OPERATING INSTRUCTIONS

# TYPE 1112

# STANDARD FREQUENCY MULTIPLIERS

1112

GENERAL RADIO COMPANY

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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) or 3-wire(Type CAP-22, furnished) power cord.

**DIMENSIONS** Relay-rack panel, 19 by 12-1/4 in., (485 by 330 mm), over-all depth 11-1/2 in. (295 min).

**WEIGHT** 25 lb. (11.5 kg).

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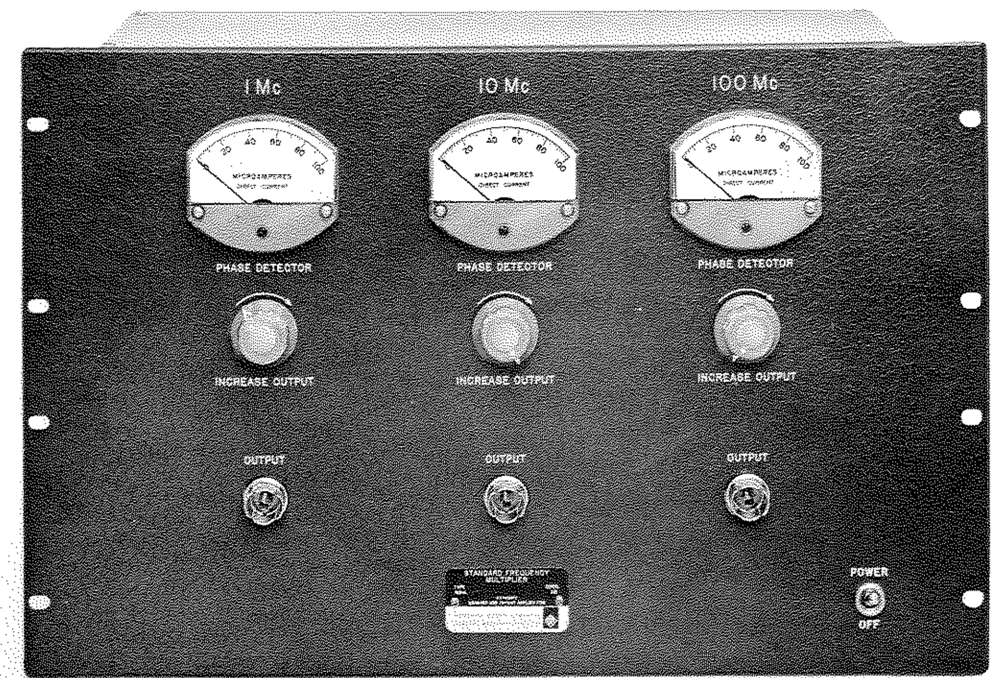



Figure A. Type 1112-A Standard Frequency Multiplier.

# 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.

The Type 1112-A Standard Frequency Multiplier is generally used either (1) to provide calibrated, stable frequencies in the vhf and uhf ranges or (2) to provide a means for testing and calibrating standard frequency oscillators. 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 ±1 x $10^{-9}$ 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. When used to provide clean signals at uhf (e.g., when used with the Type 1112-B Standard Frequency Multiplier), it may be desirable to "clean up" the driving signal by making use of the narrowband filtering properties of phase-locked oscillators. This can easily be accomplished by the procedures set forth in paragraph 4.3.

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.

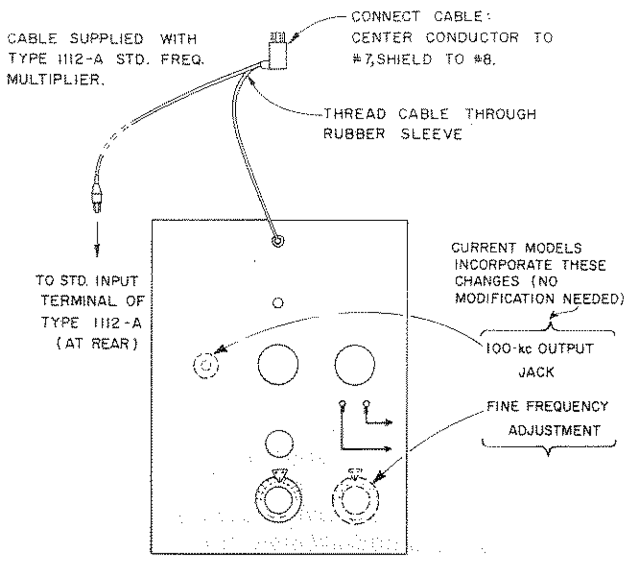
As a result of the use of the unbalanced phase detector, the meter indication may differ slightly from that for the other channels. The normal deflection of the meter with either crystal oscillator or multiplier stage energized is approximately 30 microamperes (3 volts). When both oscillator and multiplier 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.




REAR PANEL OF
TYPE 1101-A PIEZO-ELECTRIC OSCILLATOR

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.

All Type 1112-A Standard Frequency Multipliers manufactured since November, 1962, include a filter and bias circuit at the high-frequency input jack J3 as shown in the schematic diagram. This circuit reduces the phase modulation produced by audio-frequency signals added to the rf drive. The reduction is effected by the high-pass filter action of C209 and L202, combined with the long-time-constant bias circuit of C229 and R202. This circuit is especially effective in reducing fm noise caused by power frequency voltages induced in long cables between the driving oscillator and the frequency multiplier.

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.

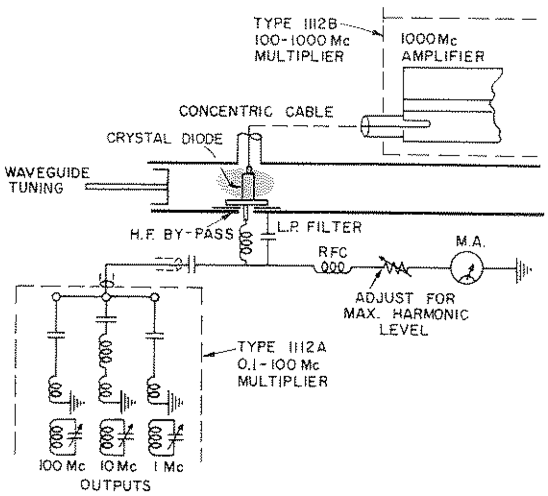



Figure C. Suggested Diode Mount.

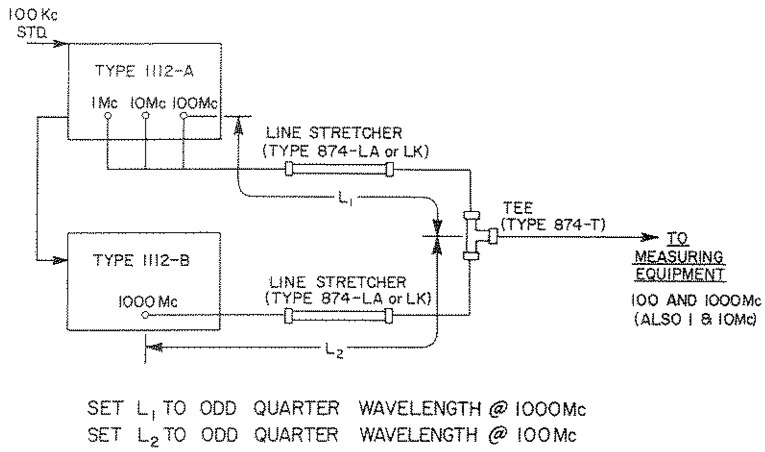



Figure D. Alternate Method of Driving Diode Harmonic Generator.

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 adjustment 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.

4.3 REDUCTION OF BANDWIDTH FOR FILTERING PURPOSES. To reduce 60-cycle fm noise on a 100-kc input signal, install a 2-μf paper or plastic capacitor across C123, that is between terminals 122 - 141 and ground. If the driving signal is at 1, 2.5, or 5 Mc, install the 2-μf capacitor across C222, that is between terminals 222 - 241 and ground. After adding the capacitor, readjust the crystal oscillator for proper lock. A larger filter capacitor may be used if desired, but the following effects should be anticipated:

(1) The capture or lock-in range of the oscillator will be reduced even further;

(2) low-frequency phase instability will be increased because of the increased phase lag in the servo loop.

# 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. OPERATION FROM A 100-KC SOURCE. For operation from a standard frequency source of 100 kc, connect plug PL2 to chassis jack J2 and connect plug PL3 to jack J3. To energize the 100-kc-to-1-Mc multiplier stage, set switch S400 to ON.

5.2.3 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.

5.2.4 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 PL3 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 drive the multiplier from the Type 1113-A Standard Frequency Oscillator, connect the multiplier to the jack on the Type 1113-A marked 5 MC TO 1112-A and adjust the output level by means of the screw-driver control. It may not be possible to reduce the level to the 30-μa level indicated at the phase-detector meter. If the 10-Mc phase-detector current is 30 μa with switch S200 at TEST OSC, satisfactory operation can be obtained as follows:

Observe the current in the TEST MULT position and then check to see that the resultant current in the USE position is equal to the square root of the sum of the squares of the two input currents. In other words, if the meter indicates 40 μa on TEST MULT and 30 μa on TEST OSC, the proper operating point is:

$$\sqrt{(30)^2 + (40)^2} = \sqrt{2500} = 50\ \mu a$$

This operating point is desirable in order to produce minimum noise by the best use of the balance phase detector, i.e., near the balance point or zero output volts.

As a quick check on the operating point, use a vacuum-tube voltmeter to measure the voltage from the lead between terminals 222 - 241 (the output connection of the phase detector) and ground. This voltage should be near zero for proper operation. It is not necessary to have exactly 30 μa from each input channel to the phase detector as long as the phase-detector output voltage is zero.

The input sensitivity of J3 is such that at 5 Mc an rms voltage between 0.3 and 0.4 volt should produce adequate drive (at least 30 μa on the meter).

When driving signals from external sources of 1, 2.5, and 5 Mc are used, the drive level should be adjusted at the source. At 1 Mc an input level of 1.0 volt rms is usually adequate to produce the required minimum current of 30 μa on the phase-detector meter. At 5 Mc, as mentioned above, 0.3 to 0.4 volt rms should be adequate. Tuned adjustments in the input stage (V200) should not be disturbed if input at 1 Mc or 5 Mc is used.

With an input signal at 2.5 Mc, it may be necessary to retune C202 slightly to obtain adequate sensitivity. Since this capacitor is usually set for 2 Mc, only a small adjustment is necessary. Under no circumstances should this circuit (C202 - L200) be tuned to resonate above 5 Mc, as the triode stage then becomes regenerative, and noisy or improper operation results. If unstable operation appears to occur with a 2.5-Mc input after readjustment of this capacitor, reset the capacitor for maximum capacitance (minimum frequency) and then slowly reduce capacitance until adequate sensitivity is obtained. The level of the 2.5-Mc signal should be at least 0.4 volt rms.

Switch S400 shuts off heater and plate power to the 100-kc-to-1-Mc stage when this stage is not being used. For 100-kc operation, refer to paragraph 5.2.2.

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 difficulty, refer to the trouble-shooting table.

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 the 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

Because of the fairly narrow frequency range over which the multiplier chain will lock properly without retuning, it is advisable to use only crystal-controlled oscillators for test and alignment of the multiplier. These test signals should be within about ±5 parts per million of the correct (standard) frequency, and it is highly desirable to have these test sources exactly on standard frequency.

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. Necessary Instruments
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 1806-A. 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 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 voltmeter 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. Recheck 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. Repeak 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.

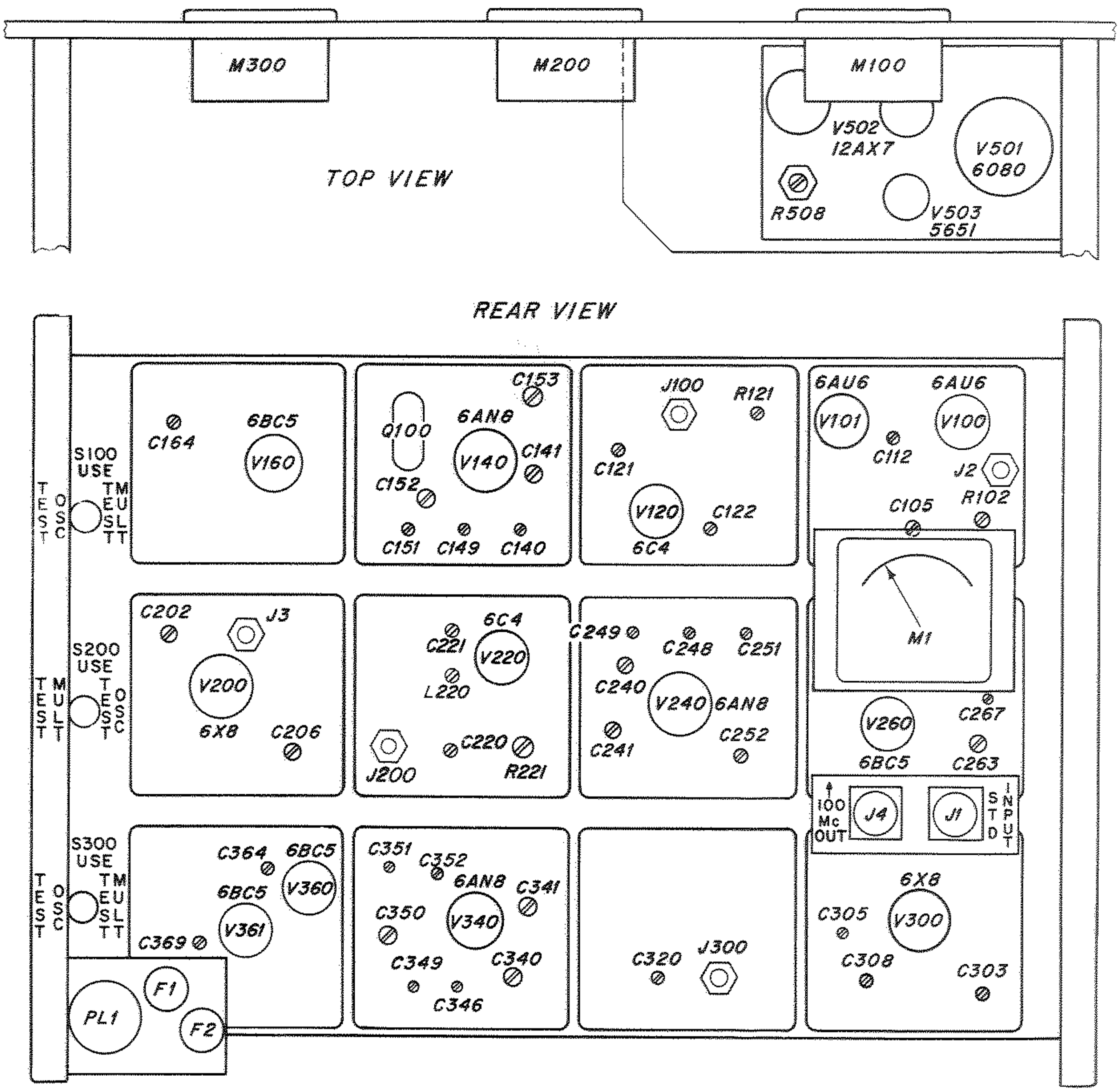



Figure E. Rear Panel Adjustments.

## PARTS LIST

### CAPACITORS

| Ref No | | Part No |
|---|---|---|
| C1A | Electrolytic, 40 µf 450 v | 1112-4180 |
| C1B | Electrolytic, 40 µf 450 v | |
| C1C | Electrolytic, 30 µf 450 v | |
| C1D | Electrolytic, 30 µf 450 v | |
| C2A | Electrolytic, 1500 µf 10 v | 4450-0700 |
| C2B | Electrolytic, 750 µf 10 v | |
| C2C | Electrolytic, 750 µf 10 v | |
| C3 | Ceramic, 0.01 µf ±20% 500 v | 4406-3109 |
| C4 | Ceramic, 0.01 µf ±20% 500 v | 4406-3109 |
| C100 | Mica, 510 pf ±5% 300 v | 4680-2600 |
| C101 | Mica, 150 pf ±5% 500 v | 4680-1700 |
| C102 | Ceramic, 0.01 µf ±20% 500 v | 4406-3109 |
| C103 | Ceramic, 0.01 µf ±20% 500 v | 4406-3109 |
| C104 | Ceramic, 0.01 µf ±20% 500 v | 4406-3109 |
| C105 | Air, 7-140 pf | 4380-1000 |
| C106 | Mica, 33 pf ±5% 500 v | 4680-0900 |
| C107A | Mica, 0.001 µf ±5% 300 v | 4680-3200 |
| C107B | Mica, 680 pf ±5% 300 v | 4680-2800 |
| C108 | Ceramic, 0.01 µf ±20% 500 v | 4406-3109 |
| C109 | Ceramic, 0.01 µf ±20% 500 v | 4406-3109 |
| C110 | Ceramic, 0.01 µf ±20% 500 v | 4406-3109 |
| C112 | Air, 2.7-19.6 pf | 4380-3700 |
| C113 | Mica, 68 or 75 pf ±5% 500 v | |
| C114 | Ceramic, 0.001 µf +100% -0% 500 v | 4400-1800 |
| C115 | Ceramic, 0.001 µf +100% -0% 500 v | 4400-1800 |
| C120 | Mica, 150 pf ±5% 500 v | 4680-1700 |
| C121 | Air, 4-50 pf | 4380-0400 |
| C122 | Air, 2.3-14.2 pf | 4380-2700 |
| C123 | Wax, 0.1 µf ±10% 100 v | 5010-2700 |
| C124 | Ceramic, 0.01 µf ±20% 500 v | 4406-3109 |
| C125 | Mica, 0.001 µf ±5% 300 v | 4680-3200 |
| C126 | Ceramic, 0.01 µf ±20% 500 v | 4406-3109 |
| C127 | Ceramic, 0.001 µf +100% -0% 500 v | 4400-1800 |
| C128 | Ceramic, 0.001 µf +100% -0% 500 v | 4400-1800 |
| C129 | Electrolytic, 60 µf 25 v | 4450-2900 |
| C130 | Mica, 10 pf ±5% 500 v | 4680-0300 |
| C140 | Air, 1.4-5.0 pf | 4380-3500 |
| C141 | Trimmer, 3-12 pf | 4910-0600 |
| C142 | Mica, 510 pf ±5% 300 v | 4680-2600 |
| C143 | Ceramic, 0.01 µf ±20% 500 v | 4406-3109 |
| C144 | Ceramic, 0.01 µf ±20% 500 v | 4406-3109 |
| C145 | Ceramic, 0.001 µf +100% -0% 500 v | 4400-1800 |
| C146 | Mica, 240 pf ±5% 500 v | 4680-2000 |
| C147 | Mica, 330 pf ±5% 500 v | 4680-2100 |
| C148 | Mica, 24 pf ±5% 500 v | 4680-0700 |
| C149 | Air, 2.7-19.6 pf | 4380-3700 |
| C150 | Mica, 22 pf ±5% 500 v | 4680-0800 |
| C151 | Air, 2.7-19.6 pf | 4380-3700 |
| C152 | Trimmer, 1.5-7.0 pf | 4910-0300 |
| C153 | Air, 7-140 pf | 4380-1100 |
| C155 | Ceramic, 0.001 µf +100% -0% 500 v | 4400-1800 |
| C156 | Ceramic, 0.001 µf +100% -0% 500 v | 4400-1800 |
| C157 | Ceramic, 0.01 µf ±20% 500 v | 4406-3109 |
| C160 | Ceramic, 2.2 pf ±10% 500 v | 4400-0200 |
| C161 | Ceramic, 0.01 µf ±20% 500 v | 4406-3109 |
| C162 | Ceramic, 0.01 µf ±20% 500 v | 4406-3109 |
| C163 | Ceramic, 0.01 µf ±20% 500 v | 4406-3109 |
| C164 | Air, 5-75 pf ±20% | 4380-0500 |
| C165 | Ceramic, 0.001 µf +100% -0% 500 v | 4400-1800 |
| C166 | Ceramic, 0.001 µf +100% -0% 500 v | 4400-1800 |
| C167 | Mica, 47 pf ±10% 500 v | 4660-1800 |
| C168 | Ceramic, 0.01 µf ±20% 500 v | 4406-3109 |
| C200 | Ceramic, 0.001 µf +100% -0% 500 v | 4400-1800 |
| C201 | Ceramic, 0.01 µf ±20% 500 v | 4406-3109 |
| C202 | Air, 6-100 pf | 4380-0700 |
| C203 | Mica, 51 pf ±5% 500 v | 4680-1000 |
| C204 | Ceramic, 0.01 µf ±20% 500 v | 4406-3109 |
| C205 | Ceramic, 0.01 µf ±20% 500 v | 4406-3109 |

### CAPACITORS

| Ref No | | Part No |
|---|---|---|
| C206 | Air, 5-75 pf | 4380-0500 |
| C207 | Ceramic, 0.01 µf ±20% 500 v | 4406-3109 |
| C208 | Ceramic, 0.001 µf +100% -0% 500 v | 4400-1800 |
| C209 | Ceramic, 100 pf ±5% 500 v | 4404-1105 |
| C220 | Air, 6-100 pf | 4380-0800 |
| C221 | Air, 2.3-14.2 pf | 4380-2700 |
| C222 | Ceramic, 0.01 µf ±20% 500 v | 4406-3109 |
| C223 | Electrolytic, 60 µf +100% -10% 25 v | 4450-2900 |
| C224 | Ceramic, 0.01 µf ±20% 500 v | 4406-3109 |
| C225 | Mica, 500 pf ±5% 500 v | 4680-2500 |
| C226 | Ceramic, 0.01 µf ±20% 500 v | 4406-3109 |
| C227 | Ceramic, 0.001 µf +100% -0% 500 v | 4400-1800 |
| C228 | Ceramic, 0.001 µf +100% -0% 500 v | 4400-1800 |
| C229 | Wax, 1.0 µf ±10% 100 v | 5010-3700 |
| C240 | Trimmer, 3-12 pf | 4910-0600 |
| C241 | Trimmer 1.5-7 pf | 4910-0300 |
| C242 | Mica, 510 pf ±5% 300 v | 4680-2600 |
| C243 | Ceramic, 0.01 µf ±20% 500 v | 4406-3109 |
| C244 | Ceramic, 0.001 µf +100% -0% 500 v | 4400-1800 |
| C245 | Ceramic, 0.01 µf ±20% 500 v | 4406-3109 |
| C246 | Mica, 0.001 µf ±5% 500 v | 4680-3200 |
| C247 | Mica, 60 pf ±5% 500 v | 4680-1100 |
| C248 | Air, 2.7-19.6 pf | 4380-3700 |
| C249 | Air, 2.7-19.6 pf | 4380-3700 |
| C250 | Mica, 15 pf ±5% 500 v | 4680-0400 |
| C251 | Air, 2.7-19.6 pf | 4380-3700 |
| C252 | Air, 4-50 pf | 4380-0300 |
| C253 | Ceramic, 0.001 µf +100% -0% 500 v | 4400-1800 |
| C254 | Ceramic, 0.001 µf +100% -0% 500 v | 4400-1800 |
| C255 | Ceramic, 0.01 µf ±20% 500 v | 4406-3109 |
| C256 | Mica, 15 pf ±5% 500 v | 4680-0400 |
| C260 | Ceramic, 1.0 pf ±10% 500 v | 4400-0100 |
| C261 | Ceramic, 0.01 µf ±20% 500 v | 4406-3109 |
| C262 | Ceramic, 0.01 µf ±20% 500 v | 4406-3109 |
| C263 | Air, 5-75 pf | 4380-0500 |
| C264 | Ceramic, 0.01 µf ±20% 500 v | 4406-3109 |
| C265 | Ceramic, 0.001 µf +100% -0% 500 v | 4400-1800 |
| C266 | Ceramic, 0.001 µf +100% -0% 500 v | 4400-1800 |
| C267 | Air, 2.9-35 pf | 4380-3100 |
| C300 | Ceramic, 0.001 µf +100% -0% 500 v | 4400-1800 |
| C301 | Ceramic, 0.01 µf ±20% 500 v | 4406-3109 |
| C302 | Ceramic, 0.01 µf ±20% 500 v | 4406-3109 |
| C303 | Air, 2.6-10.7 pf | 4380-2400 |
| C304 | Ceramic, 0.0022 µf ±20% 500 v | 4405-2229 |
| C305 | Air, 1.7-8.7 pf | 4380-3600 |
| C306 | Ceramic, 0.0022 µf ±20% 500 v | 4405-2229 |
| C307 | Ceramic, 1.0 pf ±10% 500 v | 4400-0100 |
| C308 | Trimmer, 1.5-7 pf | 4910-0300 |
| C309 | Ceramic, 0.001 µf +100% -0% 500 v | 4400-1800 |
| C310 | Mica, 51 pf ±5% | 4680-1000 |
| C320 | Air, 2.6-10.7 pf | 4380-2500 |
| C321 | Mica, 51 pf ±5% 500 v | 4680-1000 |
| C322 | Mica, 24 pf ±5% 500 v | 4680-0800 |
| C323 | Electrolytic, 60 µf 25 v | 4450-2900 |
| C340 | Trimmer, 1.5-7 pf | 4910-0300 |
| C341 | Trimmer, 1.5-7 pf | 4910-0300 |
| C342 | Mica, 51 pf ±5% 500 v | 4680-1000 |
| C343 | Ceramic, 0.0022 µf ±20% 500 v | 4405-2229 |
| C344 | Ceramic, 0.0022 µf ±20% 500 v | 4405-2229 |
| C345 | Ceramic, 22 pf ±5% NPO 500 v | 4400-3500 |
| C346 | Air, 1.4-5.0 pf | 4380-3500 |
| C347 | Ceramic, 10 pf ±10% NPO 500 v | 4400-2999 |
| C348 | Ceramic, 3.3 pf ±10% NPO 500 v | 4400-2650 |
| C349 | Air, 1.4-5.0 pf | 4380-3500 |
| C350 | Air, 1.7-8.7 pf | 4380-3600 |
| C351 | Air, 2.9-35 pf | 4380-3000 |
| C352 | Air, 1.4-5.0 pf | 4380-3500 |
| C353 | Ceramic, 0.001 µf +100% -0% | 4400-1800 |

## PARTS LIST (cont)

### CAPACITORS

| Ref No | | Part No |
|---|---|---|
| C354 | Ceramic, 0.001 µf +100% -0% | 4400-1800 |
| C355 | Ceramic, 3.3 pf ±10% NPO 500 v | 4400-2650 |
| C360 | Ceramic, 3.3 pf ±10% 500 v | 4400-0400 |
| C361 | Ceramic, 0.0022 µf ±20% 500 v | 4405-2229 |
| C362 | Ceramic, 0.0022 µf ±20% 500 v | 4405-2229 |
| C363 | Ceramic, 0.0022 µf ±20% 500 v | 4405-2229 |
| C364 | Air, 1.7-8.7 pf | 4380-3600 |
| C365 | Ceramic, 3.3 pf ±10% 500 v | 4400-0400 |
| C366 | Ceramic, 0.0022 µf ±20% 500 v | 4405-2229 |
| C367 | Ceramic, 0.0022 µf ±20% 500 v | 4405-2229 |
| C368 | Ceramic, 0.0022 µf ±20% 500 v | 4405-2229 |
| C369 | Air, 1.7-8.7 pf | 4380-3600 |
| C370 | Ceramic, 0.001 pf +100% -0% 500 v | 4400-1800 |
| C371 | Ceramic, 0.001 pf +100% -0% 500 v | 4400-1800 |
| C372 | Mica, 24 pf ±5% 500 v | 4680-0800 |
| C373 | Ceramic, 0.0022 µf ±20% 500 v | 4405-2229 |
| C508 | Wax, 0.1 µf ±10% 400 v | 5020-0700 |
| C509A<br>C509B | Electrolytic, 10 µf<br>10 µf 450 v | 6100-5565 |
| C510 | Ceramic, 0.001 µf ±20% 500 v | 4404-2109 |
| C511 | Oil, 0.0047 µf ±10% 600 v | 4510-4300 |

### RESISTORS

| Ref No | | Part No |
|---|---|---|
| R1 | Power, 47 Ω ±5% 5 w | 6660-0475 |
| R2 | Power, 47 Ω ±5% 5 w | 6660-0475 |
| R3 | Power, 47 Ω ±5% 5 w | 6660-0475 |
| R100 | POTENTIOMETER, Composition, 5 kΩ ±10% | 6000-0500 |
| R101 | Composition, 3.3 kΩ ±5% 1/2 w | 6100-2335 |
| R102 | POTENTIOMETER, Composition, 10 kΩ ±10% | 6010-0900 |
| R103 | Composition, 150 Ω ±5% 1/2 w | 6100-1155 |
| R104 | Composition, 27 kΩ ±5% 1/2 w | 6100-3275 |
| R105 | Composition, 100 Ω ±5% 1/2 w | 6100-1105 |
| R106 | Composition, 1 MΩ ±5% 1/2 w | 6100-5105 |
| R107 | Composition, 100 Ω ±5% 1/2 w | 6100-1105 |
| R108 | Composition, 27 kΩ ±5% 1/2 w | 6100-3275 |
| R109 | Composition, 1.2 kΩ ±5% 1/2 w | 6100-2125 |
| R120 | Composition, 75 kΩ ±5% 1/2 w | 6100-3755 |
| R121 | POTENTIOMETER, Composition, 50 kΩ ±10% | 6010-1400 |
| R122 | Composition, 75 kΩ ±5% 1/2 w | 6100-3755 |
| R123 | Composition, 680 Ω ±5% 1/2 w | 6100-1685 |
| R124 | Composition, 2.7 kΩ ±5% 1/2 w | 6100-2275 |
| R125 | Composition, 1 MΩ ±5% 1/2 w | 6100-5105 |
| R140 | Composition, 100 kΩ ±5% 1/2 w | 6100-4105 |
| R141 | Composition, 1.5 kΩ ±5% 1/2 w | 6100-2155 |
| R142 | Composition, 100 kΩ ±5% 1/2 w | 6100-4105 |
| R143 | Composition, 470 Ω ±5% 1/2 w | 6100-1475 |
| R144 | Composition, 6.8 kΩ ±5% 1 w | 6110-2685 |
| R145 | Composition, 100 Ω ±5% 1/2 w | 6100-1105 |
| R146 | Composition, 470 kΩ ±5% 1/2 w | 6100-4475 |
| R147 | Composition, 100 kΩ ±5% 1/2 w | 6100-4105 |
| R160 | Composition, 1 MΩ ±5% 1/2 w | 6100-5105 |
| R161 | Composition, 150 Ω ±5% 1/2 w | 6100-1155 |
| R162 | Composition, 27 kΩ ±5% 1/2 w | 6100-3275 |
| R163 | Composition, 100 kΩ ±5% 1/2 w | 6100-4105 |
| R164 | Composition, 1.2 kΩ ±5% 1/2 w | 6100-2125 |
| R200 | POTENTIOMETER, Composition, 5 kΩ ±10% | 6000-0500 |

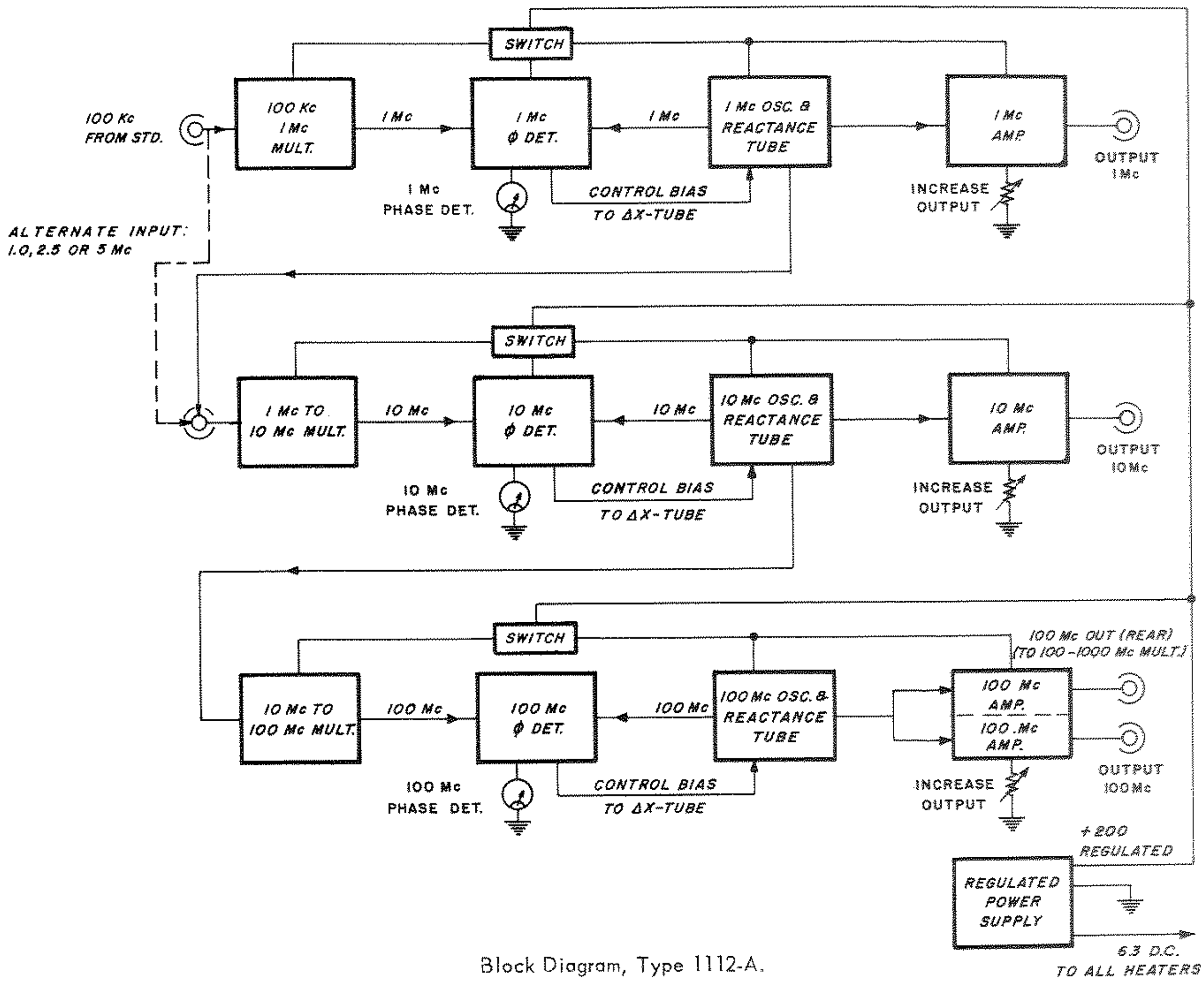
### RESISTORS

| Ref No | | Part No |
|---|---|---|
| R202 | Composition, 1 MΩ ±5% 1/2 w | 6100-5105 |
| R203 | Composition, 22 kΩ ±5% 1 w | 6110-3225 |
| R204 | Composition, 150 Ω ±5% 1/2 w | 6100-1155 |
| R205 | Composition, 1 MΩ ±5% 1/2 w | 6100-5105 |
| R206 | Composition, 560 kΩ ±5% 1/2 w | 6100-4565 |
| R207 | Composition, 1.2 kΩ ±5% 1/2 w | 6100-2125 |
| R220 | Composition, 75 kΩ ±5% 1/2 w | 6100-3755 |
| R221 | POTENTIOMETER, Composition, 50 kΩ ±10% | 6010-1400 |
| R222 | Composition, 75 kΩ ±5% 1/2 w | 6100-3755 |
| R223 | Composition, 680 Ω ±5% 1/2 w | 6100-1685 |
| R224 | Composition, 2.7 kΩ ±5% 1/2 w | 6100-2275 |
| R225 | Composition, 1.0 MΩ ±5% 1/2 w | 6100-5105 |
| R226 | Composition, 15 kΩ ±5% 1/2 w | 6100-3155 |
| R240 | Wire-wound, 220 Ω ±5% 1/2 w | 6760-1225 |
| R241 | Composition, 100 kΩ ±5% 1/2 w | 6100-4105 |
| R242 | Composition, 470 Ω ±5% 1/2 w | 6100-1475 |
| R243 | Composition, 470 kΩ ±5% 1/2 w | 6100-4475 |
| R244 | Composition, 100 Ω ±5% 1/2 w | 6100-1105 |
| R245 | Composition, 6.8 kΩ ±5% 1 w | 6110-2685 |
| R246 | Composition, 100 kΩ ±5% 1/2 w | 6100-4105 |
| R260 | Composition, 1 MΩ ±5% 1/2 w | 6100-5105 |
| R261 | Composition, 150 Ω ±5% 1/2 w | 6100-1155 |
| R262 | Composition, 100 kΩ ±5% 1/2 w | 6100-4105 |
| R263 | Composition, 27 kΩ ±5% 1/2 w | 6100-3275 |
| R264 | Composition, 1.2 kΩ ±5% 1/2 w | 6100-2125 |
| R300 | POTENTIOMETER, Composition, 5 kΩ ±10% | 6000-0500 |
| R301 | Composition, 100 Ω ±5% 1/2 w | 6100-1105 |
| R302 | Composition, 1 MΩ ±5% 1/2 w | 6100-5105 |
| R303 | Composition, 22 kΩ ±5% 1 w | 6110-3225 |
| R304 | Composition, 150 Ω ±5% 1/2 w | 6100-1155 |
| R305 | Composition, 1 MΩ ±5% 1/2 w | 6100-5105 |
| R306 | Composition, 75 kΩ ±5% 1/2 w | 6100-3755 |
| R307 | Composition, 1.2 kΩ ±5% 1/2 w | 6100-2125 |
| R320 | Composition, 100 kΩ ±5% 1/2 w | 6100-4105 |
| R340 | Composition, 51 Ω ±5% 1/2 w | 6100-0515 |
| R341 | Composition, 100 kΩ ±5% 1/2 w | 6100-4105 |
| R342 | Composition, 68 Ω ±5% 1/2 w | 6100-0685 |
| R343 | Composition, 18 kΩ ±5% 1/2 w | 6100-3185 |
| R344 | Composition, 3.3 kΩ ±5% 2 w | 6120-2335 |
| R345 | Composition, 47 kΩ ±5% 1/2 w | 6100-3475 |
| R346 | Composition, 1.5 kΩ ±5% 1/2 w | 6100-2155 |
| R360 | Composition, 1 MΩ ±5% 1/2 w | 6100-5105 |
| R361 | Composition, 150 Ω ±5% 1/2 w | 6100-1155 |
| R362 | Composition, 27 kΩ ±5% 1/2 w | 6100-3275 |
| R363 | Composition, 1 MΩ ±5% 1/2 w | 6100-5105 |
| R364 | Composition, 150 Ω ±5% 1/2 w | 6100-1155 |
| R365 | Composition, 27 kΩ ±5% 1/2 w | 6100-3275 |
| R366 | Composition, 100 kΩ ±5% 1/2 w | 6100-4105 |
| R367 | Composition, 220 Ω ±5% 1/2 w | 6100-1225 |
| R368 | Composition, 220 Ω ±5% 1/2 w | 6100-1225 |
| R501 | Composition, 1 MΩ ±10% 1/2 w | 6100-5109 |
| R502 | Composition, 2.4 MΩ ±5% 1/2 w | 6100-5245 |
| R503 | Film, 36 kΩ ±1% 1/4 w | 6350-3360 |
| R504 | Film, 12 kΩ ±1% 1 w | 6550-3120 |
| R505 | Film, 36 kΩ ±1% 1/4 w | 6350-3360 |
| R506 | Composition, 470 kΩ ±5% 1/2 w | 6100-4475 |
| R507 | Film, 39 kΩ ±1% 1/4 w | 6350-3390 |
| R508 | POTENTIOMETER, Composition, 10 kΩ ±10% | 6010-0900 |
| R509 | Composition, 5.6 MΩ ±10% 1/2 w | 6100-5569 |
| R510 | Composition, 100 Ω ±10% 1/2 w | 6100-2109 |
| R511 | Composition, 100 Ω ±10% 1/2 w | 6100-2109 |
| R512 | Composition, 470 kΩ ±5% 1/2 w | 6100-4475 |
| R513 | Composition, 620 kΩ ±5% 1/2 w | 6100-4625 |
| R514 | Composition, 120 kΩ ±5% 1/2 w | 6100-4125 |

## PARTS LIST (cont)

| Ref No | INDUCTORS | Part No |
|---|---|---|
| L1 | Choke | 0485-4001 |
| L100 | Coil Assembly | 1112-2000 |
| L101 | Coil Assembly | 1112-2010 |
| L120 | Coil Assembly | 1120-2020 |
| L140 | Air Choke 2.5 mh R.F.C. | 4290-4600 |
| L141 | Air Choke 2.5 mh R.F.C. | 4290-4600 |
| L160 | Coil Assembly | 1112-2030 |
| L200 | Coil Assembly | 1112-2040 |
| L201 | Coil Assembly | 1112-4010 |
| L202 | Metal Choke 680 µh | 4300-4600 |
| L203 | Metal Choke 100 µh | 4300-6392 |
| L220 | Coil Assembly | 1112-2200 |
| L240 | Air Choke 2.5 mh R.F.C. | 4290-4600 |
| L241 | Air Choke 2.5 mh R.F.C. | 4290-4600 |
| L242 | Metal Choke 8.2 µh R.F.C. | 4300-2100 |
| L260 | Coil Assembly | 1112-0410 |
| L261 | Air Choke | 4290-0900 |
| L300 | Coil Assembly | 1112-0420 |
| L301 | Coil Assembly | 1112-0430 |
| L320 | Coil Assembly | 1112-0440 |
| L340 | Choke Assembly | 1112-2050 |
| L341 | Air Choke | 4290-1300 |
| L342 | Air Choke | 4290-1300 |
| L343 | Coil | 1112-4020 |
| L344 | Coil | 1112-0450 |
| L345 | Coil | 1112-0460 |
| L360 | Coil | 1112-0430 |
| L361 | Coil | 1112-8240 |
| L362 | Coil | 1112-0430 |
| L363 | Coil | 1112-8250 |

| Ref No | MISCELLANEOUS | Part No |
|---|---|---|
| J1 | CONNECTOR, Coaxial, STD INPUT | 0874-4542 |
| J2 | JACK | 4230-2300 |
| J3 | JACK | 4230-2300 |
| J4 | CONNECTOR, Coaxial, 100 MC TO 1112-B | 0874-4542 |
| J100 | JACK | 4260-0400 |
| J101 | CONNECTOR, Coaxial 1 MC | 0874-4552 |
| J200 | JACK | 4260-0400 |
| J201 | CONNECTOR, Coaxial, 10 MC | 0874-4552 |
| J300 | JACK | 4260-0400 |
| J301 | CONNECTOR, Coaxial, 100 MC | 0874-4552 |
| M1 | METER, 0-100 µa, 1.0 kΩ | 5730-0790 |
| M100 | METER, 0-100 µa, 1.0 kΩ | 5730-0950 |
| M200 | METER, 0-100 µa, 1.0 kΩ | 5730-0950 |
| M300 | METER, 0-100 µa, 1.0 kΩ | 5730-0950 |
| PL1 | PLUG, Power 4240-0600 | part of 1112-0350 |
| PL2 | PLUG | part of 1112-0350 |
| PL3 | PLUG | part of 1112-0300 |
| PL4 | PLUG | 1112-4070 |
| Q100 | QUARTZ PLATE, 1 Mc | 1112-4040 |
| Q200 | QUARTZ PLATE, 10 Mc | 1112-4030 |
| Q300 | QUARTZ PLATE | 1112-4060 |
| RX1 | RECTIFIER, Type 1N3255 | 6081-1003 |
| RX2 | RECTIFIER, Type 1N3255 | 6081-1003 |
| RX5 | RECTIFIER, Type 1N3660R | 6081-1006 |
| RX6 | RECTIFIER, Type 1N3660R | 6081-1006 |
| S1 | SWITCH, Toggle, POWER | 7910-1300 |
| S100 | SWITCH, | 7910-0600 |
| S200 | SWITCH | 7910-0600 |
| S300 | SWITCH | 7910-0600 |
| S400 | SWITCH | 7910-1300 |
| T1 | TRANSFORMER | 0365-4890 |
| V100 | TUBE, Type 6AU6 | 8360-2100 |
| V101 | TUBE, Type 6AU6 | 8360-2100 |
| V120 | TUBE, Type 6C4 | 8360-3800 |
| V140 | TUBE, Type 6AN8 RCA | 8360-1300 |
| V160 | TUBE, Type 6BC5 | 8360-2900 |
| V200 | TUBE, Type 6X8 | 8360-8400 |
| V220 | TUBE, Type 6C4 | 8360-3800 |
| V240 | TUBE, Type 6AN8 RCA | 8360-1300 |
| V260 | TUBE, Type 6BC5 | 8360-2900 |
| V300 | TUBE, Type 6X8 | 8360-8400 |
| V340 | TUBE, Type 6AN8 RCA | 8360-1300 |
| V360 | TUBE, Type 6CY5 | 8360-4426 |
| V361 | TUBE, Type 6CY5 | 8360-4426 |




Block Diagram, Type 1112-A.

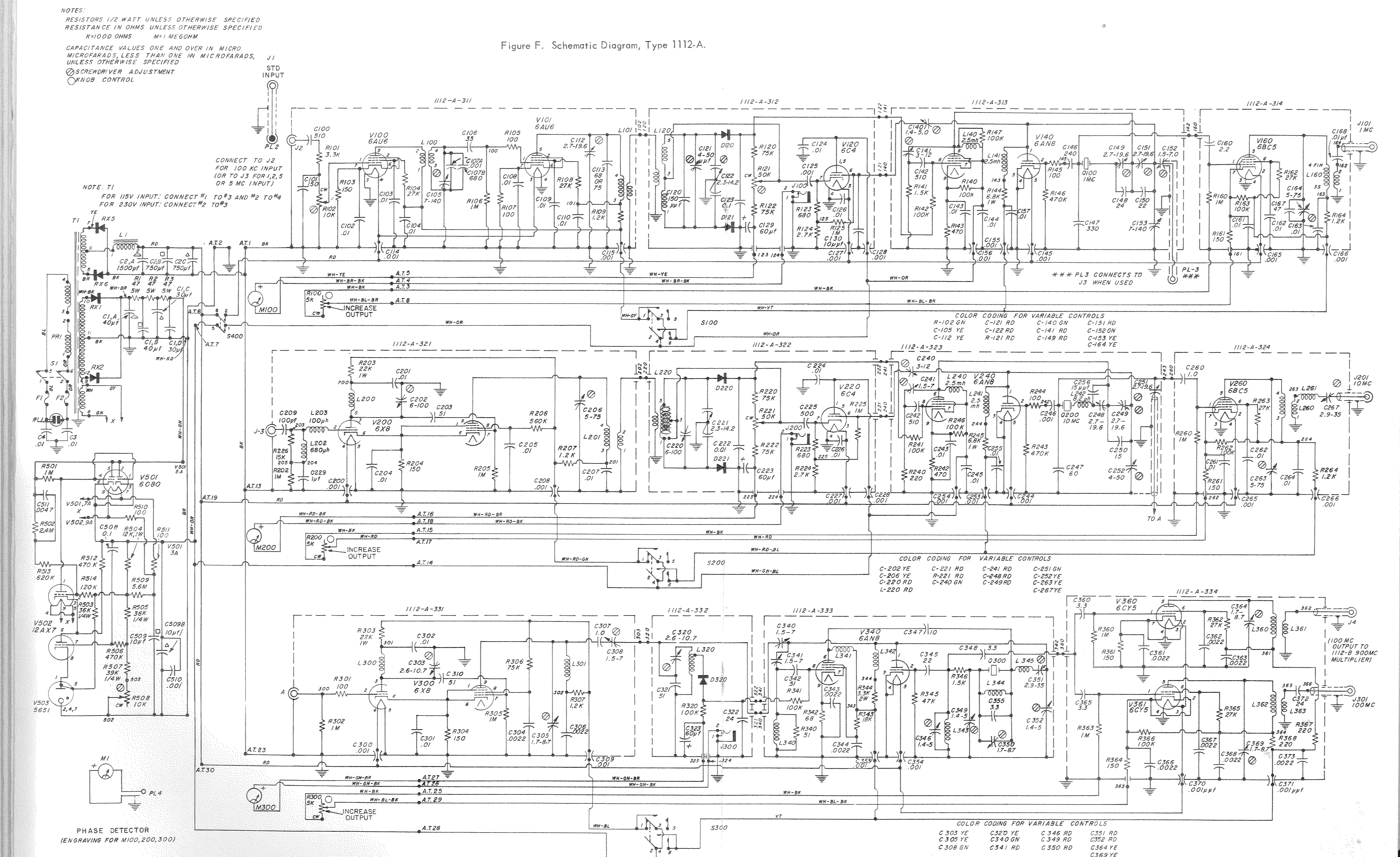


Figure F. Schematic Diagram, Type 1112-A.

# 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; 250 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) or 3-wire (Type CAP-22, furnished) Power Cord. |
| **DIMENSIONS** | Relay-rack panel width 19 in., height 12-1/4 in. (485 by 330 mm). Over-all depth 11-1/2 in. (295 mm). |
| **WEIGHT** | 35 lb. (16 kg). |

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.

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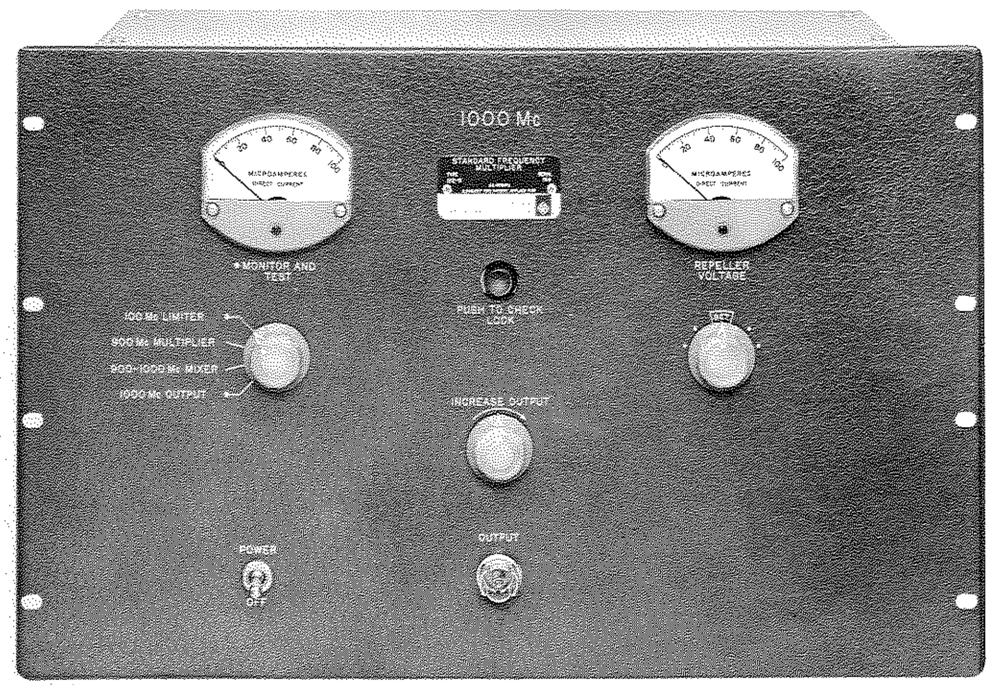



Figure 1. Type 1112-B Standard Frequency Multiplier.

# 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 oscillator such as the General Radio Type 1113-A or 1115-B.

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 250 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. A combination of the General Radio Type 1218-A 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 (General Radio Type 1806-A).

d. Heterodyne test oscillator (A combination of a Type 1218-A Unit Oscillator, Type 874-MR Mixer-Rectifier, and a suitable audio amplier).

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

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

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

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

## PARTS LIST

### CAPACITORS

| Ref No | | Part No |
|---|---|---|
| C1A | 50 µf | |
| C1B | Electrolytic, 25 µf 450 v | 4450-0800 |
| C1C | 25 µf | |
| C2A | 50 µf | |
| C2B | Electrolytic, 25 µf 450 v | 4450-0800 |
| C2C | 25 µf | |
| C3A | 50 µf | |
| C3B | Electrolytic, 25 µf 450 v | 4450-0800 |
| C3C | 25 µf | |
| C4A | 50 µf | |
| C4B | Electrolytic, 25 µf 450 v | 4450-0800 |
| C4C | 25 µf | |
| C5A | 1500 µf | |
| C5B | Electrolytic, 750 µf | 4450-0700 |
| C5C | 750 µf | |
| C6A | 1500 µf | |
| C6B | Electrolytic, 750 µf | 4450-0700 |
| C6C | 750 µf | |
| C7A | 1500 µf | |
| C7B | Electrolytic, 750 µf | 4450-0700 |
| C7C | 750 µf | |
| C8A | 50 µf | |
| C8B | Electrolytic, 25 µf 450 v | 4450-0800 |
| C8C | 25 µf | |
| C9A | 50 µf | |
| C9B | Electrolytic, 25 µf 450 v | 4450-0800 |
| C9C | 25 µf | |
| C101 | Air, 4-50 pf | 4380-0400 |
| C102 | Ceramic, 47 pf ±10% N750 500 v | 4400-4300 |
| C103 | Ceramic, 470 pf ±20% 500 v | 4400-1500 |
| C104 | Ceramic, 470 pf ±20% 500 v | 4400-1500 |
| C105 | Ceramic, 470 pf ±20% 500 v | 4400-1500 |
| C106 | Ceramic, 470 pf ±20% 500 v | 4400-1500 |
| C107 | Air, 2.7-10.8 pf | 4380-2300 |
| C108 | Ceramic, 47 pf ±10% N750 500 v | 4400-4300 |
| C109 | Ceramic, 47 pf ±10% N750 500 v | 4400-4300 |
| C110 | Ceramic, 470 pf ±20% 500 v | 4400-1500 |
| C111 | Ceramic, 470 pf ±20% 500 v | 4400-1500 |
| C112 | Air, 2.2-8.5 pf | 4380-2200 |
| C113 | Air, 2.2-8.5 pf | 4380-2200 |
| C114 | Air, 1.5-3.1 pf | 4380-2000 |
| C115 | Ceramic, 470 pf ±20% 500 v | 4404-1479 |
| C116 | Ceramic, 470 pf ±20% 500 v | 4404-1479 |
| C117 | Ceramic, 470 pf ±20% 500 v | 4404-1479 |
| C118 | Ceramic, 470 pf ±20% 500 v | 4400-2000 |
| C119 | Ceramic, 470 pf ±20% 500 v | 4400-2000 |
| C120 | H-F By-Pass, Built-In | 1117-8450 |
| C121 | Air, 2.7-10.8 pf | 4380-2300 |
| C122 | Ceramic, 470 pf ±20% 500 v | 4400-2000 |
| C123 | Ceramic, 470 pf ±20% 500 v | 4400-2000 |
| C124 | Ceramic, 4.7 pf ±10% 500 v | 4400-0700 |
| C125 | Ceramic, 470 pf ±20% 500 v | 4400-1500 |
| C126 | Air, 2.7-19.6 pf | 4380-3700 |
| C127 | Trimmer | 1117-8080 |
| C128 | Trimmer, Adjustable | 1117-8080 |
| C129 | H-F By-Pass, Built-In | 1117-8440 |
| C130 | Ceramic, 470 pf ±20% 500 v | 4404-1479 |
| C131 | Oil, 0.01 µf ±10% 600 v | 4510-4400 |
| C132 | Mica, 760 pf ±5% 300 v | 4680-3000 |
| C133 | Oil, 0.01 µf ±10% 600 v | 4510-4400 |
| C134 | Ceramic, 0.01 µf ±20% 500 v | 4406-3109 |
| C135 | Air, 1.5-3.1 pf | 4380-2000 |
| C136 | H-F By-Pass, 35 pf ±8 pf | 1117-8510 |
| C137 | Air, 2.2-8.0 pf | 4380-2000 |
| C138 | Ceramic, 470 pf ±20% 500 v | 4400-2000 |
| C139 | Ceramic, 47 pf ±10% N750 500 v | 4400-4300 |
| C140 | Ceramic, 470 pf ±20% 500 v | 4404-1479 |
| C141 | Ceramic, 470 pf ±20% 500 v | 4404-1479 |

### CAPACITORS

| Ref No | | Part No |
|---|---|---|
| C142 | Ceramic, 470 pf ±20% 500 v | 4404-1479 |
| C143 | Ceramic, 470 pf ±20% 500 v | 4400-2000 |
| C144 | Ceramic, 47 pf ±10% N750 500 v | 4400-4300 |
| C145 | Ceramic, 470 pf ±20% 500 v | 4404-1479 |
| C146 | Ceramic, 470 pf ±20% 500 v | 4404-1479 |
| C147 | Ceramic, 470 pf ±20% 500 v | 4404-1479 |
| C148 | Ceramic, 470 pf ±20% 500 v | 4404-1479 |
| C149 | Ceramic, 470 pf ±20% 500 v | 4400-2000 |
| C150 | Ceramic, 47 pf ±10% 500 v | 4400-4300 |
| C151 | Ceramic, 470 pf ±20% 500 v | 4400-2000 |
| C152 | Ceramic, 4.7 pf ±10% 500 v | 4400-0700 |
| C153 | Ceramic, 15 pf ±10% 500 v | 4400-3300 |
| C154 | Ceramic, 470 pf ±20% 500 v | 4404-1479 |
| C155 | Ceramic, 470 pf ±20% 500 v | 4404-1479 |
| C156 | Ceramic, 470 pf ±20% 500 v | 4400-2000 |
| C157 | Trimmer, Built-In | |
| C158 | Ceramic, 470 pf ±20% 500 v | 4400-2000 |
| C159 | Ceramic, 470 pf ±20% 500 v | 4400-2000 |
| C161 | Ceramic, 470 pf ±20% 500 v | 4404-1479 |
| C201 | Air, 1.4-5.0 | 4380-3500 |
| C202 | Button Mica, 200 pf ±10% 500 v | 4920-0400 |
| C203 | Button Mica, 200 pf ±10% 500 v | 4920-0400 |
| C204 | Button Mica, 200 pf ±10% 500 v | 4920-0400 |
| C205 | Ceramic, 3.3 pf ±10% 500 v | 4400-0400 |
| C206 | Insulator | 0874-0740 |
| C508A | | |
| C508B | Wax, 0.1 µf ±10% 400 v | 5020-0700 |
| C508C | | |
| C509A | 10 µf | |
| C509B | Electrolytic, 10 µf 450 v | 4450-0300 |
| C509C | 10 µf | |
| C510 | Ceramic, 0.001 µf ±20% 500 v | 4404-2109 |
| C511 | Oil, 0.0047 µf ±10% 600 v | 4510-4300 |

### RESISTORS

| | | |
|---|---|---|
| R100 | POTENTIOMETER, Wire-wound, 5 kΩ ±5% | 0971-3913 |
| R101 | Composition, 10 kΩ ±5% 1/2 w | 6100-3105 |
| R102 | Composition, 220 Ω ±5% 1/2 w | 6100-1225 |
| R103 | Composition, 56 kΩ ±5% 1/2 w | 6100-3565 |
| R104 | Composition, 3.3 kΩ ±5% 1 w | 6110-2335 |
| R105 | Composition, 33 kΩ ±5% 1/2 w | 6100-3335 |
| R106 | Composition, 33 kΩ ±5% 1/2 w | 6100-3335 |
| R107 | Composition, 1 kΩ ±5% 1 w | 6110-2105 |
| R108 | Composition, 1.8 kΩ ±5% 2 w | 6120-2185 |
| R109 | Composition, 22 kΩ ±5% 1/2 w | 6100-3225 |
| R110 | Composition, 220 Ω ±5% 1/2 w | 6100-1225 |
| R111 | Composition, 56 kΩ ±5% 1/2 w | 6100-3565 |
| R112 | Composition, 1 kΩ ±5% 1/2 w | 6100-2105 |
| R113 | Composition, 2.2 kΩ ±5% 1/2 w | 6100-2225 |
| R114 | POTENTIOMETER, Wire-wound, 2kΩ ±5% | 0971-4130 |
| R115 | Composition, 10 Ω ±5% 1/2 w | 6100-0105 |
| R116 | POTENTIOMETER, Wire-wound, 1 kΩ ±5% | 0971-3911 |
| R117 | Composition, 22 kΩ ±5% 2 w | 6120-3225 |
| R118 | Composition, 33 kΩ ±5% 2 w | 6120-3335 |
| R119 | Composition, 56 kΩ ±5% 1/2 w | 6100-3565 |
| R120 | Composition, 1 kΩ ±5% 1/2 w | 6100-2105 |
| R121 | Composition, 3.3 kΩ ±5% 1 w | 6100-2335 |
| R122 | Composition, 100 Ω ±5% 1/2 w | 6100-1105 |
| R123 | Composition, 470 kΩ ±5% 1/2 w | 6100-4475 |
| R124 | Composition, 220 Ω ±5% 1/2 w | 6100-1225 |
| R125 | Composition, 5.6 kΩ ±5% 1/2 w | 6100-2565 |
| R126 | Power, 13 kΩ ±5% 5 w | 6660-3135 |
| R127 | Composition, 470 kΩ ±5% 1/2 w | 6100-4475 |
| R128 | Composition, 220 Ω ±5% 1/2 w | 6100-1225 |

## PARTS LIST (cont)

### RESISTORS

| Ref No | | Part No |
|---|---|---|
| R129 | Composition, 10 Ω ±5% 1/2 w | 6100-0105 |
| R130 | Power, 13 kΩ ±5% 5 w | 6660-3135 |
| R131 | Composition, 10 kΩ ±5% 1/2 w | 6100-3105 |
| R132 | Composition, 10 Ω ±5% 1/2 w | 6100-0105 |
| R133 | Power, 13 kΩ ±5% 5 w | 6660-3135 |
| R134 | Composition, 100 Ω ±5% 1/2 w | 6100-1105 |
| R135 | Value to be determined by Lab. | |
| R136 | Composition, 75 Ω ±5% 1/2 w | 6100-0755 |
| R137 | Composition, 47 Ω ±5% 1/2 w | 6100-0475 |
| R138 | Composition, 75 Ω ±5% 1/2 w | 6100-0755 |
| R139 | Composition, 82 Ω ±5% 1/2 w | 6100-0825 |
| R140* | Composition, 5.1 kΩ ±5% 1/2 w | 6100-2515 |
| R142 | Composition, 68 kΩ ±10% 2 w | 6120-3689 |
| R143 | Composition, 3.3 kΩ ±10% 1 w | 6110-2339 |
| R144 through R149 | Composition, 100 kΩ 2 w | 6120-4109 |
| R150 | Power, 47 Ω ±5% 10 w | 6670-0475 |
| R151 | Power, 47 Ω ±5% 10 w | 6670-0475 |
| R152 | Power, 47 Ω ±5% 10 w | 6670-0475 |
| R153 | Power, 0.7 Ω ±10% 10 w | 6670-8709 |
| R154 | Power, 1.0 Ω ±5% 10 w | 6670-9105 |
| R155 | Power, 1.8 Ω ±10% 10 w | 6670-9189 |
| R156 | Composition, 560 kΩ ±5% 1/2 w | 6100-4565 |
| R157 | Composition, 560 kΩ ±5% 1/2 w | 6100-4565 |
| R158 | Composition, 560 kΩ ±5% 1/2 w | 6100-4565 |
| R159 | Composition, 1 kΩ ±5% 1/2 w | 6100-2105 |
| R501A | Composition, 1 MΩ ±10% 1/2 w | 6100-5105 |
| R501B | Composition, 1 MΩ ±10% 1/2 w | 6100-5105 |
| R501C | Composition, 1 MΩ ±10% 1/2 w | 6100-5105 |
| R502A | Composition, 2.4 MΩ ±5% 1/2 w | 6100-5245 |
| R502B | Composition, 2.4 MΩ ±5% 1/2 w | 6100-5245 |
| R502C | Composition, 2.4 MΩ ±5% 1/2 w | 6100-5245 |
| R503A | Film, 36 kΩ ±1% 1/4 w | 6350-2360 |
| R503B | Film, 36 kΩ ±1% 1/4 w | 6350-2360 |
| R503C | Film, 36 kΩ ±1% 1/4 w | 6350-2360 |
| R504A | Film, 26 kΩ ±1% 1 w | 6550-2260 |
| R505A | Film, 36 kΩ ±1% 1/4 w | 6350-2360 |
| R505B | Film, 36 kΩ ±1% 1/4 w | 6350-2360 |
| R505C | Film, 36 kΩ ±1% 1/4 w | 6350-2360 |
| R506A | Composition, 470 kΩ ±5% 1/2 w | 6100-4475 |
| R506B | Composition, 470 kΩ ±5% 1/2 w | 6100-4475 |
| R506C | Composition, 470 kΩ ±5% 1/2 w | 6100-4475 |
| R507A | Composition, 39 kΩ ±1% 1/4 w | 6350-2390 |
| R507B | Composition, 39 kΩ ±1% 1/4 w | 6350-2390 |
| R507C | Composition, 39 kΩ ±1% 1/4 w | 6350-2390 |
| R508A | POTENTIOMETER, Wire-wound, 10 kΩ ±10% | 6050-1800 |
| R508B | POTENTIOMETER, Wire-wound, 10 kΩ ±10% | 6050-1800 |
| R508C | POTENTIOMETER, Wire-wound, 10 kΩ ±10% | 6050-1800 |
| R509A | Composition, 5.6 MΩ ±10% 1/2 w | 6100-5565 |
| R509B | Composition, 5.6 MΩ ±10% 1/2 w | 6100-5565 |
| R509C | Composition, 5.6 MΩ ±10% 1/2 w | 6100-5565 |
| R510A | Composition, 100 Ω ±10% 1/2 w | 6100-1105 |
| R510B | Composition, 100 Ω ±10% 1/2 w | 6100-1105 |
| R510C | Composition, 100 Ω ±10% 1/2 w | 6100-1105 |
| R511A | Composition, 100 Ω ±10% 1/2 w | 6100-1105 |
| R511B | Composition, 100 Ω ±10% 1/2 w | 6100-1105 |
| R511C | Composition, 100 Ω ±10% 1/2 w | 6100-1105 |
| R512A | Composition, 470 kΩ ±5% 1/2 w | 6100-1105 |
| R512B | Composition, 470 kΩ ±5% 1/2 w | 6100-4475 |
| R512C | Composition, 470 kΩ ±5% 1/2 w | 6100-4475 |
| R513A | Composition, 620 kΩ ±5% 1/2 w | 6100-4625 |
| R513B | Composition, 620 kΩ ±5% 1/2 w | 6100-4625 |
| R513C | Composition, 620 kΩ ±5% 1/2 w | 6100-4625 |
| R514A | Composition, 120 kΩ ±5% 1/2 w | 6100-4125 |
| R514B | Composition, 120 kΩ ±5% 1/2 w | 6100-4125 |
| R514C | Composition, 120 kΩ ±5% 1/2 w | 6100-4125 |

### INDUCTORS

| Ref No | | Part No |
|---|---|---|
| L101 | Inductor | 1170-8242 |
| L102 | Inductor | 1170-0253 |
| L103 | Inductor | 1117-8010 |
| L104 | Choke, Air, 10 µh | 4290-0500 |
| L105 | Inductor | 1170-8110 |
| L106 | Choke, Air, 2 µh | 4290-1400 |
| L107 | Inductor | 1170-8030 |
| L108 | Inductor | 1170-3400 |
| L110 | Inductor Assembly | 1117-2010 |
| L111 | Inductor | 1117-8020 |
| L112 | Built-in loop | |
| L113 | Coil Assembly | 1117-4010 |
| L113A | Coil Assembly | 1117-4012 |
| L114 | Choke, Air, 2 µh | 4290-1400 |
| L115 | Coil Assembly | 1117-0420 |
| L116 | Built-in loop | part of 1117-2200 |
| L117 | Built-in loop | 1117-8090 |
| L118 | Inductor | 1117-8540 |
| L119 | Inductor | 1117-8530 |
| L120 | Inductor | 1117-8520 |
| L121 | Inductor Assembly | 1117-2210 |
| L122 | Inductor Assembly | 1117-2220 |
| L123 | Inductor Assembly | 1117-2250 |
| L124 | Inductor Assembly | 1117-2010 |
| L125 | Built-in loop | part of 1117-2200 |
| L126 | Coupling Loop | |
| L127 | Coupling Loop | |
| L128 | Choke, Air, | 4290-0600 |
| L129 | Built-in loop | |
| L201 | Built-in loop | 1117-8250 |
| L202 | Built-in loop | 1117-1130 |
| L203 | Choke, Air, 2 µh | 4290-1400 |
| L204 | Choke, Air, 2 µh | 4290-1400 |
| L205 | Choke, Air, 2 µh | 4290-1400 |
| L206 | Choke, Air, 2 µh | 4290-1400 |
| L207 | Built-in Inductance | 1117-1110 |
| L208 | Inductor | 1112-8290 |

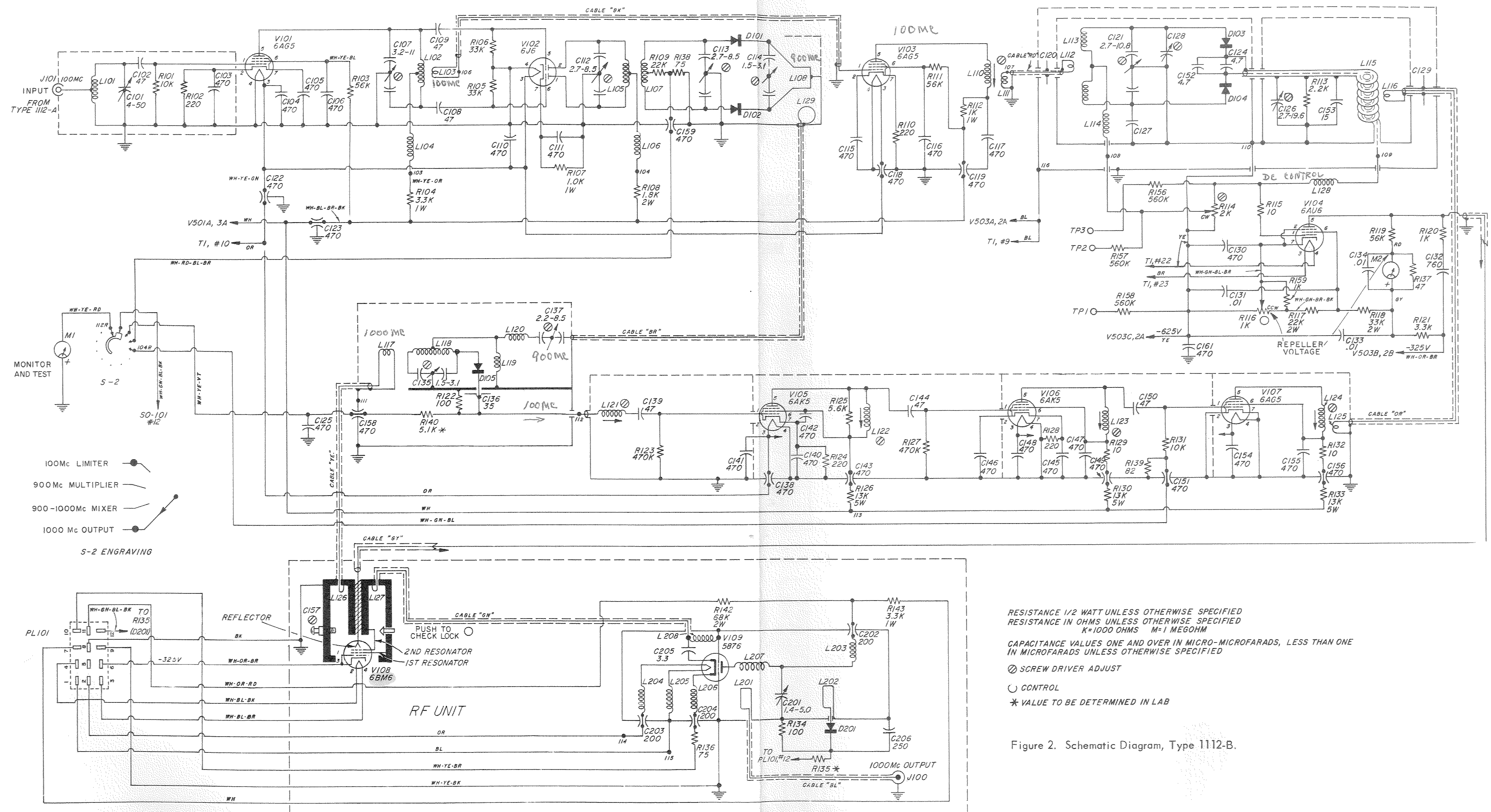
### MISCELLANEOUS

| Ref No | | Part No |
|---|---|---|
| D101 | DIODE, Type 1N34A (s) | 6082-1003 |
| D102 | DIODE, Type 1N34A (s) | 6082-1003 |
| D103 | DIODE, Type 1N35A (s) | 6082-1004 |
| D104 | DIODE, Type 1N35A (s) | 6082-1004 |
| D105 | DIODE, Type 1N21B | 6084-1001 |
| D201 | DIODE, Type 1N21B | 6084-1001 |
| F1 | FUSE, 115 v, 1.6a | 5330-1700 |
| | FUSE, 230 v, 0.8a | 5330-1200 |
| F2 | FUSE, 115 v, 1.6a | 5330-1700 |
| | FUSE, 230 v, 0.8a | 5330-1200 |
| J100 | Shielded Cable Set | 1117-0300 |
| J101 | CONNECTOR, Coaxial | 0874-4505 |
| M1 | METER | 5730-0950 |
| M2 | METER | 5730-0950 |
| PL1 | PLUG, Power | 4240-0600 |
| PL101 | PLUG | 4220-5100 |
| RX1 through RX6 | RECTIFIER, Type 1N3255 | 6081-1003 |
| RX13 | RECTIFIER, Type 1N3253 | 6081-1001 |
| RX14 | RECTIFIER, Type 1N3253 | 6081-1001 |

PARTS LIST (cont)

| Ref No | MISCELLANEOUS | Part No |
|---|---|---|
| S1 | SWITCH | 7910-1300 |
| S2 | SWITCH, Rotary Wafer | 7890-1540 |
| SO101 | SOCKET | 4230-3700 |
| T1 | TRANSFORMER | 0685-4000 |
| V101 | TUBE, Type 6AG5 | 8360-0400 |
| V102 | TUBE, Type 6J6 | 8360-5500 |
| V103 | TUBE, Type 6AG5 | 8360-0400 |
| V104 | TUBE, Type 6AU6 | 8360-2100 |
| V105 | TUBE, Type 6AK5 | 8360-0700 |
| V106 | TUBE, Type 6AK5 | 8360-0700 |

| Ref No | MISCELLANEOUS | Part No |
|---|---|---|
| V107 | TUBE, Type 6AG5 | 8360-0400 |
| V108 | TUBE, Type 6BM6 | 8360-3300 |
| V109 | TUBE, Type 5876 | 8380-5876 |
| V501A | TUBE, Type 6AU5GT | 8360-2000 |
| V501B | TUBE, Type 6AU5GT | 8360-2000 |
| V501C | TUBE, Type 6AU5GT | 8360-2000 |
| V502A | TUBE, Type 12AX7 | 8370-0900 |
| V502B | TUBE, Type 12AX7 | 8370-0900 |
| V502C | TUBE, Type 12AX7 | 8370-0900 |
| V503A | TUBE, Type 5651 | 8380-5651 |
| V503B | TUBE, Type 5651 | 8380-5651 |
| V503C | TUBE, Type 5651 | 8380-5651 |




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

⊘ SCREW DRIVER ADJUST

◡ CONTROL

* VALUE TO BE DETERMINED IN LAB

Figure 2. Schematic Diagram, Type 1112-B.

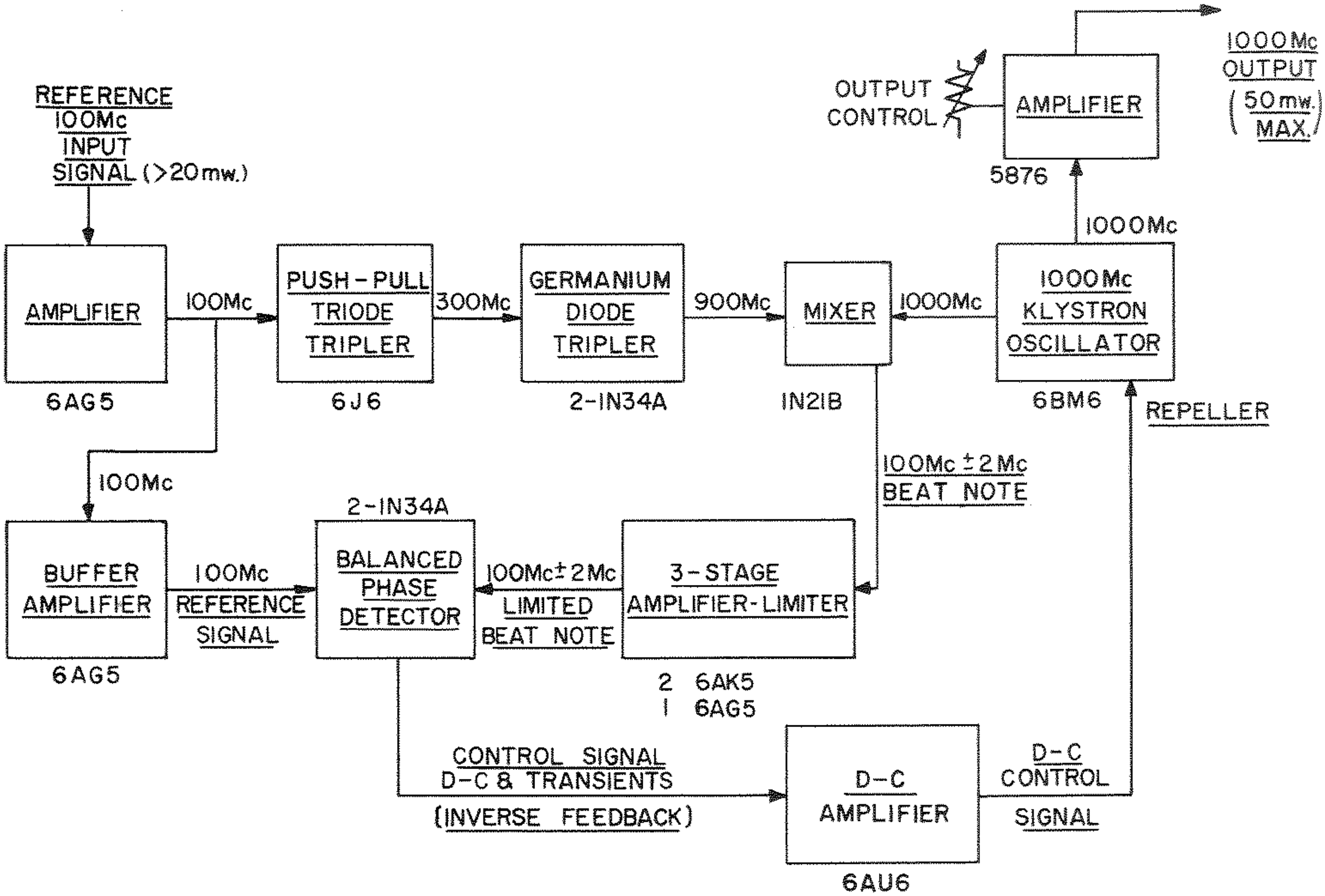
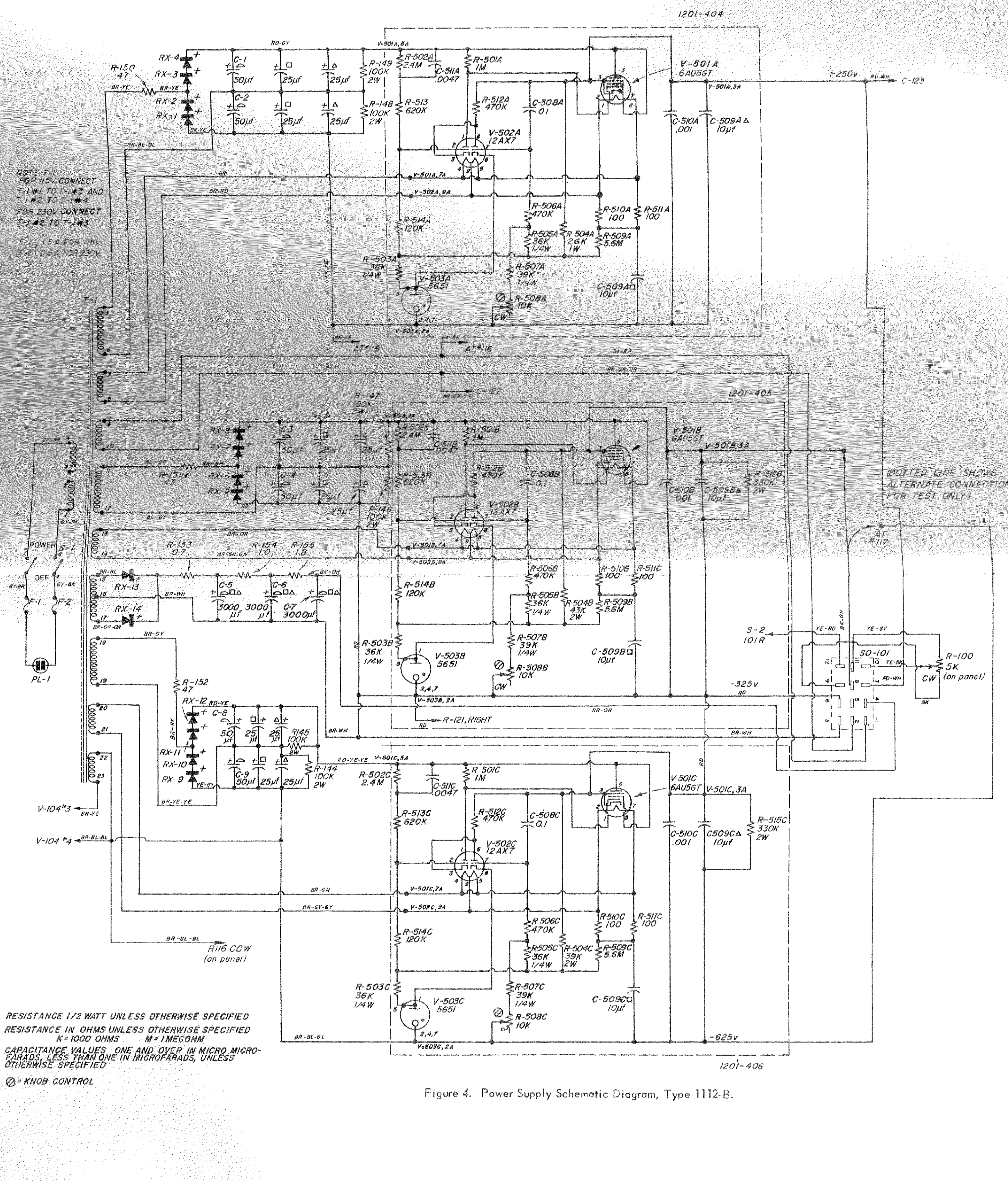



Figure 3. Block Diagram, Type 1112-B




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 MICRO-FARADS, LESS THAN ONE IN MICROFARADS, UNLESS OTHERWISE SPECIFIED
⊘ = KNOB CONTROL

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

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