OPERATING INSTRUCTIONS

TYPE 1220-A

UNIT KLYSTRON OSCILLATOR

GENERAL RADIO COMPANY

932-B

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TYPE 1220-A

UNIT KLYSTRON OSCILLATOR

Form 932-B
September, 1959

GENERAL RADIO COMPANY
WEST CONCORD, MASSACHUSETTS, USA

SPECIFICATIONS

Frequency Range	Depends upon klystron tube used (refer to table , p. 17).
Modulation	Internal 1-kc square wave, adjustable within ±15 cps.
	External square wave, 50 cps to 200 kc; sine- or square-wave modulating signal of at least 15 v rms required. Type 1210-C Unit R-C Oscillator recommended modulator.
	Pulse, 1 to 10,000 μsec duration, less than 0.2 μsec rise and fall time, 50 cps to 200 kc repetition rate; at least 20 v peak pulse voltage required. Type 1217-A Unit Pulser recommended modulator.
	Frequency Modulation, at least 15 Mc excursion obtainable with less than 3 db change in output; at 60 cps, an rms input of about 10 v is suitable.
Output Connector	Type 874 50-ohm Coaxial Connector. Adaptors to other types available. (Refer to Table at rear of this manual.)
Tube Complement	Klystron, as specified in the table on page 17; one 6AB4, one 5963, two OA2.
Power Supply	Recommended are Type 1201-B Unit Regulated Power Supply for high stability and minimum incidental fm; Type 1203-B Unit Power Supply for less critical applications where low cost is important.
Accessories Recommended	Fixed attenuator pad for isolating oscillator from load; adaptors to other coaxial connectors.
Dimensions	Height 5-3/4 in., width 10-5/8 in., depth 6-1/4 in., overall.
Weight	6 lb, with klystron.

U.S. Patent No. 2,548,457.

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TABLE OF CONTENTS

Figure 1. Panel View, Type 1220-A Unit Klystron Oscillator.

TYPE 1220-A
UNIT KLYSTRON OSCILLATOR

Section 1
INTRODUCTION

1.1 PURPOSE. The Type 1220-A Unit Klystron Oscillator (Figure 1) is a simple, compact, general-purpose oscillator covering the frequency range between 2700 and 7425 Mc.[1] It produces either c-w, square-wave, pulse-, or frequency-modulated signals for laboratory measurements, classroom demonstrations, and production-line tests. As a source of frequency-modulated signals, the instrument is particularly useful in the observation of band-pass characteristics.

1.2 DESCRIPTION.

1.2.1 GENERAL. The Unit Klystron Oscillator covers the frequency range between 2700 and 7425 Mc by means of eight interchangeable, plug-in reflex klystrons, each of which has a self-contained resonant cavity that can be tuned over several hundred megacycles. In addition to the external power supply required (refer to paragraph 1.3.1), two d-c supplies are contained in the klystron oscillator. The a-c power for these supplies is obtained from the 6.3-volt a-c heater supply, which is transformed to 300 volts ac and rectified. The external d-c source supplies the klystron cathode current (300 volts at about 30 milliamperes) and an internal 1-kc R-C oscillator (about 5 milliamperes). One of the two power supplies derived from the heater voltage is stabilized at 300 volts dc by voltage-regulator tubes and is used for the low-current repeller voltage. The other supply derived from the heater voltage is for the Schmitt squaring circuit (270 volts dc at about 13 milliamperes).

The anode of the electron gun, which supplies cathode current, is the metallic shell of the klystron, and is connected to the chassis (ground). The cathode of the klystron tube operates at a potential of -300 volts with respect to ground. The repeller voltage can be varied over the range

[1] In addition to tubes available with the instrument, klystron tubes Types 2K25 (8500 to 9660 Mc) and QK414 (9660 to 10,250 Mc) can be used. The frequency ranges of these tubes are high enough so that the Type 874 connectors can support higher-order transmission modes (non TEM). However, satisfactory performance can generally be obtained with these tubes.

of -330 to -600 volts with respect to ground. The positive side of the Schmitt circuit is directly connected to the repeller voltage, so that when the repeller voltage is shifted, the entire Schmitt circuit follows. In other words, the three d-c supplies (cathode, repeller, and Schmitt circuit) are connected in series, with the positive side of the cathode supply connected to ground.

The klystron is amplitude modulated by the addition of a pulse-shaped signal to the d-c repeller voltage. This signal, obtained from the Schmitt squaring circuit, is directly coupled to the repeller voltage, so that the frequency of operation is the same when the klystron is operating, with or without amplitude modulation. The Schmitt squaring circuit may be driven from the internal 1-kc R-C oscillator or from external sine or square waves or pulses. The klystron can be frequency modulated by the addition of a sine wave to the d-c component of the repeller voltage. The sine wave must be supplied from an external source, such as the Type 1210 Unit R-C Oscillator, or the power line. This signal is coupled to the repeller voltage by a capacitor so that it does not change the average value of repeller voltage.

A functional block diagram of the instrument is given in Figure 2.

1.2.2 CONTROLS. The following controls are on the panel of the Type 1220-A Unit Klystron Oscillator:

Name	Type	Function
MODULATION	Five-position rotary switch	Controls type of modulation applied to klystron.
REPELLER VOLTAGE CONTROL	Continuously adjustable potentiometer	Sets repeller voltage on klystron. Calibrated in d-c voltage, negative with respect to klystron cathode.
AMPLITUDE MODULATION VOLTAGE ADJUST	Screw-driver adjustment	Controls peak-to-peak amplitude of an amplitude-modulating signal applied to repeller.
1-kc FREQ ADJUST	Screw-driver adjustment	Fine frequency adjustment for internal R-C oscillator.
KLYSTRON CATHODE CURRENT ADJUST	Screw-driver adjustment	Adjusts beam current in klystron over a small range.

1.2.3 CONNECTIONS. The following connections are on the panel of the Type 1220-A Unit Klystron Oscillator.

Name	Type	Function
EXTERNAL MODULATION	Jack-top binding posts (two)	Receives modulating signal from external source.
OUTPUT	Type 874 Coaxial Connector	Oscillator output connection.
KLYSTRON CATHODE CURRENT	Phone jack	Permits monitoring of cathode current by phone plug and milliammeter.

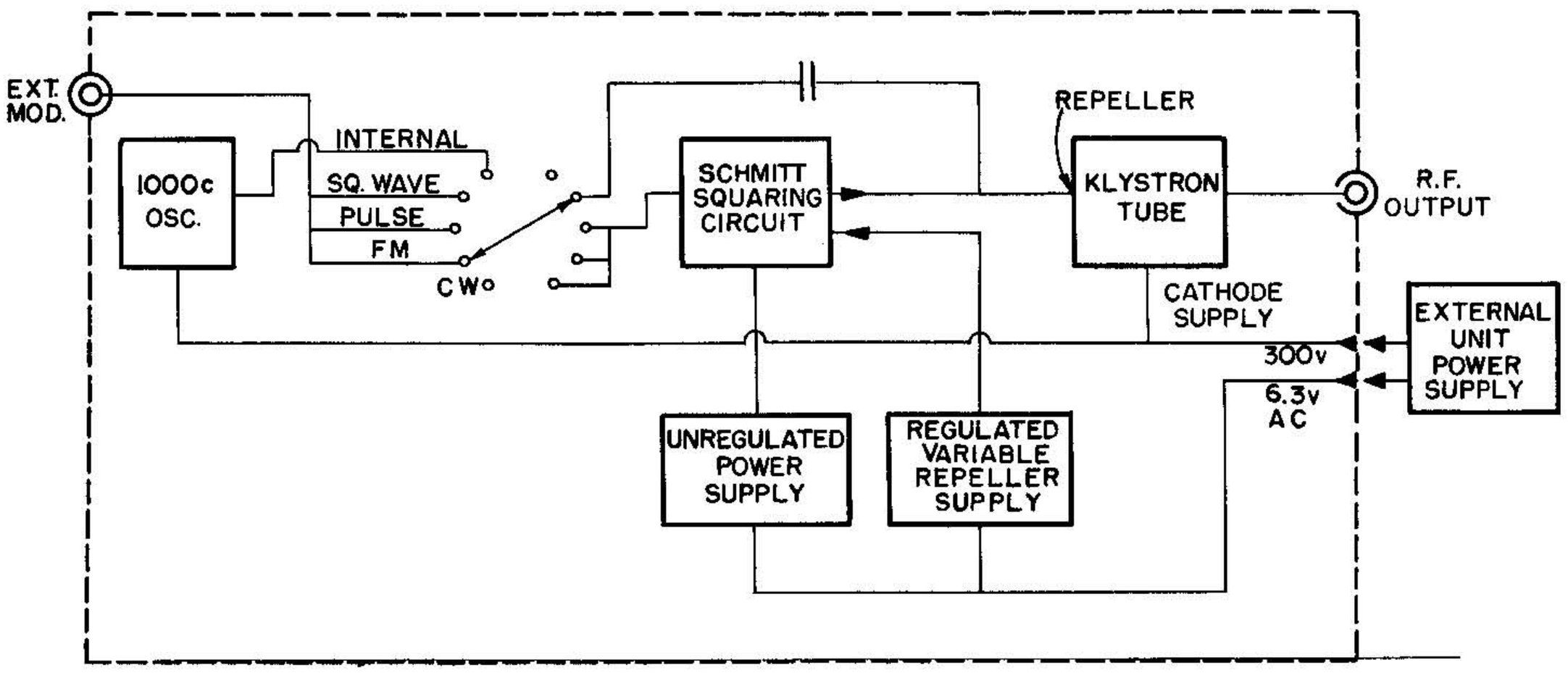

Figure 2. Functional Block Diagram.

1.3 ACCESSORIES.

1.3.1 POWER SUPPLY. The following Unit Power Supplies can be used as power sources for the Unit Klystron Oscillator:

a. Type 1201-B Unit Regulated Power Supply is recommended for high stability and minimum incidental fm, and is the preferred power source.

b. Type 1203-B Unit Power Supply is adequate for less critical applications where cost is an important consideration. (When the Type 1203-B is used, cathode current must be adjusted by means of the KLYSTRON CATHODE ADJUST control.

1.3.2 OTHER ACCESSORIES. Types 874-G6, -G10, and -G20 Attenuator Pads (6, 10, and 20 db, respectively) are recommended as means of

isolating the oscillator from the load. These pads are especially desirable when the klystron is frequency modulated.

The components of the general-purpose untuned detector setup shown in Figure 6 are available from General Radio Company. They are: Type 874-VR Voltmeter Rectifier, Type 874-VI Voltmeter Indicator, and Type 874-WN Short-Circuit Termination. The combination of a Type 874-VQ Voltmeter Detector and Type 874-WM Matched Termination may be used instead of the -VR and -WN combination. Refer to the table at the rear of this manual for a list of Type 874 accessories available.

Section 2

PRINCIPLES OF OPERATION

2.1 OPERATION OF THE KLYSTRON. To oscillate, the klystron tube requires two d-c supplies: one for the cathode and one for the repeller voltage. The latter supply is variable, since the repeller voltage must be varied as frequency is changed. The frequency of the klystron is controlled chiefly by the mechanical dimensions of the resonant cavity. For every frequency, there are several discrete ranges (or modes) of repeller voltage for oscillation. (See Figure 4.) If a pulse-type waveform is added to the steady repeller voltage, the klystron is brought into and out of oscillation without much frequency modulation. During the oscillation part of this modulation cycle, the repeller voltage is within one of the modes of oscillation (for example, between 85 and 130 volts for mode 2; see Figure 3). During the off part of the cycle, the repeller voltage is not within any mode (for example, between 130 and 235 volts). This is the type of amplitude modulation used in the Unit Klystron Oscillator.

It is also evident from Figure 4 that if a varying voltage is added to the steady repeller voltage, the klystron can be frequency modulated. With this type of frequency modulation, there is present a generally undesirable amplitude modulation, the amplitude of which is directly related to the amount of frequency modulation as shown in Figures 3 and 4. For small amounts of frequency modulation (of the order of a few megacycles), the accompanying amplitude modulation is only a few percent. The frequency difference between the two points where the power of a

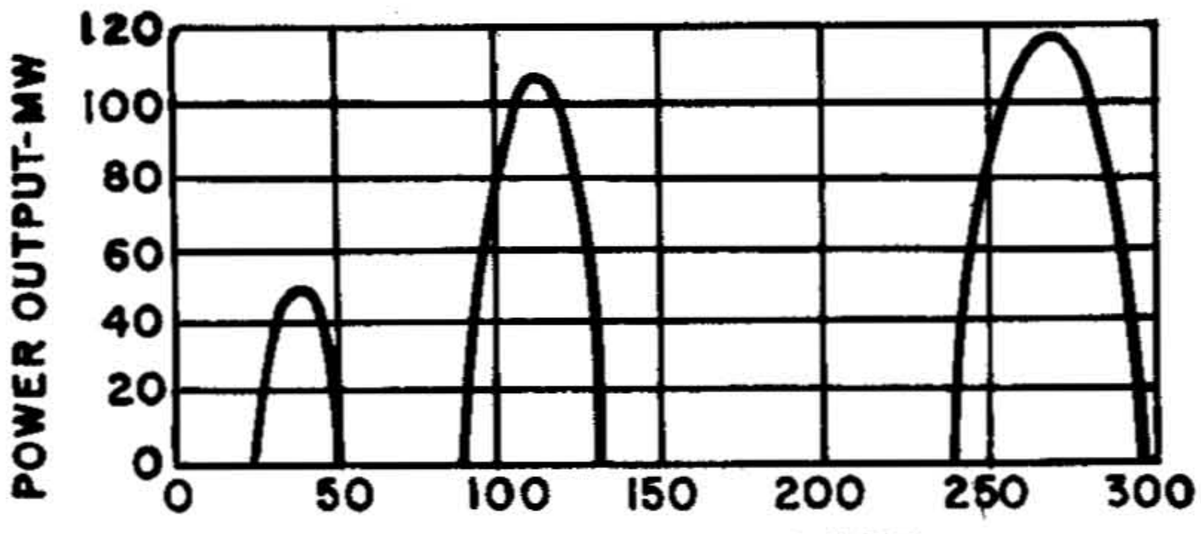

Figure 3.
Output as a Function of Repeller Voltage.

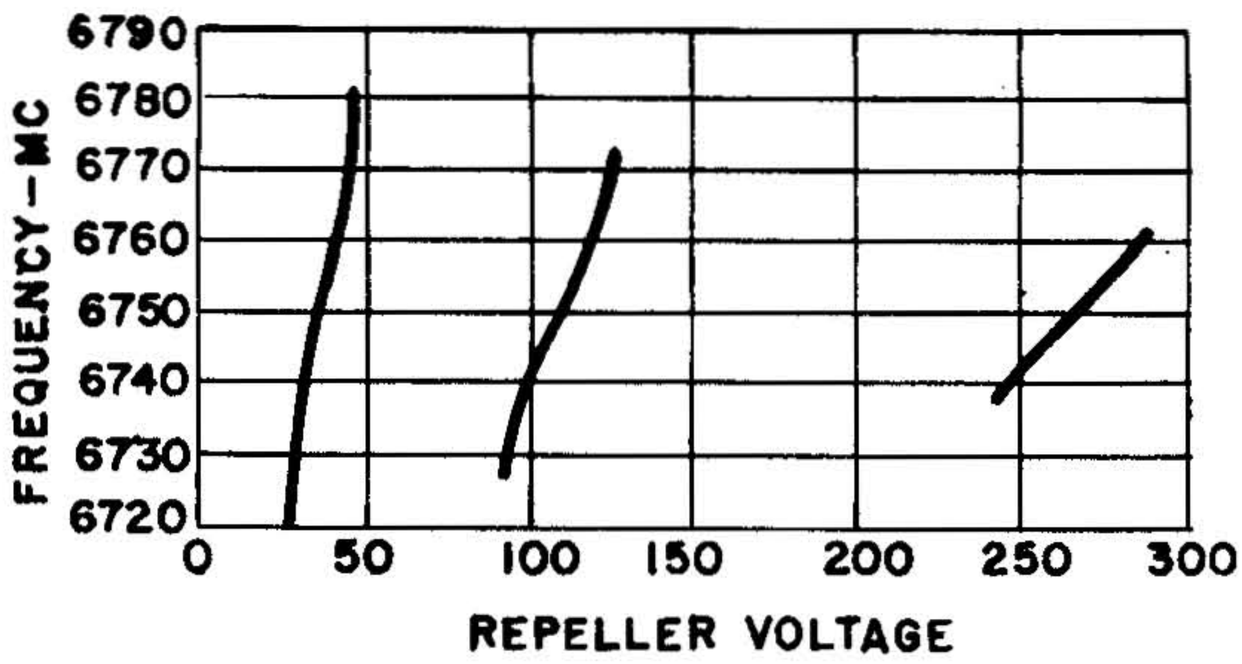

Figure 4.
Effect of Repeller-Voltage Variation on Frequency.

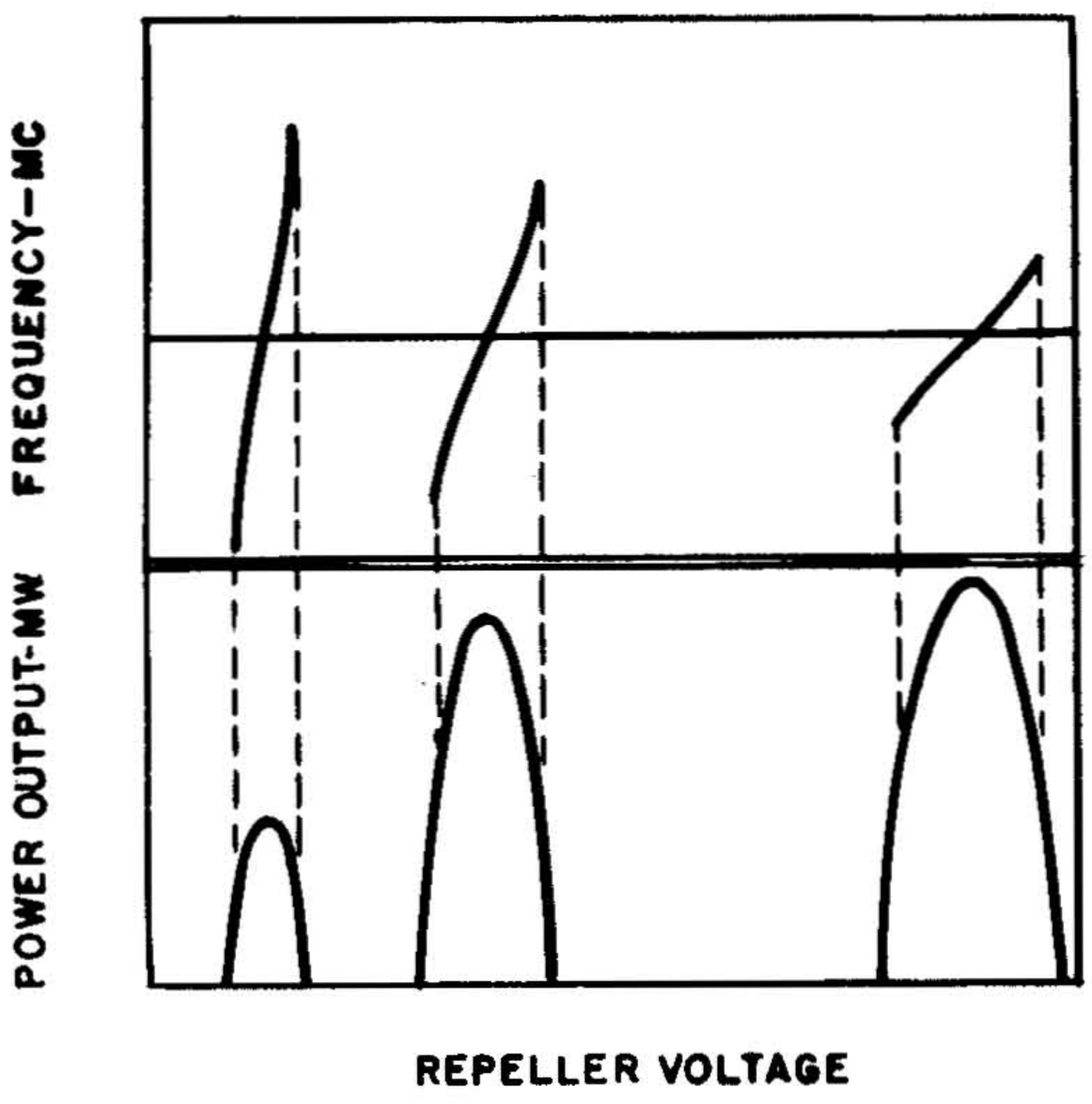

Figure 5.
Output and Frequency vs Repeller Voltage.

mode is one-half the power at the center of the mode is called the electronic tuning range (see Figure 5). The electronic tuning range changes slightly over the frequency range of the tube.

In summary, it can be said that the frequency at which the klystron oscillates is determined by the dimensions of the cavity and the value of repeller voltage.

Section 3
OPERATING PROCEDURE

3.1 INSTALLATION OF THE KLYSTRON TUBE.

WARNING

Always turn off instrument when installing tubes, as high voltage is present.

3.1.1 INSTALLATION OF TUBE TYPES 726C, 2K29, 2K56, 2K22, 6115, QK404, 5976.[2]

a. Install the Type 874 Coaxial Connector and cable (the shorter of the two supplied) as follows: Remove the large, knurled ring nut from the rear of the panel fixture and insert, from the rear of the panel, the Type 874 Connector. Then replace the ring nut.

b. Take the small metal plate that contains an octal socket and the words KLYSTRON, FRONT, and FRONT 6043, and place it on the two stud spacers on the instrument shelf, behind the MODULATION switch. attaching it to the spacers by means of its two 6-32 screws. Orient the plate so that the word KLYSTRON is nearest the rear of the instrument (see Figure 19).

c. With the tube socket thus oriented, pin 4, which has been drilled out, is in the right rear corner of the instrument (as viewed from the top front). The output connector of the tube is a rigid coaxial line, which fits through the modified No. 4 pin of the tube socket. Insert the klystron tube in the socket and attach the repeller lead to the metallic cap on the top of the tube. The repeller lead is the insulated wire with a plastic cap on its end, projecting through the rear of the switch shield.

CAUTION

The repeller lead should always be attached to the tube when the power is on, to avoid damage to the tube.

d. Take the output cable installed in step a, and bend it down into the hole in the shelf beneath the klystron. Loosen the 3/8-inch nut on the cable adaptor, and slip the adaptor unit over the coaxial line of the tube. When the adaptor is flush up against the tube socket, tighten the 3/8-inch nut, locking on the lead. A 3/8- and 7/16-inch wrench, mounted on the side panel of the instrument, are supplied for this purpose. The 7/16-inch wrench holds the body of the adaptor when the nut is tightened.

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[2] Also Types 2K25 and QK414. See footnote 1.

3.1.2 INSTALLATION OF TUBE TYPE 6043.

a. Remove the threaded bushing and the thumb nut screwed into the shelf behind the klystron tube socket.

b. Take the small metal plate (refer to paragraph 3.1.1b), and attach it flush against the chassis (see Figure 19). Orient the plate so that the marking FRONT 6043 is nearest the front panel of the instrument (see Figure 19.)

c. Remove the large ring nut from the panel adaptor, and insert the Type 874 Coaxial Connector and cable (the longer of the two supplied) from the rear of the panel. Replace the ring nut.

d. Insert the klystron tube in its socket and place the small, bullet-shaped adaptor (clip-mounted on shelf) on the top of the tube.

e. Attach the repeller lead to the adaptor on top of the tube. The repeller lead is the insulated wire with the plastic cap, projecting through the rear of the switch shield.

CAUTION

The repeller lead should always be attached to the tube when the power is on, to avoid damage to the tube.

f. Screw the adaptor bushing (removed in step a) into the cavity of the tube in place of the plastic screw with which the tube is shipped.

g. Insert the end of the output cable into the cavity of the tube through the adaptor bushing. The loop on the end of this cable can be rotated or moved in or out of the cavity to vary the output. Maximum output is obtained with the loop mounted vertically. The tube is now installed and ready for use.

3.2 FREQUENCY TUNING. Each klystron tube can be tuned over a range of several hundred megacycles. Refer to Section 5 for the range of operation of each tube and the approximate value of repeller voltage for oscillation.

The most straightforward way to set frequency is by successive approximations, as follows:

a. Taking into consideration the frequency span of the tube and the desired output frequency, estimate the initial setting of the cavity. On the Type 6043 tube, the lowest frequency is obtained with the seven tuning screws at their counterclockwise limits. On all other tubes, the tuning screw is turned fully clockwise for the lowest frequency. The life of all tubes, except that of the Type 6043, is reduced by frequency tuning, because of fatiguing of the diaphragm.

b. Connect a detector to the OUTPUT connector (a recommended detector setup, using the Type 874-VR Voltmeter Rectifier and the Type 874-VI Voltmeter Indicator, is shown in Figure 6). Then, with power on, tune the REPELLER VOLTAGE control for the maximum output for the desired mode.

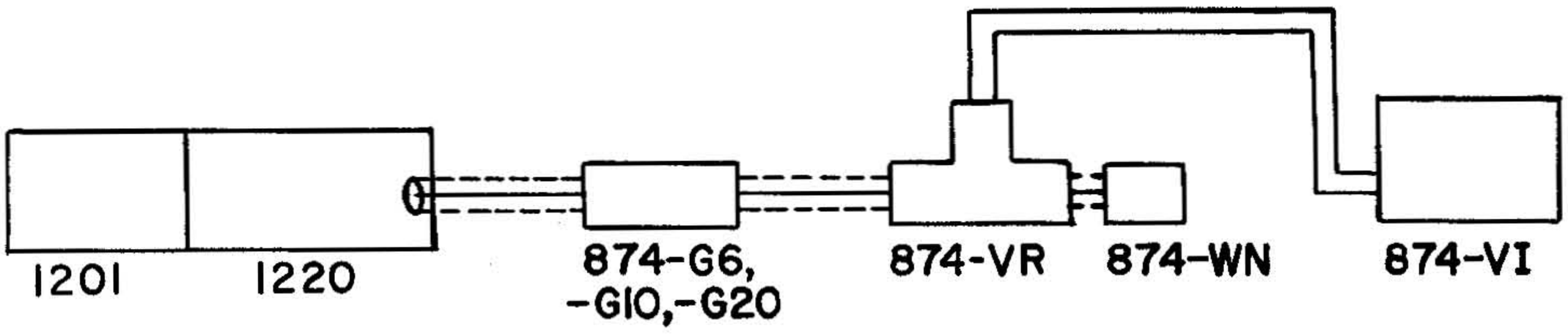


Figure 6. Recommended Detector Setup for Measuring Output.
(Numbers are General Radio Instrument Type Numbers.)

c. Measure the frequency to determine whether it is close enough to that desired. An adjustment of a few megacycles may be made (at the sacrifice of some output power) by adjustment of the REPELLER VOLTAGE control. For greater adjustments, change the cavity, as described in step d, and then reset the repeller voltage for maximum output. A method of frequency measurement is given in step e.

d. The method of adjusting the klystron tube cavity is as follows:

(1) Tube Type 6043: All seven screws must be adjusted to cover the maximum frequency range of the tube. Adjustment of one screw will effect a change up to about 40 Mc. Loosen the locking nut with the 3/8-inch wrench supplied, turn the tuning screw, and retighten the nut.

(2) Other Tubes: Reach through the round hole in the back cover of the instrument with the special wrench (a six-inch length of square tubing) supplied and turn the 3/16-inch square-head adjusting screw on the tube.

e. A simple method of measuring frequency to an accuracy of several percent is by means of the setup shown in Figure 6, except that a Type 874-D20 Adjustable Stub is used in place of the Type 874-WN Termination. A Type 874-G10 or -G20 Attenuator Pad is definitely needed. As the stub is adjusted the output indicated on the Type 874-VI will be zero at several settings. The distance the stub is moved between successive zeros is one-half wavelength. Frequency in megacycles = $\frac{30,000}{\lambda}$ where λ equals a full wavelength in centimeters.

NOTE

The adjustable stub should not be used when the repeller voltage is tuned for maximum output.

3.3 TUNING FOR C-W OPERATION.

a. Set the MODULATION switch to OFF (CW).

b. Determine from the data given in Section 5 which mode of operation is desired, and the corresponding repeller voltage.

c. Follow the frequency tuning procedure outlined in paragraph 3.2.

3.4 TUNING FOR INTERNAL SQUARE-WAVE OPERATION.

a. Do not apply any signal to the EXTERNAL MODULATION jacks. Set the MODULATION switch to OFF (CW).

b. Follow the frequency tuning procedure outlined in paragraph 3.2.

c. Set the MODULATION switch to PULSE (POS), and check that the r-f output, as indicated by a detector setup similar to that shown in Figure 6, goes to zero. Refer to paragraph 3.9 if output does not go to zero.

d. Set the MODULATION switch to INTERNAL 1 kc SQ WAVE. The klystron is now operating square-wave amplitude modulated at 1 kc. The modulating frequency may be varied over a small range (at least ±15 cps) by means of the 1 kc FREQ ADJUST panel screw-driver adjustment. By means of this adjustment, the modulating frequency can be made to coincide with sharply tuned audio amplifiers often used as detectors.

3.5 TUNING FOR EXTERNAL SQUARE-WAVE OPERATION.

a. Do not apply any signal to the EXTERNAL MODULATION jacks. Set the MODULATION switch to OFF (CW).

b. Follow the frequency tuning procedure outlined in paragraph 3.2.

c. Set the MODULATION switch to PULSE (POS), and check that the r-f output, as indicated by a detector setup similar to that shown in Figure 6, goes to zero. Refer to paragraph 3.9 if output does not go to zero.

d. Set the MODULATION switch to EXTERNAL SQ WAVE.

e. Apply to the EXTERNAL MODULATION jacks a square or sine wave subject to the following restrictions:

(1) The frequency must be between 50 cps and 200 kc.

(2) The rms amplitude should be at least 15 volts, but less than 25 volts. Fifteen to 20 volts is desirable. The Type 1210-B Unit R-C Oscillator is recommended as an external modulator.

3.6 TUNING FOR PULSE OPERATION.

a. Do not apply any signal to the EXTERNAL MODULATION jacks. Set the MODULATION switch to OFF (CW).

b. Follow the frequency tuning procedure outlined in paragraph 3.2.

c. Set the MODULATION switch to PULSE (POS), and check that the r-f output, as indicated by a detector setup similar to that shown in Figure 6, goes to zero. Refer to paragraph 3.9 if output does not go to zero.

d. Apply to the EXTERNAL MODULATION jacks an external pulse, subject to the following restrictions:

(1) The pulse must be positive.

(2) The duty ratio (ratio of pulse on time to total pulse period) shall be less than 0.5.

(3) The "on" part of the pulse cycle shall not exceed 0.01 second. Since pulses less than 1 μsec in length will not be reproduced accurately by the Schmitt trigger circuit of the Unit Klystron Oscillator, 1 μsec is recommended as the lower limit for pulse length.

(4) Pulse amplitude should be at least 20 volts, but less than 60 volts. Twenty to 30 volts gives satisfactory operation.

(5) Pulse repetition rate should be between 50 cps and 200 kc. The Type 1217-A Unit Pulser is recommended as a pulse source.

NOTE

Slightly better pulse response (faster r-f rise time and lower incidental fm) can be obtained by reduction of the amplitude of the modulating signal applied to the repeller. The effect is generally insignificant unless short pulses (about 1 to 2 μsec) are used. To effect this reduction, turn the AMPLITUDE MODULATION VOLTAGE ADJUST control clockwise (in step c) to a point just short of that at which r-f output is obtained.

3.7 TUNING FOR FREQUENCY-MODULATION OPERATION.

3.7.1 PROCEDURE.

a. Turn the MODULATION switch to OFF (CW).

b. Determine from the data given in Section 5 which mode of operation is desired, and the corresponding repeller voltage.

c. Follow the frequency tuning procedure outlined in paragraph 3.2, except do not detune the repeller voltage from maximum output, even slightly.

d. Refer to the graphs in Section 5 that apply to the tube used. Two of these graphs define the f-m characteristics of the tube for a particular mode of operation. (It should be remembered that these data are representative of average tubes.) The graphs are named "Repeller Voltage Sweep Between PO/2 Points vs Frequency" and "Electronic Tuning Between PO/2 Points vs Frequency". The designation PO/2 indicates the points on a repeller mode where the r-f output power equals one-half the maximum output power for that mode. (See Figure 7.) One graph gives the approximate voltage sweep on the repeller necessary to sweep the mode of oscillation between the PO/2 points vs the frequency to which the mechanical cavity is tuned. The other graph gives the approximate total frequency deviation between the PO/2 points vs the frequency to which the mechanical cavity is tuned. If the repeller is not swept be-

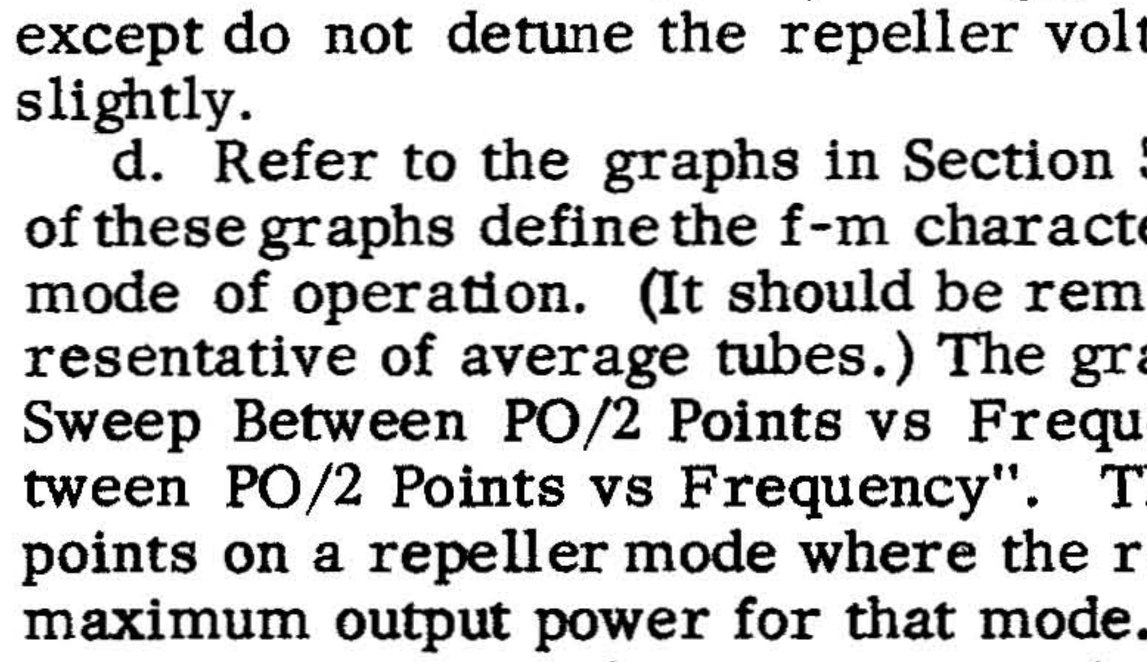


Figure 7.
Location of $\frac{PO}{2}$ Points.

yond the PO/2 points, then the amount of frequency modulation (frequency sweep) is very nearly proportional to the amount of sweep voltage on the repeller. With this information, the approximate amount of sweep voltage necessary for a given amount of frequency modulation can be determined. For an illustration of how this voltage is determined, refer to paragraph 3.7.2.

The coupling circuit between the EXTERNAL MODULATION jacks and the repeller terminal of the klystron tube is shown in Figure 8, where $E_{m\ in}$ is the magnitude of the modulating signal applied to the EXTERNAL MODULATION jacks and $E_{m\ repeller}$ is the signal reaching the repeller terminal of the klystron tube. It can be seen that a greater signal must be applied to the EXTERNAL MODULATION jacks than is actually desired on the repeller. A graph of the ratio of $E_{m\ repeller}/E_{m\ in}$ vs modulation frequency is shown in Figure 9. It is also evident that the modulating voltage on the klystron itself will be out of phase with the input modulating voltage.

e. Set the MODULATION switch to FREQ MOD, and apply the modulating voltage, as determined in step d, to the EXTERNAL MODULATION jacks. The klystron is now set up for frequency-modulation operation.

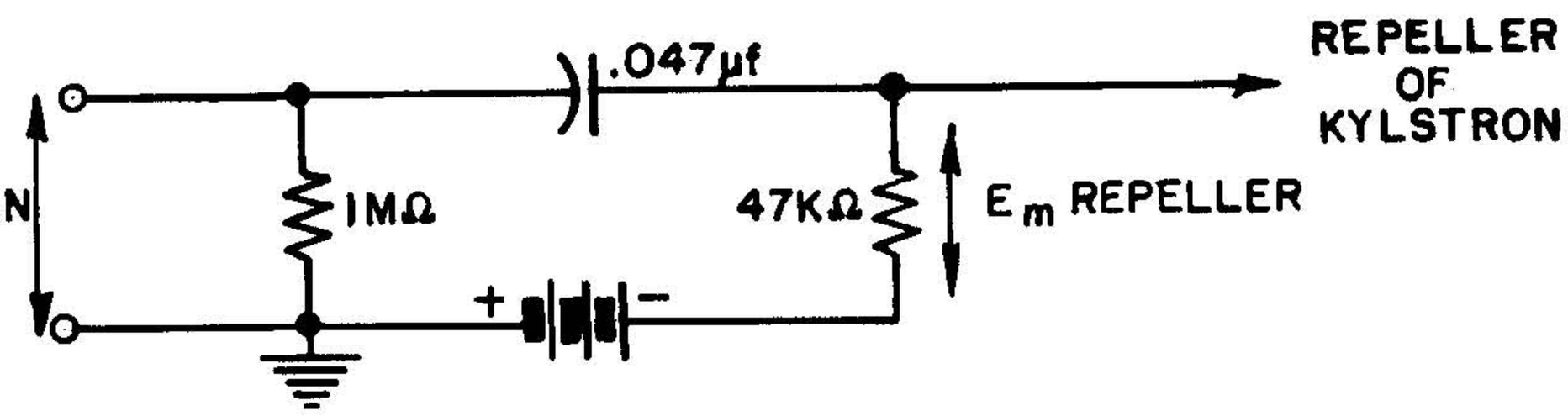


Figure 8.
Coupling Circuit Between External Modulation and Repeller Voltage.

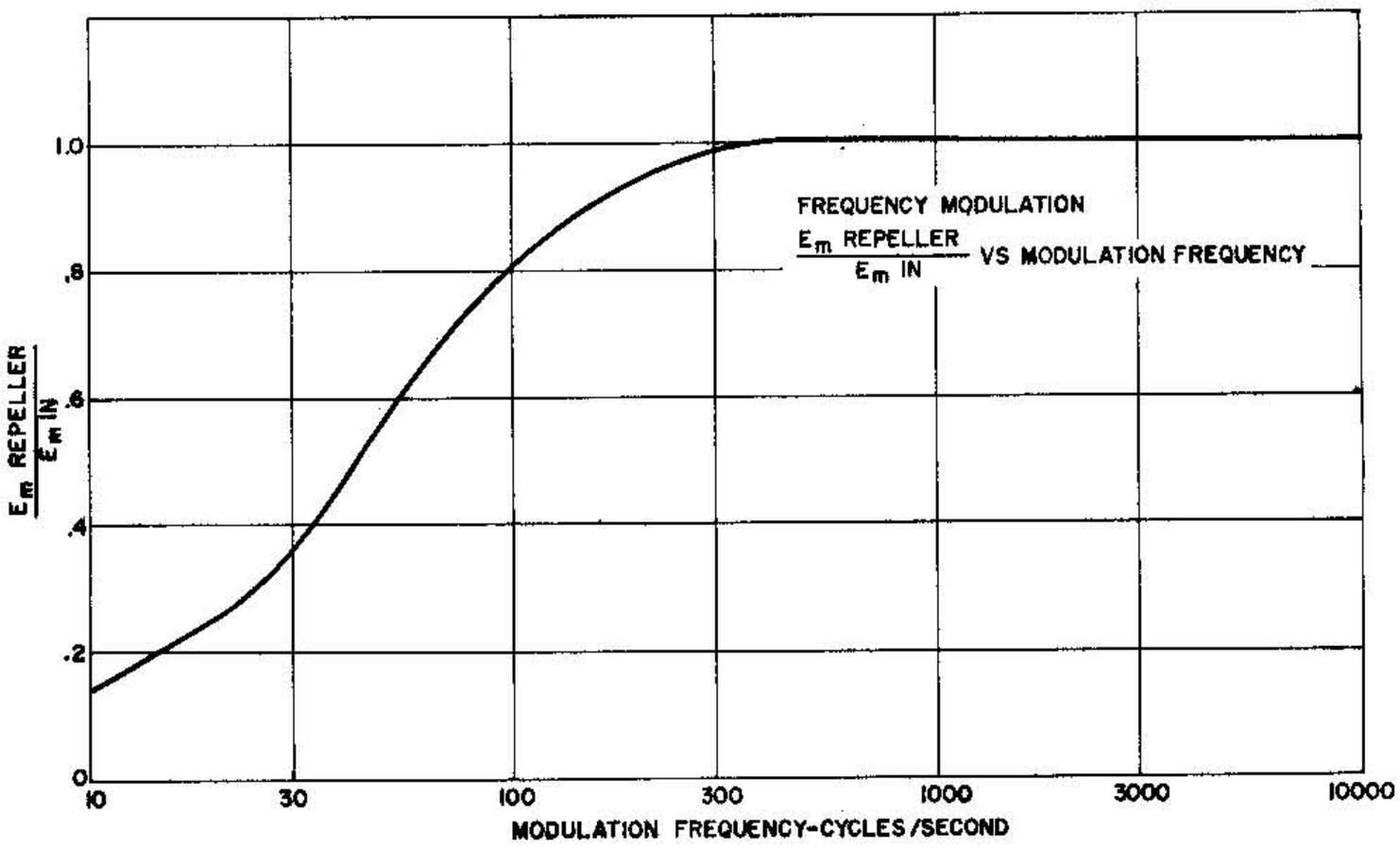


Figure 9.
Ratio of Input to Repeller Voltage as a Function of Modulating Frequency.

3.7.2 SAMPLE PROBLEM. Assume the Type 2K56 Klystron tube, operating at 4000 Mc, is to be frequency modulated over a 30-Mc sweep at a 60-cps modulation rate. Suppose Mode A is chosen (refer to Section 5 for data). From the graph titled "Repeller Voltage Sweep Between PO/2 vs Frequency" we find that at 4000 Mc, a 25-1/2-volt sweep on the repeller is necessary to sweep the oscillator between the PO/2 points. From the graph titled "Electronic Tuning Between PO/2 vs Frequency" we find that at 4000 Mc, a 35-1/2-Mc sweep will be produced if the repeller voltage is swept between the PO/2 points. Making the approximation that the frequency is proportional to the voltage sweep, we find that:

$$\frac{E_{m\ repeller\ (v)}}{30\ Mc} = \frac{25\text{-}1/2\ v}{35\text{-}1/2\ Mc}$$

$$E_{m\ repeller} = 21.6\ v$$

Thus we need 21.6 volts on the repeller. From the graph (Figure 9) we find that at 60 cps, 64 percent of the voltage applied to the EXTERNAL MODULATION jacks reaches the repeller of the klystron tube. Therefore, we must apply 34 volts (21.6/0.64) to the EXTERNAL MODULATION jacks. Remember that all these calculations involve peak-to-peak amplitudes of sine waves; thus the rms value of the input sine wave is $\frac{34}{2\sqrt{2}}$ or 12.1 volts rms. The accuracy of these calculations is misleading, since the graph data given on these klystrons are only representative of average tubes.

The above is the general procedure for determining the proper signal to be applied to the EXTERNAL MODULATION jacks to produce a predetermined amount of frequency modulation. The klystron tubes may be frequency modulated over a slightly greater range than is defined by the PO/2 points of a mode, but amplitude modulation, which accompanies the frequency modulation, then becomes large and approaches 100 percent.

3.7.3 SPECIAL CONSIDERATIONS. When a frequency-modulating signal is applied to the Unit Klystron Oscillator, care must be taken that the repeller voltage is never positive with respect to the cathode. In other words, the peak value of the modulating signal (1.4 times the rms value) on the repeller terminal should be equal to or less than the d-c component of the repeller voltage, indicated on the REPELLER VOLTAGE calibration. This restriction is satisfied under usual operating conditions.

A reactive load on the klystron tube will shorten the electronic tuning range and cause a nonlinear variation of frequency with reflector voltage. Therefore the use of a Type 874-G6, -G10, or -G20 Attenuator Pad is recommended to assure a resistive load on the tube.

3.8 SCREW-DRIVER ADJUSTMENTS.

3.8.1 1 kc FREQ ADJUST. This control can be left in any position, but should generally be adjusted for maximum output with a sharply tuned 1-kc audio amplifier used as a detector.

3.8.2 AMPLITUDE MODULATION VOLTAGE ADJUST. This control should generally be turned fully clockwise.

3.8.3 KLYSTRON CATHODE CURRENT ADJUST. When a Type 1201 Unit Power Supply is used, this control should be turned fully clockwise. When a Type 1203 Unit Power Supply is used, the control should be set so that the klystron cathode current, as measured through the phone jack on the panel, is in accord with the value given in Section 5.

3.9 TUNING CHECK FOR AMPLITUDE MODULATION. If, in the process of tuning for amplitude modulation, the r-f output does not go to zero when the MODULATION switch is set to PULSE (POS), check and adjust as follows:

a. Make sure that there is no modulating signal connected to the EXTERNAL MODULATION jacks.

b. Check that the REPELLER VOLTAGE control is adjusted for maximum r-f output with the MODULATION switch set to OFF (CW).

c. Set the MODULATION switch to PULSE (POS) and try adjusting the AMPLITUDE MODULATION VOLTAGE ADJUST screw-driver control to make the r-f power go to zero. (This control should normally be in its full clockwise position.)

d. If steps a, b, and c fail to produce zero r-f power when the MODULATION switch is set to PULSE (POS), the fault is probably either a malfunctioning Schmitt circuit or the repeller mode of the klystron being such that the tube oscillates over a wide voltage range. The former is more likely, but the latter is checked so quickly that it should be looked into first. To check the klystron mode, then, turn the MODULATION switch to OFF (CW) and adjust the repeller voltage to be a little more negative (a greater dial reading), but not so negative as to stop oscillation. Turn the MODULATION switch to PULSE (POS), and check that the AMPLITUDE MODULATION VOLTAGE ADJUST control is fully clockwise. If the r-f output still does not go to zero, the Schmitt circuit is most likely malfunctioning (refer to paragraph 4.4).

Section 4
SERVICE AND MAINTENANCE

4.1 GENERAL. The two-year warranty given with every General Radio instrument is our way of proclaiming the quality of materials and workmanship we know to exist in our products. When difficulties do occur, our factory-trained service engineers at our main plant and at several district offices stand ready to assist in any way possible.

In case of difficulties that cannot be solved by the use of these service instructions, please write or phone our Service Department, giving full information of the malfunction and of steps taken to remedy the trouble. Be sure to mention the serial and type numbers of the instrument.

Before returning an instrument to General Radio for service, please write to our Service Department or nearest district office, requesting a Returned Material Tag. Use of this tag will insure proper handling and identification. Also, for instruments not covered by the warranty, a purchase order should be forwarded to avoid unnecessary delay.

WARNING

Dangerously high voltages are present on the underside of the chassis. Use great caution when operating the instrument with the dust cover removed.

4.2 R-C OSCILLATOR. With the MODULATION switch set to INT 1 kc SQ WAVE, the a-c output from the 1-kc R-C oscillator tube (6AB4) should be about 35 volts rms, measured at pin 1. This measurement can be made with a cathode-ray oscilloscope, vacuum-tube voltmeter, or volt-ohmmeter. If a volt-ohmmeter is used, set its selector switch to OUTPUT.

If no output appears at pin 1 of this tube, the tube should be replaced. No readjustments are necessary after replacement of this tube.

4.3 REPELLER VOLTAGE. With the klystron tube completely removed from the instrument, the repeller voltage circuit can be checked by means of a d-c voltmeter having a 1000-volt scale and at least 20,000-

ohm-per-volt resistance. Since the repeller voltages are negative with respect to the chassis, the positive terminal of the voltmeter should be connected to the chassis of the instrument. The negative terminal of the voltmeter, which should not be directly coupled to the chassis of the voltmeter, should be connected to the repeller cap lead. With nothing connected to the EXTERNAL MODULATION jacks, the KLYSTRON CATHODE CURRENT ADJUST control at its full-clockwise position, and a Type 1201 Unit Power Supply driving the Unit Klystron Oscillator, the voltages read on the voltmeter should be 300 plus the REPELLER VOLTAGE dial calibration setting. These readings should remain unchanged as the MODULATION switch setting is changed from OFF (CW) to FREQ MOD and SQ WAVE. With the AMPLITUDE MODULATION VOLTAGE ADJUST control set at its full-clockwise position, the voltmeter indication should increase by about 35 volts when the MODULATION switch is set to PULSE (POS). This last measurement is also a check on the Schmitt squaring circuit.

4.4 SCHMITT SQUARING CIRCUIT. To check the operation of the Schmitt squaring circuit, attach a cathode-ray oscilloscope, on a-c response, to the repeller cap, and set the MODULATION switch to INTERNAL 1 kc SQ WAVE. The waveform observed on the oscilloscope should be a square wave of about 35 volts peak-to-peak amplitude. If such a waveform is not observed, check that at pin 2 of tube V2 (5963) there is a sine wave of about 35 volts rms. If there is a sine wave at pin 2, and no square wave at pin 6, the tube probably needs replacement.

4.5 REPLACEMENT OF V2. There are two adjustments necessary after replacement of tube V2 (5963). The procedures are as follows:

a. Attach a cathode-ray oscilloscope, on a-c response, to the repeller cap lead.
b. Attach to the EXTERNAL MODULATION jacks a 1-kc sine-wave oscillator with about 25 volts rms output into 50 kilohms.
c. Switch the MODULATION switch back and forth between EXTERNAL SQ WAVE and INT 1 kc SQ WAVE, and adjust R14 with an insulated screw-driver (this component can be over 700 volts below ground potential) so that any asymmetry in the two square waves is about equal. (R14, a component in the printed circuit, can be adjusted at the top of the printed board.)

If optimum performance with pulse amplitude modulation is desired, a slight adjustment of C8 may be necessary. Proceed as follows:

a. Attach a pulse-type oscilloscope, on a-c response, to the repeller cap lead.
b. Attach to the EXTERNAL MODULATION jacks a pulse generator with a 1- to 5-microsecond pulse of at least 20 volts output.
c. Set the MODULATION switch to PULSE (POS).

d. Adjust C8 with an insulated screw driver to obtain about 10-percent overshoot on the trailing edge of the pulse. A slight readjustment of R14 may be necessary to prevent elongation of the pulse for short (1 μsec) durations. (C8, a component of the printed circuit, can be adjusted at the top of the printed board.)

WARNING

In step d above, be sure to use only a well-insulated screw driver. The component can be over 600 volts below ground potential, and can cause severe injury.

4.6 VOLTAGE CHART. The following table lists test voltages, as measured with a 20,000-ohm-per-volt multimeter. Power source for these measurements was a Type 1201 Unit Power Supply, operating from a 115-volt a-c line.

TABLE OF VOLTAGES

TUBE	ELEMENT	PINS	VOLTS
V1	PLATE	1 - 7	+160
	GRID	6 - 7	- 0.3
	CATHODE	7 - GND	-300
	HEATER	3 - 4	6.7 AC
V2	PLATE 1	1 - 3	+ 85
	PLATE 2	6 - 3	+170
	GRID 1	2 - 3	+ 0.2
	GRID 2	7 - 3	- 23
	CATHODE	3 - GND	-490
	HEATER	4 - 9	6.4 AC
		5 - 9	6.4 AC
V3 (DUMMY) (NOTE A)	CATHODE	2 - GND	-300
		3 - GND	-300
		8 - GND	-300
	REPELLER	CAP - GND	-330
	HEATER	2 - 7	6.3 AC
V4	ANODE	5 - 2	+150
V5	ANODE	5 - 2	+150

NOTES:
(A) Dummy klystron consists of 10 kilohms, 10 watts across pins 3 and 6, and 15 ohms, 5 watts across pins 2 and 7.
Switch Settings:
REPELLER VOLTAGE at minimum (30)
MODULATION at OFF (CW)
Voltage across C12B (Δ to −) equals +270 v dc.

Section 5

KLYSTRON TUBE DATA

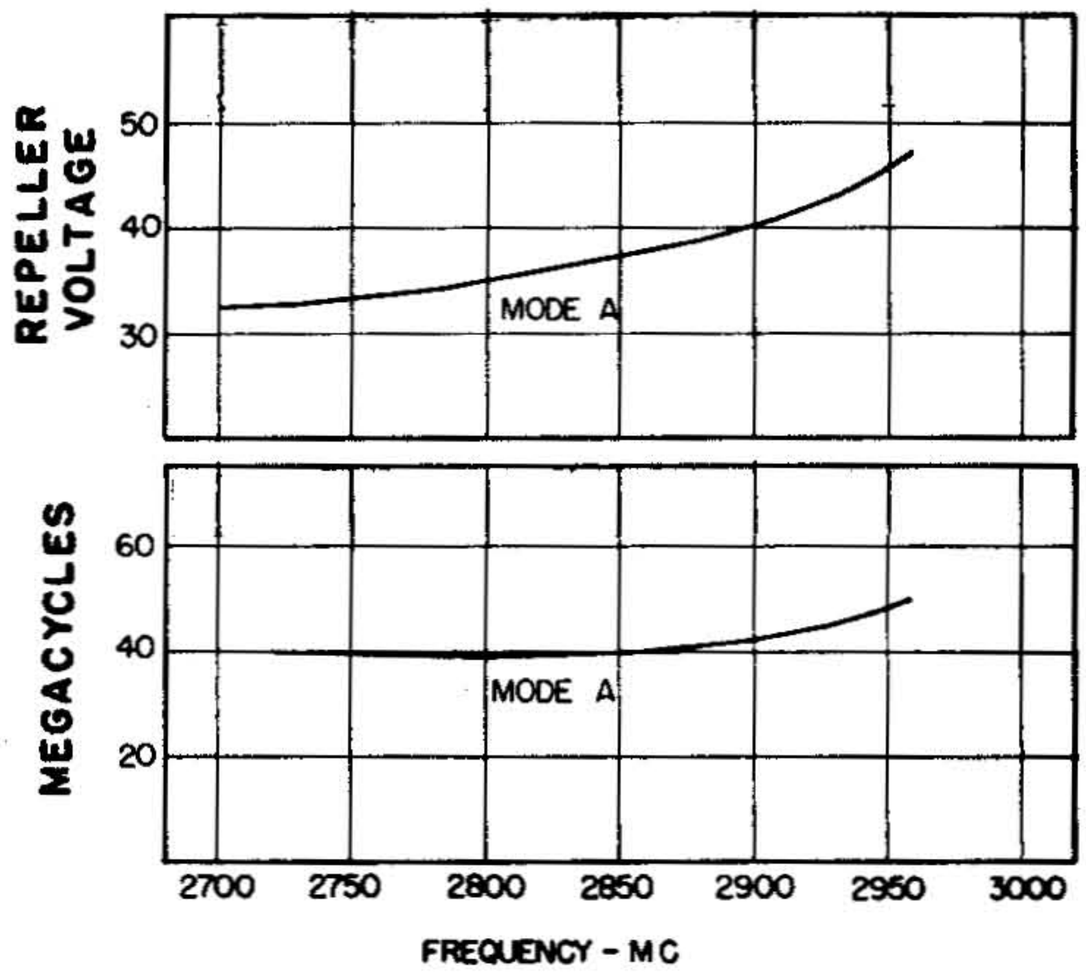


Figure 10a.

Repeller Voltage Sweep Between $\frac{PO}{2}$ Points vs Frequency.

Figure 10b.

Electronic Tuning Between $\frac{PO}{2}$ Points vs Frequency.

Figure 10c.

Repeller Voltage at Maximum Power Output vs Frequency.

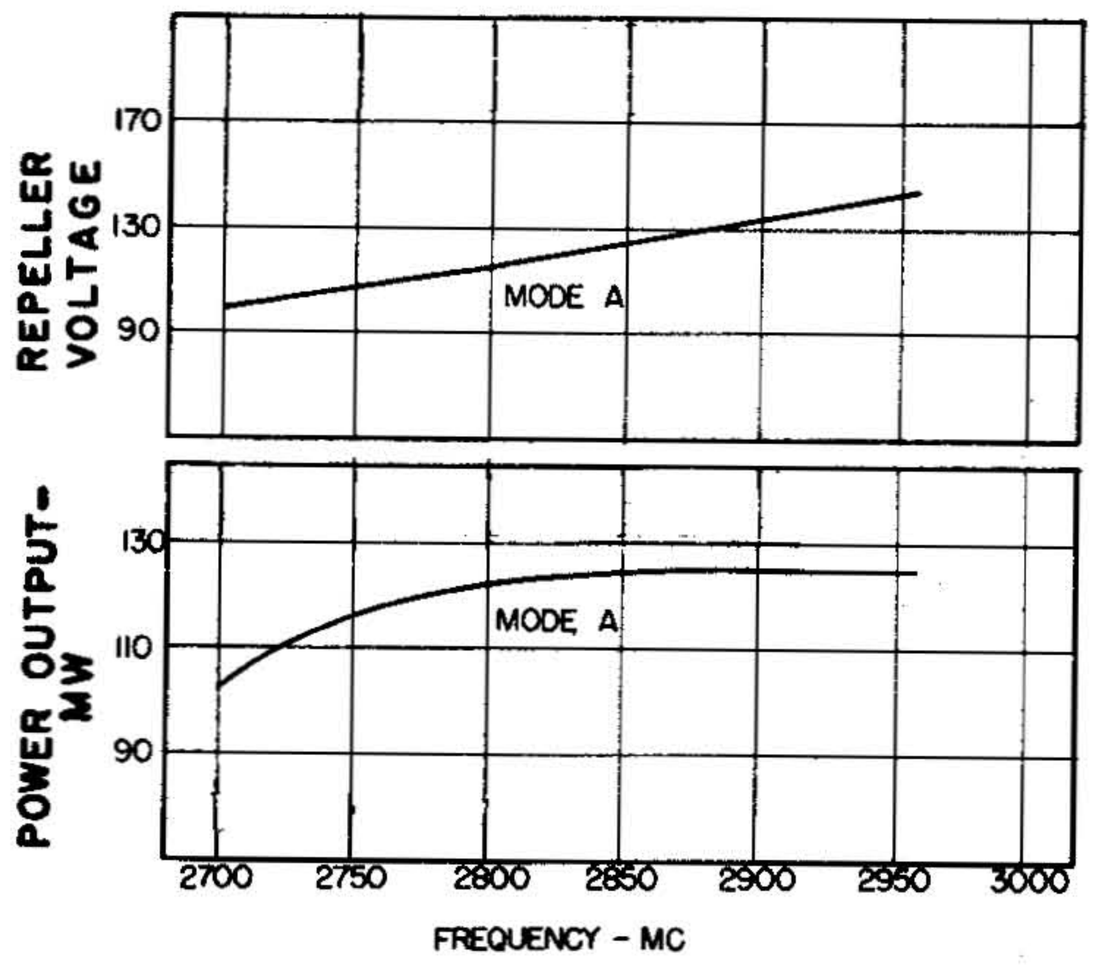


Figure 10d.

Maximum Power Output vs Frequency.

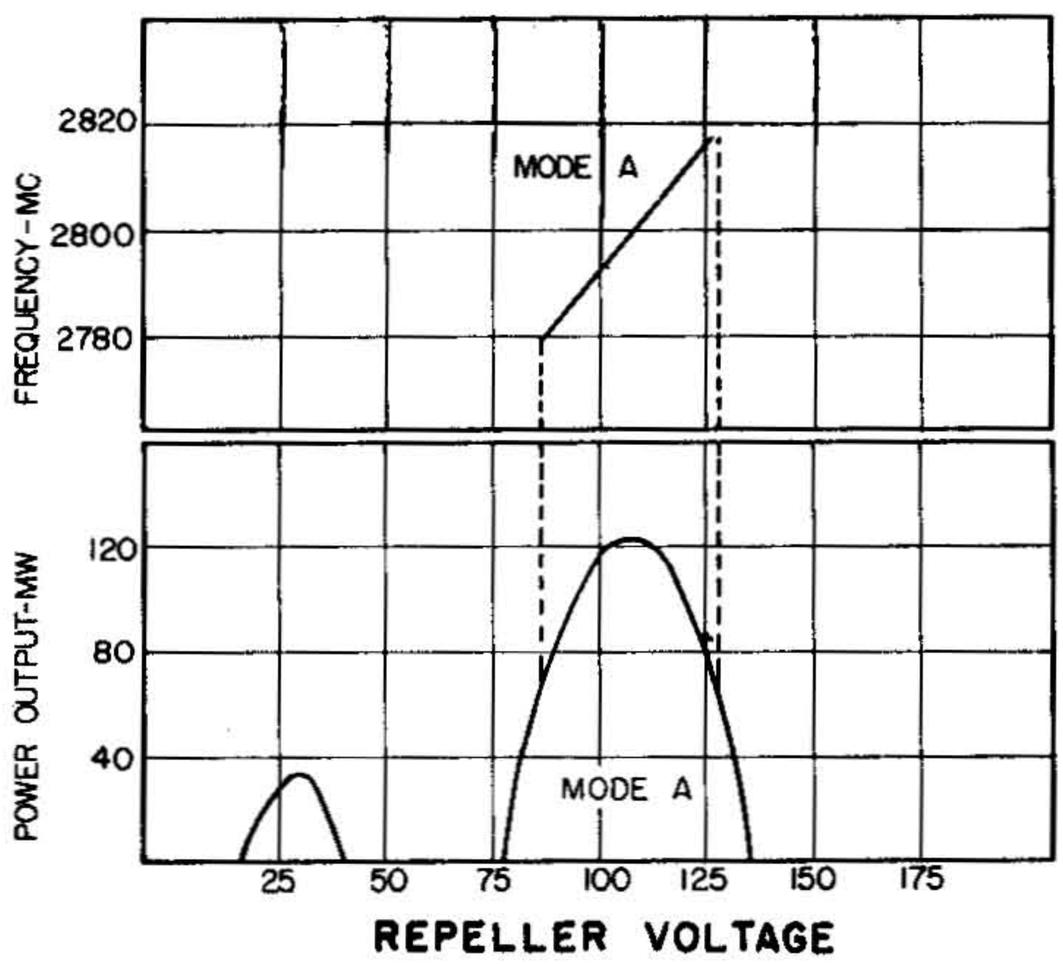


Figure 10e.

Power and Frequency vs Repeller Voltage.

Klystron Cathode Current

Max current	35 ma
Typical current (at 300 v cathode voltage)	30 ma

KLYSTRON TUBE 6043, 2950 - 3275 Mc

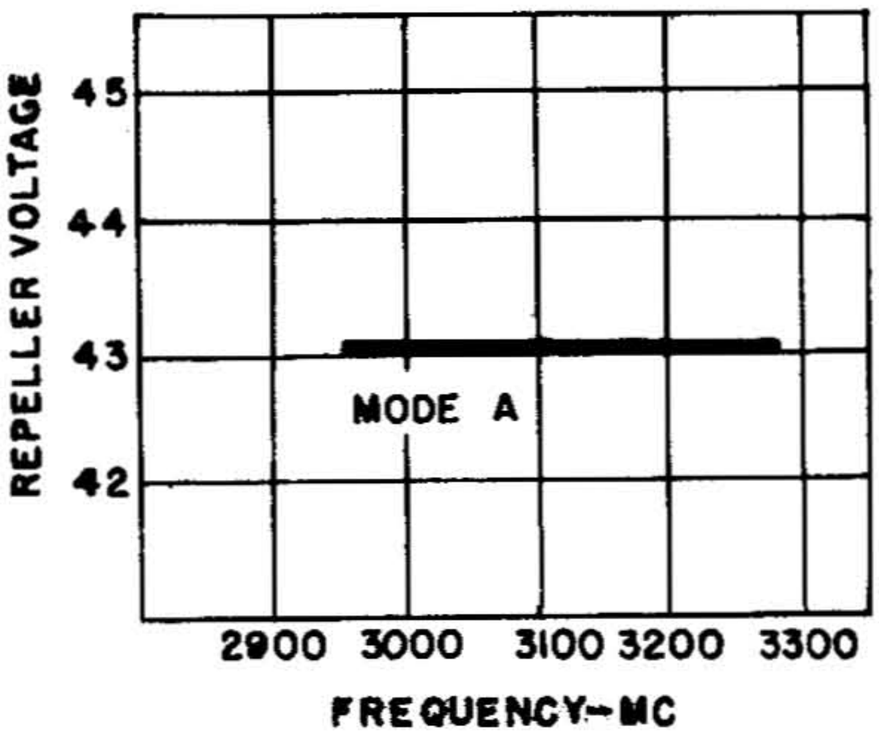


Figure 11a.
Repeller Voltage Sweep Between $\frac{PO}{2}$ Points vs Frequency.

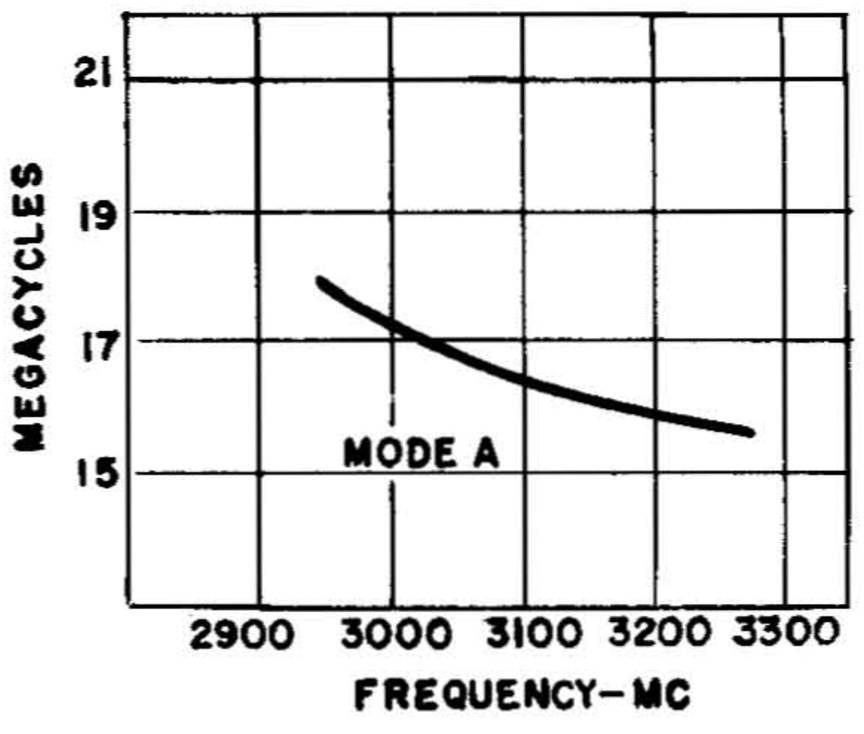


Figure 11b.
Electronic Tuning Between $\frac{PO}{2}$ Points vs Frequency.

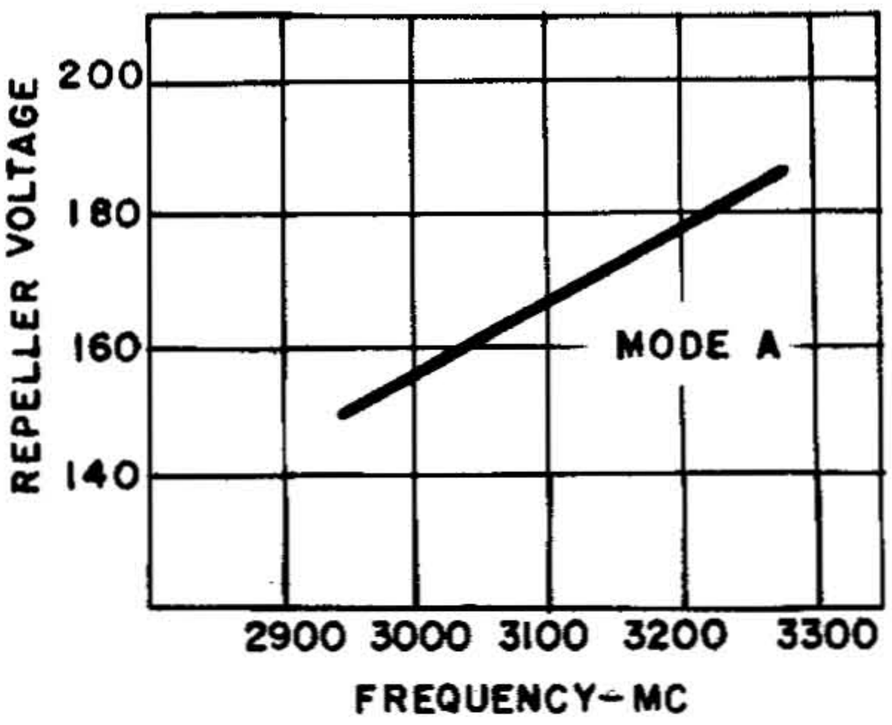


Figure 11c.
Repeller Voltage at Maximum Power Output vs Frequency.

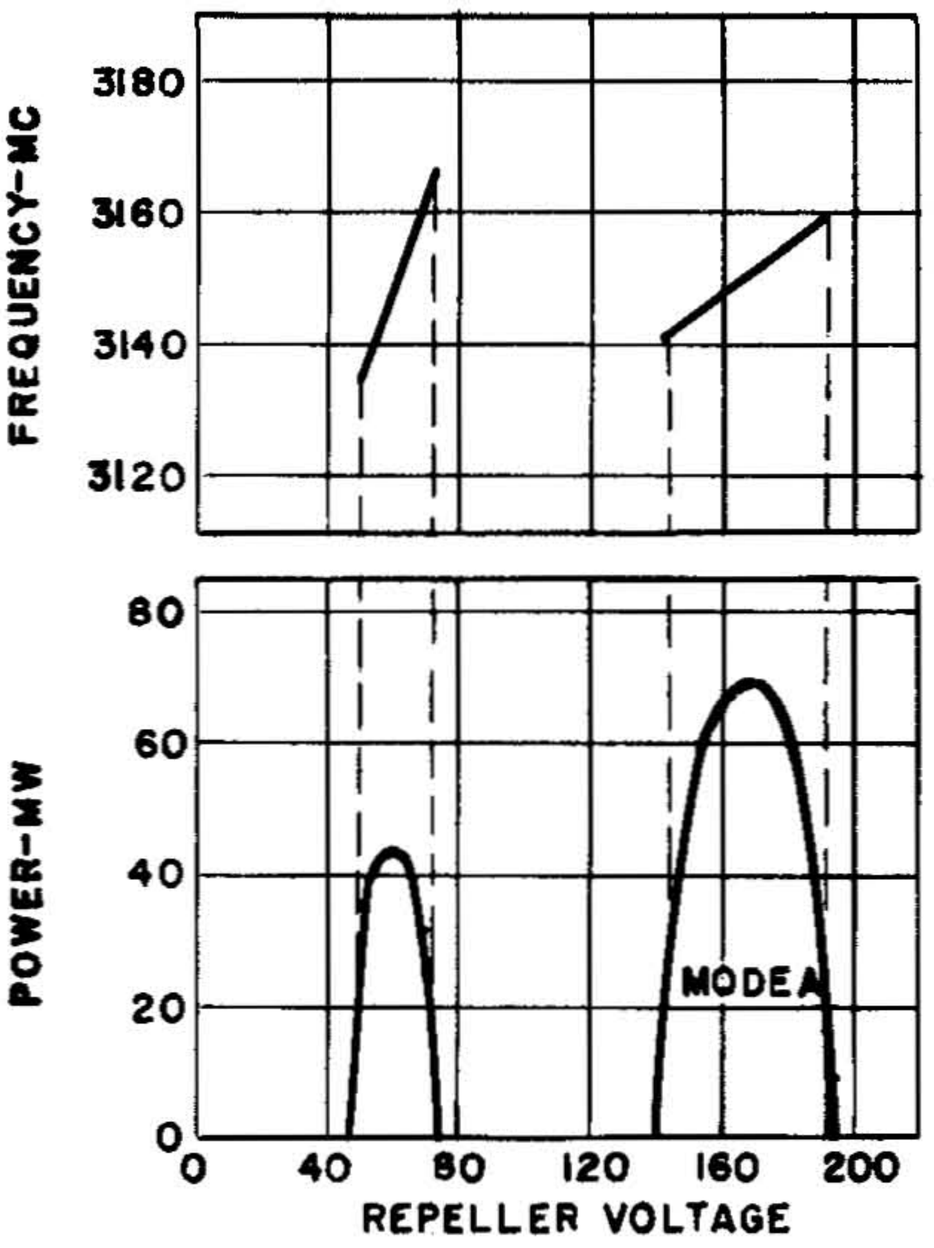


Figure 11e.
Power and Frequency vs Repeller Voltage.

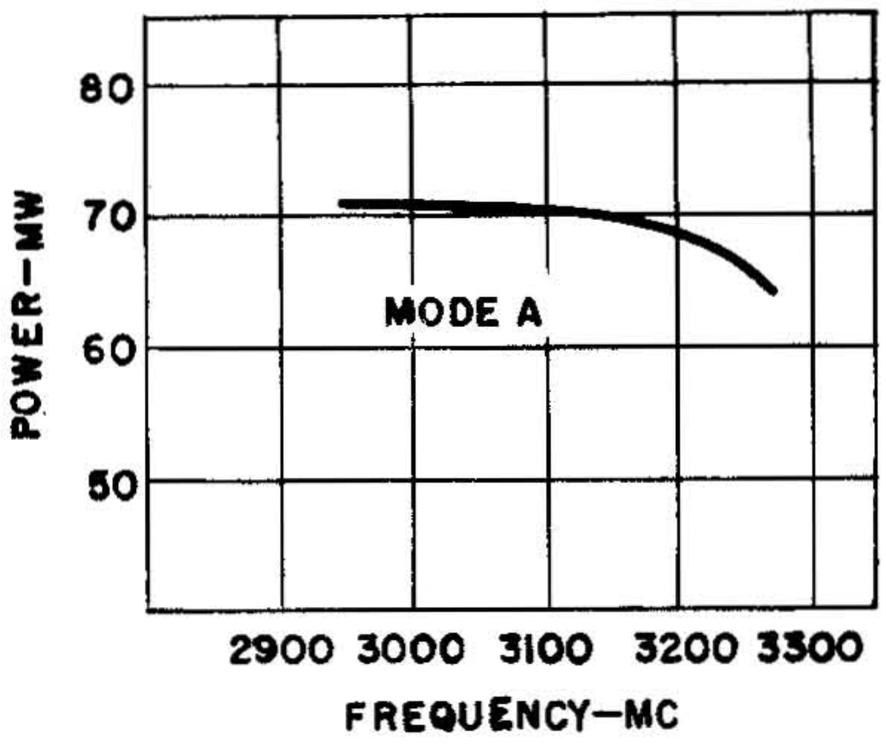


Figure 11d.
Maximum Power Output vs Frequency

Klystron Cathode Current

Max current	45 ma
Typical current (at 300 v cathode voltage)	25 ma

KLYSTRON TUBE 2K29, 3400-3960 Mc

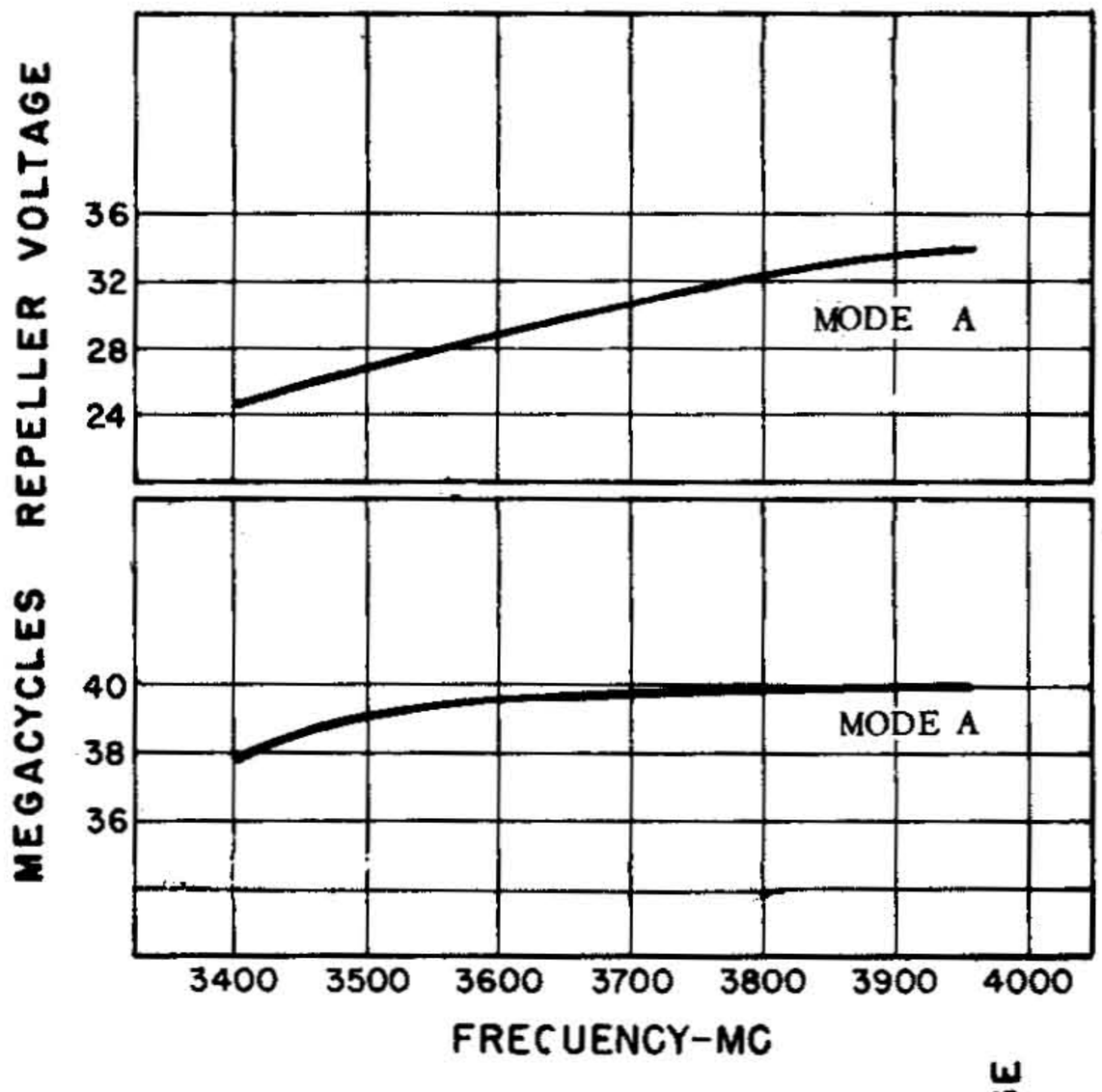


Figure 12a.

Repeller Voltage Sweep Between $\frac{PO}{2}$ Points vs Frequency.

Figure 12b.

Electronic Tuning Between $\frac{PO}{2}$ Points vs Frequency.

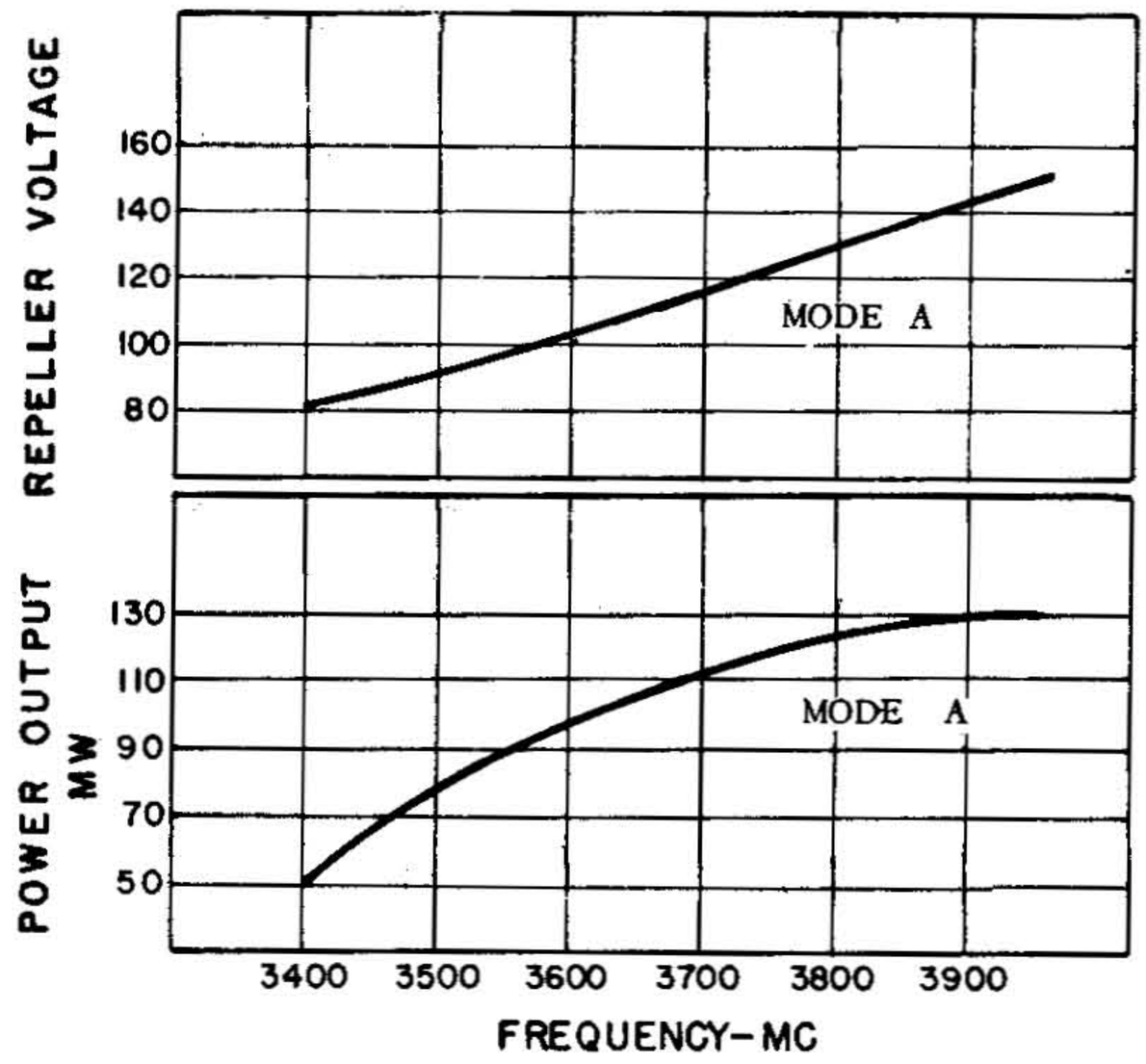


Figure 12c.

Repeller Voltage at Maximum Power Output vs Frequency.

Figure 12d.

Maximum Power Output vs Frequency.

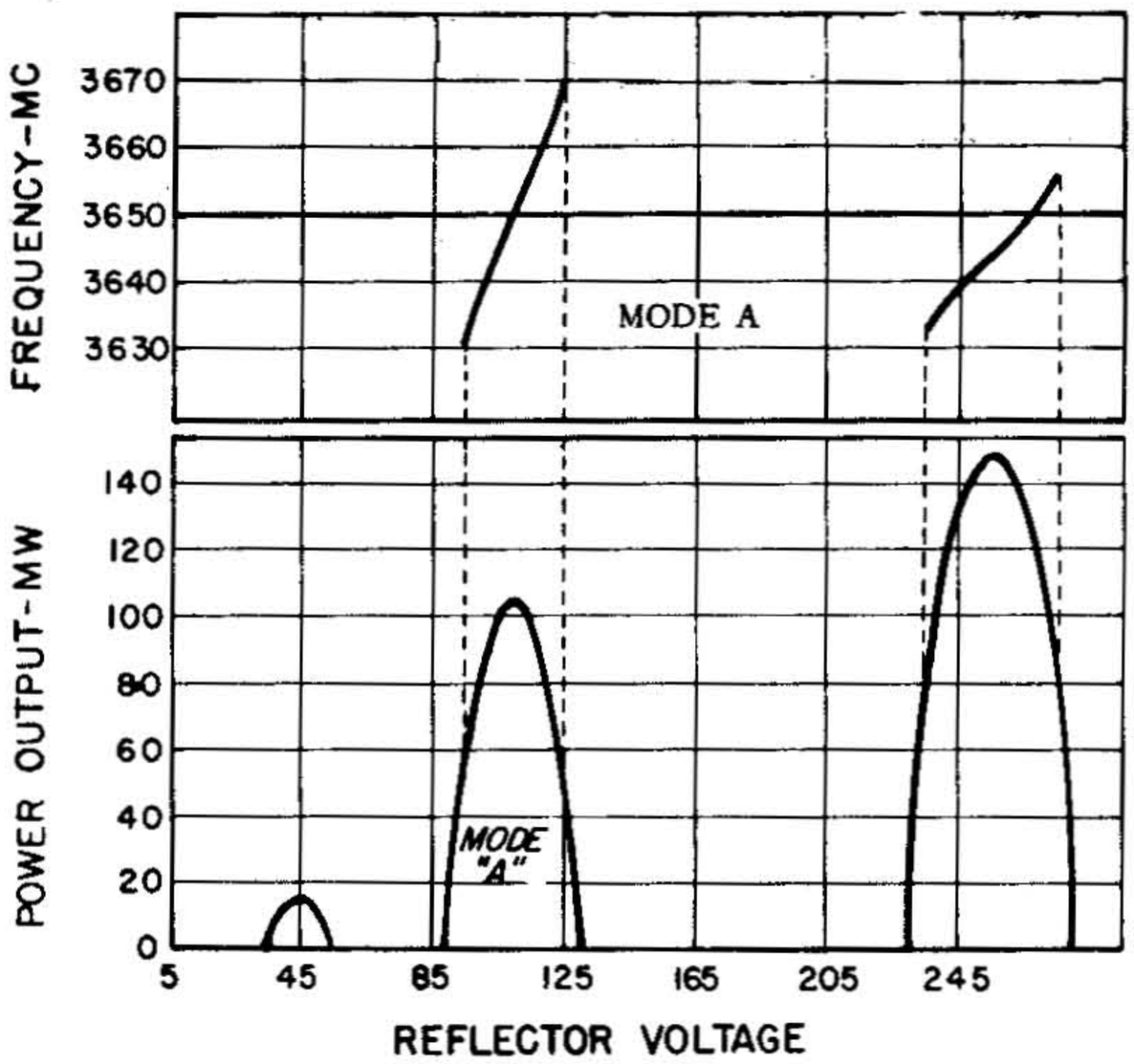


Figure 12e.

Power and Frequency vs Repeller Voltage.

Klystron Cathode Current

Max current	37 ma
Typical current (at 300 v cathode voltage)	24 ma

Figure 13a.

Repeller Voltage Sweep Between $\frac{PO}{2}$ Points vs Frequency:-

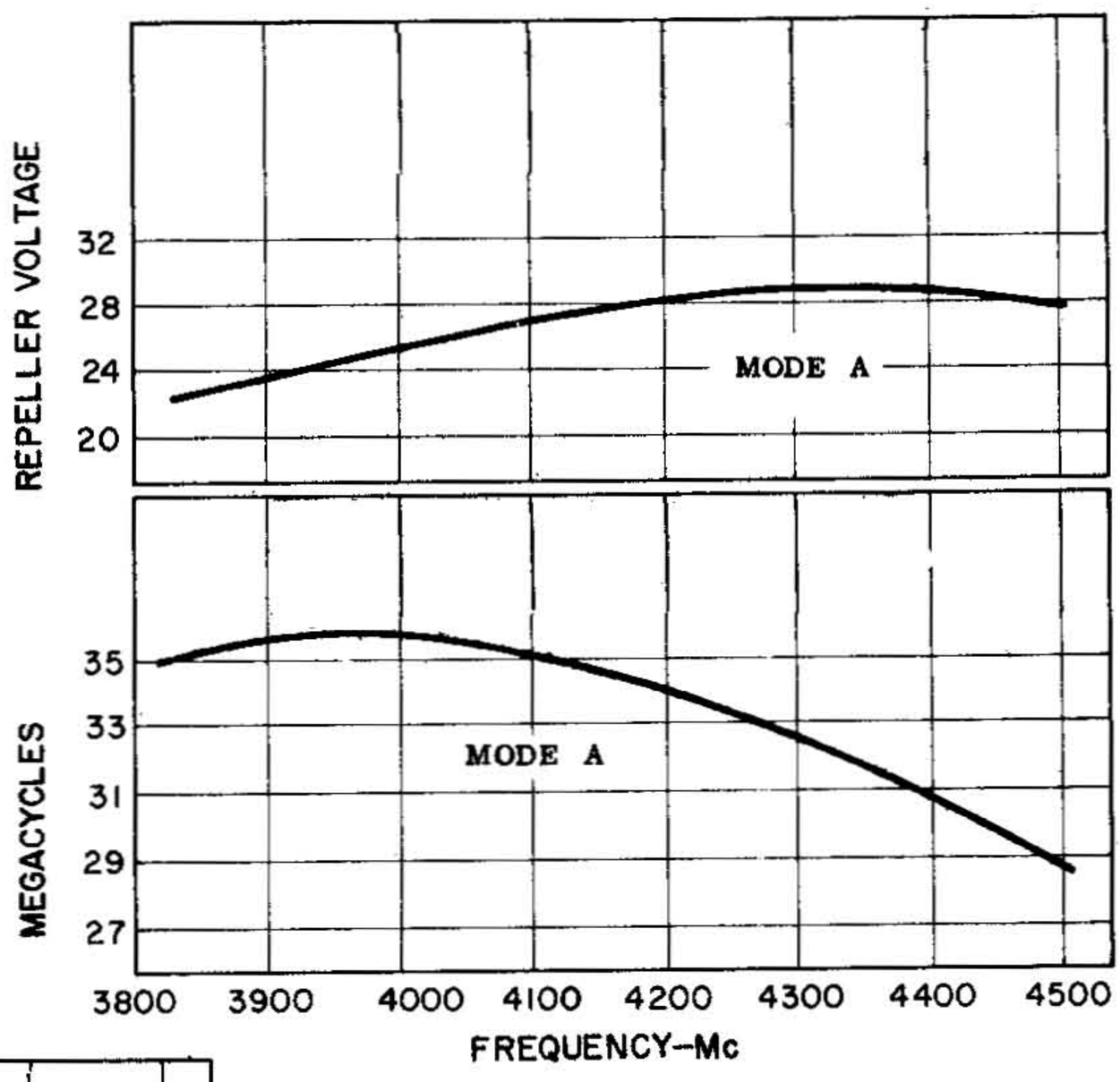


Figure 13b.

Electronic Tuning Between $\frac{PO}{2}$ Points vs Frequency.

Figure 13c.

Repeller Voltage at Maximum Power Output vs Frequency.

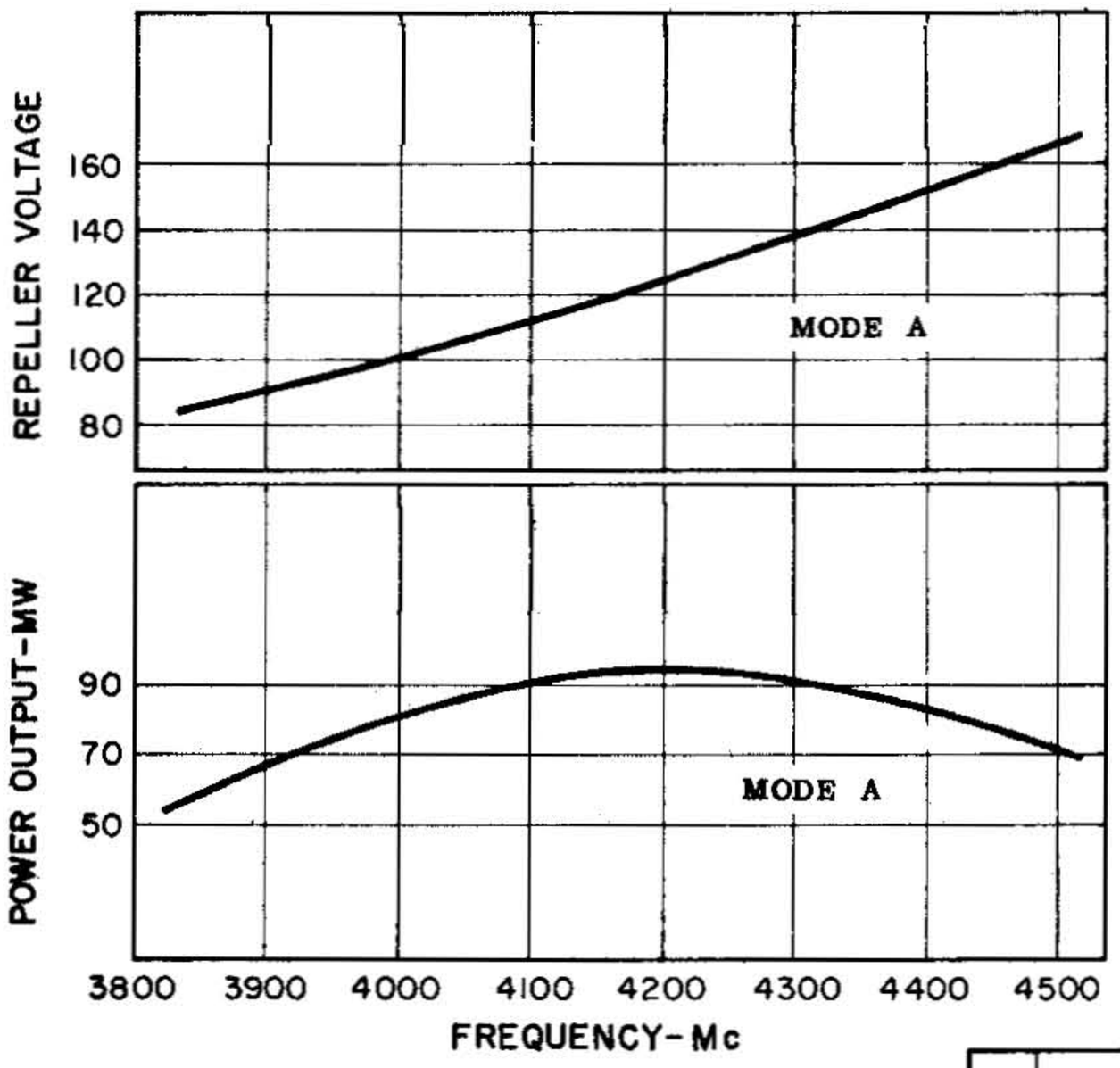


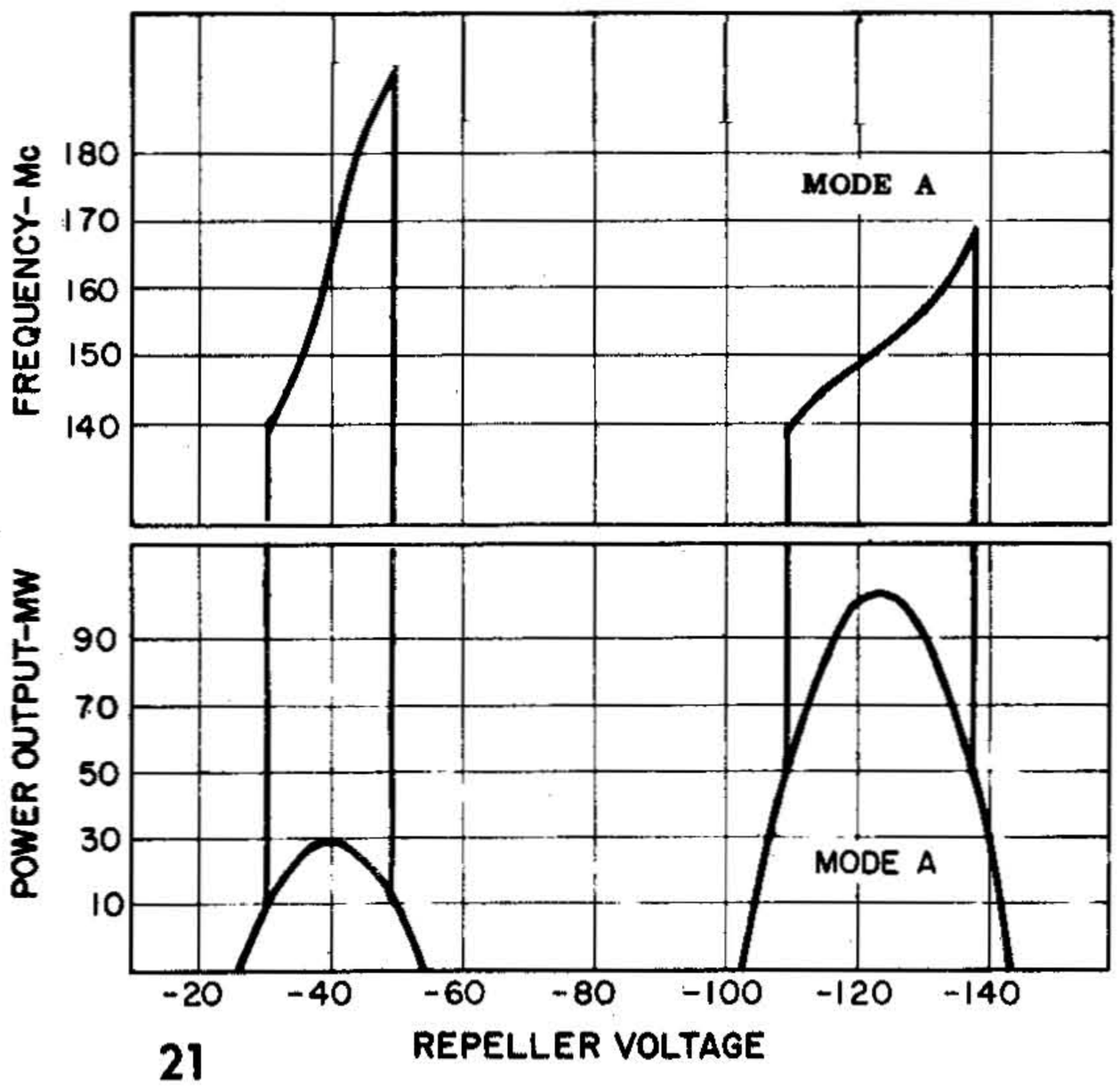
Figure 13d.

Maximum Power Output vs Frequency.

Figure 13e.

Power and Frequency vs Repeller Voltage.

Klystron Cathode Current	
Max current	37 ma
Typical current (at 300 v cathode voltage)	26 ma



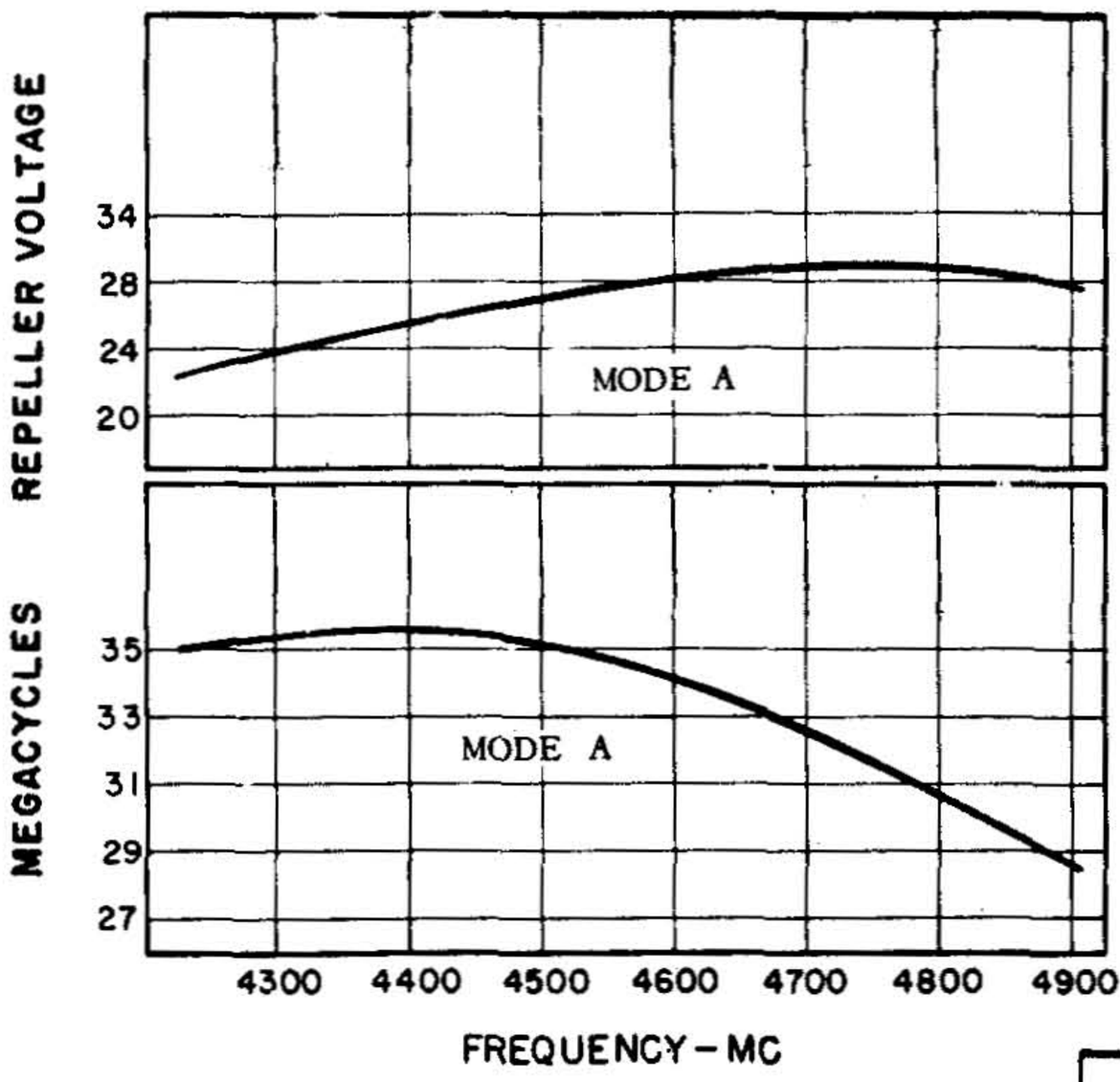


Figure 14a.

Repeller Voltage Sweep Between $\frac{PO}{2}$ Points vs Frequency.

Figure 14b.

Electronic Tuning Between $\frac{PO}{2}$ Points vs Frequency.

Figure 14c.

Repeller Voltage at Maximum Power Output vs Frequency.

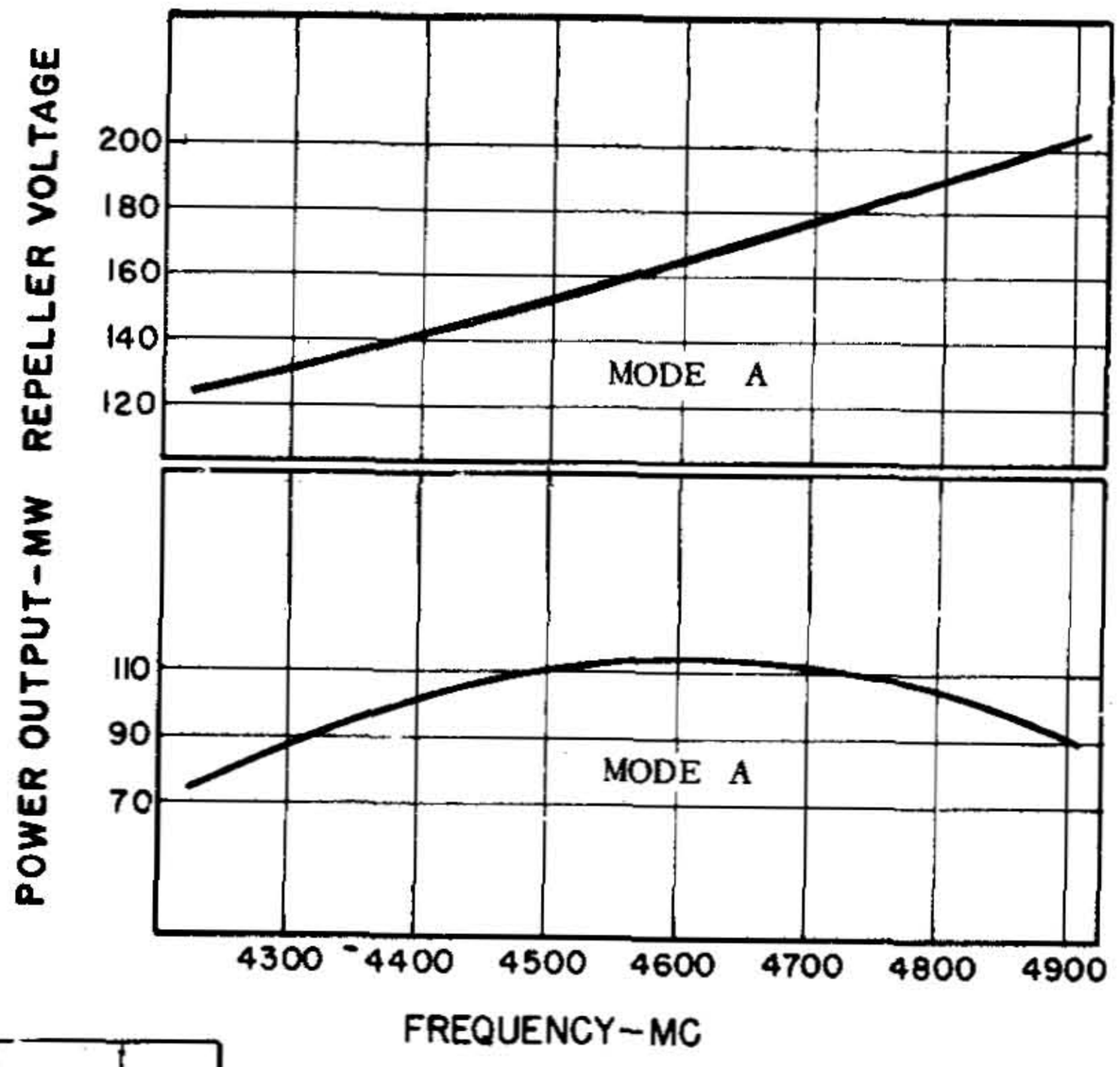


Figure 14d.

Maximum Power Output vs Frequency.

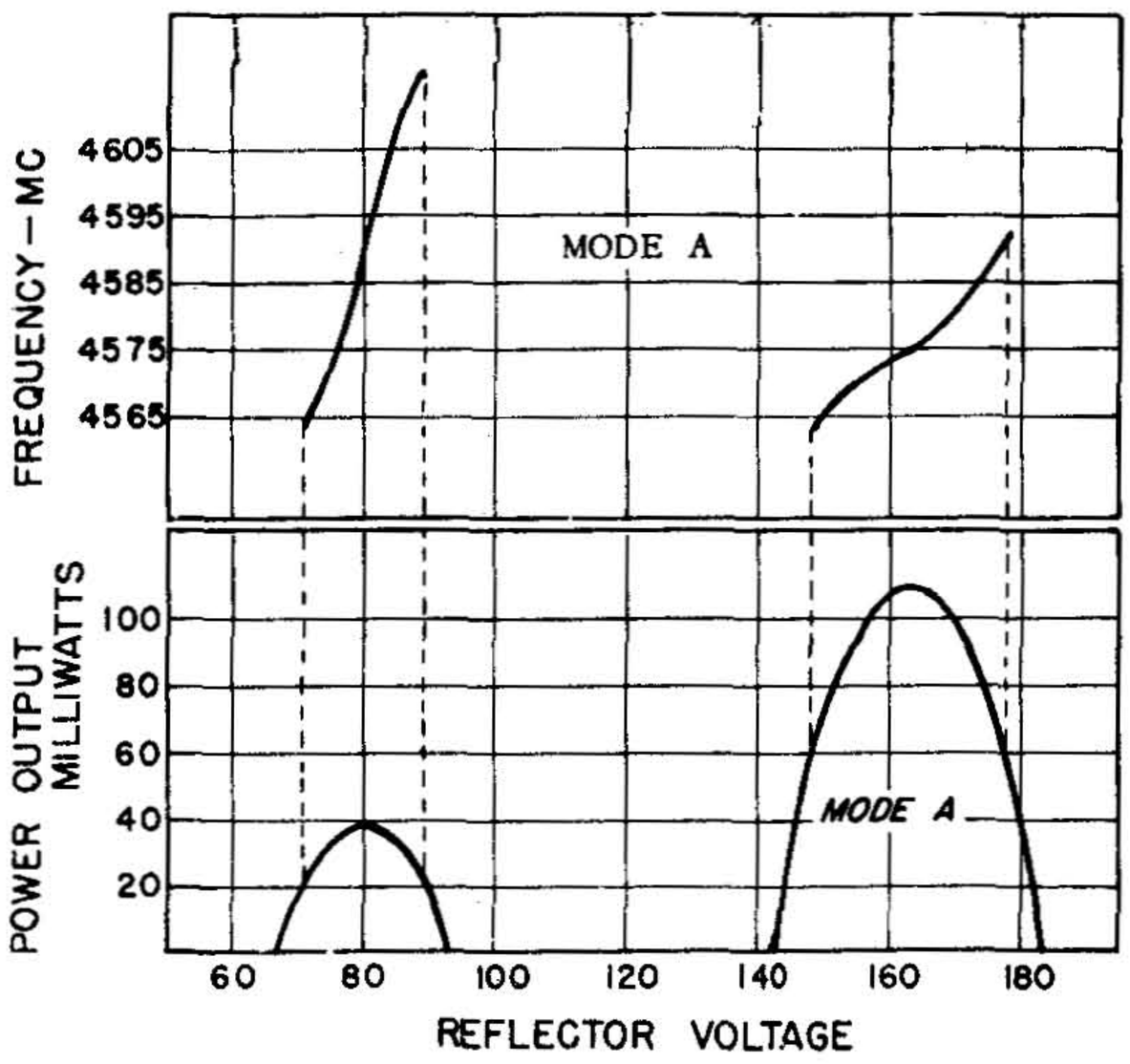


Figure 14e.

Power and Frequency vs Repeller Voltage.

Klystron Cathode Current

Max current	30 ma
Typical current (at 300 v cathode voltage)	34 ma

Figure 15a.

Repeller Voltage Sweep Between $\frac{PO}{2}$ Points vs Frequency.

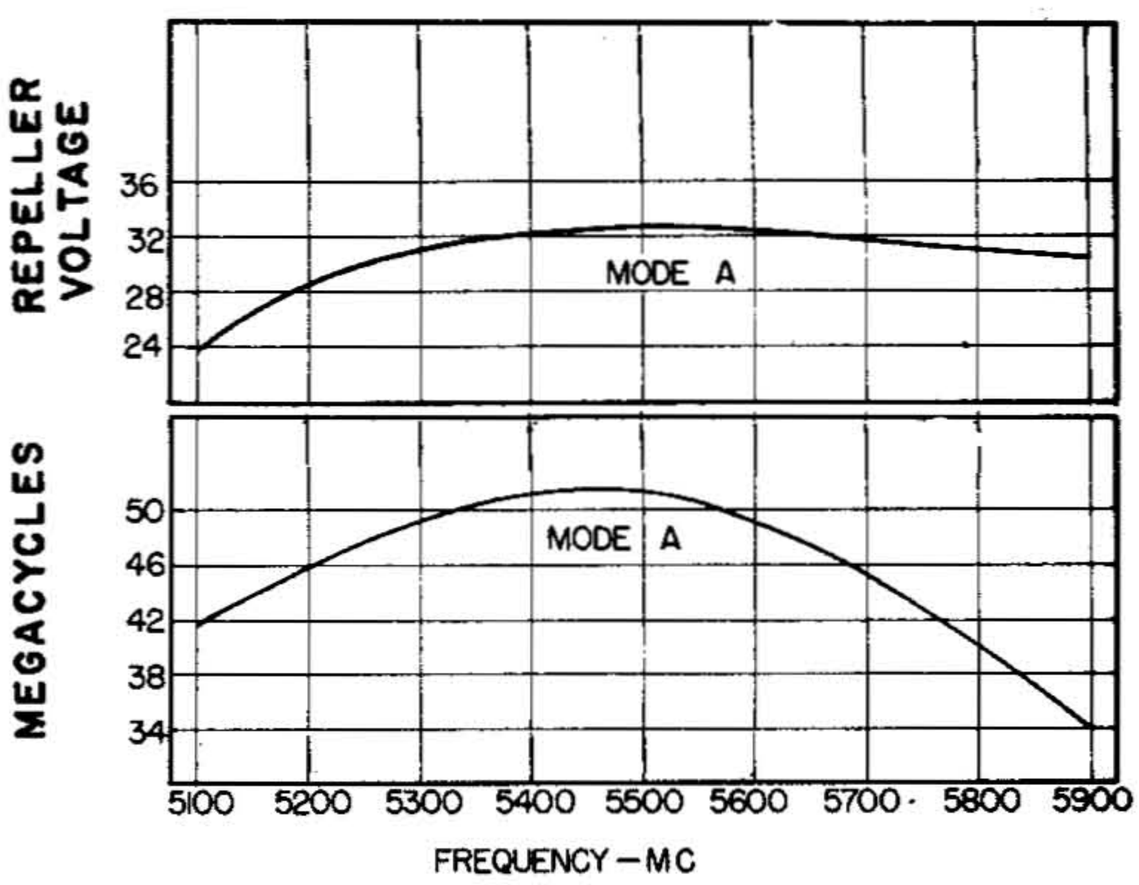


Figure 15b.

Electronic Tuning Between $\frac{PO}{2}$ Points vs Frequency.

Figure 15c.

Repeller Voltage at Maximum Power Output vs Frequency.

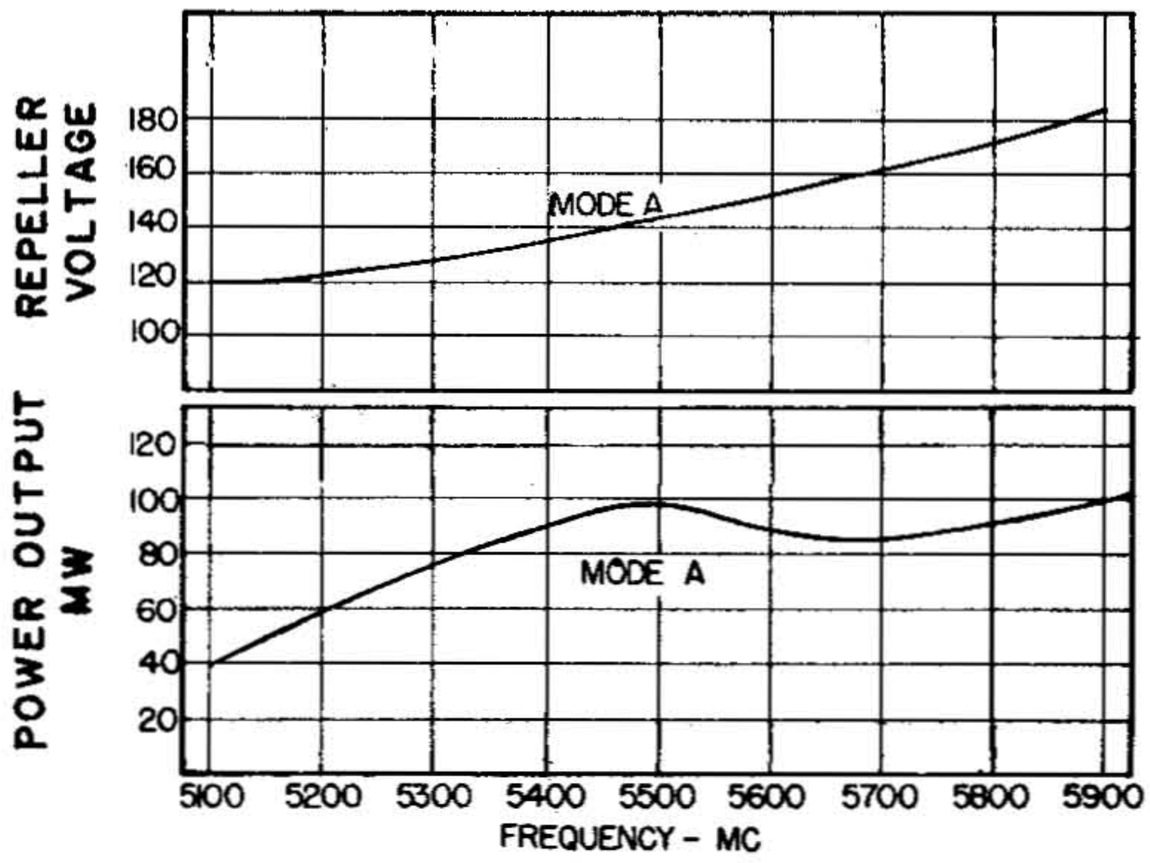
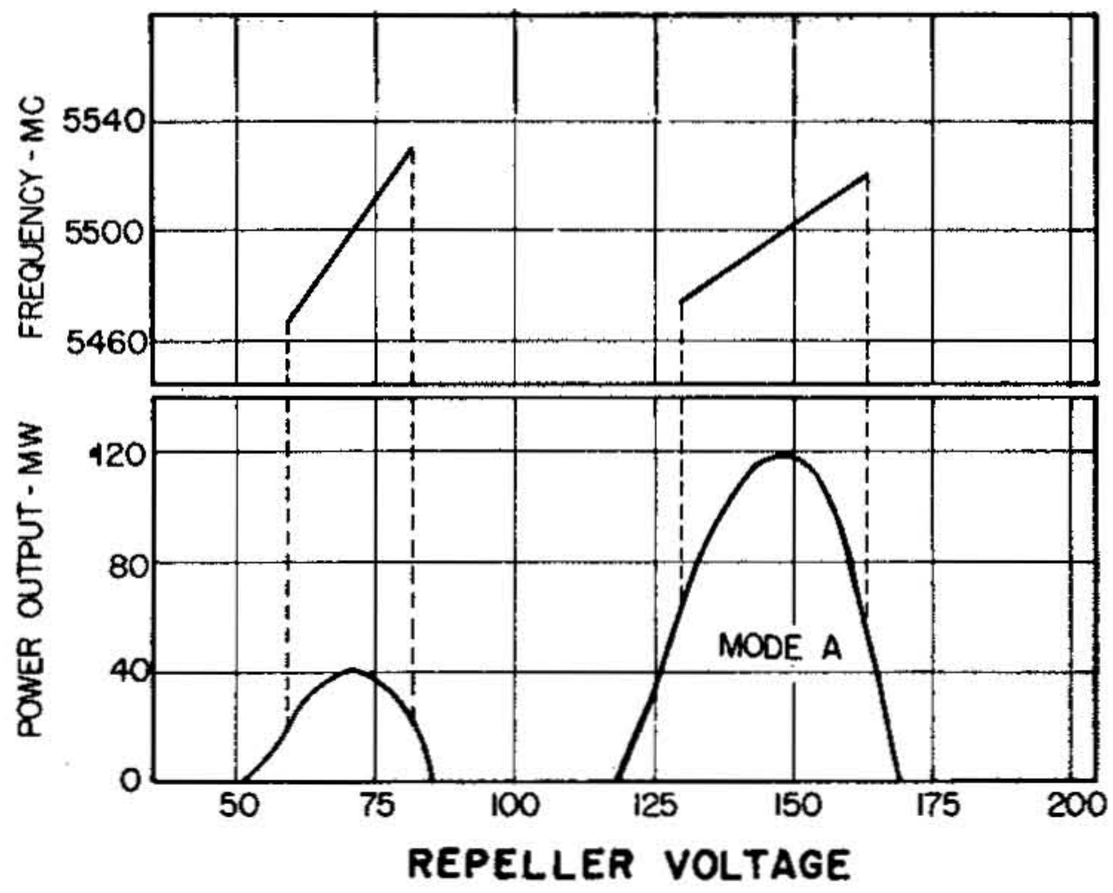


Figure 15d.

Maximum Power Output vs Frequency.

Figure 15e.

Power and Frequency vs Repeller Voltage.



Klystron Cathode Current

Max current	35 ma
Typical current (at 300 v cathode voltage)	25 ma

KLYSTRON TUBE QK404, 5925-6450 Mc

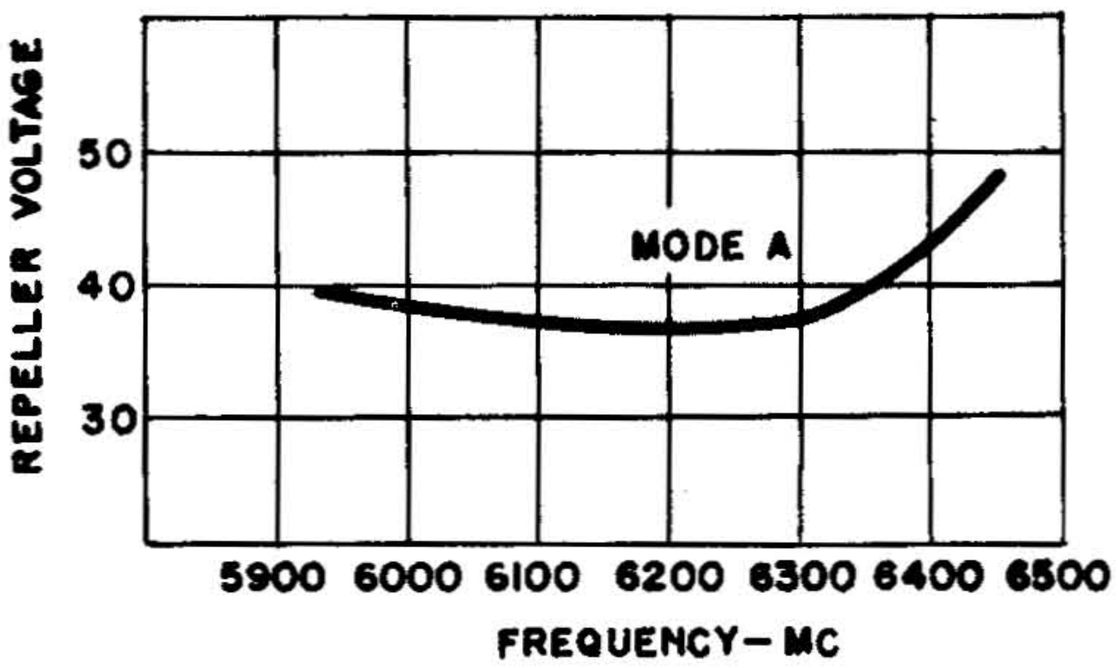


Figure 16a.
Repeller Voltage Sweep Between $\frac{PO}{2}$ Points vs Frequency.

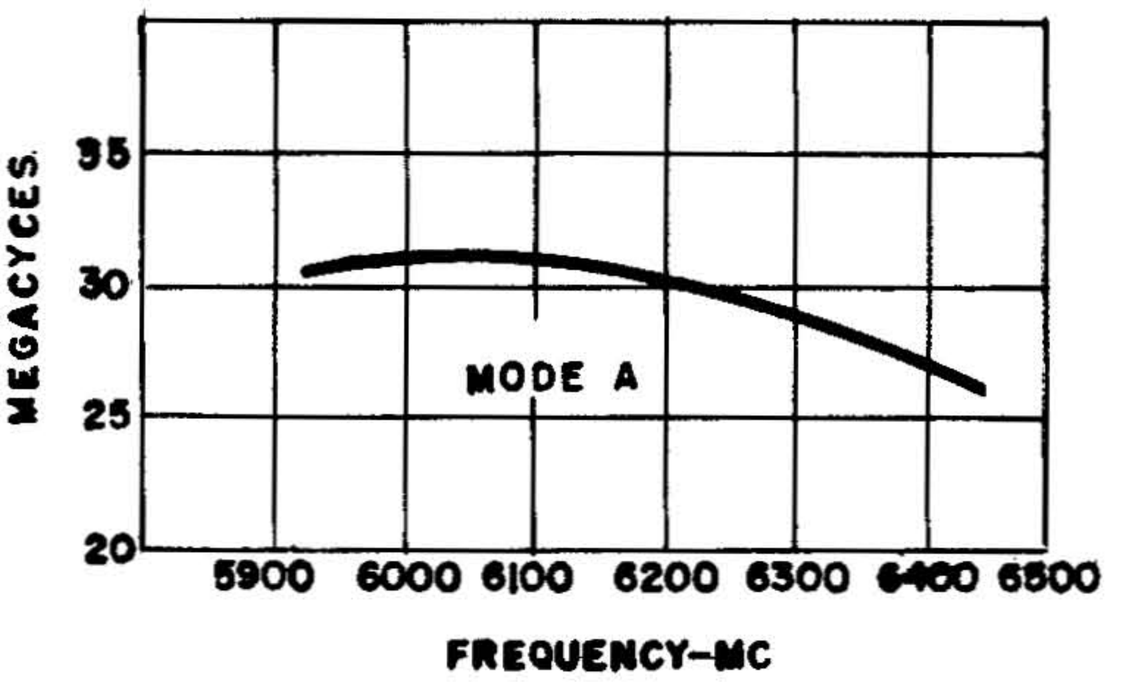


Figure 16b.
Electronic Tuning Between $\frac{PO}{2}$ Points vs Frequency.

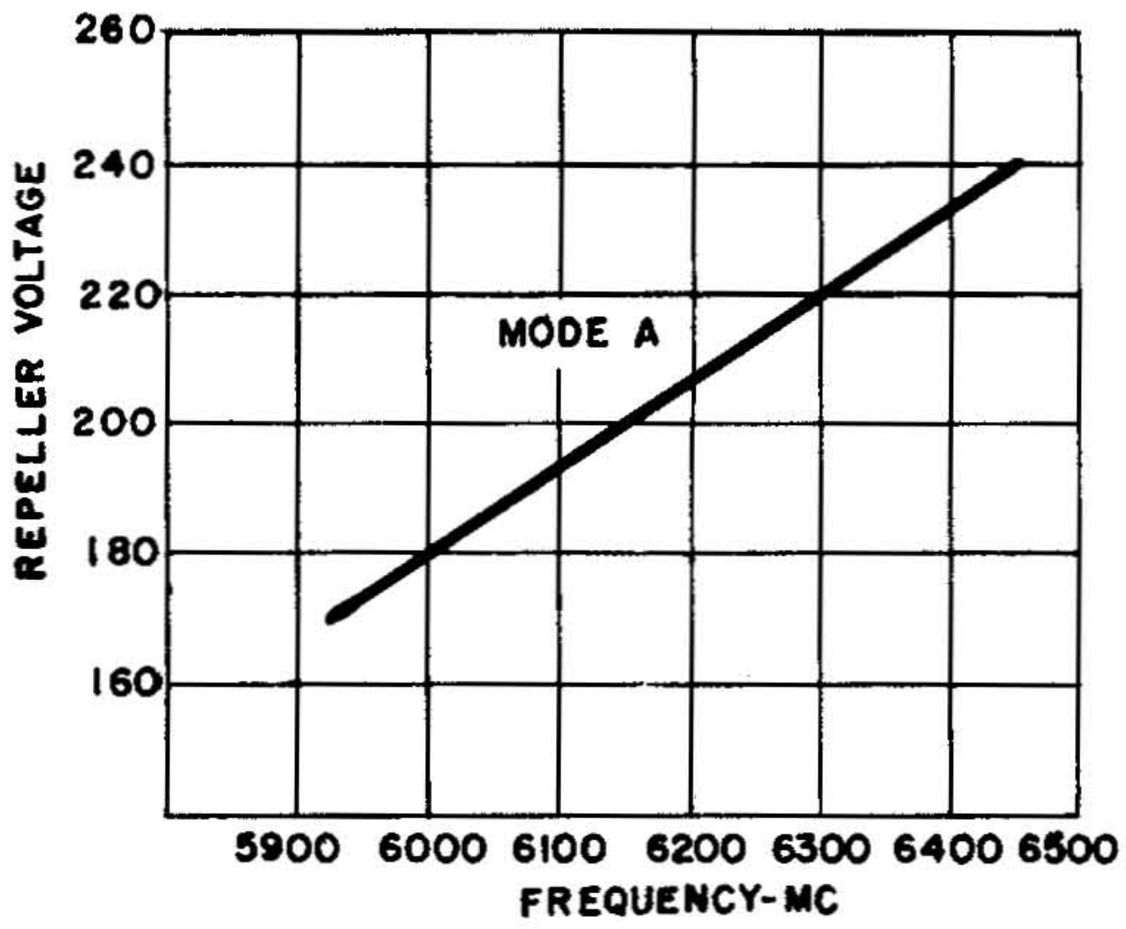


Figure 16c.
Repeller Voltage at Maximum Power Output vs Frequency.

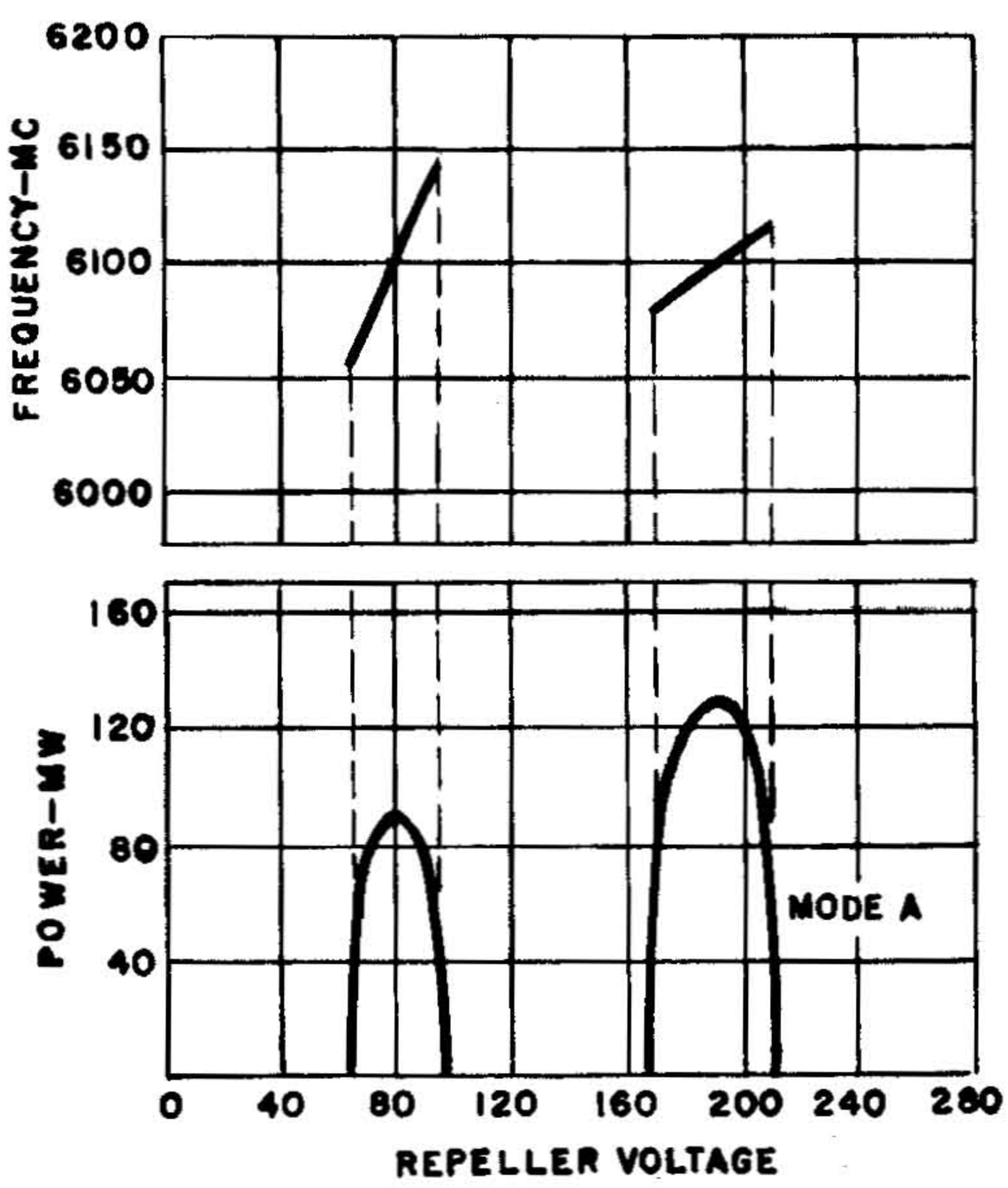


Figure 16e.
Power and Frequency vs Repeller Voltage.

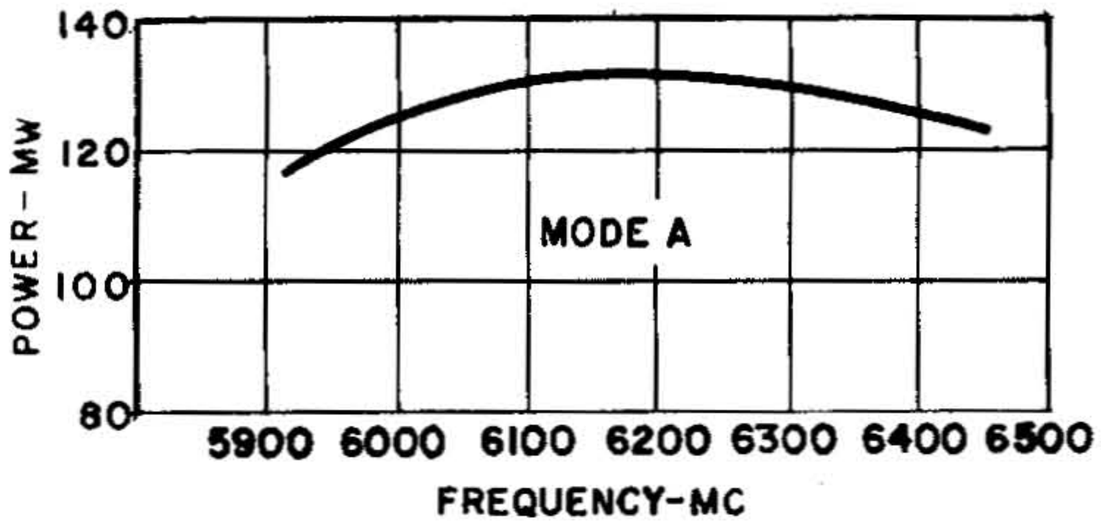


Figure 16d.
Maximum Power Output vs Frequency.

Klystron Cathode Current

Max current	35 ma
Typical current (at 300 v cathode voltage)	25 ma

Figure 17a.

Repeller Voltage Sweep Between $\frac{PO}{2}$ Points vs Frequency.

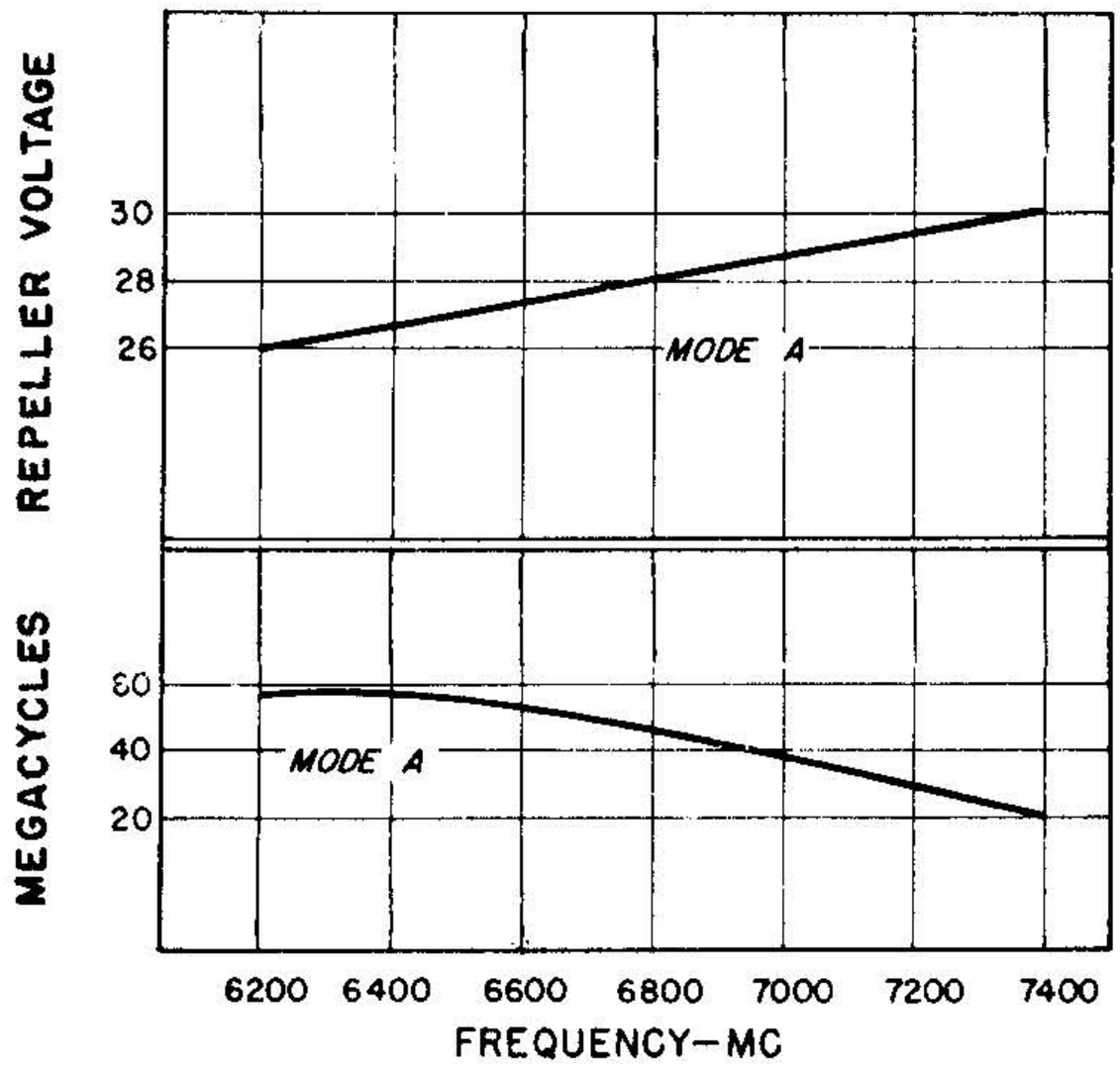


Figure 17b.

Electronic Tuning Between $\frac{PO}{2}$ Points vs Frequency.

Figure 17c.

Repeller Voltage at Maximum Power Output vs Frequency.

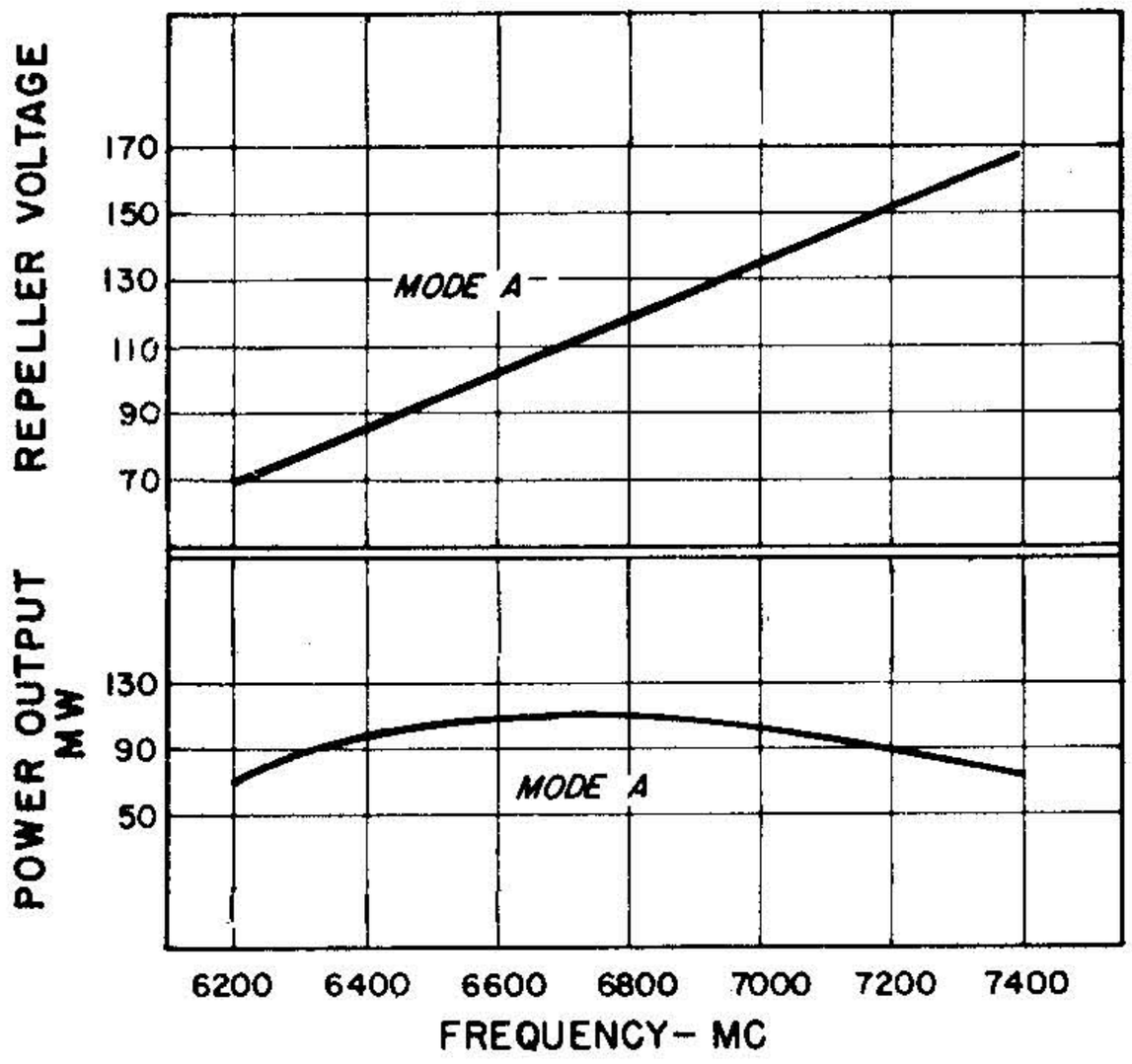
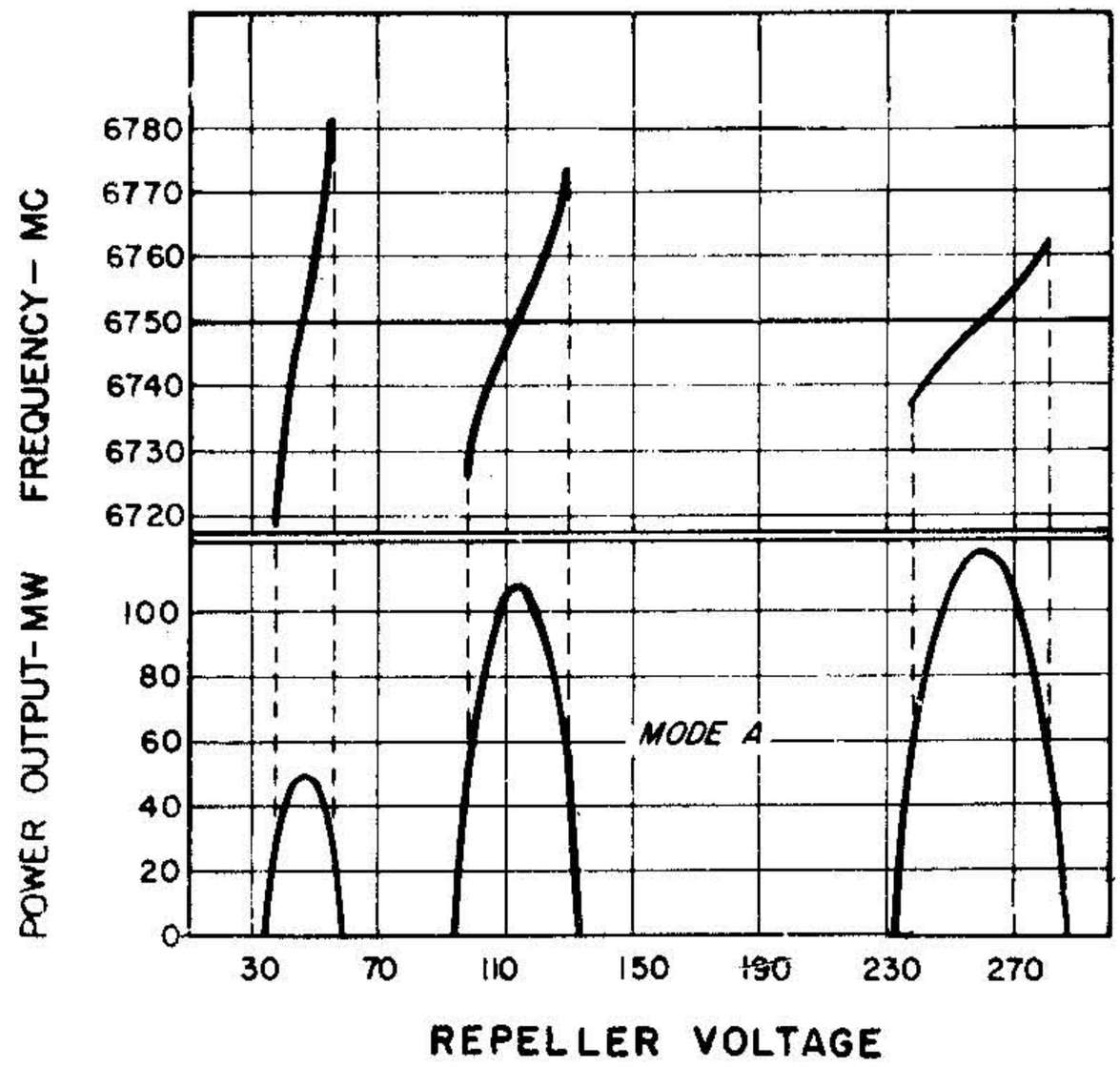


Figure 17d.

Maximum Power Output vs Frequency.

Figure 17e.

Power and Frequency vs Repeller Voltage.



Klystron Cathode Current

Max current	35 ma
Typical current (at 300 v cathode voltage)	25 ma

Section 6
PARTS LIST

	GR No. (Note A)				GR No. (Note A)
RESISTORS (Note B)	R1	27 k	± 5%, 1 w	REC-30BF	
	R2	360	± 5%, 1/2 w	REC-20BF	
	R4	3.3 M	± 5%, 1/2 w	REC-20BF	
	R5	35 k	± 1%, 1/4 w	REF-65	
	R6	56 k	± 1%, 1/4 w	REF-65	
	R7	25 k	±10%	POSC-11	
	R8	158.8 k	± 1%, 1/4 w	REF-65	
	R9	340 k	± 1%, 1/4 w	REF-65	
	R10	510	± 5%, 1/2 w	REC-20BF	
	R11	120 k	± 5%, 1/2 w	REC-20BF	
	R12	6.2 k	± 5%, 2 w	REC-41BF	
	R13	130 k	± 5%, 1/2 w	REC-20BF	
	R14	50 k	±10%	POSC-11	
	R16	27 k	± 5%, 1/2 w	REC-20BF	
	R17	75 k	± 5%, 1/2 w	REC-20BF	
	R18	7.5 k	± 5%, 2 w	REC-41BF	
	R19	82 k	± 5%, 1/2 w	REC-20BF	
	R20	2.7 k	± 5%, 1/2 w	REC-20BF	
	R21	2.7 k	± 5%, 1/2 w	REC-20BF	
	R22	5.1 k	± 5%, 1/2 w	REC-20BF	
	R23	5.1 k	±10%, 2 w	REC-41BF	
	R24	250 k	±10%	1220-42	
	R25	2.5 k	±10%	POSC-11	
	R26	2.5 k	±10%	POSC-11	
	R27	24 k	± 5%, 1/2 w	REC-20BF	
	R28	1 M	± 5%, 1/2 w	REC-20BF	
	R29	47 k	± 5%, 1/2 w	REC-20BF	
	R30	0.47	±10%, 1/2 w	REW-3C	
CAPACITORS (Note C)	C3	0.047	±10%, 400 dcwv		COW-25
	C4	0.0047	± 1%		COM-5F
	C5	0.0022	± 1%		COM-5F
	C6	0.001	± 1%		COM-5F
	C7	470 μμf	± 1%		COM-5F
	C8	7-45 μμf			COT-12
	C9	0.15	±20%, 1000 dcwv		1220-44
	C11A	50 +100% -10%	450 dcwv		COE-10
	C11B	25 +100% -10%			
	C11C	25 +100% -10%			
	C12A	10 +100% -10%	450 dcwv		COE-5
	C12B	10 +100% -10%			
	C13	4 +100% -10%,	450 dcwv		COE-32
	C14	4 +100% -10%,	450 dcwv		COE-32
MISCELLANEOUS	J1	JACK			CDSJ-10
	J2	BINDING POST			BP-10,1
	J3	BINDING POST			BP-10, 11/16
	J4	JACK			874-404
	PL1	PLUG			CDMP-11-4
	RX1 thru RX8	RECTIFIERS			2RE-25
	S1	SWITCH			SWRW-115-2
	T1	TRANSFORMER			345-466

NOTES

(A) Type designations for resistors and capacitors are as follows:

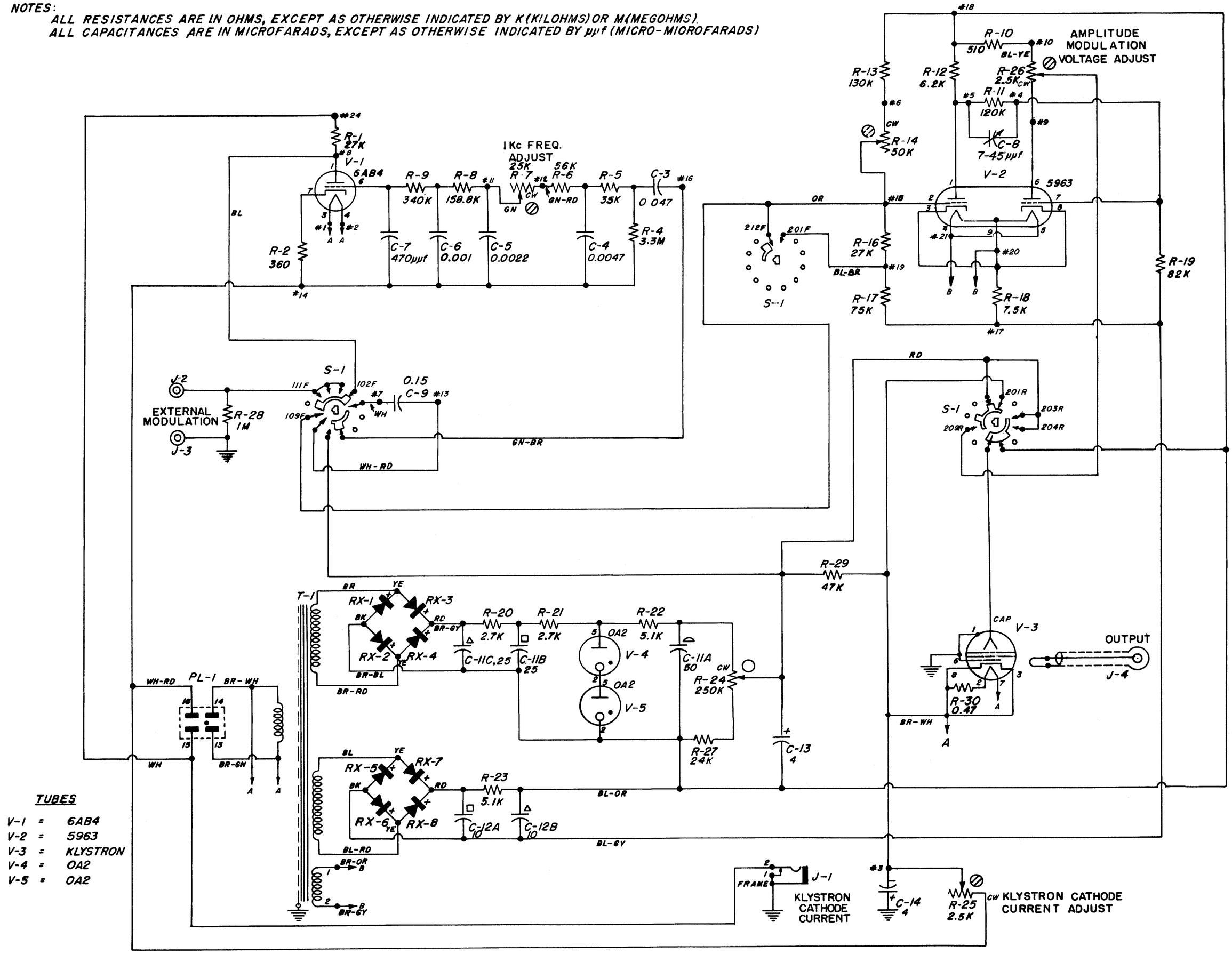
COE - Capacitor, electrolytic
COM - Capacitor, mica
COT - Capacitor, trimmer
COW - Capacitor, wax

POSC - Resistor, variable, composition
REC - Resistor, composition
REF - Resistor, film
REW - Resistor, wire-wound

(B) All resistances are in ohms, except as otherwise indicated by k (kilohms) or M (megohms).
(C) All capacitances are in microfarads, except as otherwise indicated by μμf (microfarads).

When ordering replacement components, be sure to include complete description as well as Part Number. (Example: R85, 51k ±10%, 1/2 w, REC-20BF.)

NOTES:
ALL RESISTANCES ARE IN OHMS, EXCEPT AS OTHERWISE INDICATED BY K(KILOHMS) OR M(MEGOHMS).
ALL CAPACITANCES ARE IN MICROFARADS, EXCEPT AS OTHERWISE INDICATED BY μμf (MICRO-MICROFARADS)



TUBES

V-1	=	6AB4
V-2	=	5963
V-3	=	KLYSTRON
V-4	=	OA2
V-5	=	OA2

Schematic Diagram.

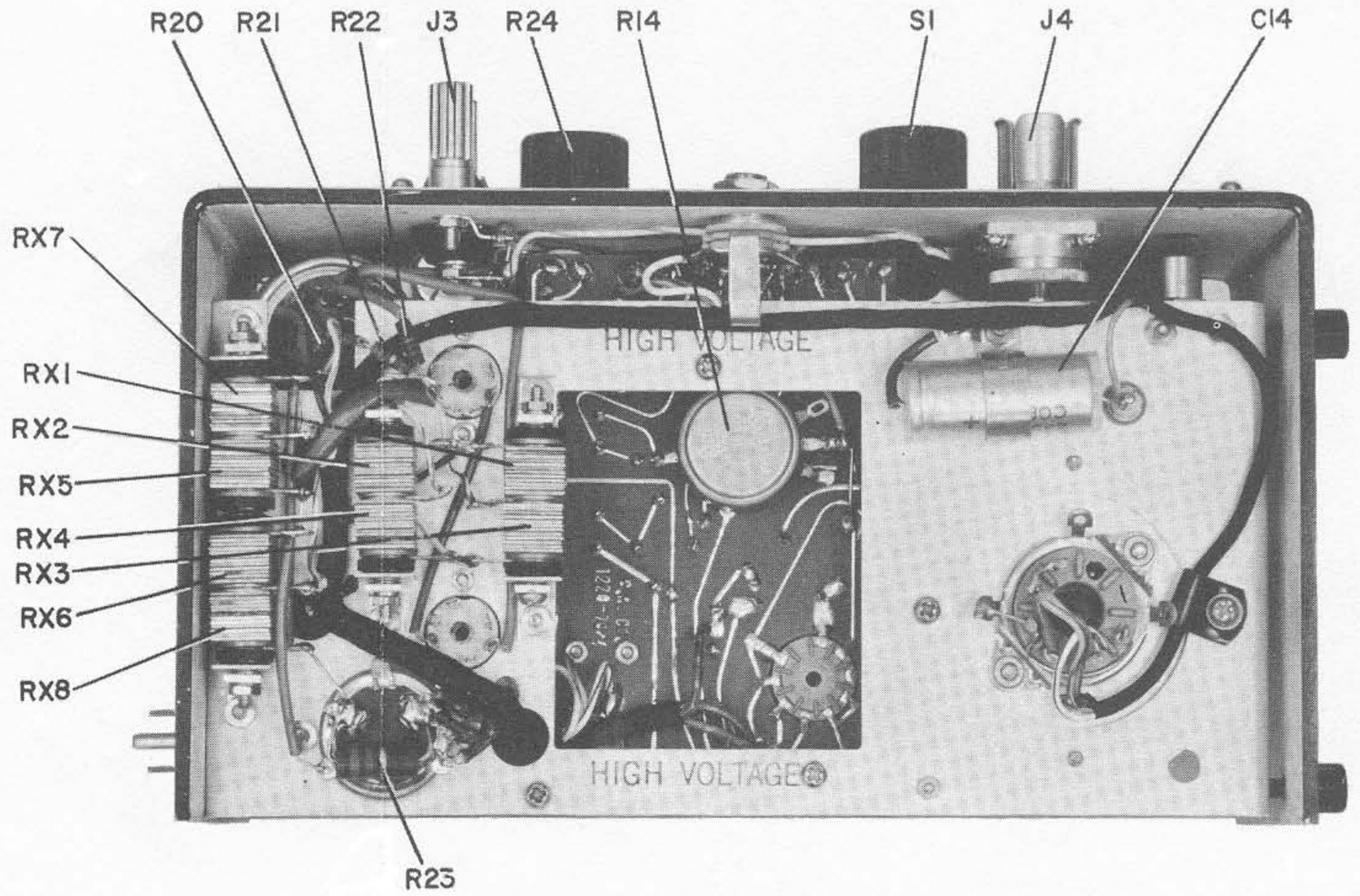


Figure 18. Interior View.

Figure 19. Interior View.
(Inset shows mounting of 6043 Tube.)

TYPE 874 ACCESSORIES

ADAPTORS

Type	Contains Type 874 Connector and	Fits
874-QBJ	BNC Jack	BNC Plug
874-QBP	BNC Plug	BNC Jack
874-QCJ	C Jack	C Plug
874-QCP	C Plug	C Jack
874-QHJ	HN Jack	HN Plug
874-QHP	HN Plug	HN Jack
874-QLJ	LC Jack	LC Plug
874-QLP	LC Plug	LC Jack
874-QLTJ	LT Jack	LT Plug
874-QLTP	LT Plug	LT Jack
874-QNJ	N Jack	N Plug
874-QNP	N Plug	N Jack
874-QSCJ	SC Jack	SC Plug
874-QSCP	SC Plug	SC Jack
874-QTNJ	TNC Jack	TNC Plug
874-QTNP	TNC Plug	TNC Jack
874-QUJ	UHF Jack	UHF Plug
874-QUP	UHF Plug	UHF Jack
874-QU1A		7/8" 50Ω UHF rigid air line
874-QU2		1-5/8" 50Ω UHF rigid air line
874-QU3A		3-1/8" 50Ω UHF rigid air line
874-QV2A		1-5/8" 51.5Ω VHF rigid air line
874-QV3		3-1/8" 51.5Ω VHF rigid air line
874-Q2	274 Jack	274 Plug
874-Q6	Pin & Sleeve	274-NF
874-Q7	774 Jack	774 Plug

CABLE (DOUBLE-SHIELDED)

Type	Z	Attenuation/100 ft
874-A2	50Ω ±5%	2.6 db at 100 Mc
874-A3	50Ω ±5%	5.3 db at 100 Mc

CONNECTORS

CABLE CONNECTORS TYPE	FOR CABLE TYPE
874-C	874-A2
874-C8	RG8/U
874-C9	RG9/U, RG116/U
874-C58	874-A3, RG29/U, RG55/U, RG58/U, RG58A/U
874-C62	RG59/U, RG62/U
PANEL CONNECTORS (-P -HEX NUT MTG, -PB -FLANGE MTG)	
874-P, -PB	874-A2
874-P8, -PB8	RG8/U
874-P9, -PB9	RG9/U, RG116/U
874-P58, -PB58	874-A3, RG29/U, RG55/U, RG58/U, RG58A/U
874-P62, -PB62	RG59/U, RG62/U

PATCH CORDS (3 FT)

TYPE	CONNECTOR	CABLE	CONNECTOR
874-R20	874-C	874-A2	874-C
874-R22	874-C58	874-A3	874-C58
874-R33	874-C58	Single-shielded	274-P
874-R34	874-C58	Single-shielded	274-NK

MISCELLANEOUS

TYPE 874-		TYPE 874-		TYPE 874-	
BM	300Ω Balanced Termination	LK	Constant-Z Adjust. Line	UB-P3	300Ω Balun Terminal Pad
D	Adjustable Stubs	LR	Radiating Line	VC	Variable Capacitor
EL	90° Ell	LT	Trombone-Constant-Z Line	W100	100Ω Coax. Standard
F	Low-Pass Filter			W200	200Ω Coax. Standard
FR	Rejection Filter	M	Component Mount	WM	50Ω Termination
G	Fixed Attenuator	MA	Adjustable Coupling Probe	WN	Short-Circuit Termination
GA	Adjustable Attenuator			WO	Open-Circuit Termination
JR	Rotary Joint	MB	Coupling Probe	X	Insertion Unit
K	Coupling Capacitor	T	Tee	XL	Series Inductor
L	Air Line	UB	Balun	Y	Cliplock
LA	Adjustable Line	UB-P2	200Ω Terminal Unit	Z	Stand

The above is a partial listing. For complete list and specifications, refer to the General Radio Catalog.

GENERAL RADIO COMPANY

WEST CONCORD, MASSACHUSETTS

EMerson 9-4400 **CLearwater 9-8900**

DISTRICT OFFICES

NEW YORK

Broad Ave. at Linden, Ridgefield, N. J.

Telephone N.Y. WOrth 4-2722
N.J. WHitney 3-3140

PHILADELPHIA

1150 York Rd., Abington, Penna.

Telephone HAncock 4-7419

WASHINGTON

8055 13th St., Silver Spring, Md.

Telephone JUniper 5-1088

CHICAGO

6605 West North Ave., Oak Park, Ill.

Telephone VIllage 8-9400

LOS ANGELES

1000 N. Seward St., Los Angeles 38, Calif.

Telephone HOllywood 9-6201

SAN FRANCISCO

1186 Los Altos Ave., Los Altos, Calif.

Telephone WHitecliff 8-8233

CANADA

99 Floral Pkwy., Toronto 15, Ont.

Telephone CHerry 6-2171

REPAIR SERVICES

EAST COAST

General Radio Company

Service Department

22 Baker Ave., W. Concord, Mass.

Telephone EMerson 9-4400

NEW YORK

General Radio Company

Service Department

Broad Ave. at Linden, Ridgefield, N. J.

Telephone N.Y. WOrth 4-2722

N.J. WHitney 3-3140

MIDWEST

General Radio Company

Service Department

6605 West North Ave., Oak Park, Ill.

Telephone VIllage 8-9400

WEST COAST

Western Instrument Co.

826 N. Victory Blvd., Burbank, Calif.

Telephone VIctoria 9-3013

CANADA

Bayly Engineering, Ltd.

First Street, Ajax, Ontario

Telephone Toronto EMpire 8-6866

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