OPERATING INSTRUCTIONS

TYPE 1112

STANDARD FREQUENCY MULTIPLIERS

1112

GENERAL RADIO COMPANY

960-C

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STANDARD FREQUENCY MULTIPLIERS

Form 960-C
September, 1960

GENERAL RADIO COMPANY
WEST CONCORD, MASSACHUSETTS, USA

Special Request to the User of this Instrument:

We believe that the most effective way to make our products more useful is to learn from the experience and opinions of those who use them. The resulting better products will benefit our customers as well as ourselves.

Your answers to the questions below, based on your experience in using this instrument, will be of great value to General Radio engineers and other personnel concerned with new products. Such comments will have a strong influence on the direction of future development work.

This questionnaire is self-mailing, requiring no envelope or postage. Any information you supply will not go outside our company without your specific, advance authorization. May we have your opinions?

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TYPE 1112-A

SPECIFICATIONS

SPURIOUS SIGNALS Unwanted harmonics of the input frequency are at least 100 db below the desired output frequency.

FREQUENCY-MODULATION NOISE Less than $\pm 1 \times 10^{-9}$ residual noise.

LOCKING RANGE The input signal can drift ±15 ppm before the locked oscillator goes out of control.

BANDWIDTH (Expressed as allowable frequency-deviation rate)

Decade	Approx Bandwidth in cps at Input Frequency
100 kc - 1 Mc	50
1 Mc - 10 Mc	500
10 Mc - 100 Mc	5000

INPUT 1-volt, 100-kc sine wave from standard-frequency oscillator. Can also be driven at input frequencies of 1, 2.5, and 5 Mc. Required input approx 5 volts. Will run free with no input signal, but absolute frequency will be in error by several ppm unless standardized.

OUTPUT Four channels; one each of 1 Mc and 10 Mc, and two of 100 Mc. Sine wave, 50 ohms. 20 mw max into 50 ohms.

TERMINALS Type 874 Coaxial Connectors; adaptors are available to fit all commonly used connector types.

POWER SUPPLY 105-125 (or 210-250) volts, 50-60 cps, 110 watts. Power input receptacle accepts either 2-wire (Type CAP-35, furnished) or 3-wire (Type CAP-15) power cord.

DIMENSIONS Relay-rack panel, 19 by 12-1/4 in., over-all depth 11-1/2 in.

WEIGHT 25 lb.

General Radio EXPERIMENTER **reference:** Vol 32, No. 14, July 1958.

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

This apparatus uses inventions of United States Patents licensed by Radio Corporation of America. Patent numbers supplied upon request. Licensed only for use in measuring or testing electronics devices, electron tube circuits, parts of such devices and circuits, and elements for use in such devices and circuits.

TABLE OF CONTENTS

Figure A. Type 1112-A Standard Frequency Multiplier.

TYPE 1112-A STANDARD FREQUENCY MULTIPLIER (1, 10, 100 Mc)

Section 1
INTRODUCTION

1.1 PURPOSE. The Type 1112-A Standard Frequency Multiplier (Figure A) is a narrow-band system designed to multiply the frequency of a highly accurate 100-kc frequency standard in decade steps of 10, 100, and 1000. Alternatively, if a standard frequency signal is available at a frequency of 1.0, 2.5, or 5.0 Mc, this signal may be used to control the multiplier chain as described in paragraph 3.1. Outputs are available at 1, 10, and 100 Mc at 50-ohm impedance, and are adjustable in level by individual panel controls. If the input signal is 1, 2.5, or 5 Mc, then output signals are available only at 10 and 100 Mc. The output power is 20 mw or more. A companion instrument, the Type 1112-B Standard Frequency Multiplier, 100 Mc to 1000 Mc, is designed to multiply the 100-Mc output of the Type 1112-A Standard Frequency Multiplier by 10, producing a highly accurate 1000-Mc output. The outputs of both instruments may be applied to a diode mounted in a waveguide system to provide higher multiples above 1000 Mc. Both instruments are equipped with built-in power supplies.

When the frequency multiplier is used to produce standard frequencies for measurement purposes, the residual fm noise added to the fm noise already present in the signal from the driving oscillator is usually less than $\pm 1 \times 10^{-9}$ deviation. When the multiplier is used in comparing stable oscillators for stability measurements, it will directly follow fm on the input signal up to modulating frequencies of 50 cps on the 100-kc input, or 500 cps on the 1-, 2.5-, or 5-Mc input, if the phase deviation is less than ±1 radian. If the phase deviation is very much less than ±1 radian, the multiplier will follow somewhat higher modulating frequencies.

1.2 DESCRIPTION.

1.2.1 CONNECTORS. The following connectors are on the front panel of the Type 1112-A Standard Frequency Multiplier:

Name	Type	Function
OUTPUT - 1 Mc	Type 874 Connector	RF output connection
OUTPUT - 10 Mc	Type 874 Connector	RF output connection
OUTPUT - 100 Mc	Type 874 Connector	RF output connection

The following connectors are at the rear of the Type 1112-A Standard Frequency Multiplier:

Name	Type	Function
INPUT - 100 kc (alternative 1, 2.5, or 5 Mc refer to paragraph 3.1)	Type 874 Connector	Input to instrument from 100-kc highly accurate standard (or 1-, 2.5-, or 5-Mc standard)
100 Mc OUT	Type 874 Connector	Output to connect to input of Type 1112-B Standard Frequency Multiplier
POWER	Power-cord plug	Power input connection

1.2.2 CONTROLS. The following controls are on the panel of the Type 1112-A Standard Frequency Multiplier:

Name	Type	Function
POWER	Two-position toggle switch	Energizes power supply
INCREASE OUTPUT - 1 Mc	Rotary control	Regulates output at 1-Mc terminal
INCREASE OUTPUT - 10 Mc	Rotary control	Regulates output at 10-Mc terminal
INCREASE OUTPUT - 100 Mc	Rotary control	Regulates output at 100-Mc terminal

On the rear of the Multiplier chassis are many screw-driver adjustments, jacks, switches, fuses, etc, whose locations are shown in Figure E. Adjustments are color-coded red, yellow, or green to indicate their relative importance. Controls coded red are critical and cannot be adjusted without affecting accuracy or calibration. Those coded yellow are somewhat less critical, but deserve caution. Green-coded adjustments may be varied when the occasion warrants.

1.2.3 METERS. Three meters are mounted in a row across the upper part of the panel of the Type 1112-A Standard Frequency Multiplier. These meters indicate the approximate dc voltage developed in one-half of the output load resistor of the balanced phase detectors at 1 and 10 Mc, and the full output of the 100-Mc phase detector. The normal indications are as follows: (a) With only the crystal oscillator or frequency-multiplier stage of the 1- or 10-Mc channels operating, the meter should indicate 30 microamperes, equivalent to 3 volts. (b) With both crystal oscillator and multiplier stages in operation in either the 1- or 10-Mc channel, the meter should indicate approximately $30 \sqrt{2} = 42$ microamperes when the crystal is operating near the center of its normal lock range. When the tuning of the crystal oscillators is changed, the meter indications normally will vary from very nearly zero to 60 microamperes. Note that the midrange setting is at a phase difference of approximately 90°. (c) The phase detector in the 100-Mc stage is an unbalanced phase detector. The meter reading is proportional to the dc output voltage, and will normally be about 30 microamperes with switch S300 set in either of the two TEST positions or in the USE position. (Refer to paragraph 2.1.)

A meter is mounted on the rear of the chassis, along with cord and plug to connect to the phase-detector circuit during adjustment procedure.

1.2.4 FUSES. Line fuses accessible from the rear are 1.2-ampere "slow blow" fuses for 115-volt line voltage, and 0.6-ampere "slow blow" fuses for 230-volt line voltage.

Section 2

PRINCIPLES OF OPERATION

2.1 GENERAL. The Type 1112-A Standard Frequency Multiplier is a very narrow-band, high-Q multiplier. The standard-frequency input drives a selective amplifier and harmonic amplifier, giving an output reference frequency of 10 times the 100-kc input frequency in the 1-Mc channel. The frequency of a 1-Mc quartz crystal oscillator having a reactance-tube frequency control is compared with the reference 1 Mc in a phase detector. The output of the phase detector is a dc voltage whose magnitude depends on the phase difference of the two applied voltages. This output voltage is approximately zero at a phase difference of 90° when the voltage across each half of the output load resistor of the phase detector is about 4.2 volts (42 microamperes on the meter). The meter deflection may be between 0 and 60 microamperes as the relative phase difference swings ±90°. Normal alignment gives operation near 90° phase difference, thus producing the best suppression of amplitude modulation in the phase detector.

The dc voltage output of the phase detector is applied to the control grid of the reactance tube in the correct sign to lock the crystal oscillator in fixed phase. The normal control range is approximately plus or minus 20 parts per million for a ±3-volt range of control voltage. Since none of the lower multiples of the 100-kc standard frequency appears in the control circuits, the crystal oscillator output is entirely free from unwanted lower-frequency components.

The f-m response of the crystal oscillator to hum and noise components drops off rapidly as the frequency of such components increases from low audio frequencies. The a-m noise from the crystal oscillator has been kept to a low value.

The crystal oscillator output is amplified in a tuned pentode amplifier with a 50-ohm output circuit terminating at a panel connector. The gain of the amplifier is adjustable by means of the panel INCREASE OUTPUT control.

Multiplication to 10 Mc is accomplished in a manner similar to that used for the 1-Mc multiplier, but at 10 times the frequencies.

The operation of the 100-Mc channel is similar to that of the two lower-frequency channels, except that (a) an unbalanced phase detector is used, and (b) two output amplifiers are provided. One output amplifier supplies the signal to the panel connector and the other provides a signal at a connector on the rear of the instrument for driving the Type 1112-B Standard Frequency Multiplier, 100 Mc to 1000 Mc.

As a result of the use of the unbalanced phase detector, the meter indication may differ slightly from that for the other channels. The normal deflection of the meter with either crystal oscillator or multiplier stage energized is approximately 30 microamperes (3 volts). When both oscillator and multiplier stage are energized simultaneously, the reading will again be near 30 microamperes. This gives operation in the region near 120° phase difference.

Section 3

INSTALLATION

3.1 MOUNTING. It is desirable to mount the Type 1112-A and 1112-B Standard Frequency Multipliers so that cable lengths between the multipliers and the work area are kept short. A length of 100-ohm cable short enough to sustain adequate drive level should be used between the frequency standard and the multiplier.

The driving signal from the Type 1100-A Frequency Standard should be obtained directly from the Type 1101-A Piezoelectric Oscillator. Current production models of this oscillator provide a connector which supplies this driving signal. On earlier models, it is necessary to install a cable connector in the manner outlined below.

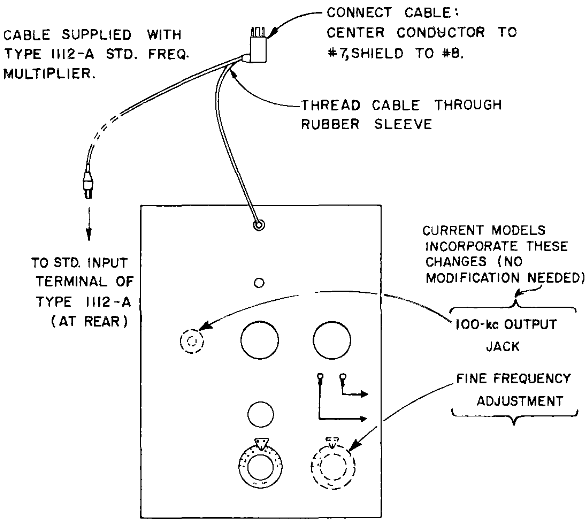


Figure B. Modification of Type 1101-A Oscillator to Drive Type 1112-A Standard Frequency Multiplier.

To install the necessary cable connector on older models of the Type 1101-A Piezoelectric Oscillator, proceed as follows: Remove the cover of the six-point multiple connector (see Figure B). Thread the end of the piece of concentric, low-loss, low-capacitance r-f cable (supplied with the Type 1112-A) through the rubber sleeve of the cover and connect the center conductor to terminal No. 7, the terminal where the center conductor of the internal concentric cable is connected. Connect the shield to terminal No. 8, the terminal where the shield of the internal concentric cable is connected. Replace the cover and screws. Replace the plug in the socket on the bottom of the Type 1102-A Multivibrator and Power Supply Unit (if plug has been removed). It is usually desirable to remove this plug, even though the Syncronometer (if used) will be stopped and the standard frequency output interrupted.

Plug the r-f connector at the end of the cable into the STD INPUT terminal at the rear of the Type 1112-A Standard Frequency Multiplier using an extra length of coaxial cable if necessary.

The output connections from the Type 1112-A Standard Frequency Multiplier are made from one or more of the panel OUTPUT connectors as desired. If more than one output frequency is used, the outputs may be connected in parallel. Isolating impedances are provided in each output circuit so that connection of one output in parallel with another does not impose appreciable loading of one on the other. No d-c return is provided for diode circuits; thus an external d-c path must be provided if needed.

Connect the Type 1112-A Standard Frequency Multiplier to the power line by means of the power cord provided.

If it is desired to use a standard frequency control signal of 1, 2.5, or 5 Mc instead of the normal 100-kc input signal, the input signal may be transferred from the standard 100-kc input position (J2 at V100) to the 1-, 2.5-, or 5-Mc input position (J3 at V200) by means of a Type BNC connector on the input cable at the chassis end. It is recommended that the first channel be made inoperative by disconnection of the appropriate multipoint power connector on the inside of the chassis. Use of this input connection invalidates the 1-Mc output frequency from the panel connector, since the first channel is no longer controlled.

Adjustment of the input signal level is required when 100-kc input is used. Set R102 (on chassis rear) for a 30-microampere deflection of the meter in channel No. 1 with switch S100 in the TEST MULT position. In the case of 1-, 2.5-, or 5-Mc input, approximately the same meter reading should be obtained (channel No. 2) but the level of the external driving source must be adjusted.

3.2 INSTALLATION AND CONNECTIONS OF TYPE 1112-B STANDARD FREQUENCY MULTIPLIER (100 Mc TO 1000 Mc). The Type 1112-B Standard Frequency Multiplier should be installed as near the work area as is practical.

a. Connect the 100 MC INPUT (at rear of the Type 1112-B Standard Frequency Multiplier) to the 100 MC OUT connector (at rear of the Type 1112-A Standard Frequency Multiplier) by means of the cable provided.

b. Connect the 1000 MC OUTPUT of the Type 1112-B Standard Frequency Multiplier to the load by means of cable provided.

c. Connect the Type 1112-B Standard Frequency Multiplier to the power line by means of the power cord provided.

3.3 CONNECTIONS TO A DIODE IN THE WAVE-GUIDE MOUNT. One of the important uses of the Type 1112-A and Type 1112-B Standard Frequency Multipliers is to provide harmonics of the standard frequencies in the range above 1000 Mc. A suggested diode mount is sketched in Figure C. The 1000-Mc output is fed to the diode in a wave-guide mount by a suitable length of cable so as to develop as large a voltage on the diode as possible. The lower standard frequencies are combined, as desired, by the use of paralleled outputs. The combined outputs are then fed to the diode through a low-pass filter, as shown in Figure C. The radio-frequency coil of the filter should have a high impedance (relative to 50 ohms) at 1000 Mc but a low impedance at frequencies of 100 Mc and lower.

The r-f choke, variable resistor, and milliammeter, as shown in Figure C, provide for adjust-

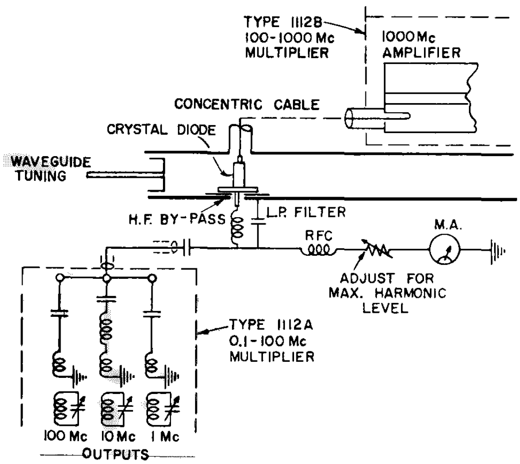


Figure C. Suggested Diode Mount.

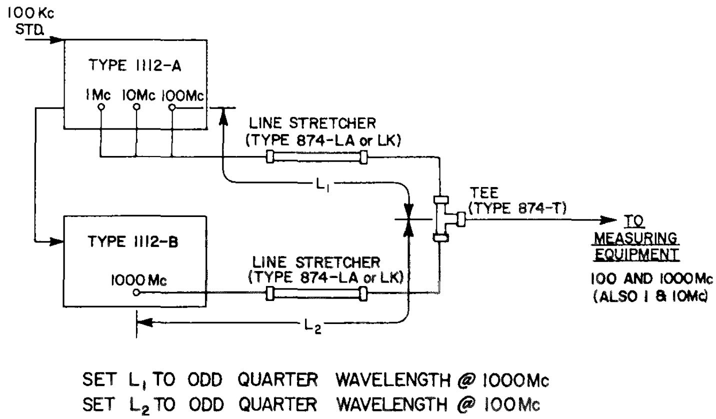


Figure D. Alternate Method of Driving Diode Harmonic Generator.

ment of the self-bias of the diode for favoring maximum harmonic output and the indication of amplitudes at desired settings.

Another method of driving a diode harmonic generator is shown in Figure D. The Type 1112-A is isolated from the Type 1112-B Multiplier by mismatched transmission lines. The adjustable-length lines should be set to give maximum output power from each unit at the crystal-diode harmonic generator.

Section 4

OPERATING PROCEDURE

4.1 NORMAL OPERATION. Turn on power supply by throwing the POWER switch to POWER.

In normal operation, after a few seconds delay, the three panel meters will show deflections with subsequent slight drifts in indication.

After approximately twenty minutes' operation, the changes in meter deflections should disappear, the readings remaining constant with time except for slight drift as the instrument warms up over several hours' time.

If the equipment is in normal operating condition, the meter indications should be near 42 divisions, corresponding to 4.2 volts on the Type 1112-A Standard Frequency Multiplier except for the 100-Mc stage (refer to paragraph 2.1). Set the input level by adjusting R102 to give a reading of 30 microamperes on the meter in channel No. 1, with a 100-kc input and with switch S100 in the TEST MULT position.

Connect to the desired outputs by plugging the cable, or cables, into the appropriate outlets on the panel. The level of each output is separately adjustable by operation of the appropriate INCREASE OUTPUT control.

Suggestions for connection of the Type 1112-A Standard Frequency Multiplier to a crystal diode in a wave-guide mount are given in paragraph 3.3.

4.2 CHECKS AND ADJUSTMENTS. The normal operation of the equipment is indicated by the meters. Normally, these remain near 42 microamperes on the 1- and 10-Mc phase detector meters, and near 30 microamperes on the 100-Mc meter. Meter readings above midscale are normal on the Type 1112-B Standard Frequency Multiplier except in the 1000 MC OUTPUT position. Meter drift for the first few minutes of operation is to be expected. In operation for several hours, slight changes in meter readings from the initial values are also to be expected.

In case the meter reading does not seem to follow adjustment of the input level control, or if a meter reading appears to "beat" or "wobble", or is otherwise erratic, refer to the trouble-shooting procedure (paragraph 5.3). If operational checks using a radio receiver to listen to the signals from the output terminals disclose any wobbling or roughness of note, refer to trouble-shooting procedure under 5.3.

Section 5
SERVICE AND MAINTENANCE

5.1 GENERAL. The two-year warranty given with every General Radio instrument attests the quality of materials and workmanship in our products. When difficulties do occur, our service engineers will assist in any way possible.

In case of difficulties that cannot be eliminated by the use of these service instructions, please write or phone our Service Department, giving full information of the trouble and of steps taken to remedy it. 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 (see back cover), requesting a Returned Material Tag. Use of this tag will insure proper handling and identification. For instruments not covered by the warranty, a purchase order should be forwarded to avoid unnecessary delay.

5.2 INSTALLATION ADJUSTMENTS.

5.2.1 GENERAL. The equipment as received from the factory has been carefully checked and adjusted and with one exception is ready for operation after proper connection to the primary standard. The exception is the adjustment of the 100-kc input level to the 0.1-Mc to 1.0-Mc multiplier. (For operation from standard frequencies of 1.0, 2.5, or 5 Mc, refer to paragraph 5.2.3.)

5.2.2 ADJUSTMENT OF 100-KC INPUT LEVEL. This adjustment is made as follows: Connect the multiplier to the frequency standard (refer to Section 3) and to the power line, and set it in operation. Disconnect the plate voltage of the 1-Mc crystal oscillator and output amplifier by throwing switch S100 to the TEST MULT position. The 1-Mc phase detector meter should now indicate the output level of the 1-Mc multiplier stage. Adjust this level to 30 microamperes by means of the input level control R102, located in the top right-hand shield can of the 1-Mc decade unit. This completes the installation adjustment. Return the switch S100 to the center (USE) position.

5.2.3 OPERATION FROM A HIGH FREQUENCY SOURCE. For operation from a standard frequency source of 1.0, 2.5, or 5.0 Mc, the input cable from the input jack, J1, to the chassis must be relocated as follows: disconnect plug PL2 from jack J2 in the 100-kc input circuit, disconnect PL2 from J3, and insert PL2 in J3. Since there is no level control provided for this input connection, it is necessary to adjust the level of the input signal at the source to 30 microamperes as indicated on M1 with S200 in the TEST MULT position. To reduce heating of the instrument and to remove the uncontrolled 1-Mc signal from the panel jack, it is desirable to remove the power plug PL100, located behind S100 (on the rear of the swinging chassis assembly). To return to the "normal" 100-kc input operation, reverse the above procedure.

5.3 TROUBLE SHOOTING. The Type 1112-A Standard Frequency Multiplier will probably operate normally if it has not been damaged mechanically or if vacuum-tube characteristics are not outside normal limits. Before carrying out alignment adjustments, make sure that all tubes are in good condition. In case of trouble, refer to the trouble-shooting table on page 7.

5.4 ALIGNMENT PROCEDURE.

5.4.1 GENERAL OUTLINE OF ADJUSTMENT PROCEDURE. Before starting any extensive alignment procedure, make sure that the tubes in the instrument are well within specifications. Also, check the supply voltages. The plate supply voltage should be +200 volts dc, and the heater voltage approximately 6.3 volts dc. Regulated plate voltage is adjusted by R508.

The alignment table outlines the adjustment procedure for realignment of the entire instrument. Since the instrument has already been calibrated at the factory, the adjustments should be near the optimum settings unless they have been disturbed. It is assumed that any personnel carrying out this alignment are familiar with radio-frequency alignment technique. The table is divided into the logical sections and groups convenient for alignment procedure.

5.4.2 EQUIPMENT. For complete alignment of this instrument the following test equipment will be involved:

a. <u>Necessary Instruments</u>

Volt-ohm-milliammeter, such as Simpson Model 260, Triplett Model 630-A, or Weston Model 980 (20,000 ohms per volt). Vacuum-Tube Voltmeter (VTVM), such as General Radio Type 1800-B, General Radio Type 1803-B. Modulated Signal Generator 100 kc to 10 Mc. Radio Receiver (to cover at least 1 to 10 Mc).

b. Desirable Instruments (Increase Ease of Adjustment)
Grid-Dip Oscillator, such as Measurements Corporation, Boonton, New Jersey, Model 59 and 59-LF (both needed to cover range of 100 kc to 100 Mc). Sensitive Audio Voltmeter, such as General Radio Type 1231-B, or General Radio Type 1932-A.

TROUBLE - SHOOTING TABLE

Symptom	Circuits	Test Conditions	Adjustment	Remarks
1-Mc meter indication constant at approx 30 μa (1-Mc oscillator free running)	Multiplier stages (V100, V101)	S100 in USE	None	No input signal. Connect to 100-kc signal source.
		S100 in TEST MULT	R102	Set meter to 30 μa, then set S100 to USE.
		S100 in TEST MULT	R102	If R102 has no effect, check level of 100-kc input signal. Check operation of multiplier and phase detector (see below).
	Phase detector (D120, D121, V120)	S100 in TEST MULT	C121	Tune for maximum. Set R102 for 30 μa. Set S100 to USE.
		S100 in TEST OSC	C140	Set C140 for 30 μa. Set S100 to USE.
	Crystal oscillator (V140)	S100 in TEST OSC	C140	Set C140 for 30 μa. Set S100 to USE.
		S100 in USE	C149	Set C149 for 42 μa on M100 (M1) after checking level as above. Check that meter reading varies as C149 is adjusted (use insulated screwdriver.)
1-Mc meter "beats" or "pumps" constantly	Multiplier stages (V100, V101)	S100 in USE	None	See above.
		S100 in TEST MULT	R102	Set level to 30 μa.
			None	Check for adequate input signal level from 100-kc source, using VTVM.
	Oscillator-Reactance Tube (V140)	S100 in TEST OSC	C140	Set level to 30 μa. Return S100 to USE.
		S100 in USE	C149	Check that meter indication follows variation of C149 inside lock range, and that
		S100 in USE	C149	beating occurs outside ends of lock range. (Use a radio receiver as monitor.) Set C149 inside lock range for meter reading of 42 μa. Use insulated screwdriver.
Insufficient output power at 1-Mc jack (J101)	Amplifier (V160)	S100 in USE	R100 (Output)	If output level does not follow adjustment of R100, check amplifier stage using VTVM. Meter M100 should read normally. See above.
10-Mc stage meter abnormal	10-Mc stage	See above (Use S200, etc.)	See above (Use appropriate controls)	Technique similar to that for 1-Mc stage. Read M300 (or M1 plugged into 100-Mc stage) and VTVM as above. Use C251 to set input level. Meter should read 30 μa when lock is established. (See above).

NOTES: Use M100, M200, M300 (or M1) as indicator except where VTVM is prescribed.

Proper operation requires good tubes. Before proceeding with elaborate adjustments, make sure that tubes are within tolerance.

This is an abbreviated procedure. For detailed instructions, refer to paragraph 5.4.

ALIGNMENT TABLE

I. 100-kc to 1-Mc Circuits (Group 100) Apply 100-kc driving signal at J1

Sequence	Circuit Element	Circuit	Indicator Used	Position of S100	Purpose of Adjustment	Remarks
1	R102	100-kc to 1-Mc Multiplier	M1 (plugged into 1-Mc stage)	TEST MULT	Adjusts 100-kc drive level.	Set for 30 μa.
	C105	"	"	"	Resonate to 100 kc.	Peak for maximum.
	C112	"	"	"	Resonate to 1 Mc.	Peak for maximum.
2	C121	Phase Detector	M1	"	Resonate to 1 Mc.	Peak for maximum.
3	C151	1-Mc Oscil-lator	Frequency Standard	TEST OSC	Fine frequency adjustment.	Set to 1 Mc (free running).
	C149	"	"	"	Coarse frequency adjustment.	"
	C140	"	M1 (plugged into 1-Mc stage)	"	Fine level adjustment.	Set for 30 μa.
	C153	"	"	"	Coarse level adjustment.	"
	C149	"	"	USE	Center of Lock Range.	Set for 42 μa.
	C141	1-Mc React-ance Tube	Frequency Standard	"	This control is a factory-set adjust-ment.	
4	C164	1-Mc Output	VTVM 50-ohm load	"	Resonate to 1 Mc.	Peak for maximum (at least 1.5 volts) with R100 set fully clockwise.
5	C121	1-Mc Phase Detector	M1 (plugged into 1-Mc stage)	TEST MULT	Resonate to 1 Mc.	Peak for maximum.
	R121	"	D-C VTVM at A.T. 122	TEST MULT and TEST OSC	Phase-detector load balance (a-m rejec-tion control).	Adjust for zero d-c volts at both S100 positions.
	C122	"	"	"	"	Balance depends on proper setting of R121 and C122.

II. 1-Mc to 10-Mc Circuit (Group 200) Set S100 to USE

Sequence	Circuit Element	Circuit	Indicator Used	Position of S200	Purpose of Adjustment	Remarks
1	C202	Frequency Doubler	Grid-Dip Meter and M1 (plugged into 10-Mc stage)	TEST MULT	Resonate to 2 Mc.	Peak for maximum.
	C206	X5 Multiplier	"	"	Resonate to 10 Mc.	"
	C220	Phase Detector	"	"	"	"
	C152 (located in 1-Mc channel)	1-Mc Drive	M1	"	Set 10-Mc level.	Set to 30 μa.
2	C252	10-Mc Oscil-lator	"	TEST OSC	Coarse level adjustment.	Set to 30 μa.
	C240	"	"	"	Fine level adjust-ment.	"
	C249	"	Frequency Standard	"	Frequency adjustment.	Set to 10 Mc.
	C248	"	"	"	"	"
	C249	"	M1	USE	Center of lock range.	Set to 42 μa.
	C241	10-Mc React-ance Tube	"	"	Reactance tube slope adjustment.	Factory setting.

ALIGNMENT TABLE (CONT)

II. 1-Mc to 10-Mc Circuit (Group 200) (Continued)

Sequence	Circuit Element	Circuit	Indicator Used	Position of S200	Purpose of Adjustment	Remarks
3	C220	10-Mc Phase Detector	"	TEST MULT	Resonate to 10 Mc.	(See Group 100.)
	C221	"	VTVM at A.T. 222	TEST MULT and TEST OSC	Capacitance balance.	Adjust for zero d-c volts at both S200 positions.
	L220	"	"	"	Inductance balance.	"
	R221	"	Sensitive a-c volt-meter at A.T. 222	TEST MULT	Phase detector load balance (a-m rejection control).	Adjust for best null with 1-Mc 30% a-m signal on J3. Re-check C220, C221, L220.
4	C263	10-Mc output amplifier	VTVM 50-ohm load	USE	Resonate to 10 Mc.	Set for maximum.
	C267	10-Mc output	"	"	10-Mc Coupling Network.	Set for maximum (isolates 10-Mc stage when paralleled with other stages).

III. 10-Mc to 100-Mc Circuits (Group 300) Set S200 to USE

Sequence	Circuit Element	Circuit	Indicator Used	Position of S300	Purpose of Adjustment	Remarks
1	C303	Frequency Doubler	Grid-Dip Meter and M1 plugged into 100-Mc stage	TEST MULT	Resonate to 20 Mc.	Peak for maximum.
	C305	X5 Multiplier	"	"	Resonate to 100 Mc.	"
	C320	100-Mc Phase Detector	"	"	"	"
	C308	Multiplier Coupling	M1	"	Adjust coupling to 100-Mc phase detector.	Set for near minimum capacitance.
	C251 (Located in 10-Mc channel)	10-Mc Drive	"	"	Coarse level control	Set for 30 μa (adjust C308 until this is possible).
2	C350	Overtone crystal circuit	Grid-Dip Meter	L344, C350 and Q300 disconnected from circuit. Instrument OFF.	Tune out crystal holder capacitance (factory adjusted).	Resonate tank circuit to crystal at 100 Mc. Reconnect Q300, L344, C350.
	C346	100-Mc Tank Circuit	Grid dipper & M1 plugged into 100-Mc stage	TEST OSC (Reconnect Q300, L344, C350)	Resonate grid circuit to 100 Mc.	Tune for maximum reading on M1 after grid-dip check.
	C349	100-Mc Oscillator	M1	TEST OSC	Set C349 and C352 for 30-μa level while maintaining frequency at 100 Mc, using C351.	Note: C351 should be set near 2/3 capacitance. Repeat C346 and check C349, C352, and C351.
	C352	"	"	"	"	"
	C351	100-Mc Oscillator Main Frequency Adjustment	"	"	"	"
	C351	"	"	USE	Set for approximately 30 μa center of lock range.	"

ALIGNMENT TABLE (CONT)

III. 10-Mc to 100-Mc Circuits (Group 300) (Continued)

Sequence	Circuit Element	Circuit	Indicator Used	Position of S100	Purpose of Adjustment	Remarks
3	C364	100-Mc output	VTVM and 50-ohm load	USE	Resonate to 100 Mc.	Peak for maximum.
	L361	"	"	"	Output coupling.	Move coupling coil - approximately 1 volt into 50-ohm load.
	C369	100-Mc output (gain controlled amplitude)	"	"	Resonate to 100 Mc.	Peak for maximum.
	L363	"	"	"	Set to 50-ohm impedance.	Move coupling coil - approximately 1 volt into 50-ohm load.

NOTE: All voltages measured with respect to ground unless otherwise specified.

TABLE OF VOLTAGES

TUBE (TYPE)	PIN	DC VOLTS
V100 (6AU6)	1	0
	2	+1.5
	3	0
	4	+6.1
	5	+200
	6	+150
	7	+1.5
V101 (6AU6)	1	0
	2	+0.85
	3	+6.1
	4	0
	5	+190
	6	+125
	7	+0.85
V120 (6C4)	1	+200
	3	+6.1
	4	0
	5	+200
	6	+20.0
	7	+26.0
V140 (6AN8)	1	+135
	2	-0.7
	3	0
	4	0
	5	+6.1
	6	+200
	7	+200
	8	0
	9	+4.6
V160 (6BC5)	1	0
	2,7	+2.0
	3	0
	4	+6.1
	5	+190
	6	+140

TUBE (TYPE)	PIN	DC VOLTS
V200 (6X8)	1	+0.9
	2	-0.8
	3	+110
	4	+6.1
	5	0
	6	+0.9
	7	-4.2
	8	+75
	9	190
V220 (6C4)	1,5	+200
	3	+6.1
	4	0
	6	+20
	7	+29
V240 (6AN8)	1	+130
	2	-2.8
	3	0
	4	0
	5	-6.1
	6	+200
	7	+200
	8	-3.25
	9	+2.0
V260 (6BC5)	1	0
	2	+1.7
	3	0
	4	+6.1
	5	+190
	6	+150
V300 (6X8)	1,6	+1.5
	2	0
	3	+110
	4	+6.1
	5	0
	7	-0.2
	8	+130
	9	+190

TUBE (TYPE)	PIN	DC VOLTS
V340 (6AN8)	1	+140
	2	-0.25
	3	0
	4	0
	5	+6.1
	6	+200
	7	+165
	8	-2.2
	9	+0.2
V360 (6BC5)	1	-0.65
	2,7	+1.2
	3	+6.1
	4	0
	5	+200
	6	+150
V361 (6BC5)	1	-0.65
	2,7	+1.2
	3	+6.1
	4	0
	5	+200
	6	+150
V501 (6080)	1,4	+180
	2,5	+260
	3,6	+200
	7,8	+130
V502 (12AX7)	1	+180
	2	+155
	3	+160
	4,5,9	+130
	6	+160
	7	+80
	8	+82
V503 (5651)	1,5	+82
	2,4,7	0

NOTE: Voltages measured with VTVM and are with respect to ground. Switches S100, S200, and S300 set in USE position.

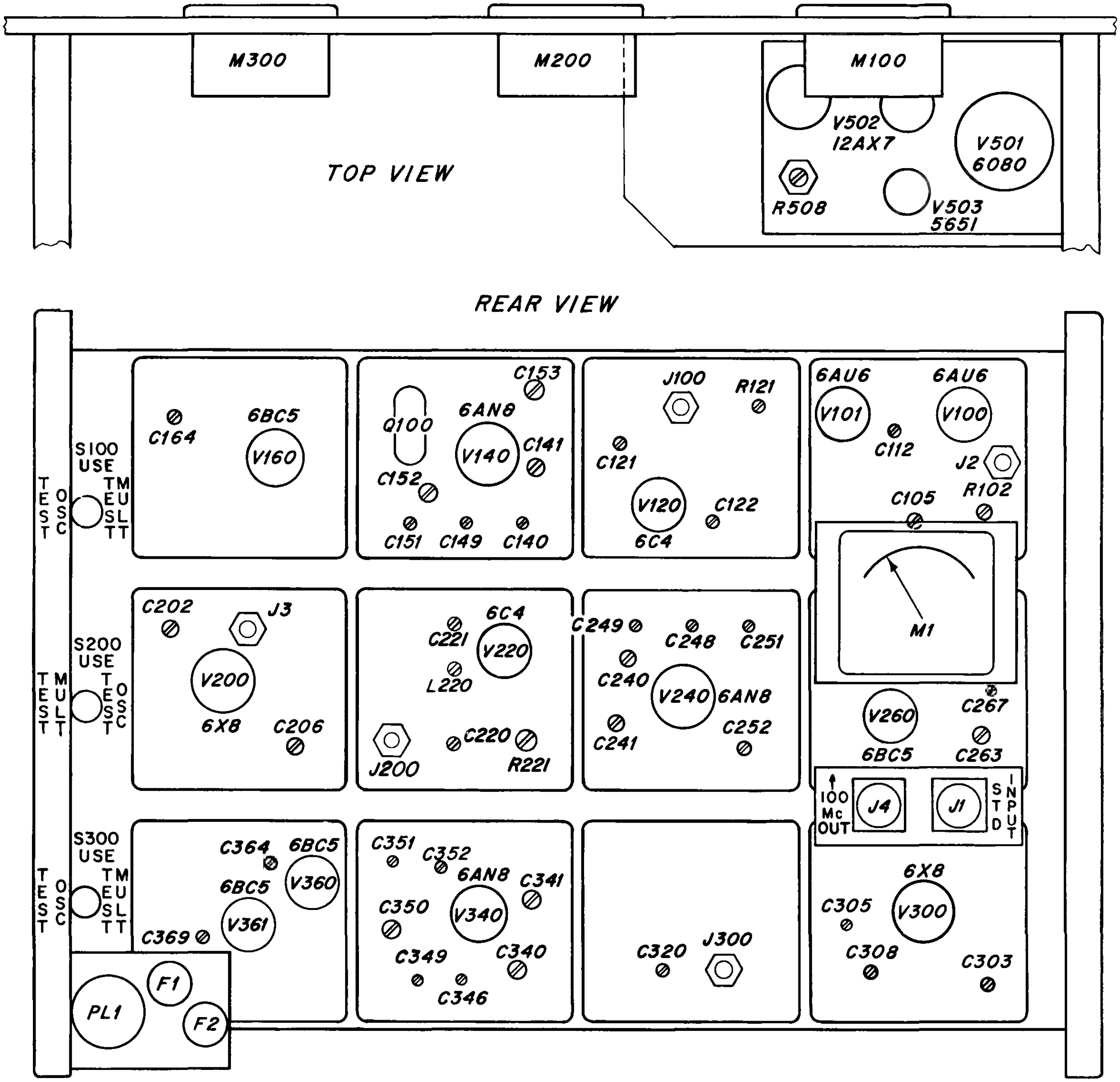


Figure E. Rear Panel Adjustments.

Section 6

PARTS LIST

		PART NO. (NOTE A)			
RESISTORS (NOTE B)	R1	47	±5%	5 w	REPO-43
	R2	47	±5%	5 w	REPO-43
	R3	47	±5%	5 w	REPO-43
	R100	5 k	±10%		POSC-7
	R101	3.3 k	±5%	1/2 w	REC-20BF
	R102	10 k	±10%		POSC-11
	R103	220	±5%	1/2 w	REC-20BF
	R104	27 k	±5%	1/2 w	REC-20BF
	R105	100	±5%	1/2 w	REC-20BF
	R106	1 M	±5%	1/2 w	REC-20BF
	R107	100	±5%	1/2 w	REC-20BF
	R108	27 k	±5%	1/2 w	REC-20BF
	R109	1.2 k	±5%	1/2 w	REC-20BF
	R120	75 k	±5%	1/2 w	REC-20BF
	R121	50 k	±10%		POSC-11
	R122	75 k	±5%	1/2 w	REC-20BF
	R123	680	±5%	1/2 w	REC-20BF
	R124	2.7 k	±5%	1/2 w	REC-20BF
	R125	1 M	±5%	1/2 w	REC-20BF
	R140	100 k	±5%	1/2 w	REC-20BF
	R141	1.5 k	±5%	1/2 w	REC-20BF
	R142	100 k	±5%	1/2 w	REC-20BF
	R143	470	±5%	1/2 w	REC-20BF
	R144	6.8 k	±5%	1 w	REC-30BF
	R145	100	±5%	1/2 w	REC-20BF
	R146	470 k	±5%	1/2 w	REC-20BF
	R147	100 k	±5%	1/2 w	REC-20BF
	R160	1 M	±5%	1/2 w	REC-20BF
	R161	150	±5%	1/2 w	REC-20BF
	R162	27 k	±5%	1/2 w	REC-20BF
	R163	100 k	±5%	1/2 w	REC-20BF
	R164	1.2 k	±5%	1/2 w	REC-20BF
	R200	5 k	±10%		POSC-7
	R201	100	±5%	1/2 w	REC-20BF
	R202	1 M	±5%	1/2 w	REC-20BF
	R203	22 k	±5%	1 w	REC-30BF
	R204	150	±5%	1/2 w	REC-20BF
	R205	1 M	±5%	1/2 w	REC-20BF
	R206	560 k	±5%	1/2 w	REC-20BF
	R207	1.2 k	±5%	1/2 w	REC-20BF
	R220	75 k	±5%	1/2 w	REC-20BF
	R221	50 k	±10%		POSC-11
	R222	75 k	±5%	1/2 w	REC-20BF
	R223	680	±5%	1/2 w	REC-20BF
	R224	2.7 k	±5%	1/2 w	REC-20BF
	R225	1.0 M	±5%	1/2 w	REC-20BF
	R240	220	±5%	1/2 w	REW-3C
	R241	100 k	±5%	1/2 w	REC-20BF
	R242	470	±5%	1/2 w	REC-20BF
	R243	470 k	±5%	1/2 w	REC-20BF
	R244	100	±5%	1/2 w	REC-20BF
	R245	6.8 k	±5%	1 w	REC-30BF
	R246	100 k	±5%	1/2 w	REC-20BF
	R260	1 M	±5%	1/2 w	REC-20BF
	R261	150	±5%	1/2 w	REC-20BF
	R262	100 k	±5%	1/2 w	REC-20BF
	R263	27 k	±5%	1/2 w	REC-20BF
	R264	1.2 k	±5%	1/2 w	REC-20BF
	R300	5 k	±10%		POSC-7
	R301	100	±5%	1/2 w	REC-20BF

		PART NO. (NOTE A)			
RESISTORS (NOTE B)	R302	1 M	±5%	1/2 w	REC-20BF
	R303	22 k	±5%	1 w	REC-30BF
	R304	150	±5%	1/2 w	REC-20BF
	R305	1 M	±5%	1/2 w	REC-20BF
	R306	75 k	±5%	1/2 w	REC-20BF
	R307	1.2 k	±5%	1/2 w	REC-20BF
	R320	100 k	±5%	1/2 w	REC-20BF
	R340	51	±5%	1/2 w	REC-20BF
	R341	100 k	±5%	1/2 w	REC-20BF
	R342	68	±5%	1/2 w	REC-20BF
	R343	18 k	±5%	1/2 w	REC-20BF
	R344	3.3 k	±5%	2 w	REC-41BF
	R345	47 k	±5%	1/2 w	REC-20BF
	R346	1.5 k	±5%	1/2 w	REC-20BF
	R360	1 M	±5%	1/2 w	REC-20BF
	R361	150	±5%	1/2 w	REC-20BF
	R362	27 k	±5%	1/2 w	REC-20BF
	R363	1 M	±5%	1/2 w	REC-20BF
	R364	150	±5%	1/2 w	REC-20BF
	R365	27 k	±5%	1/2 w	REC-20BF
	R366	100 k	±5%	1/2 w	REC-20BF
	R367	220 k	±5%	1/2 w	REC-20BF
	R368	220 k	±5%	1/2 w	REC-20BF
	R501	1 M	±10%	1/2 w	REC-20BF
	R502	2.4 M	±5%	1/2 w	REC-20BF
	R503	36 k	±1%	1/4 w	REF-65
	R504	12 k	±1%	1 w	REF-75
	R505	36 k	±1%	1/4 w	REF-65
	R506	470 k	±5%	1/2 w	REC-20BF
	R507	39 k	±1%	1/4 w	REF-65
	R508	10 k	±10%		POSC-3
	R509	5.6 M	±10%	1/2 w	REC-20BF
	R510	100	±10%	1/2 w	REC-20BF
	R511	100	±10%	1/2 w	REC-20BF
	R512	470 k	±5%	1/2 w	REC-20BF
	R513	620 k	±5%	1/2 w	REC-20BF
	R514	120 k	±5%	1/2 w	REC-20BF
CAPACITORS (NOTE C)	C1A	40			
	C1B	40		450 dcwv	1112-A-418
	C1C	30			
	C1D	30			
	C2A	1500			
	C2B	750		10 dcwv	COE-9
	C2C	750			
	C3	0.01	+100%-0%	500 dcwv	COC-63
	C4	0.01	+100%-0%	500 dcwv	COC-63
	C100	510 μμf	±5%	300 dcwv	COM-20D
	C101	150 μμf	±5%	500 dcwv	COM-20D
	C102	0.01	+100%-0%	500 dcwv	COC-63
	C103	0.01	+100%-0%	500 dcwv	COC-63
	C104	0.01	+100%-0%	500 dcwv	COC-63
	C105	7-140 μμf			COA-5
	C106	33 μμf	±5%	500 dcwv	COM-20D
	C107A	0.001	±5%	300 dcwv	COM-20D
	C107B	*	±5%	300 dcwv	COM-20D
	C108	0.01	+100%-0%	500 dcwv	COC-63
	C109	0.01	+100%-0%	500 dcwv	COC-63
	C110	0.01	+100%-0%	500 dcwv	COC-63
	C112	2.7-19.6 μμf			COA-29-4

PARTS LIST (CONT)

CAPACITORS (NOTE C)

				PART NO.
C113	**	±5%	500 dcwv	COM-20D
C114	0.001	+100%-0%	500 dcwv	COC-3
C115	0.001	+100%-0%	500 dcwv	COC-3
C120	150 μμf	±5%	500 dcwv	COM-20D
C121	4-50 μμf			COA-2L
C122	2.3-14.2 μμf			COA-26-2
C123	0.1	±10%	100 dcwv	COW-17
C124	0.01	+100%-0%	1000 dcwv	COC-63
C125	0.001	±5%	300 dcwv	COM-20D
C126	0.01	+100%-0%	1000 dcwv	COC-63
C127	0.001	+100%-0%	500 dcwv	COC-3
C128	0.001	+100%-0%	500 dcwv	COC-3
C129	50		15 dcwv	COE-47
C130	10 μμf	±5%	500 dcwv	COM-20D
C140	1.4-5.0 μμf			COA-29
C141	1.5-7.0 μμf			COT-17
C142	510 μμf	±5%	300 dcwv	COM-20D
C143	0.01	+100%-0%	500 dcwv	COC-63
C144	0.01	+100%-0%	500 dcwv	COC-63
C145	0.001	+100%-0%	500 dcwv	COC-3
C146	240 μμf	±5%	500 dcwv	COM-20D
C147	330 μμf	±5%	500 dcwv	COM-20D
C148	24 μμf	±5%	500 dcwv	COM-20D
C149	2.7-19.6 μμf			COA-29-4
C150	22 μμf	±5%	500 dcwv	COM-20D
C151	2.7-19.6 μμf			COA-29-4
C152	1.5-7.0 μμf			COT-17
C153	7-140 μμf			COA-5L
C155	0.001	+100%-0%	500 dcwv	COC-3
C156	0.001	+100%-0%	500 dcwv	COC-3
C157	0.01	+100%-0%	500 dcwv	COC-63
C160	2.2 μμf	±10%	500 dcwv	COC-1
C161	0.01	+100%-0%	500 dcwv	COC-63
C162	0.01	+100%-0%	500 dcwv	COC-63
C163	0.01	+100%-0%	500 dcwv	COC-63
C164	5-75 μμf			COA-3
C165	0.001	+100%-0%	500 dcwv	COC-3
C166	0.001	+100%-0%	500 dcwv	COC-3
C167	47 μμf	±10%	500 dcwv	COM-20B
C168	0.01	+100%-0%	500 dcwv	COC-63
C200	0.001	+100%-0%	500 dcwv	COC-3
C201	0.01	+100%-0%	500 dcwv	COC-63
C202	6-100 μμf			COA-4
C203	51 μμf	±5%	500 dcwv	COM-20D
C204	0.01	+100%-0%	500 dcwv	COC-63
C205	0.01	+100%-0%	500 dcwv	COC-63
C206	5-75 μμf			COA-3
C207	0.01	+100%-0%	500 dcwv	COC-63
C208	0.001	+100%-0%	500 dcwv	COC-3
C220	6-100 μμf			COA-4L
C221	2.3-14.2 μμf			COA-26-2
C222	0.01	+100%-0%	1000 dcwv	COC-63
C223	50	+100%-10%	15 dcwv	COE-47
C224	0.01	+100%-0%	1000 dcwv	COC-63
C225	500 μμf	±5%	500 dcwv	COM-20D
C226	0.01	+100%-0%	1000 dcwv	COC-63
C227	0.001	+100%-0%	500 dcwv	COC-3
C228	0.001	+100%-0%	500 dcwv	COC-3
C240	3-12 μμf			COT-23
C241	1.5-7 μμf			COT-17
C242	510 μμf	±5%	300 dcwv	COM-20D
C243	0.01	+100%-0%	500 dcwv	COC-63
C244	0.001	+100%-0%	500 dcwv	COC-3
C245	0.01	+100%-0%	500 dcwv	COC-63
C246	0.001	±5%	500 dcwv	COM-20D
C247	60 μμf	±5%	500 dcwv	COM-20D

CAPACITORS (NOTE C)

				PART NO.
C248	2.7-19.6 μμf			COA-29-4
C249	2.7-19.6 μμf			COA-29-4
C250	15 μμf	±5%	500 dcwv	COM-20D
C251	2.7-19.6 μμf			COA-29-4
C252	4-50 μμf			COA-2
C253	0.001	+100%-0%	500 dcwv	COC-3
C254	0.001	+100%-0%	500 dcwv	COC-3
C255	0.01	+100%-0%	500 dcwv	COC-63
C256	15 μμf	±5%	500 dcwv	COM-20D
C260	1.0 μμf	±10%	500 dcwv	COC-1
C261	0.01	+100%-0%	500 dcwv	COC-63
C262	0.01	+100%-0%	500 dcwv	COC-63
C263	5-75 μμf			COA-63
C264	0.01	+100%-0%	500 dcwv	COC-63
C265	0.001	+100%-0%	500 dcwv	COC-3
C266	0.001	+100%-0%	500 dcwv	COC-3
C267	2.9-35 μμf			COA-27-35L
C300	0.001	+100%-0%	500 dcwv	COC-3
C301	0.01	+100%-0%	500 dcwv	COC-63
C302	0.01	+100%-0%	500 dcwv	COC-63
C303	2.6-10.7 μμf			COA-25
C304	0.0022	+100%-0%	500 dcwv	COC-62
C305	1.7-8.7 μμf			COA-29-2
C306	0.0022	+100%-0%	500 dcwv	COC-62
C307	1.0 μμf	±10%	500 dcwv	COC-1
C308	1.5-7 μμf			COT-17
C309	0.001	+100%-0%	500 dcwv	COC-3
C310	51 μμf	±5%	300 dcwv	COM-20D
C320	2.6-10.7 μμf			COA-25L
C321	51 μμf	±5%	500 dcwv	COM-20L
C322	24 μμf	±5%	500 dcwv	COM-20D
C323	50		15 dcwv	COE-47
C340	1.5-7 μμf			COT-17
C341	1.5-7 μμf			COT-17
C342	51 μμf	±5%	500 dcwv	COM-20D
C343	0.0022	+100%-0%	500 dcwv	COC-62
C344	0.0022	+100%-0%	500 dcwv	COC-62
C345	22 μμf	±5%	500 dcwv	COC-21NPO
C346	1.4-5.0 μμf			COA-29
C347	10 μμf	±10%	500 dcwv	COC-21NPO
C348	3.3 μμf	±10%	500 dcwv	COC-21NPO
C349	1.4-5.0 μμf			COA-29
C350	1.7-8.7 μμf			COA-29-2
C351	2.9-35 μμf			COA-27-35
C352	1.4-5.0 μμf			COA-29
C353	0.001	+100%-0%	500 dcwv	COC-3
C354	0.001	+100%-0%	500 dcwv	COC-3
C360	3.3 μμf	±10%	500 dcwv	COC-1
C361	0.0022	+100%-0%	500 dcwv	COC-62
C362	0.0022	+100%-0%	500 dcwv	COC-62
C363	0.0022	+100%-0%	500 dcwv	COC-62
C364	1.7-8.7 μμf			COA-29-2
C365	3.3 μμf	±10%	500 dcwv	COC-1
C366	0.0022	+100%-0%	500 dcwv	COC-62
C367	0.0022	+100%-0%	500 dcwv	COC-62
C368	0.0022	+100%-0%	500 dcwv	COC-62
C369	1.7-8.7 μμf			COA-29-2
C370	0.001 μμf	+100%-0%	500 dcwv	COC-3
C371	0.001 μμf	+100%-0%	500 dcwv	COC-3
C372	24 μμf	±5%	500 dcwv	COM-20D
C373	0.0022	+100%-0%	500 dcwv	COC-62
C508	0.1	±10%	400 dcwv	COW-25
C509A	10		450 dcwv	COE-25
C509B	10			
C510	0.001	+100%-0%	500 dcwv	COC-61
C511	0.0047	±10%	600 dcwv	COL-71

PARTS LIST (CONT)

		DESCRIPTION AND PART NO.		
MISCELLANEOUS	L1		485-4001	
	L100		1112-A-200	
	L101		1112-A-201	
	L120		1112-A-202	
	L140	2.5 mh	CHA-597	
	L141	2.5 mh	CHA-597	
	L160		1112-A-203	
	L200		1112-A-204	
	L201		1112-A-401	
	L220		1112-A-220	
	L240	2.5 mh	CHA-597	
	L241	2.5 mh	CHA-597	
	L242	8.2 mh	CHM-1	
	L260		1112-A-41	
	L261		ZCHA-19	
	L300		1112-A-42	
	L301		1112-A-43	
	L320		1112-A-44	
	L340		1112-A-205	
	L341		ZCHA-36	
	L342		ZCHA-36	
	L343		1112-A-402	
	L344		1112-A-45	
	L345		1112-A-46	
	L360		1112-A-43	
	L361		1112-A-824	
	L362		1112-A-43	
	L363		1112-A-825	
	D120	DIODE	1N35	
	D121	DIODE	1N35	
	D220	DIODE	1N35	
	D221	DIODE	1N35	
	D320	DIODE	1N34A	
	F1	FUSE, 1.2 amp (115 v)		FUF-1
	F1	FUSE, 0.6 amp (230 v)		FUF-1
	F2	FUSE, 1.2 amp (115 v)		FUF-1
	F2	FUSE, 0.6 amp (230 v)		FUF-1
	J1	CONNECTOR		874-371
	J2	JACK		CDMS-21
	J3	JACK		CDMS-21
	J4	CONNECTOR		874-371
	J100	JACK		CDMJ-21
	J101	CONNECTOR		874-371

		DESCRIPTION AND PART NO.	
MISCELLANEOUS	J200	JACK	CDSJ-10
	J201	CONNECTOR	874-371
	J300	JACK	CDSJ-10
	J301	CONNECTOR	874-371
	M1	METER, 0-100 μa, 1.5 k	MEDS-79
	M100	METER, 0-100 μa, 1.5 k	MEDS-95
	M200	METER, 0-100 μa, 1.5 k	MEDS-95
	M300	METER, 0-100 μa, 1.5 k	MEDS-95
	PL1	PLUG	CDPP-10
	PL2	PLUG	CDMP-20
	PL3	PLUG	CDMP-28
	PL4	PLUG	CDMP-22
	PL100	PLUG	CDMP-1264-8
	PL200	PLUG	CDMP-1264-8
	PL300	PLUG	CDMP-1264-8
	Q100	1-Mc QUARTZ PLATE	1112-A-404
	Q200	10-Mc QUARTZ PLATE	1112-A-403
	Q300	100-Mc QUARTZ PLATE	1112-A-406
	RX1	RECTIFIER	1N1083
	RX2	RECTIFIER	1N1083
	RX3	RECTIFIER	1N1083
	RX4	RECTIFIER	1N1083
	RX5	RECTIFIER, Transitron Co.	TM-7
	RX6	RECTIFIER, Transitron Co.	TM-7
	S1	SWITCH, dpst	SWT-333NP
	S100	SWITCH, dp3t	SWT-12
	S200	SWITCH, dp3t	SWT-12
	S300	SWITCH, dp3t	SWT-12
	S0100	SOCKET	CDMS-1-8
	S0200	SOCKET	CDMS-1-8
	S0300	SOCKET	CDMS-1-8
	T1	TRANSFORMER	365-489

TUBES	V100	6AU6	V260	6BC5
	V101	6AU6	V300	6X8
	V120	6C4	V340	6AN8
	V140	6AN8	V360	6BC5
	V160	6BC5	V361	6BC5
	V200	6X8	V501	6080
	V220	6C4	V502	12AX7
	V240	6AN8	V503	5651

NOTES:

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

COA - Capacitor, air
COC - Capacitor, ceramic
COE - Capacitor, electrolytic
COL - Capacitor, oil-impregnated
COM - Capacitor, mica
COT - Capacitor, trimmer
COW - Capacitor, wax
POSC - Potentiometer, composition
REC - Resistor, composition
REF - Resistor, film
REPO - Resistor, power
REW - Resistor, wire-wound

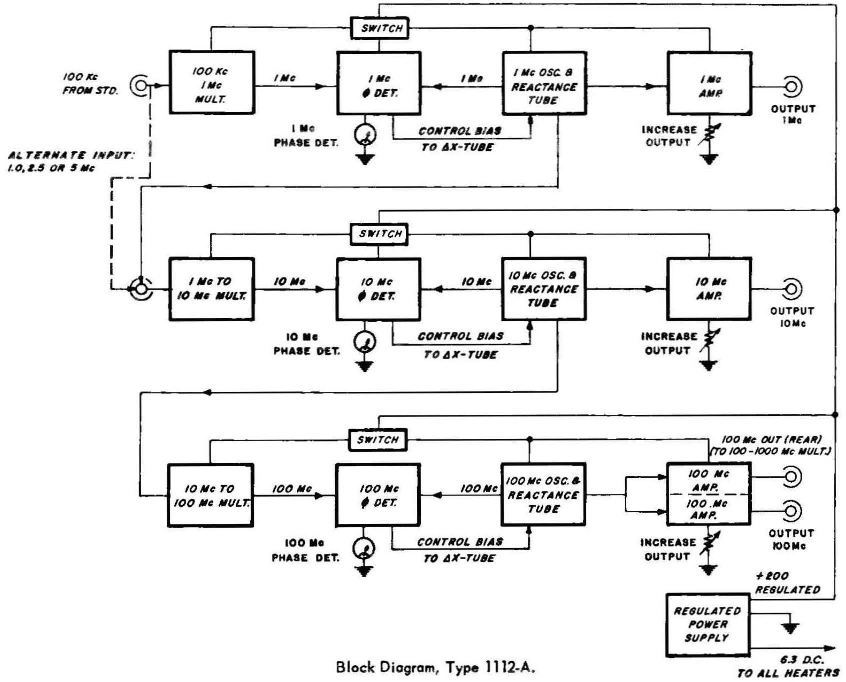
(B) All resistances are in ohms unless otherwise designated by k (kilohms) or M (megohms).

(C) All capacitances are in microfarads unless otherwise designated by μμf (micromicrofarads).

* Value determined in GR test lab; may be 680, 750, or 820 μμf.

** Value determined in GR test lab; may be 62, 68, or 75 μμf.

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



Block Diagram, Type 1112-A.

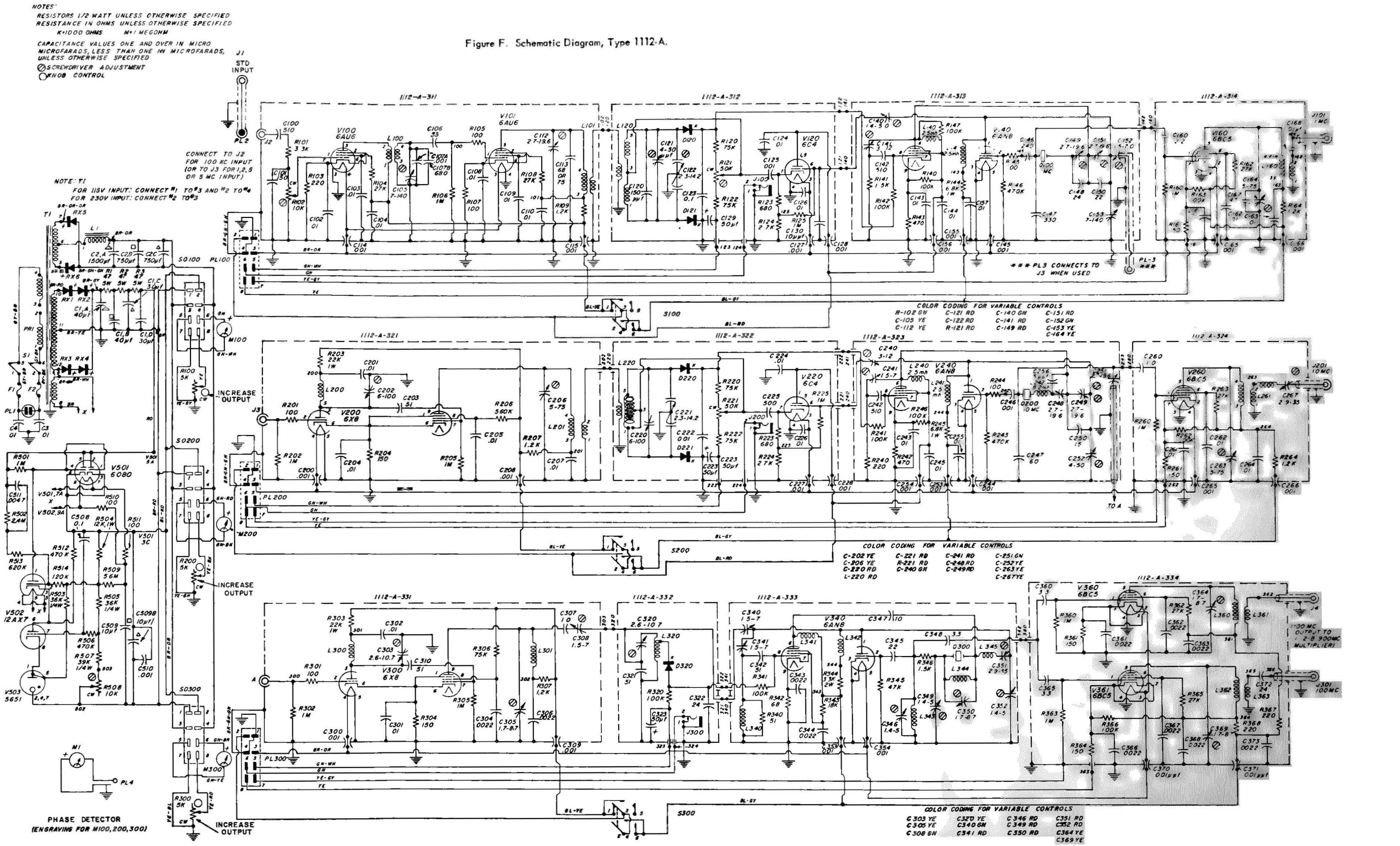


Figure F. Schematic Diagram, Type 1112-A.

TYPE 1112-B

SPECIFICATIONS

SPURIOUS SIGNALS	Unwanted harmonics of the input frequency are at least 100 db below the desired output frequency.
FREQUENCY MODULATION NOISE	Less than $\pm 1 \times 10^{-9}$ residual noise.
INPUT	20 mw, 100 Mc, sine wave from Type 1112-A.
OUTPUT	1000-Mc sine wave; 50 mw into 50-ohm load; 50-ohm output impedance.
LOCKING RANGE	±100 kc at the input frequency.
BANDWIDTH	Allowable frequency deviation rate is 100,000 cps at the input frequency.
POWER SUPPLY	105-125 (210-250) v, 50-60 cps, 120 watts. Power input accepts either 2-wire (Type CAP-35, furnished) or 3-wire (Type CAP-15) Power Cord.
DIMENSIONS	Relay-rack panel width 19 in., height 12-1/4 in. Over-all depth 11-1/2 in.
WEIGHT	25 lb.

General Radio EXPERIMENTER **reference:** Vol. 32, No. 10, March 1958.

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

This apparatus uses inventions of United States Patents licensed by Radio Corporation of America. Patent numbers supplied upon request. Licensed only for use in measuring or testing electronics devices, electron tube circuits, parts of such devices and circuits, and elements for use in such devices and circuits.

TABLE OF CONTENTS

Figure 1. Type 1112-B Standard Frequency Multiplier.

TYPE 1112-B
STANDARD FREQUENCY MULTIPLIER
(1000 Mc)

Section 1
INTRODUCTION

1.1 PURPOSE. The Type 1112-B Standard Frequency Multiplier (Figure 1) provides a 1000-Mc signal when supplied with a suitable 100-Mc input. Such an input is most conveniently derived from a companion instrument, the Type 1112-A Standard Frequency Multiplier, which in turn can be driven by a frequency standard such as the General Radio Type 1100-A.

1.2 DESCRIPTION.

1.2.1 CONTROLS. The table below lists the controls on the front panel of the Type 1112-B Standard Frequency Multiplier.

1.2.2 CONNECTORS. The Type 874 Coaxial Connector on the front panel is the 1000-Mc rf output connector. On the rear of the instrument are a Type 874 Connector for the 100-Mc input and a three-terminal male power connector.

1.2.3 METERS. The MONITOR AND TEST meter indicates limiter grid current, diode current in the 900-Mc multiplier, mixer diode current, or output level, depending on the setting of the switch below the meter. Meter calibration is from 0 to 100 microamperes.

The REPELLER VOLTAGE meter indicates current proportional to repeller voltage. The indication has been set on scale by means of an internal calibration adjustment. Meter calibration is from 0 to 100 microamperes.

TABLE OF CONTROLS

Name	Description	FUNCTION
POWER	Toggle switch	Turns instrument on or off.
MONITOR AND TEST	4-position selector switch	Determines function of MONITOR AND TEST meter. Continuous monitoring positions are marked by • .
REPELLER VOLTAGE	rotary control	Controls repeller voltage static value.
PUSH TO CHECK LOCK	Push button	Actuates detuning device in klystron cavity.
INCREASE OUTPUT	Continuous rotary control	Controls gain of 1000-Mc amplifier.

Section 2

PRINCIPLES OF OPERATION

2.1 GENERAL. The circuit of the Type 1112-B (see Figure 2) comprises a klystron oscillator and triode amplifier operating at 1000 Mc, and control circuits for establishing and maintaining a tight phase lock of the oscillator frequency to the tenth harmonic of the 100-Mc input frequency. The use of a locked oscillator as a selector eliminates the confusing spurious output signals often found in conventional multipliers.

The instrument requires an input of at least 20 milliwatts at 100 Mc. The available output power at 1000 Mc is at least 50 milliwatts.

2.2 INPUT AMPLIFIER AND MULTIPLIERS. The 100-Mc input signal is amplified in a 6AG5 pentode stage and then multiplied to 900 Mc by two tripler stages. The first tripler is a 6J6 push-pull triode, the second a pair of germanium diodes. Part of the output from the input amplifier is used to drive a 6AG5 buffer stage, which supplies the reference-phase signal to a 100-Mc phase detector.

As a check on the over-all operation of the multiplier stages, the rectified dc in the diode tripler stage is metered, and may be read on the MONITOR AND TEST meter with the switch set at 900 MC MULTIPLIER.

2.3 OFFSET LOCKING SYSTEM. The 900-Mc output of the second tripler stage is fed to a diode mixer, along with the 1000-Mc signal from the klystron oscillator, producing a beat frequency of 100 Mc. This 100-Mc intermediate frequency is amplified and limited in a three-stage amplifier, and supplied to the "variable phase" input of the 100-Mc phase detector. The output of the phase detector is mainly a dc voltage that varies with the relative phase of the two input signals. This dc signal drives a 6AU6 dc amplifier, which varies the klystron repeller voltage, thus varying the oscillator frequency. When the frequency is near zero beat with the 1000-Mc target frequency, the phase-detector output signal causes the repeller voltage to lock the klystron on frequency. The output frequency is thus stabilized at a value of 1000 Mc.

2.4 DIODE MIXER. The 1N21B diode mixer stage comprises an input parallel-tuned circuit (L118, C135 in Figure 2) at 1000 Mc, and a series-tuned circuit (L120, C137) for the 900-Mc input. The inductance L119 acts as an rf choke, furnishing a dc return for the diode current. The mixer diode current can be read on the MONITOR AND TEST meter with the switch set at 900-1000 MC MIXER. The output circuit of the mixer is the series-tuned input circuit of V105 (C136, L121, and C_{gk} of V105; C139 is a blocking capacitor). This circuit is tuned by adjustment of L121.

2.5 I-F AMPLIFIER LIMITER. The i-f amplifier limiter comprises V105 and V106 as amplifiers, and V107 as a limiter stage. The pass band of this amplifier is at about 100 ±1.7 Mc. The 100-Mc amplitude-limited output signal is supplied to the input of the 100-Mc phase detector.

2.6 PHASE DETECTOR. The 100-Mc phase detector compares the reference-phase signal from the 6AG5 buffer with the "variable-phase" signal from the amplifier limiter. The reference-phase input signal is applied to a tuned input circuit (L113, C121), balanced to rf "ground" by means of C127 and C128. The "variable phase" signal is applied to a tuned circuit (L115, C126), with one side at rf "ground". This circuit is broad-banded by the loading resistor R113.

The vector sum of the "variable phase" voltage across C126 and one-half of the reference-phase voltage across L113 (one side of C121) produces voltages which are rectified by diodes D103 and D104. If the "variable phase" voltage is at a 90-degree angle to the reference-phase voltage, the summation voltages are equal, and the rectified voltages developed by diodes D103 and D104 are equal and opposite in sign with respect to the slider arm of R114. The arm of R114 must be carefully centered to compensate for rectification characteristics of the diodes. This procedure is described in paragraph 5.2.4.

WARNING

The rf chassis of the 100-Mc phase detector and the phase-detector circuits are -625 volts off dc ground. Do not touch the adjustments or use a volt-ohmmeter on these circuits while normal operating voltages are applied.

In normal operation the phase-detector dc output voltage varies on both sides of zero, driving the grid of the dc amplifier V104, and causing the repeller voltage to change in order to keep the klystron in the phase-locked condition. Repeller voltage can be read on the front-panel REPELLER VOLTAGE meter.

2.7 OSCILLATOR AND AMPLIFIER. The 1000-Mc klystron oscillator (V108) and pencil-triode amplifier (V109) are mounted on a removable subassembly, which is fastened to brackets on the rear of the panel. In order to facilitate tube changes, this subassembly can be removed from the brackets with cable connections left undisturbed. The klystron is mounted in a quarter-wavelength coaxial cavity, and operates in the 1-3/4 mode. The 5876 grounded-grid amplifier provides gain and isolation to protect the control circuit and klystron tuning from the effects of external signals and variation of load impedance. A PUSH TO CHECK LOCK button on the front panel provides a means of introducing a small detuning effect in the klystron resonator. Pressing this button produces a deviation of the klystron cavity tuning, which causes the control circuit to readjust the repeller voltage to maintain phase lock. The resulting deviation in the repeller voltage can then be read on the REPELLER VOLTAGE meter.

2.8 POWER SUPPLY. The power supply operates from 105-125 (or 210-250) volts, 50-60 cps alternating current, and uses 120 watts. The power-transformer primary may be connected for either 105-125 or 210-250 volts as indicated in Figure 4. Three high-voltage regulating circuits are provided, one to operate the conventional circuits with the negative side grounded to the chassis, a second for the main klystron supply, and a third for the klystron repeller-voltage control circuit. The klystron uses a rectified heater supply.

Section 3

OPERATING PROCEDURE

3.1 INSTALLATION. The Type 1112-B should be installed as close as convenience permits to the place where measurements are to be made. Distance from the driving source should also be kept to a minimum, to reduce cable losses and ensure the necessary 20-milliwatt input signal.

Before connecting power to the instrument, check that the fuses and power transformer connections are correct for the operating voltage to be used. Power fuses are mounted at the rear of the instrument, just above the power connector. The voltage for which the power transformer is connected is indicated on the nameplate near the power input connector. When changing transformer connections, reverse this nameplate and substitute fuses of the proper rating, as listed in the Parts List at the rear of this manual.

The 100-Mc input should be connected to the Type 874 Coaxial Connector on the right rear of the instrument. The output cable should be connected to the Type 874 OUTPUT coaxial connector on the front panel. A 50-ohm coaxial cable is recommended.

Make certain that all tubes are in their proper sockets. Under some circumstances, the klystron and possibly the pencil triode (V109) may be shipped separately.

3.2 SETTING MULTIPLIER IN OPERATION. After making the checks described in paragraph 3.1, place the Standard Frequency Multiplier in operation as follows:

a. Connect the power cord to the male power connector on the rear of the Multiplier and to a suitable ac power source. Snap the POWER switch on.

b. Set the MONITOR AND TEST switch to 900 MC MULTIPLIER. Check for a meter deflection of about half scale (50 μa), representing dc rectified by the diode tripler stage.

c. Check for input to the mixer by setting the MONITOR AND TEST switch to 900-1000 MC MIXER. The meter deflection should be about half scale or less.

d. Set the MONITOR AND TEST switch to 100 MC LIMITER. If the klystron and its control circuits are operating properly, there will be grid current in the limiter stage.

e. Set the MONITOR AND TEST switch to 1000 MC OUTPUT, and check the available output power at 1000 Mc by turning the INCREASE OUTPUT control clockwise and noting increasing current on the meter.

f. To check that the klystron is locked, first rotate the REPELLER VOLTAGE control. The REPELLER VOLTAGE meter indication should be within about 15 divisions of midscale, and should hold steady as the control is rotated through much of its range. Set the control within the range marked SET. Then push the PUSH TO CHECK LOCK button. The REPELLER VOLTAGE meter should deflect slightly. Only if these two checks are made successfully is the klystron locked. Under normal conditions, the entire multiplier should stabilize and lock after five minutes of warm-up.

g. If the klystron fails to lock properly, it may be necessary to adjust the oscillator frequency by means of the adjustment (C157) on the side of the resonator. Refer to paragraph 5.2.7.

h. For normal operation, the MONITOR AND TEST switch should be left in one of the positions marked with a dot, because the meter will then indicate a sudden change in operating mode. The 100 MC LIMITER current reading indicates that the klystron beat note is within the i-f amplifier pass band, with adequate level, and that the klystron is probably locked. The 1000 MC OUTPUT current indicates output level, and thus over-all performance. However, this may be misleading if external signals are fed into the OUTPUT connector or if the INCREASE OUTPUT control is set for low output.

Section 4

CHECKS AND ADJUSTMENTS

4.1 KLYSTRON LOCK. If proper lock is established, changing the INCREASE OUTPUT setting will cause the REPELLER VOLTAGE meter reading to vary only slightly from its normal midscale position. However, the 100-MC LIMITER current (as read on the MONITOR AND TEST meter with the switch at 100 MC LIMITER) should not change as the INCREASE OUTPUT setting is varied.

A check with a heterodyne oscillator will immediately detect a properly locked condition if the input signal is crystal-controlled (as from a Type 1112-A Standard Frequency Multiplier). When the klystron is thus properly locked at 1000 Mc, the output signal sounds like that of a crystal oscillator, assuming the controlling source is adequately stable.

If the resonator cavity needs retuning, the process will be simplified with the aid of a heterodyne oscillator to observe effects of tuning adjustments. The General Radio Type 720 Heterodyne Frequency Meter or a combination of Type 1218 Unit Oscillator, Type 874-MR Mixer-Rectifier and a suitable audio amplifier is recommended.

4.2 INCORRECT KLYSTRON MODE. The klystron repeller-voltage control circuit may accidentally lock the frequency at 1000 Mc in the 2-3/4 mode, instead of the proper 1-3/4 mode (refer to paragraph 2.7). This is most likely if power is interrupted after the instrument is warmed up. When locked in the 2-3/4 mode, the klystron delivers only a fraction of its normal output power. The REPELLER VOLTAGE meter will read between 0 and 20 μa (about -20 to -30 volts dc on the repeller). To restore proper operation in the 1-3/4 mode, rotate the REPELLER VOLTAGE control through the SET sector, then reset it in the SET sector.

4.3 FALSE LOCK. The klystron may sometimes generate a sideband that locks at 1000 Mc, leaving the main klystron carrier frequency unlocked. When this occurs, the 100-Mc LIMITER meter will indicate well below midscale, and a check with a heterodyne oscillator-detector will disclose a weak clean signal at 1000 Mc, a strong, rough signal either above or below 1000 Mc, and an additional sideband or series of sidebands on the other side of the carrier. Rotating the REPELLER VOLTAGE control counterclockwise and returning it to the SET sector usually restores proper lock. If this readjustment does not restore proper lock, retune L124 (refer to paragraph 5.2.9).

Section 5

SERVICE AND MAINTENANCE

5.1 GENERAL. Refer to paragraph 5.1, page 6.

5.2 ALIGNMENT PROCEDURE.

WARNING

High voltage is applied continuously to the subchassis of the 100-Mc phase-detector unit during the operation of the instrument. This subchassis, covered by a shield can marked WARNING HIGH VOLTAGE, should not normally require adjustment.

5.2.1 GENERAL. For a complete alignment, several items of test equipment will be needed:

Required Items:

a. Volt-ohm-milliammeter, 20,000 ohms/volt. (Scales to cover up to at least 650 volts dc.)

b. Grid-dip oscillator, 100-300 Mc.

c. Vacuum-tube voltmeter (GR Type 1800-B or 1803-B).

d. Heterodyne test oscillator (GR Type 720 Heterodyne Frequency Meter).

Desirable Items:

e. UHF grid-dip oscillator (900-1000 Mc).

f. VHF signal generator (GR Type 1021-AV).

5.2.2 100-900-MC MULTIPLIER ADJUSTMENT. To check the alignment of this section, set the MONITOR AND TEST switch to 900 MC MULTIPLIER and check that C101, C107, C112, and C113 are set for maximum meter current. If these adjustments seem to be correct, and if the klystron oscillator seems to be functioning properly, set the MONITOR AND TEST switch to 100 MC LIMITER. The limiter current will then be directly affected by the settings of C101, C107, C112, C113, C114, and C137. The 900-1000 Mc mixer is driven by the multiplier chain and by the klystron, but since the magnitude of the klystron signal is much larger than that of the multiplier-chain output, the beat-note amplitude is controlled principally by the amplitude of the 900-Mc signal. Thus the 100 MC LIMITER current is an index of the effectiveness of the multiplier chain.

For a further check on the 100-900 Mc multiplier chain, it is possible to check the tuning of the chain by setting the MONITOR AND TEST switch to 900-1000 MC MIXER, disabling the klystron oscillator by pulling out the rf unit power cable plug (PL101), and checking for maximum mixer current while trimming C101, C107, C112, C113, C114, and C137. The setting of C137 is broad, and depends on correct adjustment of C135. C137 should not be readjusted under normal circumstances.

CAUTION

Before reinserting the power plug for the rf units, switch the entire instrument off to avoid danger of damaging the klystron.

In view of the check afforded by the 100 MC LIMITER current, it should seldom, if ever, be necessary to carry out a complete check by disabling the klystron.

To check operation of the diode harmonic generators (D101, D102), measure the dc voltage from the center tap of L107 (R109) to ground. This should be from 10 to 19 volts measured with a vacuum-tube or 20,000 ohm/volt meter. With some diodes, proper operation may be obtained with slightly lower dc voltage developed.

Each stage can be aligned for proper operation easily with a grid-dip oscillator (such as Measurements Corp. Model 59 Megacycle Meter) for C101-L101, C107-L102, C112-L105, and C113-L107. Adjustment of C114-L108 requires a 900-Mc wavemeter such as the GR Type 1140 (with meter indicator) or a uhf grid-dip oscillator (such as the Boonton Electronics Model 101). C137 must be set for maximum 900-1000 MIXER current after adjustment of the 900-Mc multiplier circuits and after proper setting of C135 (refer to paragraph 5.2.6).

5.2.3 100-MC AMPLIFIER-LIMITER ADJUSTMENT. The two 100-Mc amplifier stages and the 100-Mc limiter stage are mounted in a shielded subchassis. Alignment of these stages is easy to check, up to the limiter grid current. Set the MONITOR AND TEST switch to 100 MC LIMITER and peak grid current with L121, L122, and L123. For this test, the beat note from the normally operating signal system will be adequate. A test signal can be injected (for trouble-shooting) at C136 (crystal mixer diode socket) if the 100-Mc test signal is connected across C136 to ground. When normal operation is resumed, L121 may require slight readjustment to peak up the input circuit.

Adjustment of the 100-Mc limiter requires reference to the 100-Mc phase-detector output circuit. Before beginning this adjustment, disable the klystron power supplies by removing the series-regulator tubes (V501B, V501C) from the voltage-regulator circuits to avoid danger of damaging the phase-detector diodes. Check the tuning of L124 by measuring the dc output voltage between slider and either end of R114 with a vacuum-tube voltmeter. Set L124 for maximum output voltage, using the 100-Mc reference standard injected across C136. Then detune L124 about one turn clockwise. (Refer to paragraph 5.2.9.)

5.2.4 100-MC PHASE-DETECTOR ADJUSTMENT.

5.2.4.1 General.

WARNING

The phase-detector subchassis, R114, and circuits associated with V104 are normally at -625 volts dc. Avoid bodily contact with components to prevent personal injury. Avoid short-circuiting any of the terminals of R114 and R115 to ground, even momentarily, as such a short will damage the phase-detector diodes (D103, D104). Carry out the following adjustments with extreme caution.

Adjustment of the 100-Mc phase detector requires adequate test equipment for proper results. The principal reason for readjustment would be failure of the diode rectifiers (D103, D104) caused by accidental short-circuiting of the phase-detector output circuit to ground, or other component failure having similar effect on these diodes. Under normal circumstances, the phase-detector circuits will not require adjustment.

Before any realignment of the phase detector is undertaken, it is necessary to change the power-supply circuits in order to ground the phase detector and to remove the accelerating voltage from the klystron. To make this change, first unsolder the lead (black with red tracer) from the terminal at the bottom rear of the middle etched-circuit regulator board in the power-supply section (this lead goes to pin 3 of V501B). Then solder this lead to anchor terminal 117, which is the solder terminal mounted over the supporting post at the top edge of the bottom etched-circuit regulator board. This wiring change is shown in Figure 4, near the multipoint connector. When this change is made, the phase-detector chassis is connected to dc chassis ground. Check this with an ohmmeter before proceeding further. With the power supply thus rewired the dc amplifier tube (V104) and the REPELLER VOLTAGE meter can be used as a vacuum-tube-voltmeter null detector to determine that the phase detector is balanced.

5.2.4.2 Adjustment of Unbalanced Phase (C126-L115).

a. Rewire the power supply as described in paragraph 5.2.4.1 to ground the phase-detector chassis.

b. Apply a 100-Mc signal across C136 to ground (900-1000-Mc mixer socket), and check the dc voltage between the slider and each end of R114 with a vacuum-tube voltmeter. The dc voltage between center and either end should be from 3 to 10 volts, and the two voltages should be equal (±10%) when the slider is set to the center of its resistance range.

c. Since the voltages from the slider to each of the load resistors are the same and add in opposition, the voltage across R114 should be zero when the circuit is working properly with input to the unbalanced-phase input circuit only. The input to the balanced-phase circuit can be completely removed (by removal of V103), but it is usually sufficient to remove the driving power from the input connector on the rear of the instrument.

5.2.4.3 Adjustment of Balanced Phase (C121-L113, C127-C128).

a. Rewire the power supply as described in paragraph 5.2.4.1 to ground the phase-detector chassis.

b. Apply a 100-Mc signal to the Type 874 input connector at the rear of the instrument.

c. Adjust C101, C107, L110, and C121 for maximum dc voltage between slider and either end of R114, as measured with a vacuum-tube voltmeter. The voltage should be between 1.5 and 3 volts between slider and each end of R114. These voltages add in opposition to produce zero volts (null) across R114 when the circuit is properly balanced.

d. Balancing of the entire phase-detector circuit requires that each of several elements be selected and adjusted to provide the best possible null across R114, with the input signal supplied to either the balanced-phase input (L112) or the unbalanced-phase input (L116). The critical balancing adjustments are R114, C127, and C128. The balancing procedure is as follows:

(1) Make sure that the diodes (D103, D104) have not been damaged and that none of the circuit components is shorted out (especially C127 and C128). These diodes have been selected for balance; if it is ever necessary to replace them, be sure to select a pair near balance, or use the diodes sold paired (e.g. 1N35). If any dc voltage is developed across both halves of R114, diodes are probably satisfactory and should not require replacement. If no dc output voltage appears between slider and either end of R114, unsolder the leads to the slider and the counterclockwise end of R114 (junction with R115), and check the forward and reverse resistances of the diodes with an ohmmeter. Forward resistance should be between 50 and 100 ohms (4.5 volts applied); reverse resistance should be over 300,000 ohms, and preferably over 500,000 ohms (4.5 volts applied). Both diodes should show similar reading. This check is not necessary if the diodes in use are the original diodes and the dc output voltage is approximately the same from each side.

(2) Check that C127 and C128 are not shorted.

(3) Center the slider of R114, using an ohmmeter. It is not necessary to unsolder leads if the negative terminal of the ohmmeter is applied to the slider.

(4) Align the rf circuits for maximum dc voltage between slider and each end of R114 (refer to preceding step), using input to unbalanced phase only.

(5) Connect a dc vacuum-tube voltmeter across R114 from end to end, or across test points TP1 and TP3. If the voltmeter indicates zero, the phase detector is balanced. If the voltmeter indication is very near (±0.1 volt) zero, adjust R114 for null.

(6) Remove the input from the unbalanced phase, apply input to the balanced phase, and adjust C128 for null as indicated by a dc vacuum-tube voltmeter across R114. If a null cannot be obtained, readjust C127 by bending the tab attached to C121, and then reset C128 for null.

(7) The REPELLER VOLTAGE meter may be used as a null indicator as follows: first establish the reading of this meter with a short circuit (i.e., a clip lead) between the ends of R114, and then remove the short circuit. When the phase detector is balanced, the meter reading will be the same as it was with the short-circuit in place.

(8) After completion of the alignment adjustments outlined above, the phase detector should be balanced for both balanced-phase and unbalanced-phase input signals, taken one at a time. Never attempt to adjust phase - detector balance with both sides energized.

(9) Rewire the power supply as it was originally connected.

5.2.5 DC AMPLIFIER ADJUSTMENT. The dc amplifier adjustment R116 should be set so that, without rf input at the coaxial input connector, a dc voltage of about -105 volts appears between the klystron cathode (pin 3, V108) and klystron repeller (pin 5, V104). This setting, which should be inside the zone marked SET on the front - panel REPELLER VOLTAGE control, is evidenced by a REPELLER VOLTAGE meter reading slightly above midscale (approximately 60 μa).

CAUTION

Both of these check points are at high negative voltage with respect to the chassis ground.

5.2.6 900-1000 MC MIXER TUNING ADJUSTMENT. The 900-1000-Mc mixer is adjusted at the factory, and should require little or no attention under normal conditions. Proper operation is evidenced by a MONITOR AND TEST meter reading near midscale with the switch at 900-1000 MC MIXER. This current indication is affected principally by rectification of the 1000-Mc input signal from the klystron. If it is certain that trouble exists in the 1000-Mc tuned circuit (C135-L118), C135 should be adjusted to peak the circuit. Improper adjustment of C135 may peak the meter indication at a frequency other than 1000 Mc, and may lead to misadjustment of the klystron for maximum output on an incorrect frequency. Such misalignment of the mixer may prevent the klystron from locking to the correct frequency.

To readjust the mixer, first set C135 for maximum current with the klystron operating at 1000 Mc. Then set C137 for maximum 100 MC LIMITER current, with the entire instrument operating and the klystron locked.

It is also possible to check the setting of C137 by disabling the klystron and carrying out the checks described in paragraph 5.2.2.

To replace the 1N21B mixer diode (D105), remove shield can from mixer, swing the spring clip to one side, lift out the diode and insert the replacement, securing it by returning the spring clip. Replace the shield can.

5.2.7 KLYSTRON OSCILLATOR ADJUSTMENT. The klystron oscillator frequency adjustment is C157, a screw-type adjustment set in the side of the oscillator resonator. It will be necessary to reset this adjustment after replacement of the klystron, and it may be necessary to reset it to re-establish proper locking conditions after aging of the circuit elements. In the absence of a 100-Mc control signal at the input connector, use a heterodyne frequency meter to establish the frequency of the klystron near 1000 Mc. Then adjust the oscillator frequency by turning the tuning screw. Once the klystron is tuned to the correct frequency, lock the screw by taking up on the check nut. Caution is advised to prevent personal contact with the series-regulator tubes in the power supply to avoid burns.

Adjustment of the tuning screw will have a pronounced effect on the REPELLER VOLTAGE meter indication if the klystron is locked at 1000 Mc with a 100-Mc signal at the input connector. If the klystron is not locked there will be no appreciable effect. It may be necessary to trim C157 after the instrument warms up in order to operate the klystron at -105-volt repeller voltage, the optimum repeller voltage value.

To replace the klystron (V108), unscrew the support plate holding the klystron socket, pull the entire tube out of the resonator, and insert the replacement Type 6BM6 klystron. It is desirable to insert the klystron into the resonator and to seat it against the internal stop-ring before installing the socket on the base of the klystron. Replacement of the klystron may necessitate retuning of the resonator (C157).

5.2.8 1000-Mc AMPLIFIER ADJUSTMENT. The tuning adjustment of the 1000-Mc amplifier is C201, on the side of the amplifier chassis. The capacitor knob can be turned with the fingers, or a screw driver can be inserted in the slot and used as an adjusting lever. A few degrees of shaft rotation covers the entire range of adjustment. C201 should be set for maximum 1000 MC OUTPUT current as indicated on the MONITOR AND TEST meter.

To replace the 1000-Mc amplifier tube (V109), proceed as follows:

a. Remove r-f chassis from brackets in rear of instrument.

b. Remove the screws that attach the cover of the amplifier chassis, and remove the cover.

c. Loosen the two screws holding the crossbar in place at the center partition. The crossbar holds the grid flange of the pencil tube captive by filling the gap in the circle of the spring contacts.

d. Remove the crossbar, withdrawing with it the spring fingers that hold the grid flange in its circular contact spring.

e. Pull off the heater-lead socket at the cathode end of the tube just far enough to release the heater leads. It is necessary to bend the rf choke leads slightly to do this.

f. Lift the grid flange, and if necessary, the cathode cylinder, of the pencil tube. The tube should come out easily.

g. To insert the replacement Type 5876 tube, first push the grid flange into the spring contact in the center partition (with crossbar removed). The cathode cylinder will engage the two-pronged cathode contact spring and snap into position when the tube is inserted properly. The anode cylinder should not bind at any point, but should make good contact with the spring fingers inside the trough (plate tuning inductance).

h. Orient the tube so that the two small heater leads can be inserted in the appropriate holes in the socket. Insert leads and push socket on until it touches cathode cylinder (as far as it will go).

i. Replace the crossbar, making sure that the spring fingers grip both sides of the grid flange. Tighten screws holding the crossbar in place.

j. Replace the cover, tightening all screws.

k. Check the tuning by advancing the INCREASE OUTPUT control and peaking the tuning adjustment (C201) for maximum 1000 MC OUTPUT current.

To replace the monitor diode (D201), remove the screw holding the retaining spring, and remove the diode. Insert the new 1N21B, and replace the spring and screw. If the 1000 MC OUTPUT current is much beyond full scale when the INCREASE OUTPUT control is fully advanced with no load, rotate the mounting of the diode coupling loop slightly to reduce coupling and lower the meter reading. To make this adjustment, loosen the nut (inside the amplifier chassis) holding the diode pickup loop, and tighten the nut while holding the loop mounting bushing at a proper angle. This adjustment should not be necessary unless the replacement 1N21B is markedly different from the original diode.

5.2.9 ADJUSTMENT TO OPTIMIZE LOCK RANGE. In order to obtain the optimum locking characteristics, it is necessary to detune L124 from the setting that gives maximum output voltage at the phase detector. With the instrument in operation, turn the tuning slug of L124 slowly clockwise while swinging the REPELLER VOLTAGE control over a wide angle. The optimum setting of L124 is that which permits the REPELLER VOLTAGE control setting to be varied most without losing lock. The amount that the slug of L124 must be detuned will normally be from 1/2 to 4 turns from its "peaked" setting.

Under normal conditions, the REPELLER VOLTAGE control should be left set inside the SET range. For further details on the adjustment of L124, refer to paragraph 5.2.3.

TABLE OF VOLTAGES

TUBE (TYPE)	PIN	DC VOLTS
V501A	1	+240
(6AU5)	3	+250
	5	+355
	8	+355
	2,7	+125
V502A	1	+240
(12AX7)	2	+155
	3	+158
	4,5,9	+125
	6	+158
	7	+ 78
	8	+ 84
V503A	1,5	+ 84
(5651)	2,4,7	0
V501B	1	- 21
(6AU5)	3	0
	5	+140
	8	+140
	2,7	-185
V502B	1	- 21
(12AX7)	2	-152
	3	-155
	4,5,9	-185
	6	-155
	7	-240
	8	-245
V503B	1,5	-245
(5651)	2,4,7	-330

TUBE (TYPE)	PIN	DC VOLTS
V501C	1	-355
(6AU5)	3	-330
	5	-180
	8	-180
	2,7	-490
V502C	1	-355
(12AX7)	2	-471
	3	-468
	4,5,9	-490
	6	-468
	7	-540
	8	-560
V503C	1,5	-560
(5651)	2,4,7	-625
V101	1	0
(6AG5)	2,7	+2.1
	3	6.5 ac
	4	0
	5	+225
	6	+135
V102	1	+220
(6J6)	2	+220
	3	6.5 ac
	4	0
	5	0
	6	0
	7	+16
V103	1	0
(6AG5)	2,7	+2.1
	3	6.5 ac
	4	0
	5	+240
	6	+145

TUBE (TYPE)	PIN	DC VOLTS
V104	1	-625
(6AU6)	2,7	-625
	3,4	-625
	5	-430
	6	-525
V105	1	0
(6AK5)	2,7	+2.1
	3	6.5 ac
	4	0
	5	+124
	6	+124
V106	1	0
(6AK5)	2,7	+2.0
	3	6.5 ac
	4	0
	5	+130
	6	+130
V107	1	-0.4
(6AG5)	2,7	0
	3	6.5 ac
	4	0
	5	+122
	6	+116
V108	1	0
(6BM6)	2	-318.5
	3	-325
	4	-325
	cap	-430
V109	L204	6.5 ac
(5876)	L205	0
	cath.	+1 to +16
	grid	0
	plate	+240

NOTE: Voltages measured with vacuum-tube voltmeter, with Multiplier in locked condition.

Section 6

PARTS LIST

		PART NO. (NOTE A)			
RESISTORS (NOTE B)	R100	5 k	±5%		971-M
	R101	10 k	±5%	1/2 w	REC-20BF
	R102	220	±5%	1/2 w	REC-20BF
	R103	56 k	±5%	1/2 w	REC-20BF
	R104	3.3 k	±5%	1 w	REC-30BF
	R105	33 k	±5%	1/2 w	REC-20BF
	R106	33 k	±5%	1/2 w	REC-20BF
	R107	1 k	±5%	1 w	REC-30BF
	R108	1.8 k	±5%	2 w	REC-41BF
	R109	22 k	±5%	1/2 w	REC-20BF
	R110	220	±5%	1/2 w	REC-20BF
	R111	56 k	±5%	1/2 w	REC-20BF
	R112	1 k	±5%	1/2 w	REC-20BF
	R113	2.2 k	±5%	1/2 w	REC-20BF
	R114	2 k	±5%		971-413
	R115	10	±5%	1/2 w	REC-20BF
	R116	1 k	±5%		971-K
	R117	22 k	±5%	2 w	REC-41BF
	R118	33 k	±5%	2 w	REC-41BF
	R119	56 k	±5%	1/2 w	REC-20BF
	R120	1 k	±5%	1/2 w	REC-20BF
	R121	3.3 k	±5%	1 w	REC-30BF
	R122	100	±5%	1/2 w	REC-20BF
	R123	470 k	±5%	1/2 w	REC-20BF
	R124	220	±5%	1/2 w	REC-20BF
	R125	5.6 k	±5%	1/2 w	REC-20BF
	R126	13 k	±5%	5 w	REPO-43
	R127	470 k	±5%	1/2 w	REC-20BF
	R128	220	±5%	1/2 w	REC-20BF
	R129	10	±5%	1/2 w	REC-20BF
	R130	13 k	±5%	5 w	REPO-43
	R131	10 k	±5%	1/2 w	REC-20BF
	R132	10	±5%	1/2 w	REC-20BF
	R133	13 k	±5%	5 w	REPO-43
	R134	100	±5%	1/2 w	REC-20BF
	R135	(NOTE C)	±5%	1/2 w	REC-20BF
	R136	75	±5%	1/2 w	REC-20BF
	R137	47	±5%	1/2 w	REC-20BF
	R138	75	±5%	1/2 w	REC-20BF
	R139	82	±5%	1/2 w	REC-20BF
	R140	5.1 k	±5%	1/2 w	REC-20BF
	R142	68 k	±10%	2 w	REC-41BF
	R143	3.3 k	±10%	1 w	REC-30BF
	R144	100 k	±10%	2 w	REC-41BF
	R145	100 k	±10%	2 w	REC-41BF
	R146	100 k	±10%	2 w	REC-41BF
	R147	100 k	±10%	2 w	REC-41BF
	R148	100 k	±10%	2 w	REC-41BF
	R149	100 k	±10%	2 w	REC-41BF
	R150	47	±10%	10 w	REPO-44
	R151	47	±10%	10 w	REPO-44
	R152	47	±10%	10 w	REPO-44
	R153	0.7	±10%	10 w	REPO-44
	R154	1.0	±10%	10 w	REPO-44
	R155	1.8	±10%	10 w	REPO-44
	R156	560 k	±5%	1/2 w	REC-20BF
	R157	560 k	±5%	1/2 w	REC-20BF
	R158	560 k	±5%	1/2 w	REC-20BF
	R159	1 k	±5%	1/2 w	REC-20BF
	R501A	1 M	±10%	1/2 w	REC-20BF

		PART NO. (NOTE A)			
RESISTORS (NOTE B)	R501B	1 M	±10%	1/2 w	REC-20BF
	R501C	1 M	±10%	1/2 w	REC-20BF
	R502A	2.4 M	±5%	1/2 w	REC-20BF
	R502B	2.4 M	±5%	1/2 w	REC-20BF
	R502C	2.4 M	±5%	1/2 w	REC-20BF
	R503A	36 k	±1%	1/4 w	REF-65
	R503B	36 k	±1%	1/4 w	REF-65
	R503C	36 k	±1%	1/4 w	REF-65
	R504A	26 k	±1%	1 w	REF-75
	R504B	43 k	±5%	2 w	REC-41BF
	R504C	39 k	±5%	2 w	REC-41BF
	R505A	36 k	±1%	1/4 w	REF-65
	R505B	36 k	±1%	1/4 w	REF-65
	R505C	36 k	±1%	1/4 w	REF-65
	R506A	470 k	±5%	1/2 w	REC-20BF
	R506B	470 k	±5%	1/2 w	REC-20BF
	R506C	470 k	±5%	1/2 w	REC-20BF
	R507A	39 k	±1%	1/4 w	REF-65
	R507B	39 k	±1%	1/4 w	REF-65
	R507C	39 k	±1%	1/4 w	REF-65
	R508A	10 k	±10%		POSW-3
	R508B	10 k	±10%		POSW-3
	R508C	10 k	±10%		POSW-3
	R509A	5.6 M	±10%	1/2 w	REC-20BF
	R509B	5.6 M	±10%	1/2 w	REC-20BF
	R509C	5.6 M	±10%	1/2 w	REC-20BF
	R510A	100	±10%	1/2 w	REC-20BF
	R510B	100	±10%	1/2 w	REC-20BF
	R510C	100	±10%	1/2 w	REC-20BF
	R511A	100	±10%	1/2 w	REC-20BF
	R511B	100	±10%	1/2 w	REC-20BF
	R511C	100	±10%	1/2 w	REC-20BF
	R512A	470 k	±5%	1/2 w	REC-20BF
	R512B	470 k	±5%	1/2 w	REC-20BF
	R512C	470 k	±5%	1/2 w	REC-20BF
	R513A	620 k	±5%	1/2 w	REC-20BF
	R513B	620 k	±5%	1/2 w	REC-20BF
	R513C	620 k	±5%	1/2 w	REC-20BF
	R514A	120 k	±5%	1/2 w	REC-20BF
	R514B	120 k	±5%	1/2 w	REC-20BF
	R514C	120 k	±5%	1/2 w	REC-20BF
	R515B	330 k	±10%	2 w	REC-41BF
	R515C	330 k	±10%	2 w	REC-41BF
CAPACITORS (NOTE D)	C1A	50 µf			
	C1B	25 µf		450 dcwv	COE-10
	C1C	25 µf			
	C2A	50 µf			
	C2B	25 µf		450 dcwv	COE-10
	C2C	25 µf			
	C3A	50 µf			
	C3B	25 µf		450 dcwv	COE-10
	C3C	25 µf			
	C4A	50 µf			
	C4B	25 µf		450 dcwv	COE-10
	C4C	25 µf			
	C5A	1500 µf			
	C5B	750 µf		10 dcwv	COE-9
	C5C	750 µf			

PARTS LIST (CONT)

		PART NO.			
CAPACITORS (NOTE D)	C6A	1500 µf			
	C6B	750 µf		10 dcwv	COE-9
	C6C	750 µf			
	C7A	1500 µf			
	C7B	750 µf		10 dcwv	COE-9
	C7C	750 µf			
	C8A	50 µf			
	C8B	25 µf		450 dcwv	COE-10
	C8C	25 µf			
	C9A	50 µf			
	C9B	25 µf		450 dcwv	COE-10
	C9C	25 µf			
	C101	4-50			COA-2L
	C102	47	±10%	500 dcwv	COC-21(N750)
	C103	470	+100%-0	500 dcwv	COC-2
	C104	470	+100%-0	500 dcwv	COC-2
	C105	470	+100%-0	500 dcwv	COC-2
	C106	470	+100%-0	500 dcwv	COC-2
	C107	2.7-10.8			COA-24A-4
	C108	47	±10%	500 dcwv	COC-21(N750)
	C109	47	±10%	500 dcwv	COC-21(N750)
	C110	470	+100%-0	500 dcwv	COC-2
	C111	470	+100%-0	500 dcwv	COC-2
	C112	2.2-8.5			COA-24A-3
	C113	2.2-8.5			COA-24A-3
	C114	1.5-3.1			COA-24
	C115	470	+100%-0	500 dcwv	COC-61
	C116	470	+100%-0	500 dcwv	COC-61
	C117	470	+100%-0	500 dcwv	COC-61
	C118	470	+100%-0	500 dcwv	COC-3
	C119	470	+100%-0	500 dcwv	COC-3
	C120	H-F Bypass			Built-in
	C121	2.7-10.8			COA-24A-4
	C122	470	+100%-0	500 dcwv	COC-3
	C123	470	+100%-0	500 dcwv	COC-3
	C124	4.7	±10%	500 dcwv	COC-1
	C125	470	+100%-0	500 dcwv	COC-2
	C126	2.7-19.6			COA-29-4
	C127	Trimmer			1112-B-808
	C128	Trimmer			1112-B-808
	C129	H-F Bypass			Built in
	C130	470	+100%-0	500 dcwv	COC-61
	C131	0.01 µf	±10%	600 dcwv	COL-71
	C132	760	±5%	300 dcwv	COM-20D
	C133	0.01 µf	±10%	600 dcwv	COL-71
	C134	0.01 µf	+100%-0	500 dcwv	COC-63
	C135	1.5-3.1			COA-24
	C136	35	±8 (H-F Bypass)		1112-B-851
	C137	2.2-8.0			COA-24A-3
	C138	470	+100%-0	500 dcwv	COC-3
	C139	47	±10%	500 dcwv	COC-21(N750)
	C140	470	+100%-0	500 dcwv	COC-61
	C141	470	+100%-0	500 dcwv	COC-61
	C142	470	+100%-0	500 dcwv	COC-61
	C143	470	+100%-0	500 dcwv	COC-3
	C144	47	±10%	500 dcwv	COC-21(N750)
	C145	470	+100%-0	500 dcwv	COC-61
	C146	470	+100%-0	500 dcwv	COC-61
	C147	470	+100%-0	500 dcwv	COC-61
	C148	470	+100%-0	500 dcwv	COC-61

		PART NO.			
CAPACITORS (NOTE D)	C149	470	+100%-0	500 dcwv	COC-3
	C150	47	±10%	500 dcwv	COC-21
	C151	470	+100%-0	500 dcwv	COC-3
	C152	4.7	±10%	500 dcwv	COC-1
	C153	15	±10%	500 dcwv	COC-21
	C154	470	+100%-0	500 dcwv	COC-61
	C155	470	+100%-0	500 dcwv	COC-61
	C156	470	+100%-0	500 dcwv	COC-3
	C157	Trimmer			Built in
	C158	470	+100%-0	500 dcwv	COC-3
	C159	470	+100%-0	500 dcwv	COC-3
	C161	470	+100%-0	500 dcwv	COC-61
	C201	1.4-5.0			COA-29
	C202	200	±10%	500 dcwv	COU-8-2
	C203	200	±10%	500 dcwv	COU-8-2
	C204	200	±10%	500 dcwv	COU-8-2
	C205	470	+100%-0	500 dcwv	COC-61
	C206				874-74
	C508A	0.1 µf	±10%	400 dcwv	COW-25
	C508B	0.1 µf	±10%	400 dcwv	COW-25
	C508C	0.1 µf	±10%	400 dcwv	COW-25
	C509A	10 µf 10 µf		450 dcwv	COE-5
	C509B	10 µf 10 µf		450 dcwv	COE-5
	C509C	10 µf 10 µf		450 dcwv	COE-5
	C510A	0.001 µf	+100%-0	500 dcwv	COC-61
	C510B	0.001 µf	+100%-0	500 dcwv	COC-61
	C510C	0.001 µf	+100%-0	500 dcwv	COC-61
	C511A	0.0047 µf	±10%	600 dcwv	COL-71
	C511B	0.0047 µf	±10%	600 dcwv	COL-71
	C511C	0.0047 µf	±10%	600 dcwv	COL-71
INDUCTORS	L101				1170-824-2
	L102				1170-P3-25-3
	L103				1112-B-801
	L104	10 µh			ZCHA-4
	L105				1170-P3-811
	L106	2 µh			ZCHA-37
	L107				1170-P3-803
	L108				1170-P3-34
	L110				1112-B-201
	L111				1112-B-802
	L112				Built in
	L113				1112-B-401
	L113A				1112-B-401-2
	L114	2 µh			ZCHA-37
	L115				1112-B-146
	L116				Built in
	L117				1112-B-809
	L118				1112-B-854
	L119				1112-B-853
	L120				1112-B-852
	L121				1112-B-221
	L122				1112-B-222
	L123				1112-B-222
	L124				1112-B-201
	L125				Built in

PARTS LIST (CONT)

			PART NO.
INDUCTORS	L126, L127		1112-B-330
	L128		ZCHA-9
	L201		Built in
	L202		Built in
	L203	2 µh	ZCHA-37
	L204	2 µh	ZCHA-37
	L205	2 µh	ZCHA-37
	L206	2 µh	ZCHA-37
	L207		Built in
MISCELLANEOUS	D101	DIODE	1N34-A
	D102	DIODE	1N34-A
	D103	DIODE (matched pair)	1N35
	D104	DIODE (matched pair)	1N35
	D105	DIODE	1N21-B
	D201	DIODE	1N21-B
	F1	FUSE, 1.5 amp Slo-Blo Type 3AG (for 115 v)	FUF-1
	F1	FUSE, 0.8 amp Slo-Blo Type 3AG (for 230 v)	FUF-1
	F2	FUSE, 1.5 amp Slo-Blo Type 3AG (for 115 v)	FUF-1
	F2	FUSE, 0.8 amp Slo-Blo Type 3AG (for 230 v)	FUF-1

			PART NO.
MISCELLANEOUS	M1	METER	MEDS-79
	M2	METER	MEDS-79
	RX1 thru RX12	RECTIFIER	1N1083
	RX13	RECTIFIER	1N536
	RX14	RECTIFIER	1N536
	S1	SWITCH, dpst	SWT-333NP
	S2	SWITCH	SWRW-154
	T1	TRANSFORMER	685-400

		TYPE		TYPE
TUBES	V101	6AG5	V501A	6AU5GT
	V102	6J6	V501B	6AU5GT
	V103	6AG5	V501C	6AU5GT
	V104	6AU6	V502A	12AX7
	V105	6AK5	V502B	12AX7
	V106	6AK5	V502C	12AX7
	V107	6AG5	V503A	5651
	V108	6BM6	V503B	5651
	V109	5876	V503C	5651

NOTES

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

COA - Capacitor, air	COW - Capacitor, wax
COC - Capacitor, ceramic	POSW - Potentiometer, wire-wound
COE - Capacitor, electrolytic	REC - Resistor, composition
COL - Capacitor, oil	REF - Resistor, film
COM - Capacitor, mica	REPO - Resistor, power
COU - Capacitor, unclassified	

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

(C) Value determined during laboratory testing.

(D) All capacitances are in micromicrofarads, except as otherwise indicated by µf (microfarads).

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

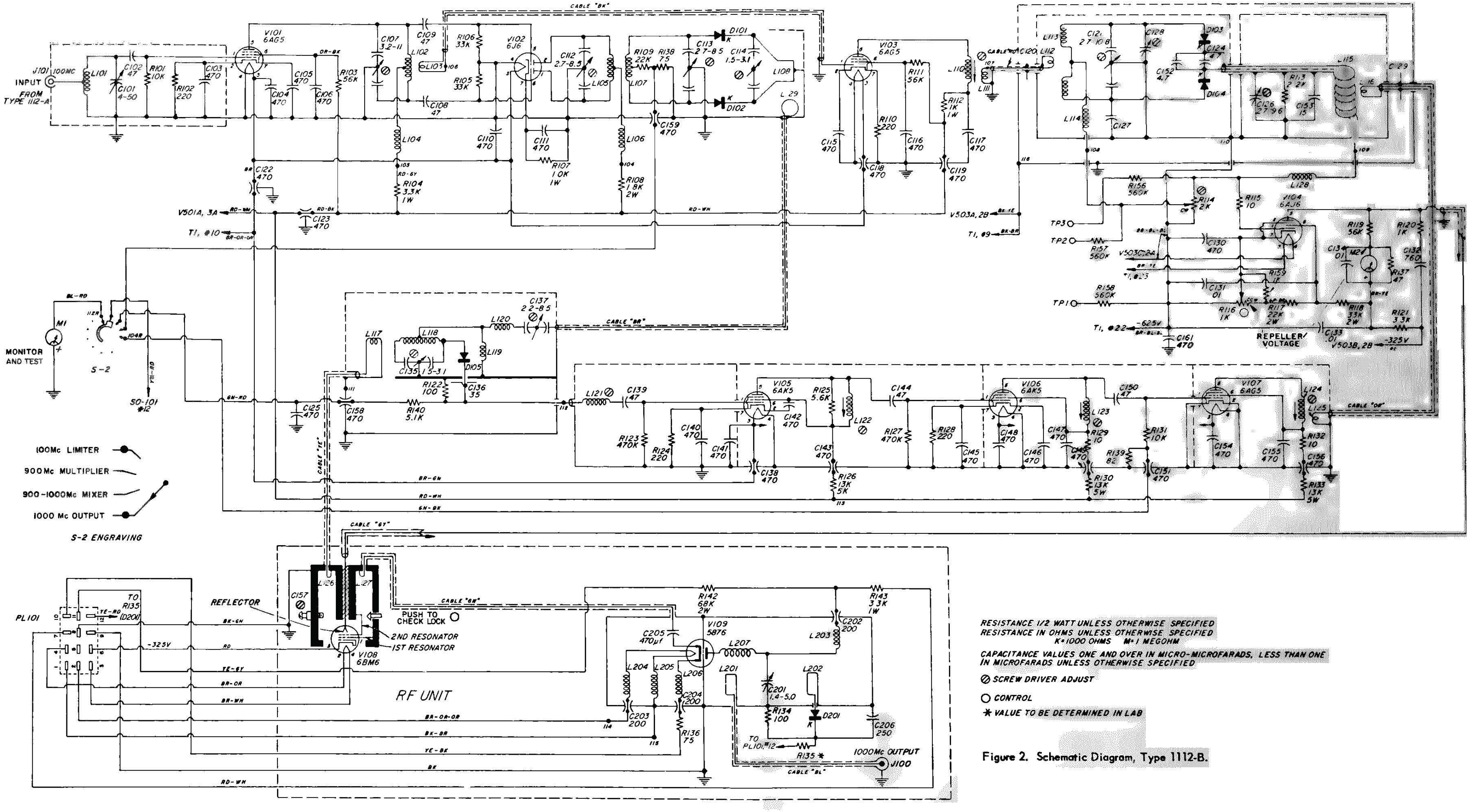


Figure 2. Schematic Diagram, Type 1112-B.

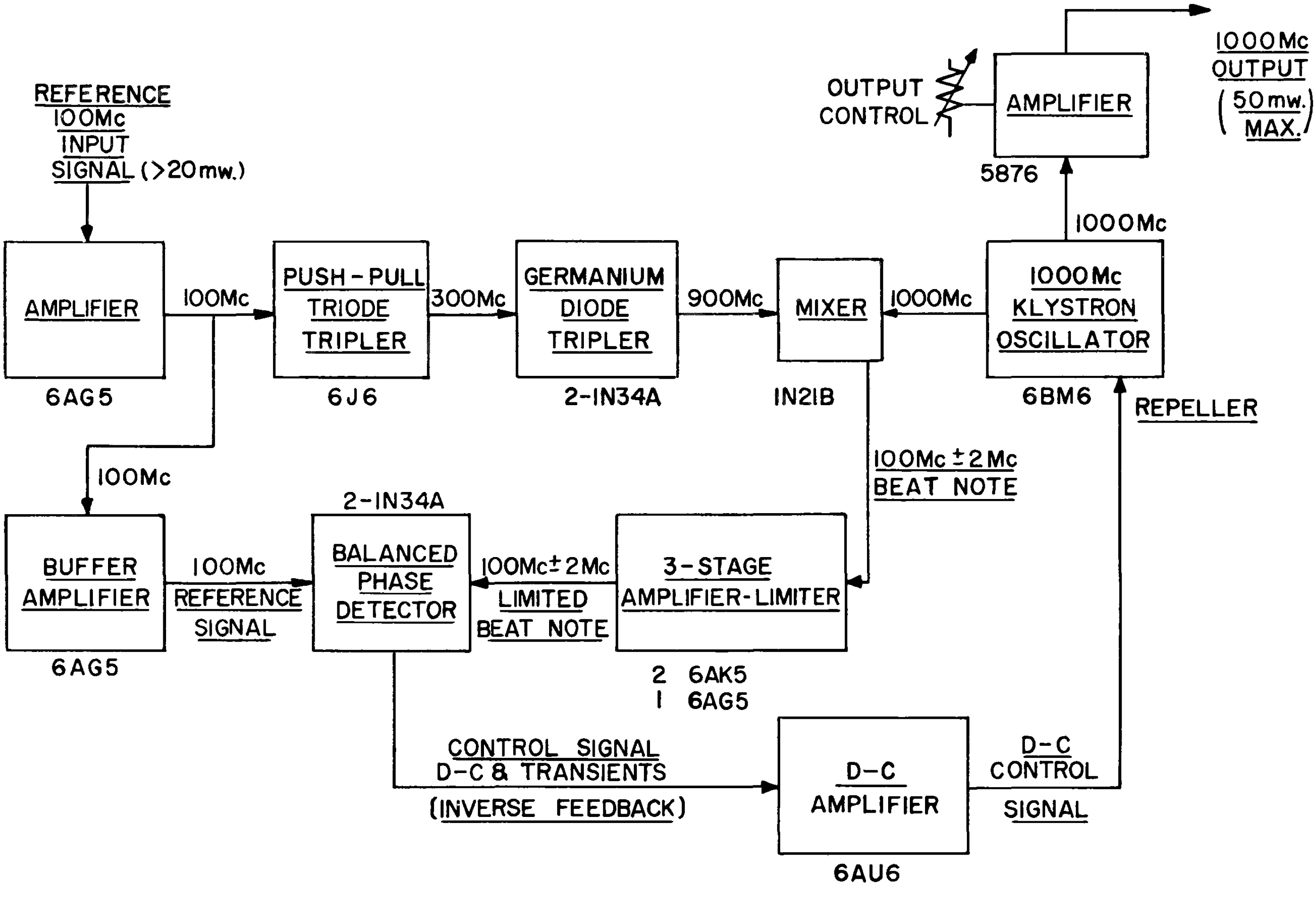
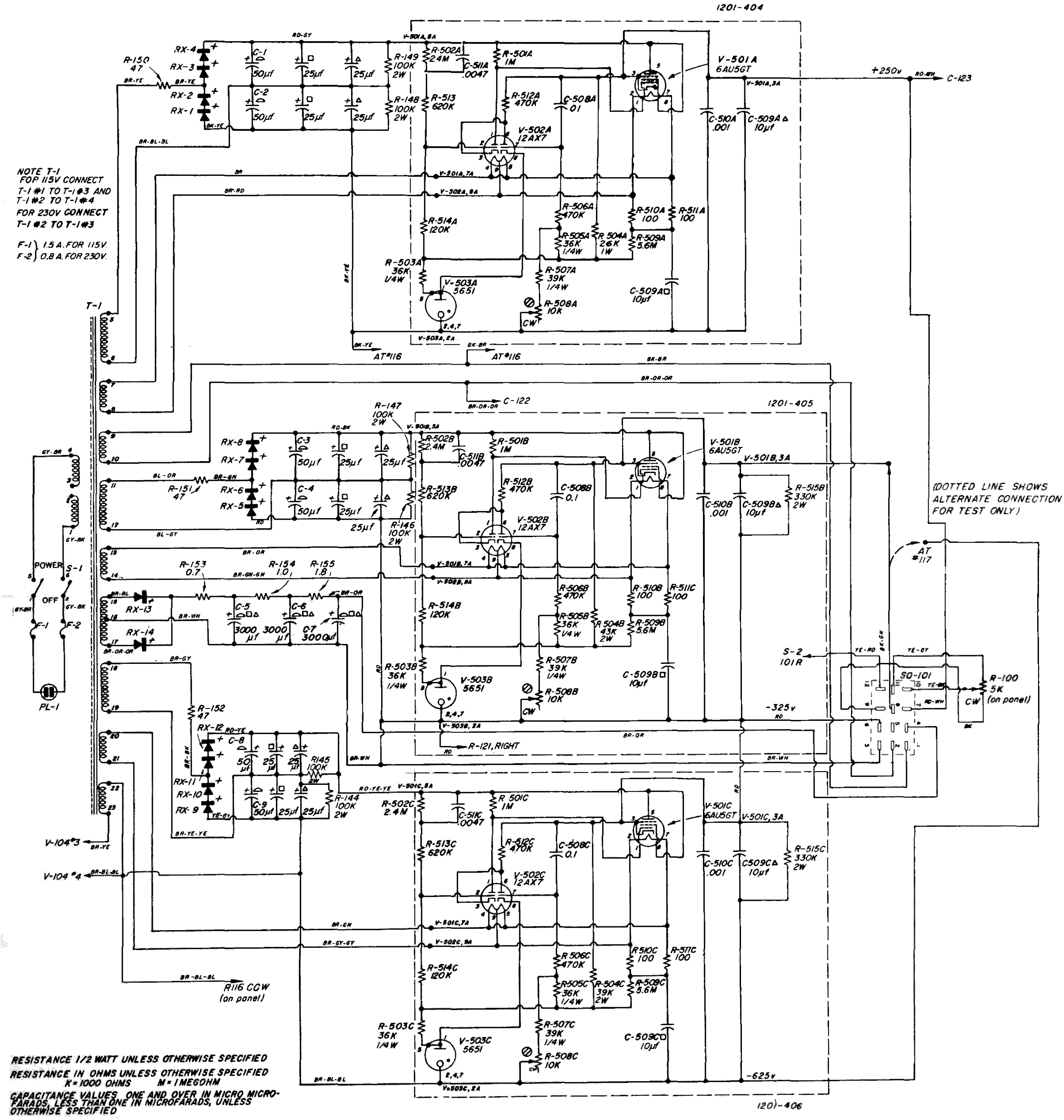


Figure 3. Block Diagram, Type 1112-B



RESISTANCE 1/2 WATT UNLESS OTHERWISE SPECIFIED
RESISTANCE IN OHMS UNLESS OTHERWISE SPECIFIED
K = 1000 OHMS M = 1 MEGOHM
CAPACITANCE VALUES ONE AND OVER IN MICRO MICROFARADS, LESS THAN ONE IN MICROFARADS, UNLESS OTHERWISE SPECIFIED
⊘ = KNOB CONTROL

Figure 4. Power Supply Schematic Diagram, Type 1112-B.

GENERAL RADIO COMPANY

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Printed in USA