF THE COUPLER AND SHOULD BE HELD TO TOLERANCES SHOWN.

ALL HIGH FREQUENCY SURFACES TO BE SILVER OR GOLD PLATED.

FIG. 1

CLASSIFICATION

The 2K25/~~723A/B~~ electron tube is an ultra high frequency oscillator in which the resonant circuit and means of tuning are integral with the tube. It has been developed for operation within a frequency range of 8500 to 9660 megacycles per second.

INSTALLATION

This tube employs a modified intermediate octal wafer type base with the No. 4 pin removed and the hole drilled to allow the coaxial output line to pass through. The output line has been designed for direct coupling with a suitable wave guide. The central conductor of the coaxial line projects beyond the outer conductor to serve as an antenna when the coaxial is projected through the wall of the guide. For best operating conditions, the full length of the antenna should be inside of the wave guide wall. The polystyrene insulator should be kept clean to avoid power loss in a conducting surface film. The tube may be mounted either in a horizontal or vertical position. For proper operation the tube socket mount should be rigidly fastened to the wave guide. The No. 4 hole in the socket, which is drilled to admit the coaxial output line, should be in alignment with the entrance hole in the wave guide wall. Tubes should be fastened rigidly to the socket mounting by clamping at the base and adjacent platform only. The tube must not be clamped above the shoulder of the platform which is located .365" ± .035" above the bottom surface of the base.

The inner and outer conductors of the coaxial output line are at the same potential as the resonator. The resonator may be operated at a potential other than that of the wave guide if a suitable by-pass condenser or choke coupling is provided between the coaxial and the wave guide.

The radio frequency properties of the tube are specified when the tube is mounted in the broadband coupling unit shown in Figure 1 and this unit is coupled to a load which presents a standing wave not exceeding .8 db at the coupler. Unless otherwise stated all characteristics discussed refer to operation in this coupler and for comparable results an equivalent unit should be employed. The coupler incorporates a choke to provide a radio frequency connection between the wave guide and tube coaxial while permitting d-c isolation.

Since the frequency is a function of the repeller and resonator voltages it is very important in many applications to shield and by-pass the leads carrying these voltages as close to the tube as possible in order to avoid modulation of the tube output by extraneous voltages.

HEATER RATING

Heater voltage	5.8 volts min.
	6.8 volts max.
Nominal heater current	0.44 ampere

The heater element of this tube is designed to operate on a voltage basis and it should be operated at as near to 6.3 volts as practicable.

OPERATING CONDITIONS AND CHARACTERISTICS

	Normal	Absolute Maximum
Heater voltage (Ef)	6.3	6.5 volts
Potential difference between heater and cathode	0	± 45 volts
Resonator voltage (Ers)	300	330 volts
Cathode current (Ik)	22	35 milliamperes
Repeller voltage (ER) range	-20 to -300	-350 volts
Ambient temperature	-	110°C*

* This is the temperature surrounding the bulb proper. The temperature of the coaxial line below the base must not exceed 90°C.

Unless otherwise specified all data given hereafter are for normal operating conditions in the coupling shown on the outline drawing.

The life of the tube will depend on the operating conditions. Operation above the normal conditions will decrease the useful life.

In equipment design it is sometimes necessary to know the expected manufacturing distribution of cathode current. This is shown in Figure 2.

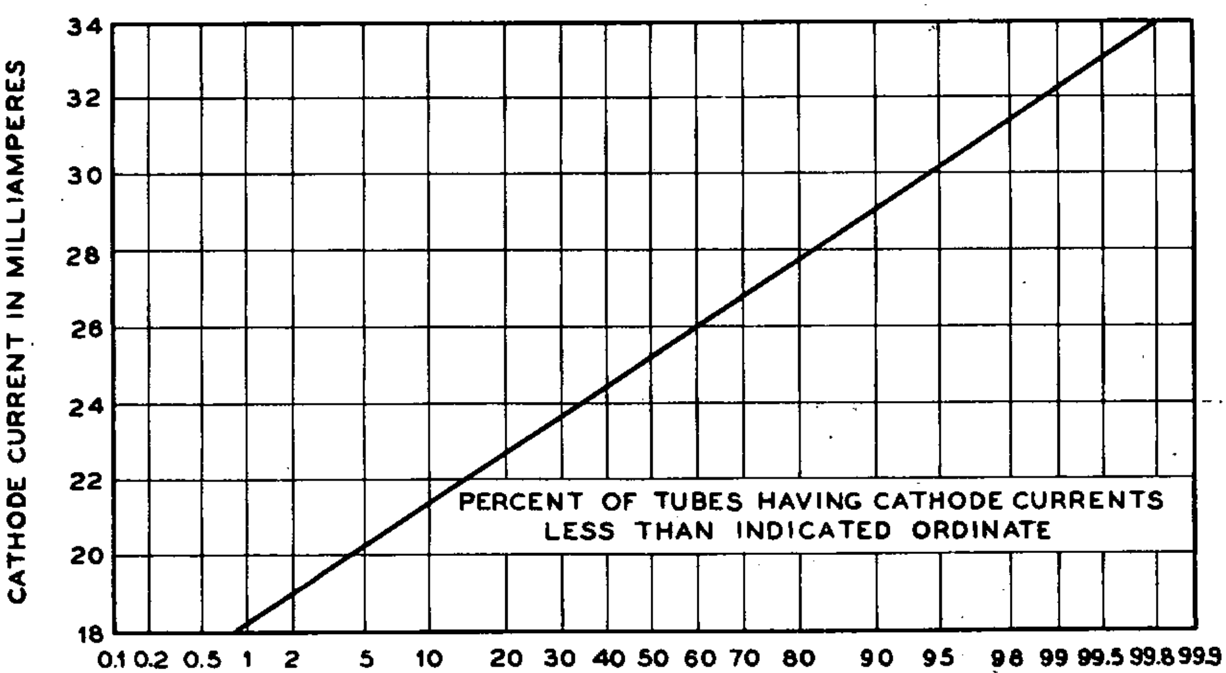


FIG. 2

MECHANICAL TUNING ADJUSTMENT

The mechanical tuning mechanism and flexible diaphragm have been designed to afford an occasional adjustment of frequency. It is not intended for use where continual or frequent adjustment is required.

When putting a tube into service, the tube should be mechanically tuned to the frequency desired. The bows should then be flexed a number of times to relax the strains in the system. By decreasing the flexing successively from a maximum of one full turn to zero in 8 or 10 flexes, the desired frequency will be found to be essentially stable.

REPELLER VOLTAGE CHARACTERISTICS

The same frequency of oscillation may be obtained at several repeller voltages when all other conditions are kept fixed including the tuning of the resonator. Each of these correspond to a different number of cycles of drift in the repeller space. These characteristics are illustrated in Figure 3 which shows approximately the relative output as a function of the repeller voltage for various mean resonator frequencies obtained by mechanical tuning. Fig. 3 also gives approximate information concerning the range of repeller voltage over which oscillation occurs in the various modes and the voltage separation between the modes. It is recommended that for most applications as a local oscillator, the mode designated A should be used, since the coupling unit was designed specifically for this mode and the test specifications were so written to ensure the properties of this mode. The two dashed lines in Figure 3 show the probable range of repeller voltages required to produce maximum power output in mode A that may be expected due to production variations. The middle curve shows the variation of repeller voltages with frequency for a typical tube.

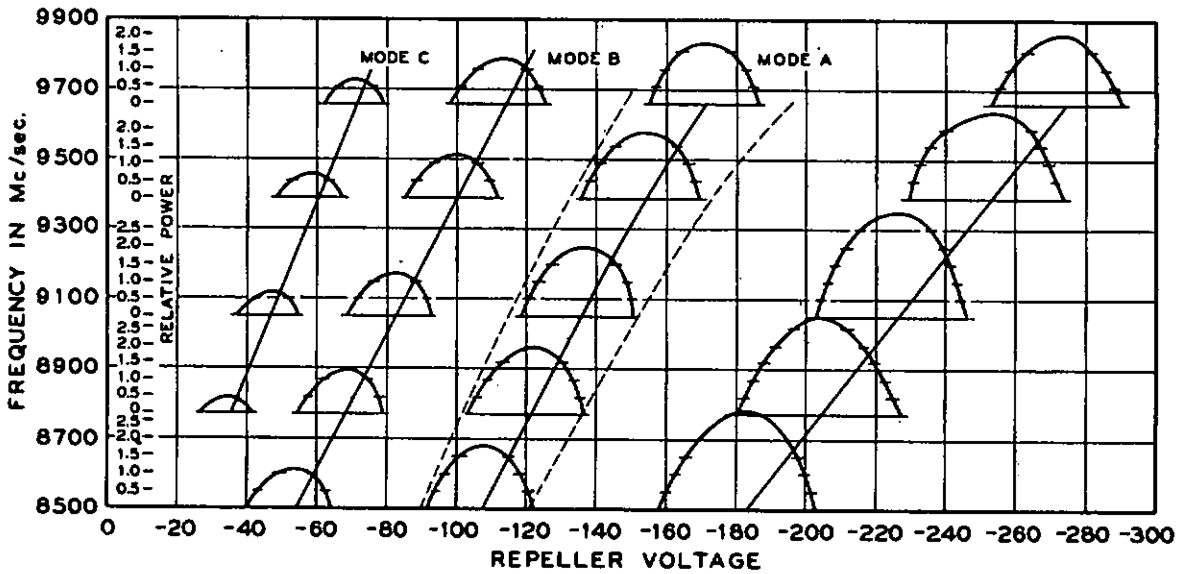


FIG.3

POWER OUTPUT

The power output characteristics for a tube oscillating in mode A and operating into a load presenting a unity standing wave ratio are shown in Figure 4 as a function of frequency. The dashed curves on either side of the power frequency curve indicate the probable variation to be expected. The test specification requires that a tube oscillating in mode A shall give not less than 20 milliwatts throughout the frequency range. The specification also requires that at 9370 Mc the power for operation in mode B of Figure 3 shall not be less than 15 milliwatts and for mode C not less than 3 milliwatts. The specifications for modes B and C are made for special applications and the use of these modes for normal service is not recommended.

ELECTRONIC TUNING

The frequency of oscillators of this type may be varied over a limited range by variations of the repeller voltage.

The amount of electronic tuning as well as the rate of change of frequency with repeller voltage is a function of the resonator voltage and the loading. Data presented here are applicable when the tube is coupled to a matched load in the recommended coupling and the resonator voltage is normal (300 V).

Figure 5 shows the range of electronic tuning as a function of maximum power frequency. Both the tuning between half power and 2.5% power points are shown. The dashed lines above and below each of the curves indicates the probable variation to be expected.

The effect on tuning ranges and power output caused by using other values of resonator voltages is shown in Figure 6.

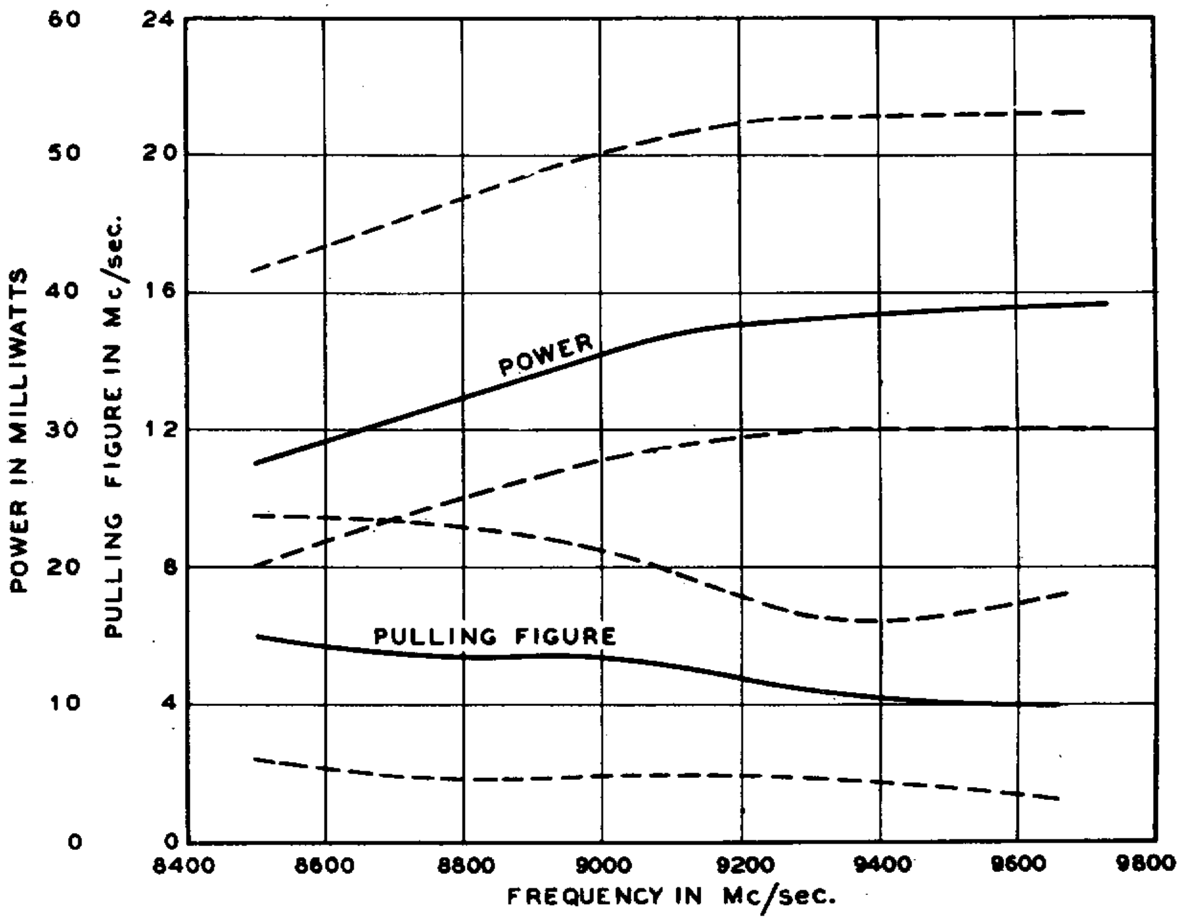


FIG. 4

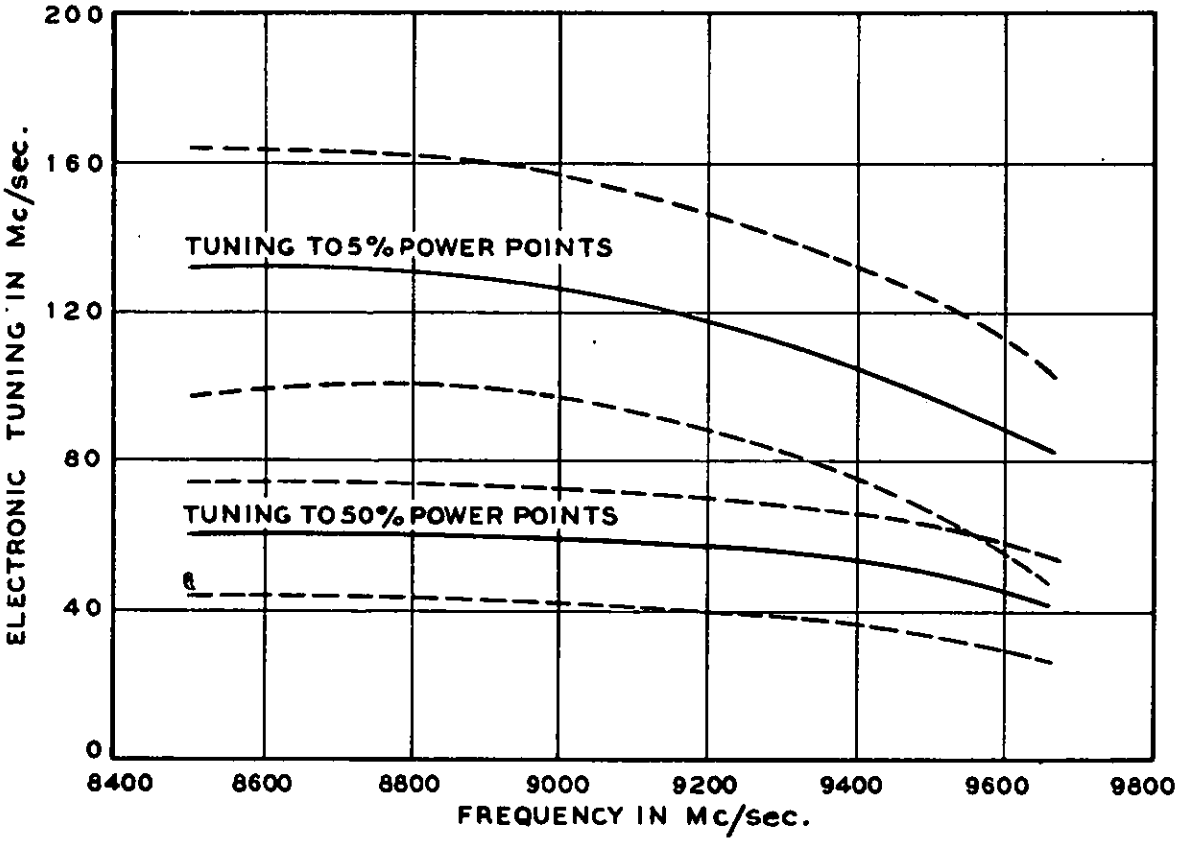
OUTPUT IMPEDANCE CHARACTERISTICS

It is not possible because of space limitations to illustrate the behavior of the oscillators as the impedance is varied for frequencies throughout the band. However, a typical impedance diagram taken at 9375 Mc on a tube of average characteristics is shown in Figure 7. With a matched load presented to the coupler, the repeller voltage was adjusted for maximum power. All voltages were held fixed while various impedances were presented to the tube. The solid lines are loci of constant power and the dotted are loci of constant frequency differences from the frequency for a matched load. The impedance plane of reference is a plane in the wave guide perpendicular to the axis and including the tube antenna.

It will be observed that the oscillator is not coupled to give maximum power output. This is a design feature of the tube and coupling and provides a margin of safety against over coupling and the possible resulting loss of oscillation. It may be observed by examining Figure 7 that wide variations in the power output of the tubes can be caused by changes in the load impedance and that sufficient over-loading can cause the tube to stop oscillating. If the load is frequency sensitive, over-loading may occur over a portion of the normal electronic tuning range and as a result there will be no output in that region.

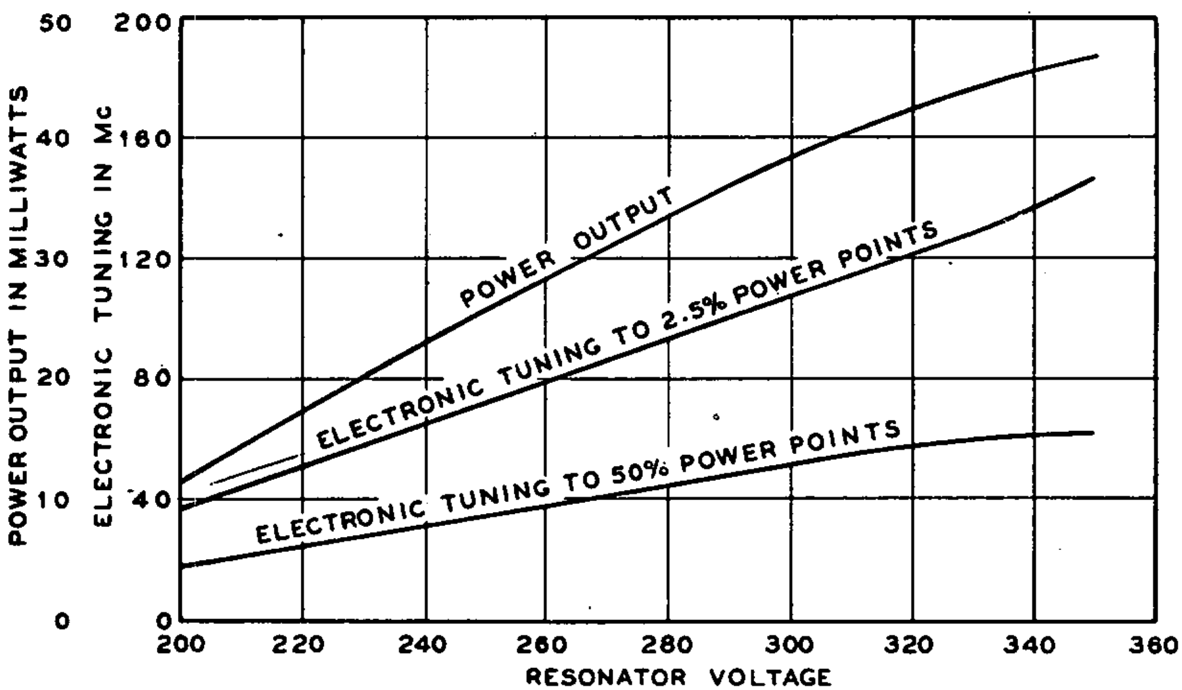
It is specified that the tube shall operate at 9370 Mc without a discontinuity in the center of the mode for a load having a standing wave ratio with an amplitude of 8 db or less and any phase position measured in the wave guide at the coupling. The minimum amplitude of standing wave ratio that will cause such a discontinuity is called the "sink margin". Figure 8 shows the variation of the sink margin over the frequency band. A reduction in resonator voltage will usually decrease the sink margin. For example a reduction from 300 V to 250 V applied to the resonator will reduce the sink margin an average of 11%.

Another important output impedance characteristic is the change in operating frequency with change in loading. This is customarily expressed in terms of the pulling figure which is defined as the maximum difference in frequencies produced when a mismatch measured at the coupler to have an absolute reflection coefficient of 0.2 is varied through 360°. All operating voltages are held fixed during this test. The expected range of pulling figures is presented as a function of frequency in Figure 4.



200
160
120
80
40
0
ELECTRONIC TUNING IN Mc/sec.
TUNING TO 5% POWER POINTS
TUNING TO 50% POWER POINTS
8400
8600
8800
9000
9200
9400
9600
9800
FREQUENCY IN Mc/sec.

FIG.5



50
40
30
20
10
0
200
160
120
80
40
0
POWER OUTPUT IN MILLIWATTS
ELECTRONIC TUNING IN Mc
POWER OUTPUT
ELECTRONIC TUNING TO 2.5% POWER POINTS
ELECTRONIC TUNING TO 50% POWER POINTS
200
220
240
260
280
300
320
340
360
RESONATOR VOLTAGE

FIG.6

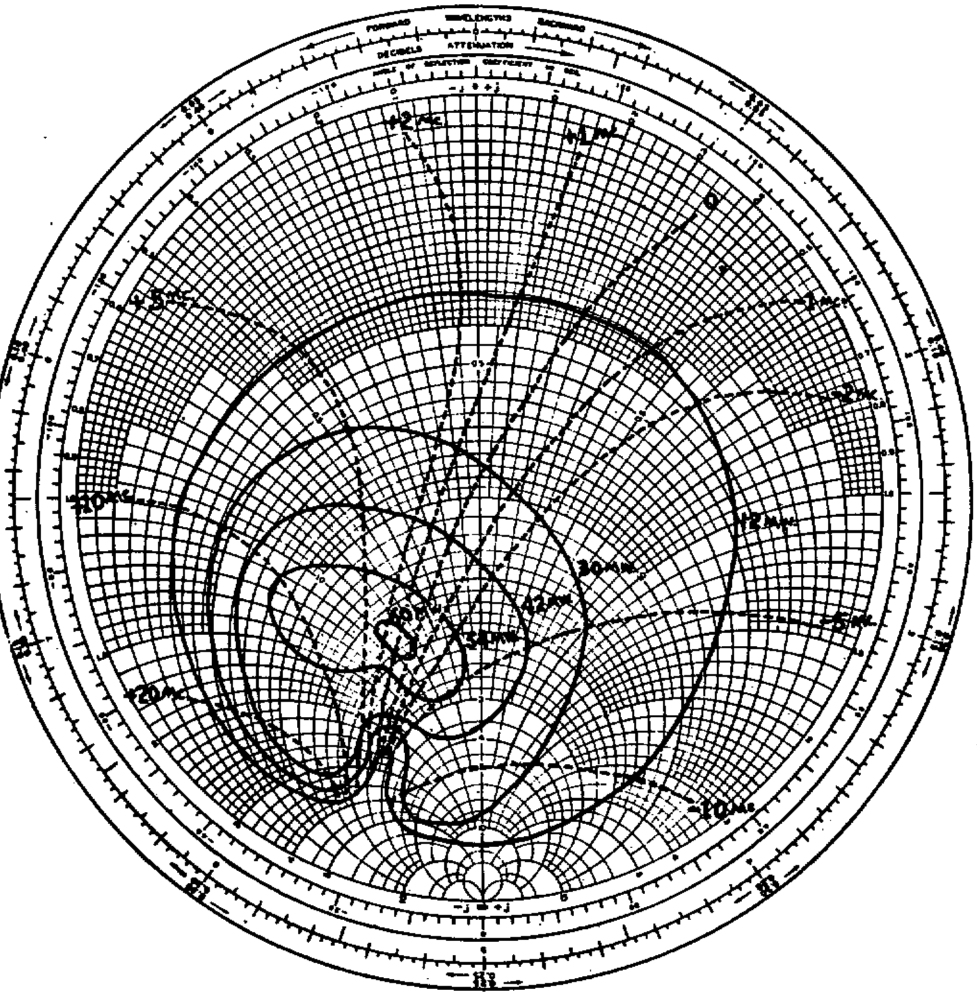
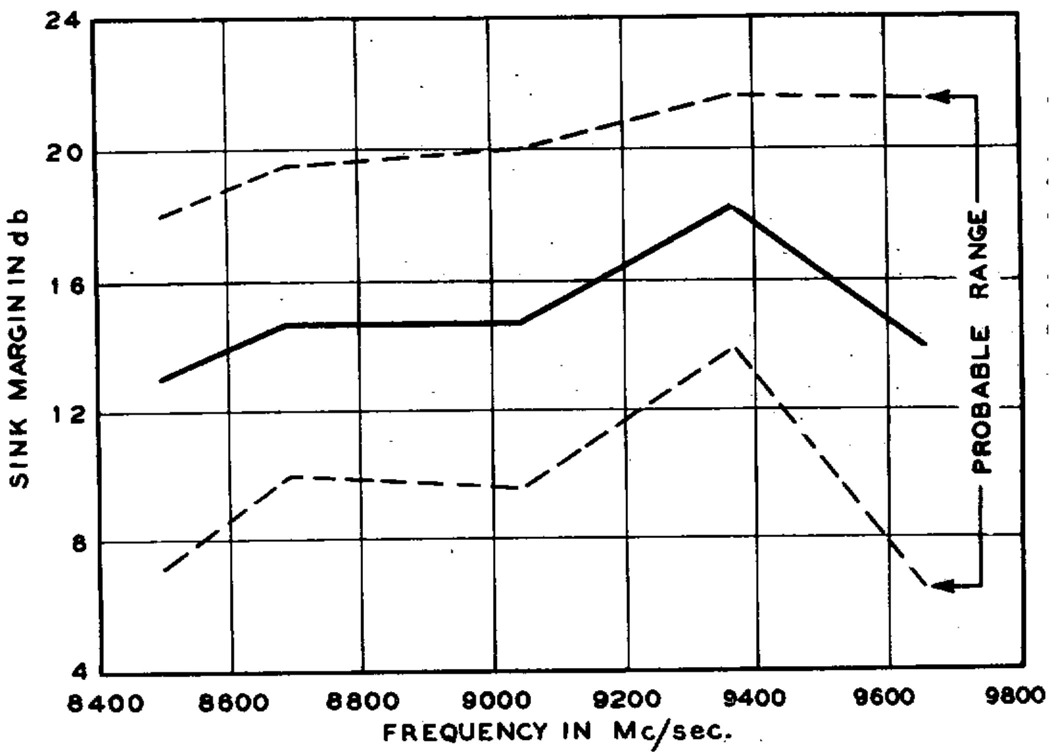


FIG. 7



24
20
16
12
8
4
8400
8600
8800
9000
9200
9400
9600
9800
SINK MARGIN IN db
FREQUENCY IN Mc/sec.
PROBABLE RANGE

FIG. 8

TEMPERATURE COEFFICIENT

The materials used in mechanical tuning mechanism have been especially selected so that their thermal expansion and heat conduction coefficients will balance with those of the other parts of the tube to produce a desirable ambient temperature coefficient. This coefficient lies between 0 and -0.20 Mc/s/°C.

The tube should be operated either in still air or in uniform drafts since varying drafts playing on the tube will produce fluctuations in the oscillating frequencies.

The tube will oscillate at a frequency with 5 Mc/sec of the equilibrium value approximately 6 minutes after power is applied, provided the tube is in still air having an ambient temperature that is nearly constant.

AFFECT OF ATMOSPHERIC PRESSURE ON FREQUENCY

The frequency of oscillation of the tube is affected by atmospheric pressure. The variation of the frequency with altitude for constant ambient temperature is shown in Figure 9, thermal affects will superimpose upon this variation.

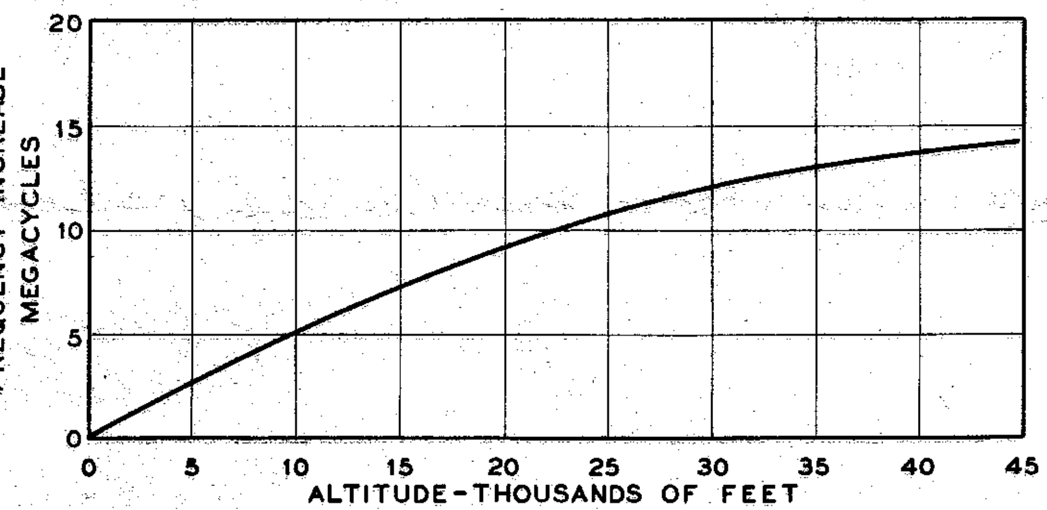


FIG. 9

PULSED OPERATION

This tube may be pulse operated for use in test equipment. Successful operation has been achieved by setting the repeller voltage at a value such that sustained oscillation does not occur. A square wave pulse is then applied which drives the repeller sufficiently positive or negative to reach the oscillating conditions. To obtain a square wave output the drive should not exceed the value to reach the optimum power output condition. The resonator voltage is held fixed.

Successful operation has also been obtained by setting the resonator cathode voltage at a value such that sustained oscillation does not occur. A square wave pulse is then applied to drive the cathode sufficiently negative to provide the operating condition. The repeller cathode voltage is set to provide the optimum condition with the square wave applied. For this latter method a greater peak resonator voltage is allowable than for steady operation but the power input to the tube should not exceed that for the maximum rating. If the tube is switched from CW operation to pulse operation at the same peak input, a frequency shift will result from thermal effects. The amount of this shift will depend upon the duty cycle, and for the extreme case of the very short duty cycle may be in the order of 10 Mc. For this reason the first method of operation is sometimes preferred.

The interelectrode capacitances which may be of importance in pulse operation are as follows:

Repeller to resonator	3.0 mmf
Cathode to resonator (heater tied to cathode)	8.0 mmf
Heater to cathode	3.0 mmf