INSTRUCTION BOOK

for

VARIABLE FREQUENCY OSCILLATOR

MODEL VOX

THE TECHNICAL MATERIEL CORP.
Mamaroneck, N. Y.

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SECTION I
GENERAL DESCRIPTION

1. PURPOSE AND BASIC PRINCIPLES

The Variable Frequency Oscillator, Model VOX is a precision, direct reading, variable frequency device, designed to provide high frequency and medium frequency oscillator injection voltage for the control of one or more receivers or transmitter exciters with extremely high stability.

The oscillator will provide the following:

A. High frequency R. F. output voltage, continuously variable over the range of 2 to 64 megacycles.

B. Crystal controlled high frequency voltage, over the range of 2 to 64 megacycles.

C. Crystal controlled BFO voltage, plus 3500 kc crystal control voltage for dual conversion superheterodynes, such as the Hammarlund 600 series.

Sufficient output is available from any of the foregoing to control up to three receivers in diversity, or the usual requirement of transmitter exciters.

The VOX incorporates a highly-stable variable

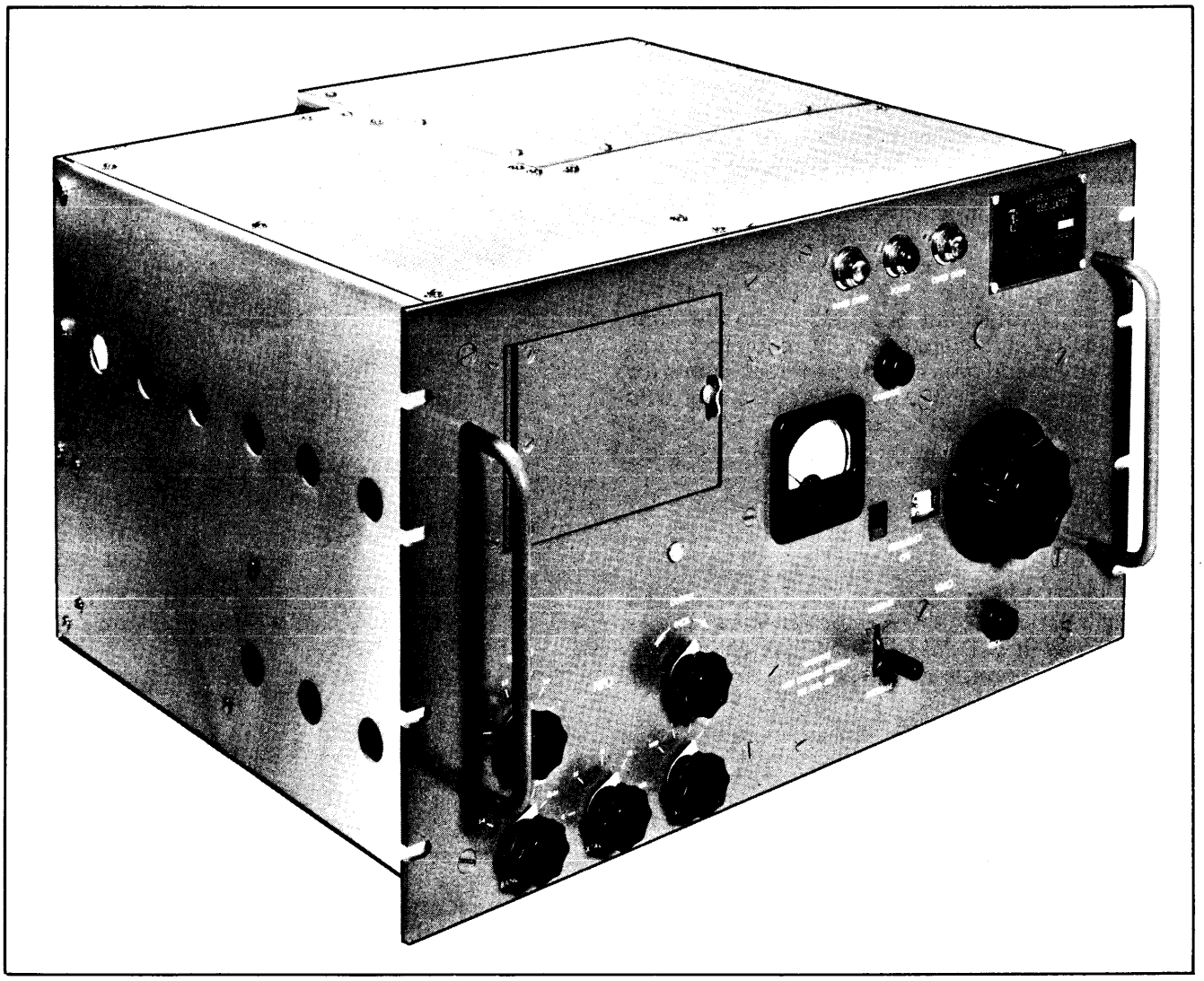

Figure 1-1. Variable Frequency Oscillator, Model VOX

Photo PH-114

frequency oscillator, with an extremely accurate counter type dial. Master oscillator frequency determining elements are contained in a temperature stabilized oven, and these components are carefully selected for high-stability operation.

In addition to the variable frequency feature, provision is made for up to three crystal controlled positions for high frequency injection. Additional crystal oscillators provide crystal controlled beat frequency oscillator voltage for use with receivers, and a 3500 kc crystal controlled RF output for dual conversion receivers.

2. DESCRIPTION OF UNIT

The Variable Frequency Oscillator, Model VOX, is shown in Figure 1-1. The panel is 3/16 inches thick by 19 inches long and $10\frac{1}{2}$ inches high, and is finished in TMC gray enamel. The chassis extends 16 inches behind the panel and is supported to the panel on each side by brackets. The controls most often used are located on the front panel, while seldom used controls and fuses are located behind an access door on the upper left-center of the panel. All vacuum tubes and relays are readily accessible from the rear of the Model VOX and are mounted in a vertical position.

The direct reading calibration of the unit enables the operator to set the output frequency to within 20 cycles per megacycle of any desired frequency within the range of the unit at any checkpoint, and the unit is resettable to the same tolerance. A self-contained 100 kc temperature controlled crystal provides 50 kc check points for calibration of the VFO. All units are isolated with buffer amplifiers, where necessary, to prevent interaction. The output is controllable from approximately .1 to 2 watts.

3. REFERENCE DATA

The Variable Frequency Oscillator, Model VOX, is composed of three simultaneously available sources of oscillator output, the characteristics of each one are as follows:

A. HF OSCILLATOR

Frequency Range
2 to 64 megacycles continuous.

Output Impedance
75 ohms coaxial.

Output Level
2 watts throughout basic range of 2 to 4 megacycles and 0.5 watts 4 to 64 megacycles adjustable.

Output Connections
Three BNC RF Connectors.

Crystal Frequencies
2 to 4 megacycles for output frequencies of 2 to 64 megacycles.

Crystal Holders
HC-6/U.

Crystal Position
3 each, available on front panel switch.

Output Voltage
Sinusoidal with no spurious frequencies.

Stability
20 cycles per megacycle for 0 to 50 degrees change in ambient temperature.

Calibration
Direct reading calibration in cycles per second from 2 to 4 megacycles.

Readability
20 cycles per megacycle.

Resettability
20 cycles per megacycle to a calibrated frequency.

Line Voltage Change Effects
10 cycles for plus/minus 10% change in Line Voltage.

Humidity Effects
No appreciable change for 50 to 95% humidity.

High Frequency Oscillator Calibration
Against 100 kc crystal oscillator at 50 kc points.

B. BEAT FREQUENCY OSCILLATOR

Frequency Range
450 to 457 kcs.

Output Level
6 volts across 1000 ohms with output level control.

Output connections
Three BNC RF Connectors.

Crystal Holders
HC-6/U.

Crystal Position
2 each, available on rear panel switch.

C. INTERMEDIATE FREQUENCY OSCILLATOR

Frequency Range
Fixed at 3.5 Mc (crystal oscillator).

Output Level
2 volts in 75 ohms.

Output Connections
Three BNC RF Connectors.

D. GENERAL

Controls
1. Primary Power Switch
2. HFO Plate Switch
3. BFO Plate Switch
4. IFO Plate Switch
5. Beat Volume Control
6. Meter Switch
7. Multiplier Tuning Control
8. HFO Output Control
9. Band Switch
10. Crystal Padding Condenser
11. HFO Crystal Selector Switch
12. Calibrate Control
13. Master Oscillator Frequency Control
14. Motor Drive Switch
15. BFO Crystal Switch
16. BFO Output Control

Metering
1. HFO Output
2. BFO Output
3. VMO output
4. VFO output
5. Zero Beat

Primary Power: 110/220 volts, 50/60 cps
Approximately 100 watts average or 250 watts peak depending upon cycling of oven heating elements.

Dimensions	19'' x 16'' x 10½'' high
Weight	157 lbs Gross, packed for shipment
Mounting	WE Relay Rack Mounting

4. TUBE COMPLEMENT

All JAN type miniature or octal.

TABLE 1-1 VACUUM TUBE COMPLEMENT

SYMBOL	TYPE	CIRCUIT
V101	5V4G	High voltage rectifier
V102	OA2	Voltage regulator
V103	6BE6	Mixer
V104	12AU7	Audio Amplifier
V105	6C4	BFO
V201	12AU7	IFO and Amplifier
V202	6C4	Crystal HFO or RF amplifier
V203	6AQ5	R.F. Amplifier
V204	6AQ5	Multiplier
V205	6AQ5	Multiplier
V206	6AQ5	Multiplier
V207	6AQ5	Multiplier
V301	6C4	VMO
V302	12AU7	Crystal oscillator and cathode follower

Components and Construction:

Equipment is manufactured in accordance with JAN specifications, wherever practicable.

We reserve the right to make changes in the design of our equipment consistent with good engineering practice in order to make improvements in design and to effect economies in manufacture.

SECTION II
THEORY OF OPERATION

1. GENERAL DESCRIPTION OF CIRCUITS

A. THE HFO CHAIN:

In the following discussion reference to Figure 2-1, Block Diagram of the Variable Frequency Oscillator, will serve to show the path of the signal from input to output.

The master oscillator (V301) is a highly stable frequency determining device, due to its enclosure in a finely engineered double oven. As an added precaution, the resonant portion of the circuit is very lightly coupled to its associated vacuum tube element and this, in turn, is isolated from external influences by a cathode follower ($\frac{1}{2}$ of V302).

The oven itself is composed of an inner and outer shell, each of which is a temperature controlled entity in itself. The outer shell is maintained, within small limits, at a given temperature by the combination of S303, which is a bimetallic temperature sensitive switch, and the heating elements R309 and R310. The inner shell is a vernier, so to speak, on the outer shell. R307 and R308, the inner shell heating elements, are controlled by an accurate mercury thermostat (S301). The entire assembly contains a large mass of metal and insulating materials, distributed through its cross section so that its heat inertia is high and, consequently, its temperature is extremely stable.

The cathode follower output feeds a dual purpose triode, called the amplifier or crystal oscillator (V202). Depending upon where S201 is set, this stage may become a simple RC ampli-

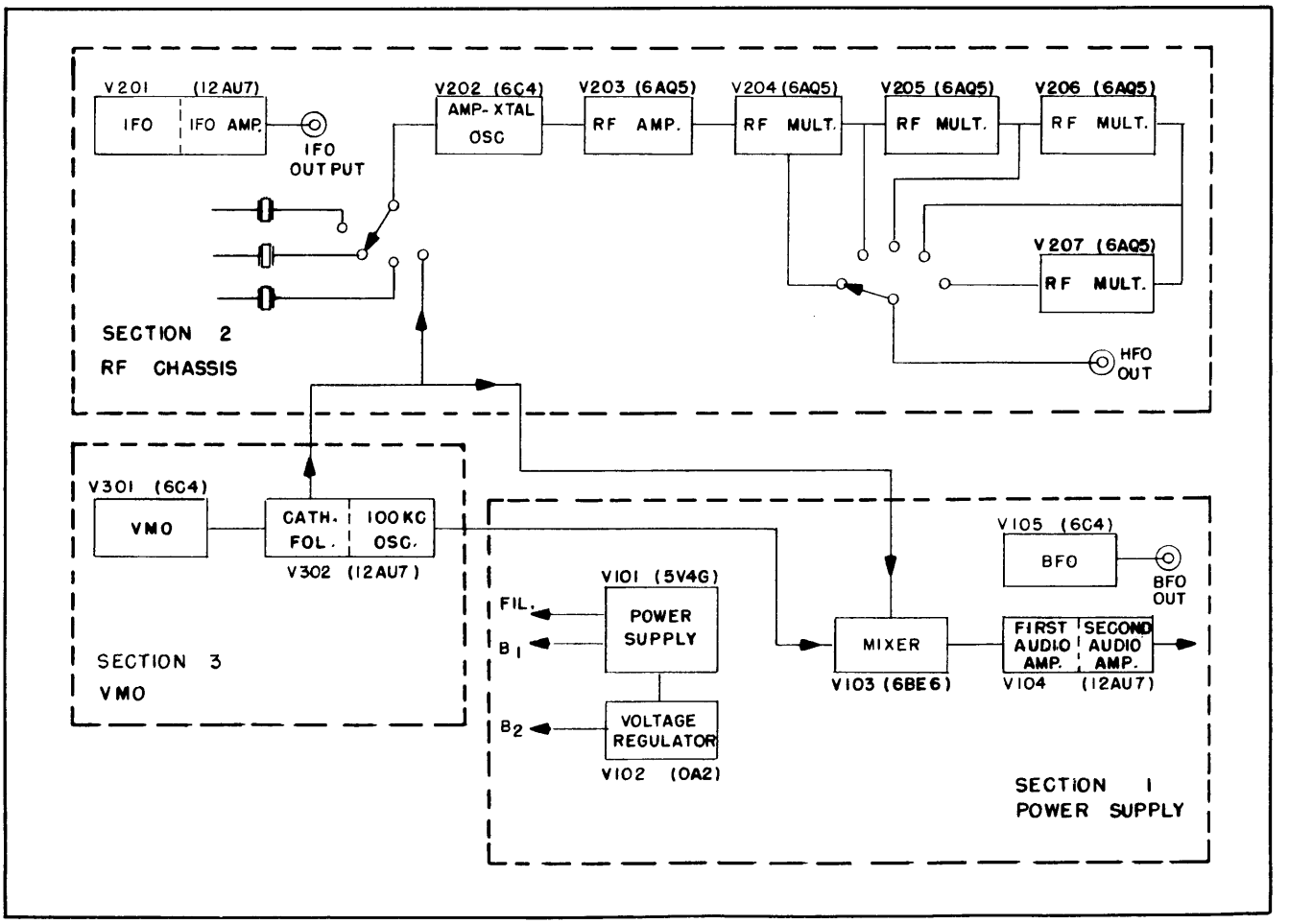

Figure 2-1. Block Diagram of the VFO, Model VOX

fier or a conventional Pierce oscillator having three crystal positions. The next stage (V203) is also an RF amplifier of the RC type, but contains a peaking coil (L202) to make its gain virtually uniform over the entire 2-4 Mc range. A series of four multipliers (V204, V205, V206, V207) then multiply the fundamental 2-4 Mc frequency range continuously up to 64 Mc. All of these stages are gang-tuned and prealigned. The output is metered by means of rectifying device (CR202) and its associated filter circuits.

B. THE IFO:

The IFO is a Pierce circuit with a permanently installed 3.5 Mc crystal. It is followed by a class C power amplifier whose tank is link-coupled to the output jacks. A germanium diode rectifier and its associated filter network produce a D.C. level proportional to the R.F. output voltage. This is fed to a front panel milliammeter, so that an output indication is available to the operator or technician. (Full scale deflection is approximately equivalent to 10 volts RMS of RF voltage.).

C. THE BFO;

This stage is also a crystal oscillator but has two crystal positions, either one of which may be chosen by means of a toggle switch. The output jacks are capacitively-coupled to the tank through an output control, which is metered in a manner similiar to that discussed in part B, above. In this case, however, full scale deflection is equivalent to 20 volts RMS of R.F. voltage.

D. THE CALIBRATING CHAIN:

Contained within the oven enclosure is a highly stable 100 KC crystal oscillator, against which the master oscillator is calibrated. Both of these voltages are fed to the mixer (V103), where the difference-frequency between one of the 100 KC harmonies and the master oscillator output is picked off. This result is obtained because of the presence of a low pass filter, connected between the mixer and first audio amplifier. The audio amplifiers (V104) provide sufficient gain to drive a head-set. These stages are designed for good low frequency response, so that when the front panel milliammeter is switched into the final amplifier cathode circuit, a zero beat may be observed.

2. CIRCUIT ANALYSIS

An understanding of the circuit as a whole may be accomplished by stage by stage signal tracing. Constant reference to the schematic diagrams, is recommended to facilitate understanding of the functions of the individual components.

A. THE HFO CHAIN

The master high frequency oscillating tube (V301) oscillates at frequencies between 2 & 4 megacycles and is tuned by condensers C301, C302 and C303. R320 provides the necessary tube bias; L302 is an RF choke to ground; R301 and C307 provide the necessary decoupling action, with the latter a low-impedance path for the a.c. Twin Triode V302 performs the double function as a cathode follower to impose less shunting effect on the preceeding stage, and as a crystal-controlled 100 KC oscillator. R302 is the unbypassed cathode resistor, across which the output is taken. R303 and C308 provide filtering action to keep the a.c. out of the power supply by bypassing it through C308 and offering as high a resistance in R303 as practicable for the B+ supply available. The output from the second part of V302 is taken across R305. R306 supplies the necessary grid bias. Crystal Y301 resonates near 100 KC and may be pulled by means of adjuster capacitor C311, which is not to be disturbed after its initial setting. R304 is the plate load, and C309 is a coupling condenser.

The cathode follower output feeds triode V202, which is used either as an amplifier or as a crystal oscillator. The position of switch S201 is the controlling factor. When it is set on VMO, the tube is a RC amplifier; when set on 1,2, or 3, the stage is a conventional Pierce oscillator having three crystal positions. Crystal Y202, Y203, and Y204 may be inserted into the circuit, according to the necessary operating conditions required. C210 is the crystal trimmer, and R207 provides the necessary grid bias. C243 is a blocking condenser to prevent any D.C. from entering the crystal. R208 is the load resistor, while C211 and R209 provide decoupling action. This stage is capacitively coupled by C212 to the grid of tetrode V203.

Tube V203 is also an RF amplifier, which features a peaking coil (L202), designed to produce uniform gain over the 2-4 Mc range. The output of this tube is controlled by the variable resistor R215, which changes the screen grid bias. R214 and R217 are dropping resistors to provide correct biasing voltage on the screen grids of V203 and also V204. C215 and C216 are a.c by-pass capacitors, so as to prevent any component of the B+ power from entering the screen grid. R213 and C213 provide decoupling action, while R212 is the plate load resistor. R210 and R211 provide the necessary bias on the grid and cathode, respectively, while C214 is the conventional cathode by-pass to ground. C217 is the coupling capacitor between stages.

Tubes V204, V205, V206 and V207, used in

conjunction with Band Switch S202, are voltage multipliers of the second harmonic of each preceding stage.

S202 is a four section, five position, rotary type switch. The "a" position of the switch controls the screen voltage bias on tubes V203 and V204. R216 and R233 are the dropping resistors involved. The "b" position of the switch, throws in either coil L203 or L205, to be used for the proper tank circuit, with variable tuning capacitor C225, the former for 2-4 Mc, and the latter for 4-8 Mc. The coils, L206, L207 and L208, are also used with the variable tuner capacitor C225, to produce outputs of 8-16 Mc, 16-32 mc and 32-64 Mc, respectively.

The output in milliamperes is metered by the detector circuit, built around crystal CR202. This crystal rectifies the a.c. current; C238 is a coupling capacitor; capacitor C237 provides filtering action; resistor R232 acts as the load resistor of the crystal. C220, C221 and R220, are all de-coupling devices, while L204 is an RF choke to prevent the a.c. from flowing through the d.c. power lines. Position "c" adds more B+ voltage to each successive multiplier, whenever called for in use. The "d" position is the output selector. The HFO Band may be picked off from 2-4, 4-8, 16-32 and 32-64 Mcs, from positions marked A-F, respectively.

B. THE IFO

The first half of triode V201 is a Pierce crystal oscillator circuit. The crystal is set at 3.5 Mc. C202, C203, and R203 provide a low band pass filter, while C242 is the crystal coupling capacitor. The second half of the tube is a class C amplifier, whose tuned plate circuit is link-coupled to the output jacks. The tank circuit is tuned by C207 to 3.5 Mcs. Metering is accomplished in essentially the same manner as described in the HFO circuit above.

C. THE BFO

Toggle Switch, S105, may throw either one of the two crystals, Y101 and Y102, into the oscillator circuit. The plate tank circuit is tuned by

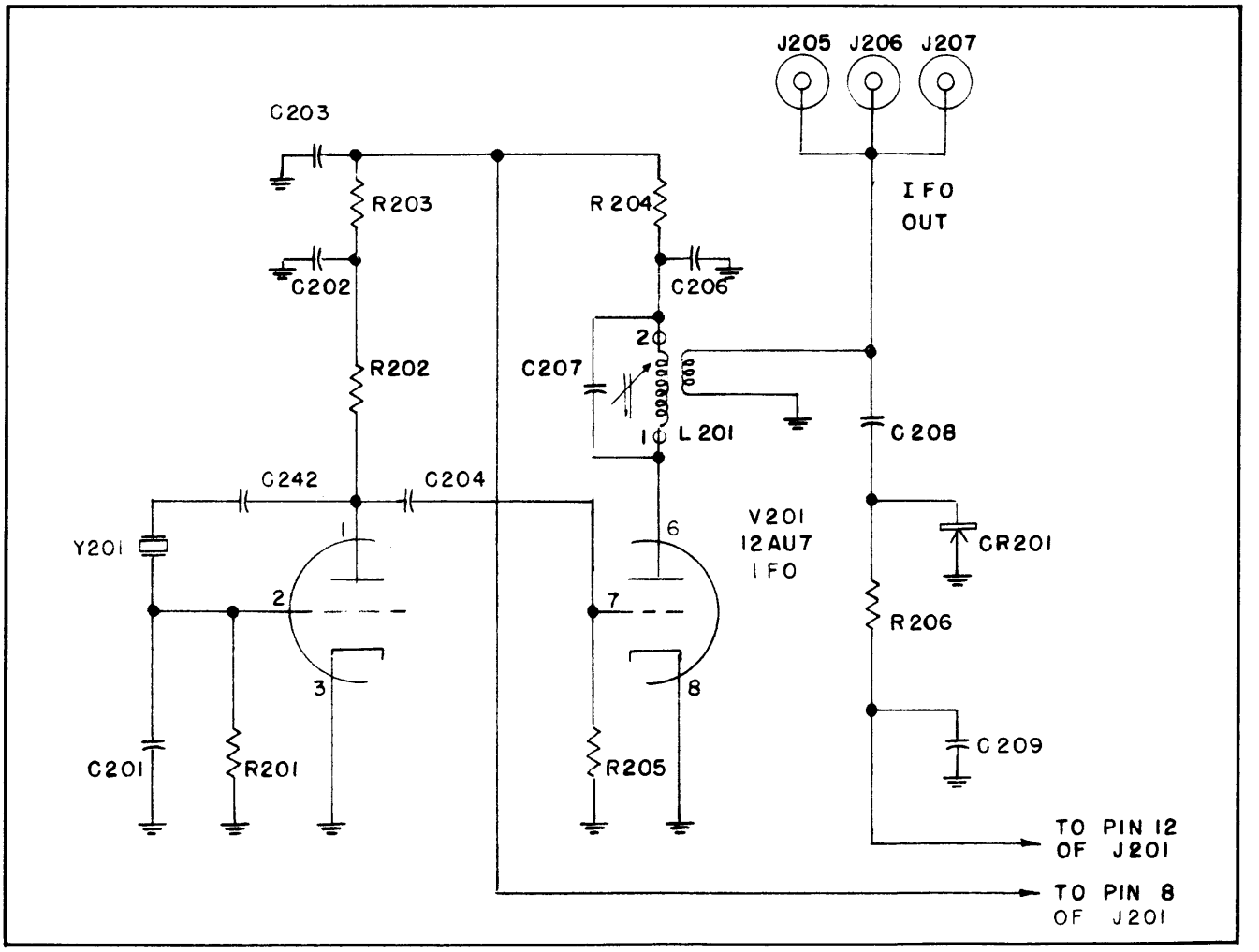

Figure 2-2. IFO Circuit

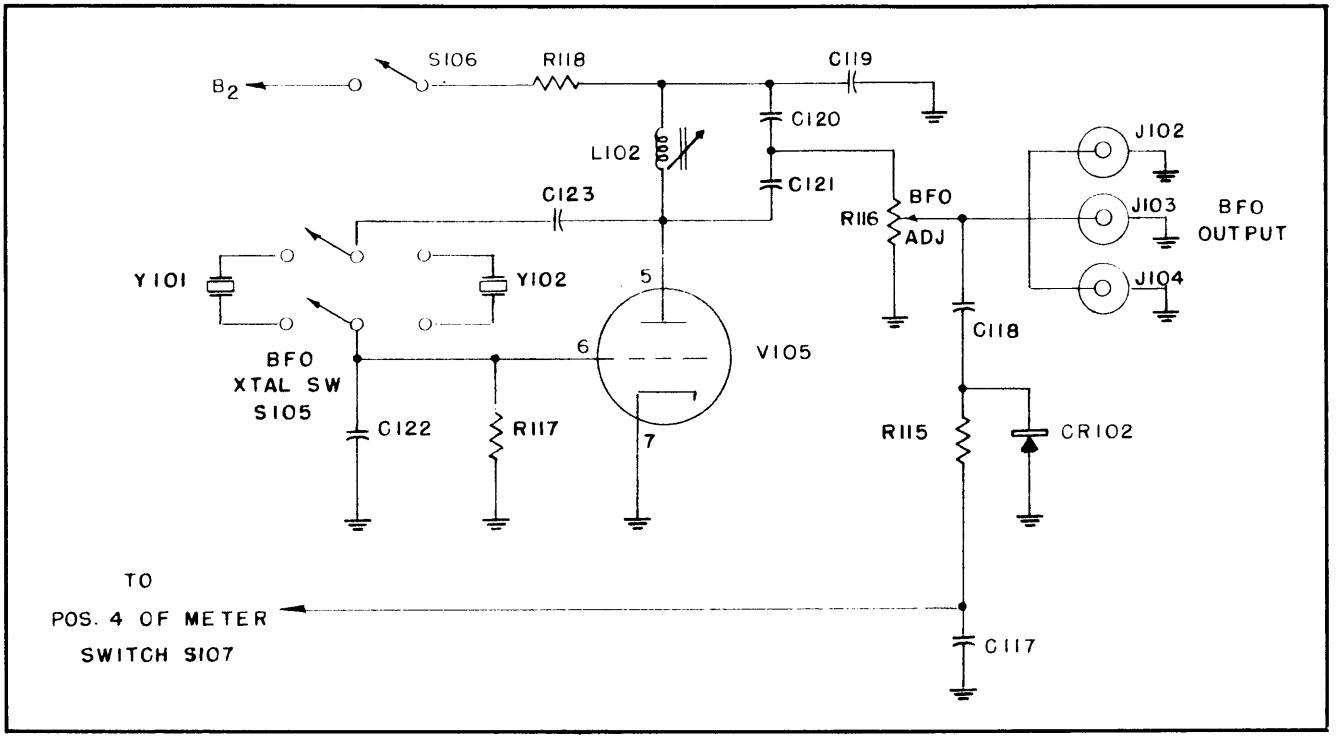

Figure 2-3. BFO Circuit

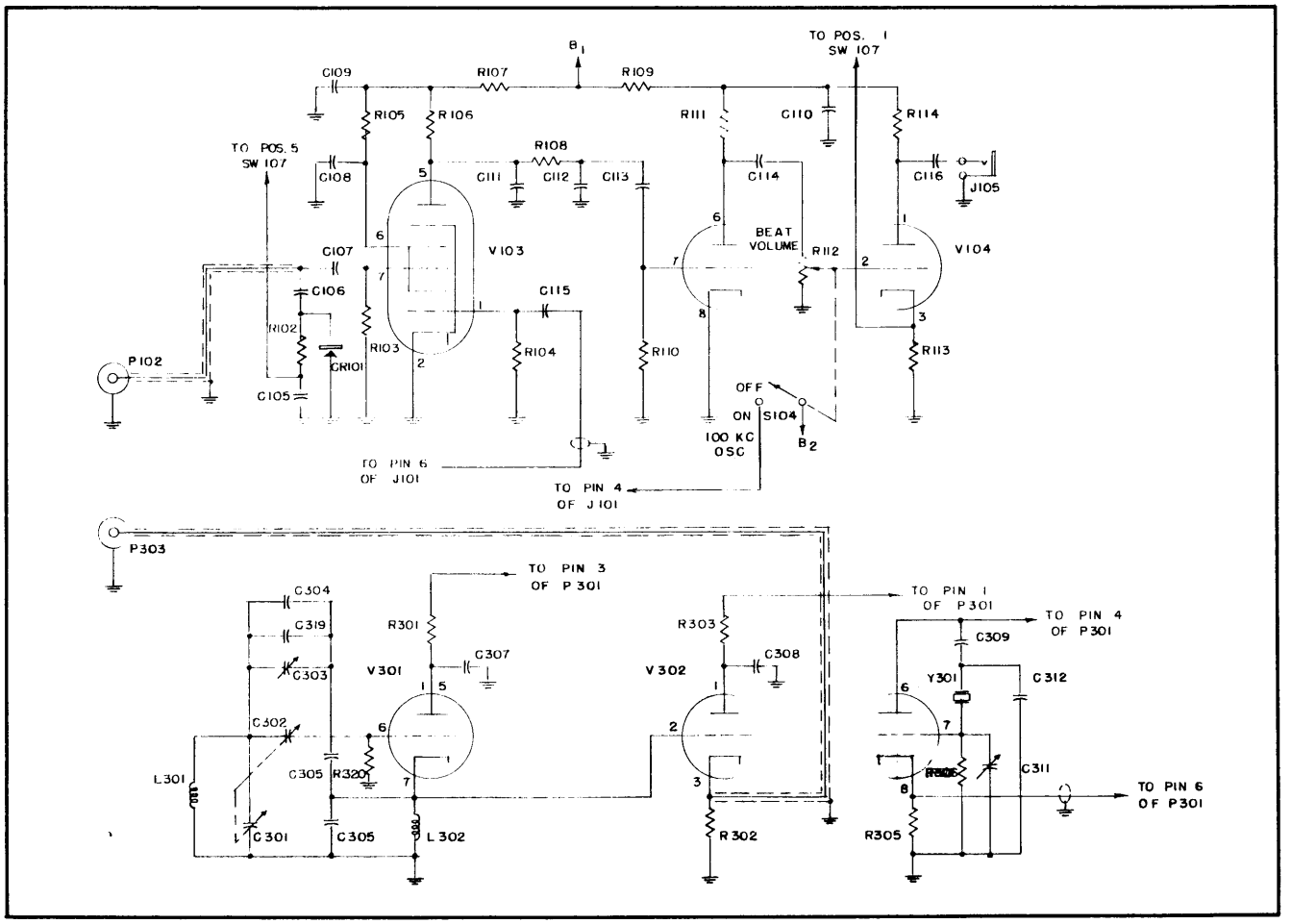

Figure 2-4. Calibrating Chain Circuit

variable inductor L102, and its voltage output is controlled by potientiometer R116. Metering of the output is accomplished in the same manner as described in section one (1) above.

D. THE CALIBRATING CHAIN

The voltage from the 100 DC crystal, Y301, and the master oscillator tube, 6C4, are fed via pins 1 and 7, respectively, into the pentagrid converter V103. The difference-frequency is picked off by filter action of capacitors C111, C112, and resistor R108. This is a low pass filter with a rising characteristic at very low frequencies. The audio signal is then amplified successively by the first and second halves of V104. Variable resistor R112 provides audio volume control, working in conjunction with rotary switch S104, which turns on or off the 100 KC oscillator. The front panel milliammeter is switched into the cathode circuit of the final amplifier, so that the zero beat may be seen by the swinging of the meter needle about the center dial reading. Earphones may be plugged in at the output of the final amplifier, at jack J105, in order to pick up the zero beat frequency. The circuit built around crystal CR101 containing C105, C106, and R102 is for metering the VMO output.

E. POWER SUPPLY

The power supply circuit is shown in figure 2-6. Transformer T101 supplies the necessary power and filament voltages. V101 is a full-wave vacuum rectifier with choke (L101) filter input. C101 and C104 provide low impedance paths to grounds for any r.f. current, while R101 is used to limit the current passing through tube V102. This tube is a glow discharge regulator type, whose output voltage is held constant and provides +150 volts.

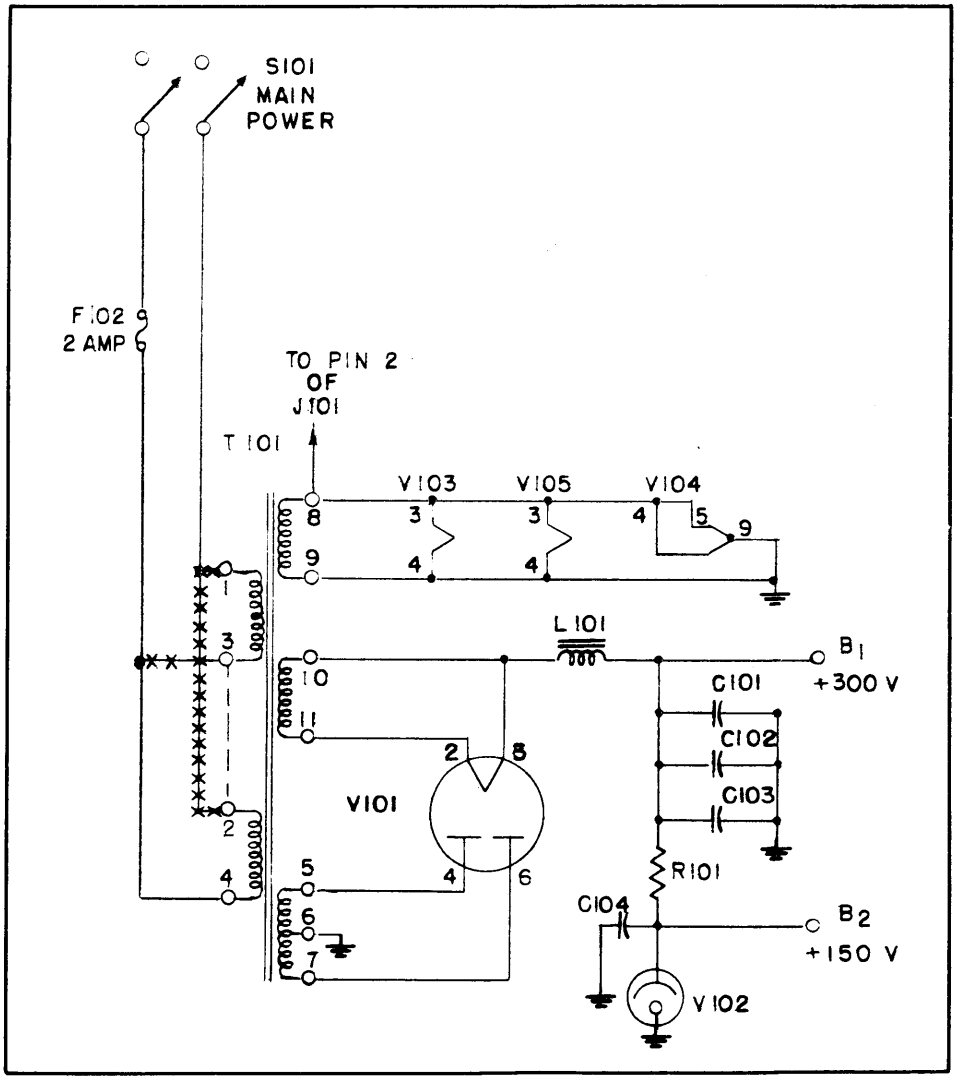

Figure 2-5. Power Supply Circuit

SECTION III
INSTALLATION AND OPERATION

1. INSTALLATION

A. UNPACKING

The Variable Frequency Oscillator, Model VOX, has been designed for ease of installation and minimum effort in operation. The unit is shipped in a separate container, and extreme care should be taken in unpacking it to avoid any physical damage. After unpacking and before installation into the rack, the operator should remove the right top cover, and then the shipping clamps and screws painted red from the motor drive assembly.

B. POWER REQUIREMENTS:

110/220 volt operation - The unit leaves the factory wired for 110 V.A.C., 50/60 cycles unless it is specifically ordered for 220 V.A.C, 50/60 cycles, in which case it will be clearly tagged.

The following changes are required, to convert for use on 220 V.A.C., 50/60 cycles:

(1) Transformer T101 primary windings must be rewired as shown on the schematic diagram. That is, remove the jumpers between terminals 1 and 2, and add a jumper between terminals 2 and 3.

(2) Rewire the outer oven heating elements, R309 and R310; the inner oven heating elements, R307 and R308; the relay circuit K301; and the motor circuit B301. This may be accomplished by changing the jumpers on terminal boards E301 and E302, which are located at the rear side of the oven assembly, as indicated on the schematic diagram.

C. ELECTRICAL CONNECTIONS

For high oscillator stability, the Model VOX must be left turned on continuously, and should be turned off only in the event of failure. This means that a separate source of primary power must be supplied the unit, so that when or if any associated equipments are turned off, the Model VOX will

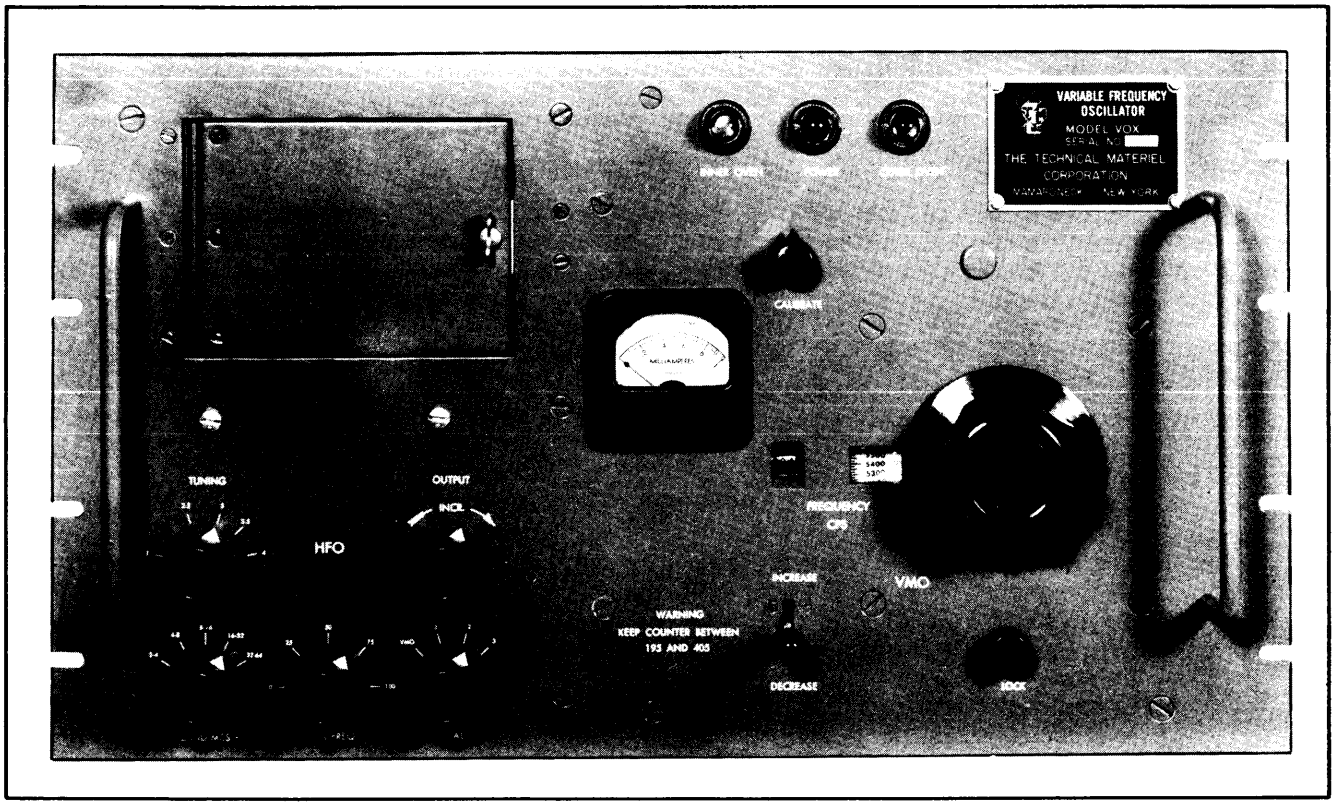

Figure 3-1. Panel Controls

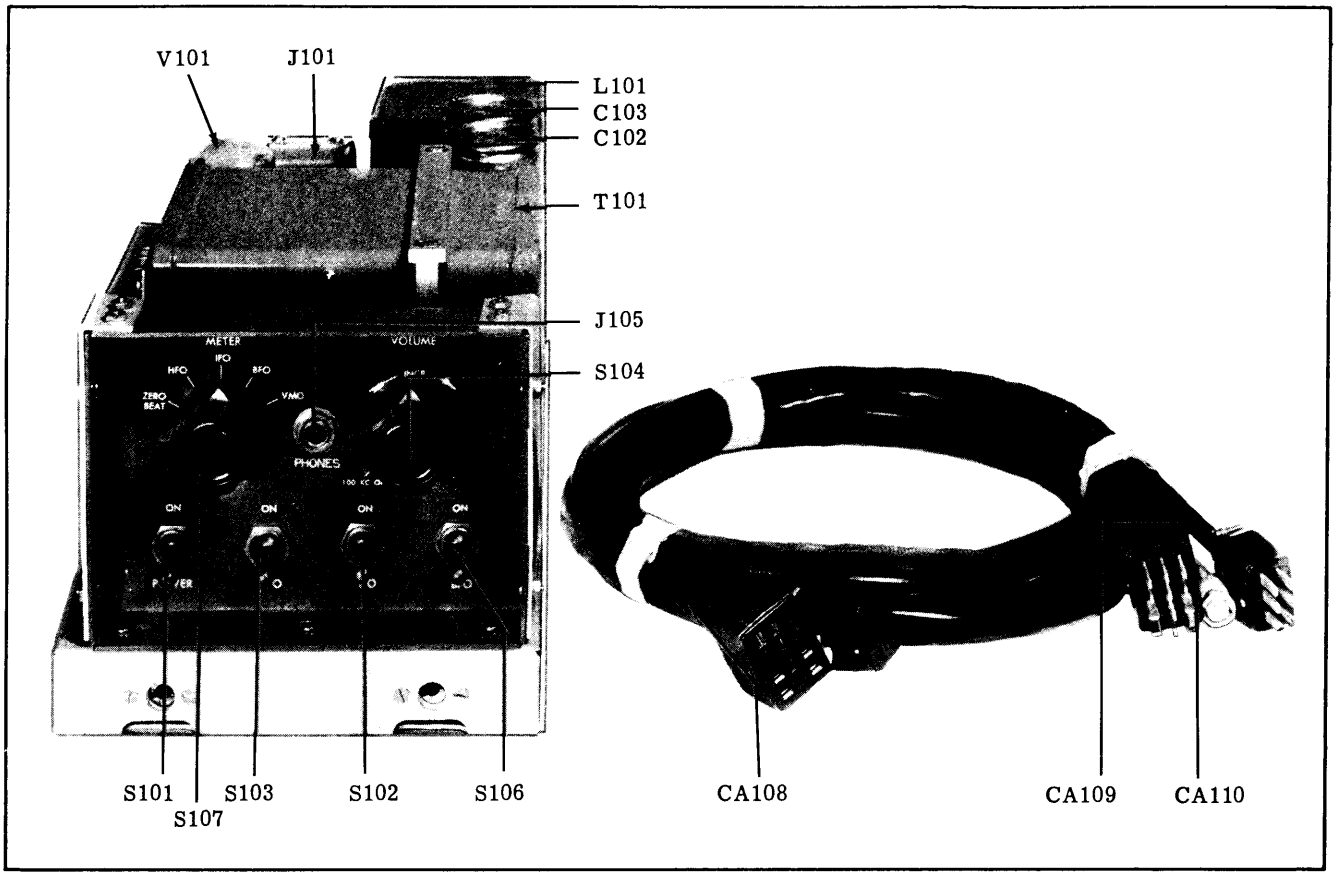

Figure 3-2. Power Supply and Interconnecting Cables

continue to operate. Inter-connection between the VOX and other units is accomplished through the use of BNC type connectors.

2. OPERATION

A. ADJUSTMENTS AND ALIGNMENT

1. In order to secure high accuracy in operation, it is recommended that the 100 kc crystal (V301) be checked and aligned at frequent intervals not exceeding a period of over two weeks. This may be accomplished in the following manner:

a. Tune a receiver to a standard frequency, such as station WWV.
b. Tune the Model VOX to the same frequency. To attain high accuracy and to eliminate the posibility of mistaking the WWV modulation as a beat, it is recommended that an "S" Meter be employed. When the Model VOX and the WWV frequencies are very close, periodic clips will be observed on the "S" Meter.
c. Plug a headset into the phone jack; set the meter switch to the Zero Beat position. Then adjust C 311 (thru the rear oven cover) until a Zero Beat is heard on the phones or seen on the meter. The initial setting of C 311 should not be changed until such time as this process is repeated for re-checking and re-alignment.

2. Once the satisfactory performance of the 100 KC crystal has been established, the operator may proceed to calibrate the Model VOX at any desired frequency. Initially, the operator should perform the following functions: (Referring to the front sub-panel):

a. Turn the power switch to the "ON" position.
b. Turn the Meter switch to the "Zero Beat" position.
c. Turn the Volume control full clockwise.
d. Plug a headset into the jack, marked "Phone".

3. Then, turn the Band-Mcs switch to the desired band and the Xtal switch to the VMO position, both on the front panel. The operator should observe the master oscillator frequency dial, which is marked directly in CPS, and tune

Photo PH-117

by hand or by use of the motor drive, until the dial reads to the nearest 50kc (see index) point of the desired frequency. In order to calculate the correct dial reading, the operator must remember to divide the desired frequency by 2 for the 4-8 Mc band, by 4 for the 8-16 Mc band, by 8 for the 16-32 band, etc. For accurate calibration and resettability, care must be taken to rotate the dial in the same direction (preferably from a lower dial reading to a higher), in order to prevent any error due to backlash. Then, by varying the Calibrate control, a zero beat indication will be obtained in the headset and on the front panel milliammeter. With a little experience, the operator will find that the meter indication alone is adequate, although he may continue to use the phones as an added convenience. The Model VOX has now been properly corrected for the dial region to be used, and should be returned to the required frequency setting.

4. When the calibration procedure has been concluded, the operator must be certain that he places the Volume control in the 100 kc "Off" position. At the same time, the Meter Switch should be tuned to HFO and the HFO Switch to the "ON" position.

WARNING

THE MODEL VOX IS A HIGH STABILITY, PRECISION INSTRUMENT AND REQUIRES AN INITIAL WARM-UP PERIOD OF AT LEAST FORTY-EIGHT (48) HOURS OF CONTINUOUS DUTY. THEREAFTER, THE UNIT SHOULD NEVER BE TURNED OFF UNLESS DETAILED REPAIRS BECOME NECESSARY.

5. Then the operator should rotate the Tuning knob to a full clockwise position, roughly approximating the master oscillator frequency dial, at which point he will obtain a reading on the front panel milliammeter with the output control. The Tuning knob will have been set properly when the highest milliammeter reading is obtained.

6. In the event that a HFO Crystal is used in place of the Variable Master Oscillator, then the following procedure must be adhered to:

a. Turn the Power switch to the "On" position.
b. Turn the HFO switch to the "On" position.
c. Turn the Meter switch to the HFO position.
d. Turn the XTAL switch to the proper position.
e. Turn the Band-Mcs switch to the proper band.
f. "Trim" the crystal by tuning XTAL-Frequency switch until the exact frequency is set and peak with the tuning knob as described above.

B. APPLICATION

1. For use as a Master Oscillator in any Diversity System:

a. The Model VOX has been designed for use with any properly modified receiver. For Diversity reception in any system, the operator must set the Model VOX frequency dial to a reading equal to the sum of the IFO value of the particular receiver in use, plus the value of the desired signal frequency.

2. For use as a Master Oscillator in the TMC Dual Diversity Receiver, Model DDR-2:

a. The combination of the Model VOX and the modified Hammarlund SP-600-JX Receiver, is the one used in the TMC Model DDR-2, Dual Diversity System, and constitutes a good illustration of typical master oscillator operation. Since the receivers are either double or single conversion units, depending upon the operation frequency, then the Model VOX must be set accordingly. Below 7.4 Mc the HFO must be 455 kc above the desired carrier, but above 7.4 Mc the HFO must be 3.955 Mc above the desired carrier. The chart on page 3-4 will serve to minimize the small amount of arithmetic involved.

b. Diversity System Tuning.
1. Turn the Power Switch to "On" position.
2. Turn the BFO switch to "On" position (For CW operation BFO XTAL - 455 Kc. For Frequency Shift operation - using TMC CFA - Frequency 455 Kc + 2550 cps)
3. Turn the IFO switch to "On" position.
4. Turn the Meter switch to Zero Beat.
5. Turn Volume control full clockwise.
6. Plug a headset into the jack marked phones.
7. Set the frequency calibration dial at the desired frequency, in accordance with the above table, and proceed with the calibration and peaking instructions as previously described.

DIVERSITY SYSTEM TUNING CHART

Received Signal Frequency	VOX - HFO Output	VOX Band	VOX - VMO Dial Setting
	Fr ± 455 Kc	2-4 Mc	Fr + 455
Below 7.4 Mc	Fr ± 455 Kc	4-8 Mc	(Fr + 455)/2
	Fr ± 3.955 Kc	8-16 Mc	(Fr + 3.955)/4
Above 7.4 Mc	Fr ± 3.955 Kc	16-32 Mc	(Fr + 3.955)/8
	Fr ± 3.955 Kc	32-64 Mc	(Fr + 3.955)/16

To complete the diversity system tuning, the operator must turn the IFO And HFO controls on both receivers to the Slave position and then tune to the approximate station frequency. Lastly, the BFO Output control (located on the rear - top of the Power Supply Chassis) must be set until a solid beat is obtained with a strong carrier. If a BFO crystal having poor activity is inserted, it may be necessary to re-touch L102, which is located near the Output control.

3. As a Transmitter Exciter

There is no essential difference in adjusting the Model VOX for this service and the procedure followed in the preceeding paragraph. All IFO and BFO referenced may, of course, be neglected and both the plate switches controlling these sections may be turned to the "Off" position.

SECTION IV
MAINTENANCE

1. OPERATOR'S MAINTENANCE

A. GENERAL

The Model VOX VARIABLE FREQUENCY OSCILLATOR has been designed to provide long term, trouble free, continuous 24 hour a day operation. It is recommended that any maintenance to the equipment be done by a competent technician. The oven and the components contained therein have been finely engineered and precision made. The two enclosed tubes and thermionic switch (S301) may be replaced easily at the rear of the unit; but in the event that maintenance to this section of the unit is required, the unit should be returned to the factory for repairs. For maintenance purposes, three service cable assemblies are supplied to enable the operator to service the Model VOX while maintaining primary power to the ovens. The cable assemblies supplied with each VOX are as follows:

Part No. CA108, Power Supply-Multiplier Interconnect; Twelve Contact.

Part No. CA109, Power Supply - Master Oscillator Interconnect; Six Contact.

Part No. CA110, R.F. Cable; Power Supply-Multiplier Interconnect; Single Contact.

Figure 4-1 shows the three service cables connected properly for maintenance operation, allowing the ovens to function as usual.

B. EMERGENCY MAINTENANCE

NOTICE TO OPERATORS - Operators should not perform any emergency measures unless properly authorized to do so. If such authorization is given, it should be preceeded by a short course of instruction.

1. REPLACEMENT OF FUSES:

WARNING

Never replace a fuse with one of higher rating! If a fuse burns out immediately after replacement, DO NOT replace it a second time until the cause has been corrected.

Two separate fusing systems are incorporated in the Model VOX, one to protect the ovens, and the other to protect the power supply proper. If the front panel pilot light marked Power fails to light when the unit is turned on, then the fuse marked Power, on the rear of the power supply chassis, must be changed. (There is a remote possibility that the pilot lamp itself is faulty, but this seldom happens.)

In the event of an oven fuse failure, both pilot lights referring to the ovens would not light. The ovens would also commence to cool. In this case, the oven fuse, which is on the power supply chassis rear, must be replaced.

2. REPLACEMENT OF TUBES:

The location of all tubes and relay in the Model VOX is indicated in Figure 4-2, 4-4, and 4-5. The tubes may be checked visually to see if they are lighted, or for warmth. The Model VOX has been so designed that the power chassis can be completely withdrawn in a matter of seconds. A set of tracks have been provided for this purpose and the operator can slip the unit out by simply half-turning four snap fasteners, two of which are located on the front panel, and two of which are located under the rear of the power supply chassis.

Tube replacement is accomplished by disconnecting the power supply as described above. Such disconnection, which automatically removes power from the oven, should not last for more than approximately five minutes, if good oven stability must be maintained. If more detailed repairs become necessary, the six foot extention cables must be employed to maintain oven power. Tubes should be carefully removed and tested, and when replaced, care should be taken to install tube shields.

2. PREVENTATIVE MAINTENANCE

In order to prevent actual failure of the equipment due to corrosion, tube failures, dust and other destructive ambient conditions, it is suggested that the following preventative maintenance be performed:

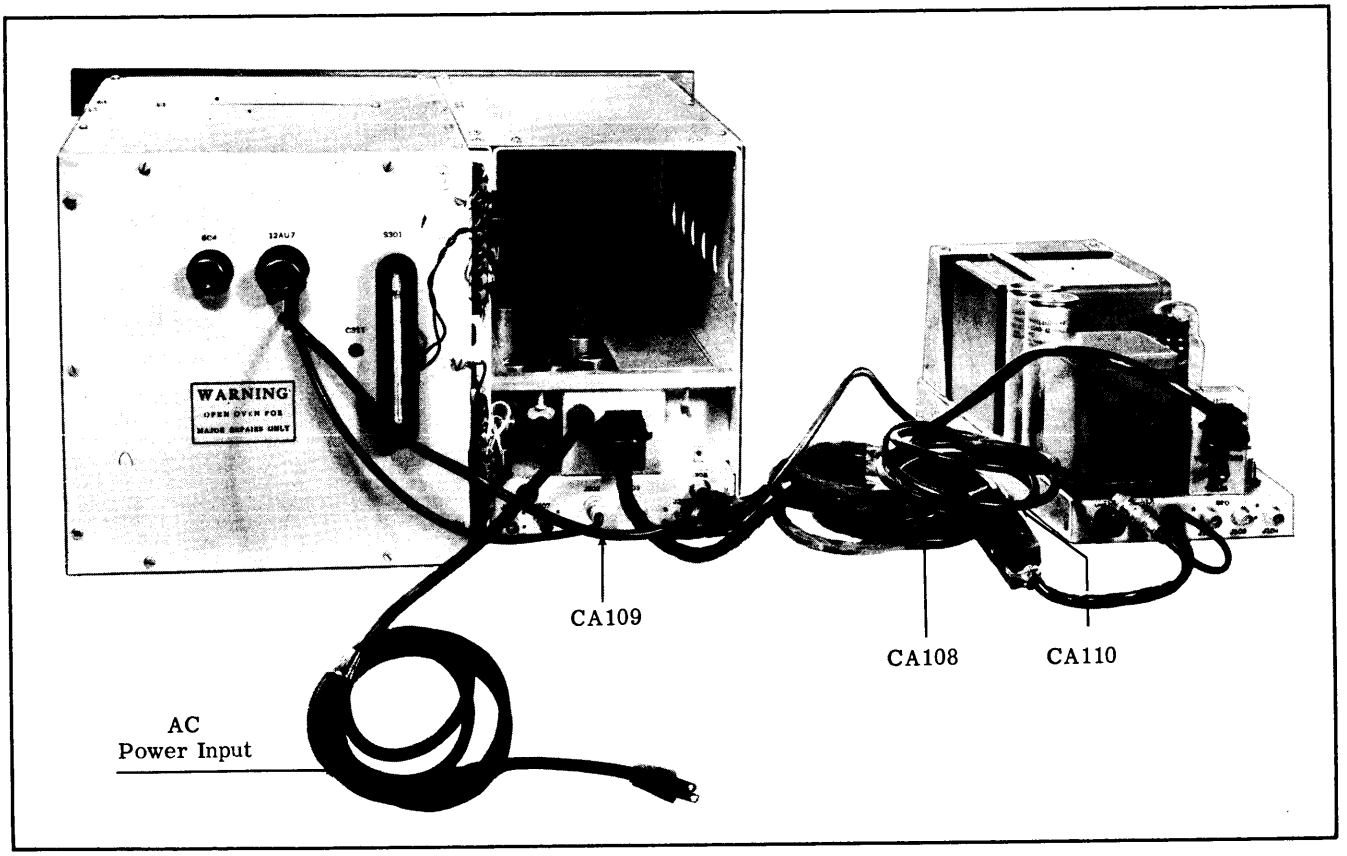

Figure 4-1. Service Cable Arrangement

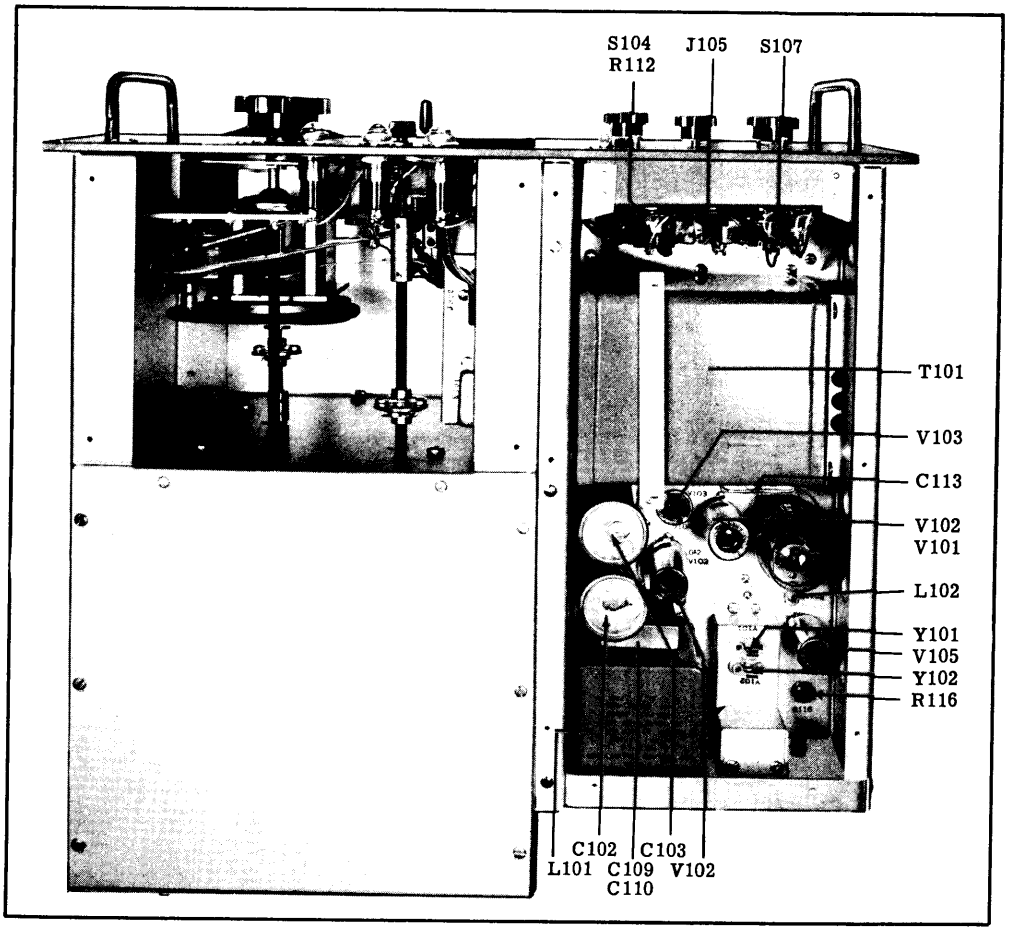

Figure 4-2. Top View, Model VOX

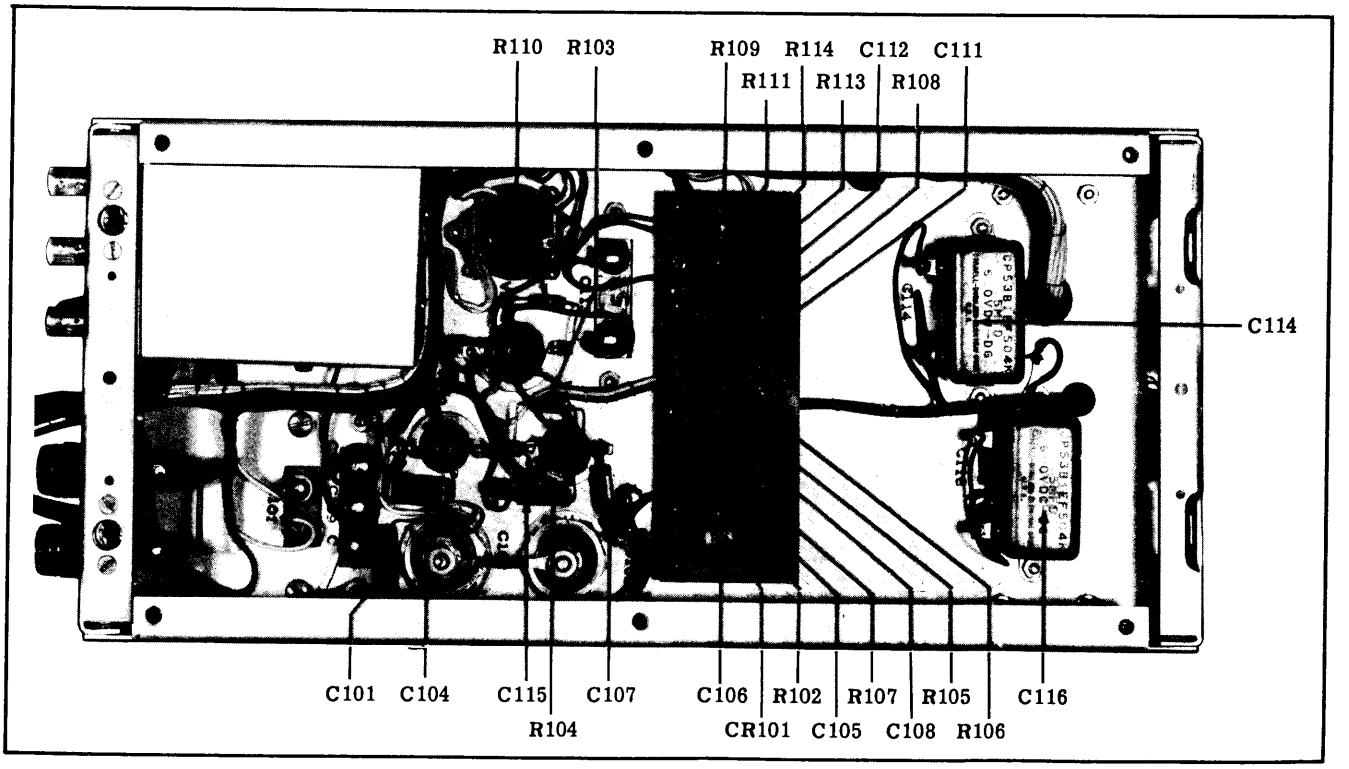

Figure 4-3. Bottom View of Power Supply, Model VOX

Photo PH-116

Photo PH-121

a. Remove equipment from the rack, and thoroughly inspect the inside of the chassis for signs of dirt, dampness, molding, charring, and corrosion. Correct any defect found. A recommended charring agent is clear carbontetrachloride, applied with a soft brush; recommended procedure, semi-annually.

b. Test all DC and AC voltages as indicated on the respective tube voltage data sheets Fig. 5-3, and investigate any serious discrepancies; recommended procedure, semi-annually.

c. Test each tube one at a time in a reliable tube tester, replacing tube in socket from which it was removed, if its measured characteristics are within the manufacturers' tolerances (usually plus or minus 20% from tube manual values.) Replace only those tubes which are found to be below par; recommended procedure, quarterly.

d. When replacing the Model VOX in the rack, be certain that all terminal screw connections at the rear of the equipment are tight.

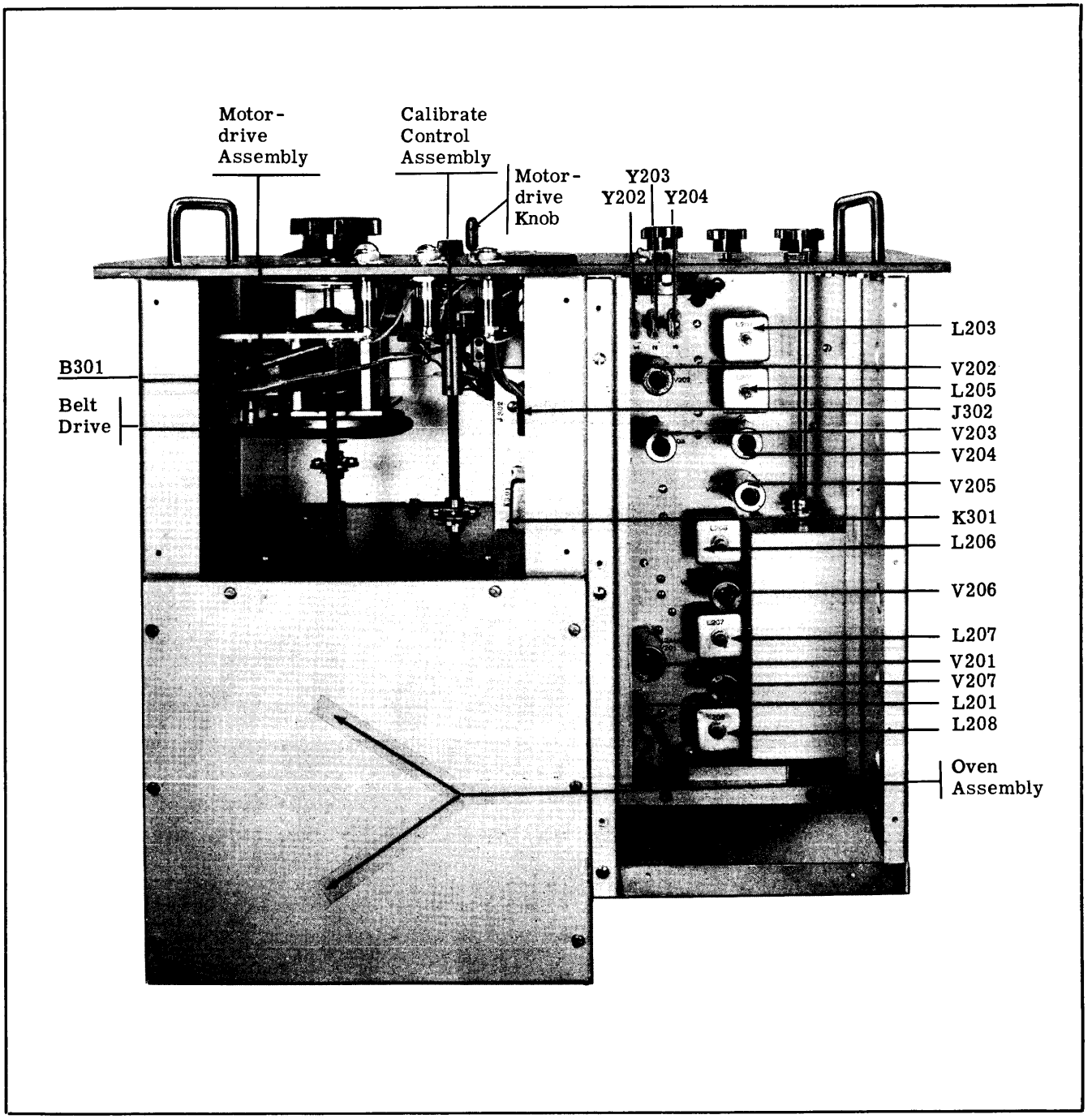

Figure 4-4. Top View Showing the RF Multiplier Section

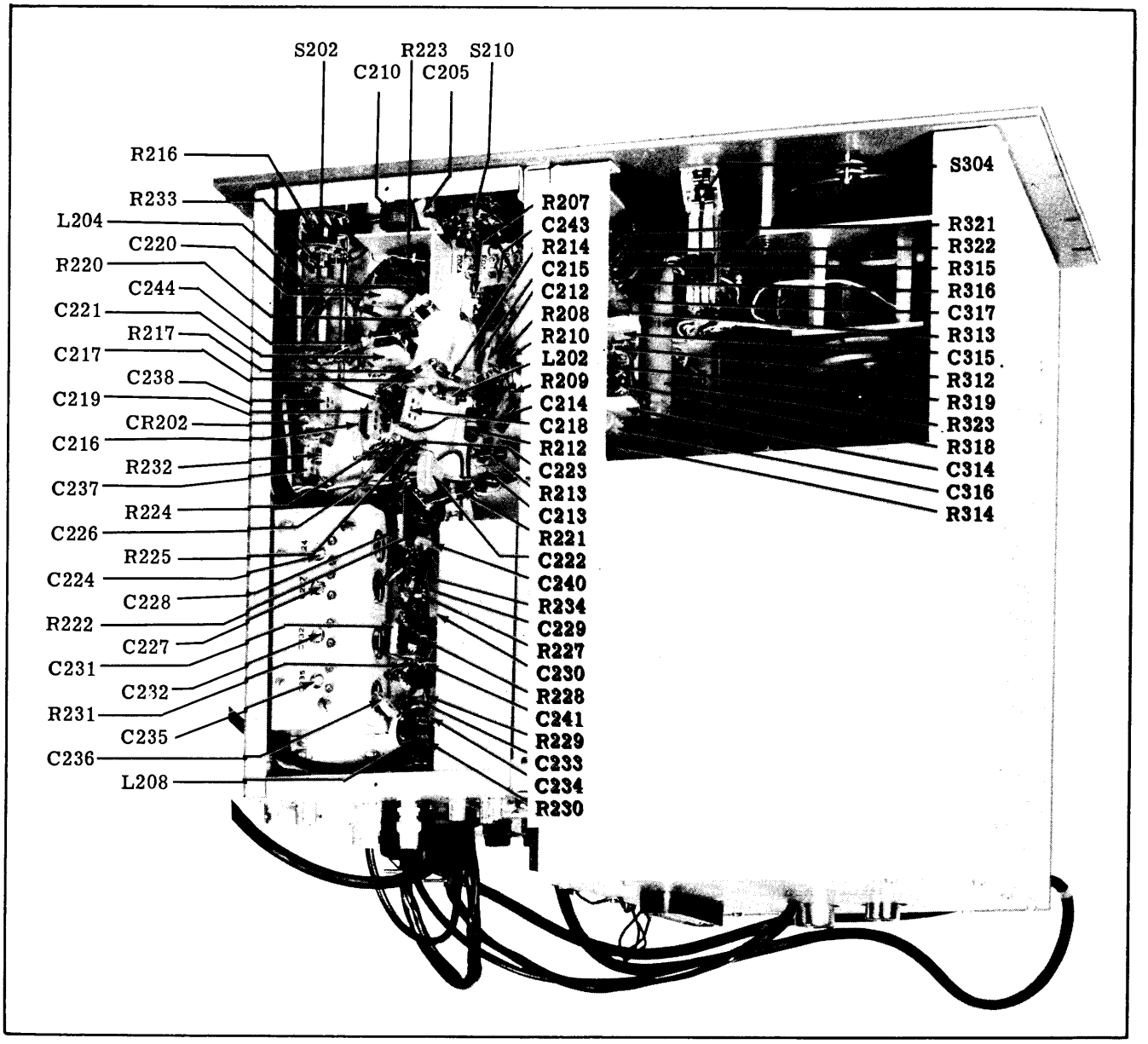

Figure 4-5. Bottom View

Photo PH-120

SECTION V
CORRECTIVE MAINTENANCE

1. SYSTEM TROUBLE SHOOTING

Careful observation while operating the various controls, may sectionalize any faults to a particular stage or circuit. Some faults, such as burned out resistors, r-f arcing, and shorted transformers, can often be located by sight, smell, or hearing. A logical division of the Model VOX would indicate four main operating divisions, and the power supply. The four divisions are the HFO Chain, the IFO, the HFO, and the Calibrating Chain.

A major fault in the power supply would abruptly cut off the B+ supply voltages to all the tubes. If there is no reading on the milliammeter for any position on the meter switch of the front panel, this is a good indication of power supply failure. The voltages on the transformer T101, and tubes V101 and V102 should be checked, to ascertain if anything is amiss.

2. THE TROUBLE SHOOTING PROCEDURE

The Model VOX has been so designed that

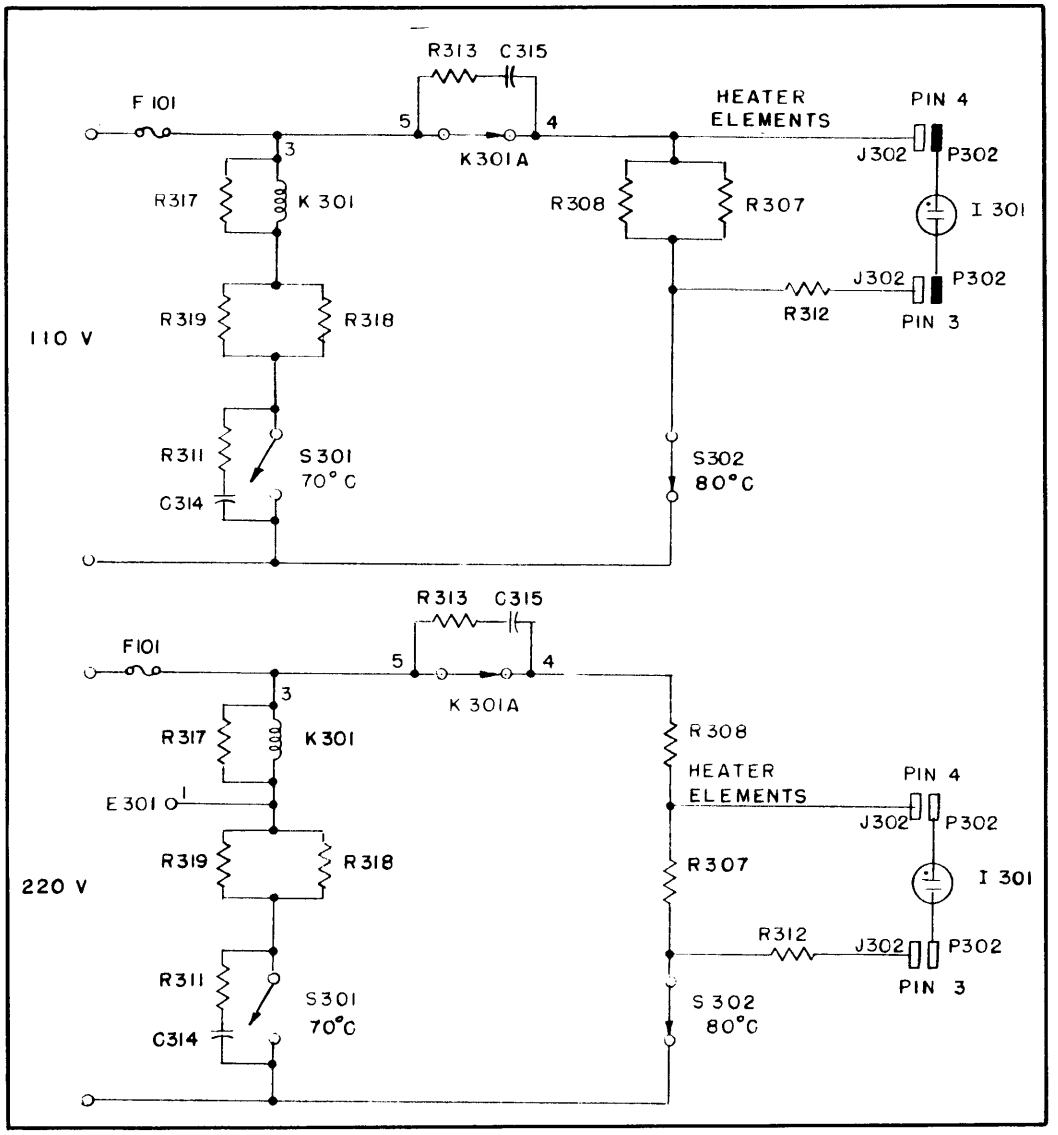

Figure 5-1. Thermostatic Switch Circuit

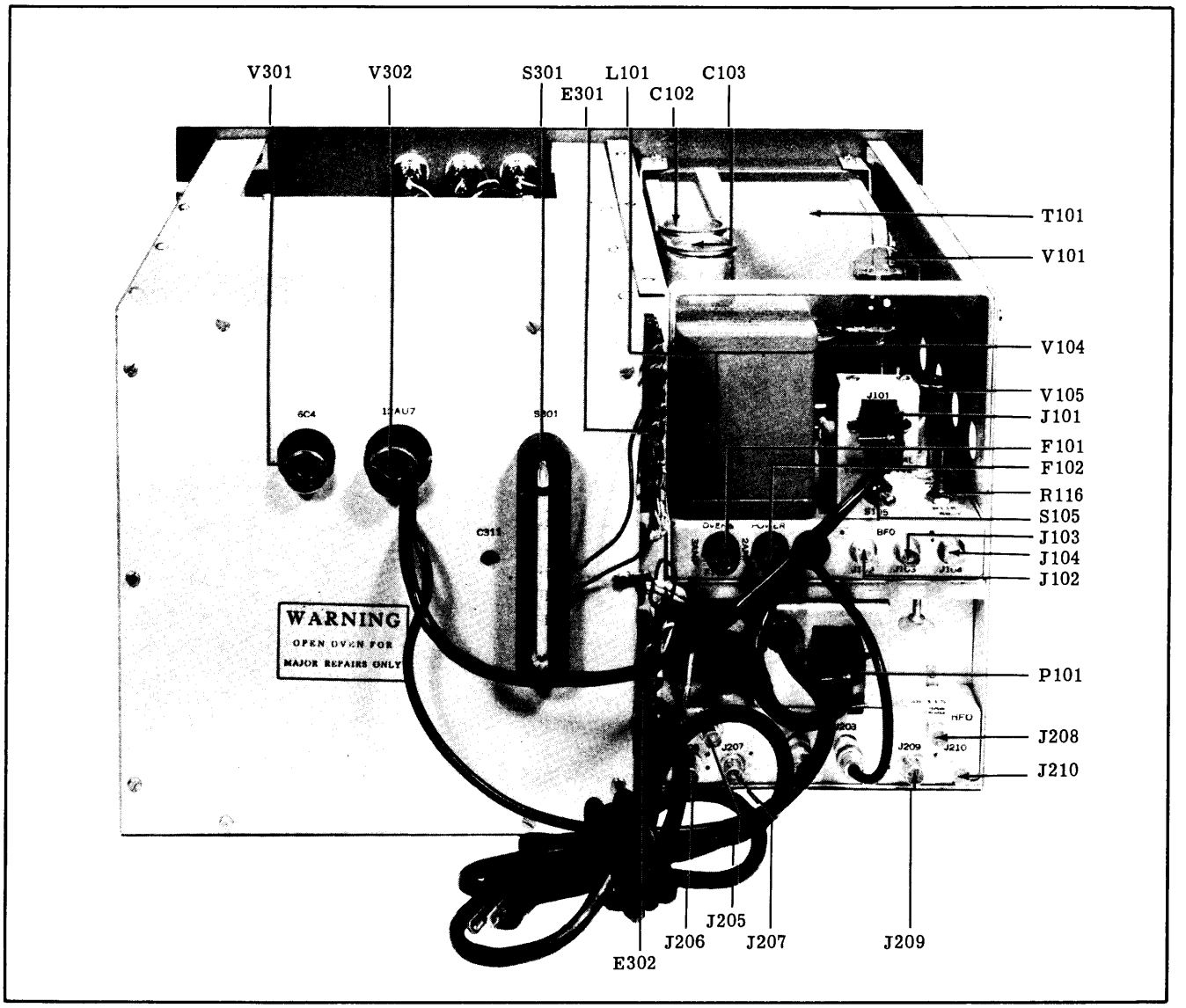

Figure 5-2. Rear View

every stage may be checked, thus facilitating trouble shooting.

a. THE HFO CHAIN

The oven is the heart of the Model VOX, and improper functioning will greatly hamper oscillation stability. The inner and outer ovens are thermostically controlled to 70°C and 60°C, respectively. An inner oven safety thermostat, S302, set at 80°C, protects the unit in case of excessive temperatures, due to sticking or mechanical failure of the Mercury thermostat, S301. Figure 5-1 illustrates the operation of the thermostat switch circuits, both for 110 and 220 volts. In normal operation, relay S301 is open and K 301 would be closed. When the temperature reaches 70°C, S301 closes, thus energizing the coil of relay K301, which in turn, opens up the contacts of the relay. In the event that S301 should fail, due to sticking, etc., at 80°C safety switch S302 would open, thus preventing further current from passing through the heating elements, R307 and R308. The neon bulbs on the front panel give good indication as to normal operation of the inner and outer ovens. In normal operation, the operator should see the Outer oven pilot lamp blink alternately "On" for approximately 5 seconds, and "Off" for approximately 30 seconds, depending on the ambient temperature. The Inner oven pilot light should blink alternately "On" for approximately 90 seconds, and "Off" for approximately 90 seconds. In the event that relay S301 is malfunctioning, the inner oven will continue to heat until safety switch S302 opens up at 80°C. When the temperature reaches 80°C, the Inner oven pilot blinks erratically at short intervals, instead of the usual 90 seconds, in normal

Photo PH-112

operation. At this point, the operator should check the thermometer on S301 in the rear of the unit and replace S301, if the thermometer reads well over 70°C.

To check the VMO output, simply turn the meter switch dial to VMO, and notice the deflection of the milliammeter on the front panel, which should read approximately .9 milliampere. Then, check the voltages and resistances on tubes V301 and V302, and lastly, the circuit components, for proper voltages and resistances. R302 is a critical resistor.

Once it has been established that the VMO is operating properly, than any succeeding stage to the HFO output may be checked and traced, stage by stage, to its fault. This may be accomplished by the following means:

1. Connect the meter switch to HFO.
2. Turn the Band dial to the desired output frequency.

Then, notice the deflection in the needle of the milliammeter of the front panel. If, for example, the user wishes to operate on 20 Mc, a null reading on the meter indicates a fault somewhere between the 16-32 stage, (V206, L207, and C225c) and each preceding stage to the initial amplifier V202. Then, the operator must change his dial reading for the 8-16 Mc band, switch to the 8-16 Mc band, and notice any output on the milliammeter. The usual test procedure is recommended for checking the two amplifier output tubes, V203 and V204.

b. THE IFO:

The output of the IFO may be checked again by switching the Meter Switch to the IFO position and observing the output reading on the milliammeter. The critical components in this circuit are variable condenser C207, coil L201, crystal Y201, and the grid bias resisto · R205.

c. THE BFO:

The BFO output may be checked again in the manner described above for the IFO. Critical components are C120, L102, R117, and variable resistor R116, together with the cry tals Y101 and Y102.

d. THE CALIBRATING CHAIN:

The calibrating chain has been designed for stable and trouble-free operation and is the least likely circuit in the unit to develop trouble. The main components of this chain are the VMO output and the 100 kc oscillator circuit. The VMO output may be checked in the manner already described. The 100 kc output may be checked by connecting an oscilloscope to pin 1 of tubes V103. Improper mixer action by V103 and faulty low pass filtering components also contribute to trouble.

NOTE

The front panel milliammeter circuits have been so adjusted that the following relationships exist in each of the Meter switch positions:
HFO position-meter reads 20 volts full scale.
IFO position-meter reads 10 volts full scale.
BFO position-meter reads 20 volts full scale.
VFO position-meter reads 10 volts full scale.

TUBE NO.	TUBE TYPE	FUNCTION	PIN #1	PIN #2	PIN #3	PIN #4	PIN #5	PIN #6	PIN #7	PIN #8	PIN #9
V101	5U4-G	Rectifier	0	+300	0	AC-378	0	AC-378	0	+300	
V102	OA2	Regulator	+147	0	0	0	+147	0	Gnd		
V103	6BE6	Mixer	-5.25	Gnd	AC6.3	Gnd	+155	+9.6	-.25		
V104	12AU7	Audio Amp.	+45	-8.1	0	AC6.3	AC6.3	+17	-.82	Gnd	Gnd
V105	6C4	BFO	+138	0	AC6.3	Gnd	+138	-7.2	Gnd		

ALL VOLTAGES TAKEN TO GROUND WITH HP-410B VTVM

Audio Gain of 12AU7 at Highest Frequency Tone - 32.5 V. AC

Figure 5-3A. Voltage Data - VOX Power Supply Chassis

	TUBE	FUNCTION	PIN 1	PIN 2	PIN 3	PIN 4	PIN 5	PIN 6	PIN 7	PIN 8	PIN 9
DC	6C4		120 V	0	0	6.3	120 V	3.3 V	.13 V		
Voltage	12AU7		162 V	.13V	6.4V	6.3	6.3	72 V	16 V	4.5 V	0
RF	6C4		.25 V	0	0	6.3	.25 V	7.1V	4.5V		
Voltage	12AU7		1.6 V	4.3V	4.3V	6.3	6.3	17.5V	18 V	2V	0

RF VOLTAGE AT PINS #2 and #3

2.0 mc.	4.3V	4.3V
2.6 mc.	4.6V	2.3V
4.0 mc.	9.0V	3.4V

RF VOLTAGE AT TOP OF TANK COIL

2.0 mc.	34V
2.6 mc.	43V
4.0 mc.	82V

RF VOLTAGE AT 100KC Osc. Output

3.6V

Figure 5-3B. Voltage Data - VOX Oscillator Chassis

	FUNCTION	PINS	VOLTS	PINS	VOLTS	PINS	VOLTS	PINS	VOLTS	PINS	VOLTS
V201 12AU7	Xtal Osc.	1	60	2	11	6	120	7	11	9	6.3
V202 6C4	HFO & RF AMP.	1	90	6	10	4	6.3				
V203 6AQ5 Band 2-4	RF Amp.	1	11	2	6	5	95	6	110	4	6.3
V204 6AQ5 Band 4-8	RF Amp. & Mult.	1	30	2	14	5	270	6	260	4	6.3
V205 6AQ5 Band 8-16	RF Mult.	1	30	2	12	5	250	6	170	4	6.3
V206 6AQ5 Band 16-32	RF Mult.	1	20	2	13	5	275	6	175	4	6.3
V207 6AQ5 Band 32-64	RF Mult.	1	35	2	13	5	265	6	225	4	6.3

ALL VOLTAGE TO GROUND WITH VTVM

2 MC Xtal Tuning at 2 MC Output at Maximum
70 ohm Load at RF output
70 ohm Load at IFO output

Figure 5-3C. Voltage Data - VOX Multiplier Chassis

PARTS LIST

The Model VOX is comprised of three component chassis, schematic symbol groups as follows:

100 through 199	Power Supply Chassis
200 through 299	Multiplier (RF) Chassis
300 through 399	Master Oscillator Chassis

SYM	DESCRIPTION	FUNCTION	TMC PART NO.
C101	CAPACITOR, fixed: mica; .01 mfd, ±10%, char A, 300 wvdc.	B+ R.F. Bypass	CM35A103K
C102	CAPACITOR, fixed: paper; 4 mfd, ±10%, 600 wvdc, oil-filled and impregnated, hermetically sealed metal case.	B+ Filter	CP40C2DF405V
C103	Same as C102	B+ Filter	CP40C2DF405V
C104	Same as C101	Reg. R.F. Bypass	CM35A103K
C105	CAPACITOR, fixed: mica; 1000 mmfd, ±10%, char A, 500 wvdc.	V.M.O. Meter Bypass	CM20A102K
C106	Same as C105	V.M.O. Meter, R.F. coupling	CM20A102K
C107	CAPACITOR, fixed: mica; 5 mmfd, ±20%, char A, 500 wvdc	V.M.O. Mixer coupling	CM20A050M
C108	Same as C105	Mixer Screen Bypass	CM20A102K
C109, C110	CAPACITOR, fixed: paper; dual unit, .5 mfd, ±10% ea. sect, 600 wvdc, oil-filled and impregnated, hermetically sealed metal case.	Mixer Plate Decoupling, Audio Plate Decoupling	CP69B4EF504K
C111	Same as C105	Mixer Plate Filter	CM20A102K
C112	Same as C105	Mixer Plate Filter	CM20A102K
C113	CAPACITOR, fixed: paper; .5 mfd, ±10%, 600 wvdc, oil-filled and impregnated, hermetically sealed metal case.	Mixer Output Coupling	CP69B1EF504K
C114	CAPACITOR, fixed: paper; .5 mfd, ±10%, 600 wvdc, oil-filled and impregnated, hermetically sealed metal case.	Audio Output Coupling	CP53B1EF504K
C115	Same as C105	100 Kc Mixer Coupling	CM20A102K
C116	Same as C114	Phones Coupling	CP53B1EF504K
C117	Same as C105	Bypass B.F.O. Meter Decoupling	CM20A102K

SYM	DESCRIPTION	FUNCTION	TMC PART NO.
C118	Same as C105	B.F.O. Meter Coupling	CM20A102K
C119	Same as C101	B.F.O. Plate Filter	CM35A103K
C120	CAPACITOR NETWORK: mica; 1500 mmfd, +5%, char A, 500 wvdc, consist of one 1000 mmfd, one 500 mmfd, paralleled.	B.F.O. Tank	CM20A102J CM20A501J
C121	CAPACITOR, fixed: mica; 1000 mmfd, ±5%, char C, 500 wvdc.	B.F.O. Voltage Divider	CM20C102J
C122	CAPACITOR, fixed: mica; 27 mmfd, ±5%, char C, 500 wvdc.	B.F.O. Xtal load	CM20C270J
C123	Same as C105	B.F.O. Xtal Coupling	CM20A102K
CR101	CRYSTAL UNIT: rectifying; germanium	V.M.O. Output Rectifier	IN34
CR102	Same as CR101	B.F.O. Output Rectifier	IN34
F101	FUSE, cartridge: 3.0 amp.	Oven Fuse	FU100-3
F102	FUSE, cartridge: 2.0 amp.	Power Fuse	FU100-2
J101	CONNECTOR, female contact: polarized; six contact, chassis mounted.	Power Supply Oven Interconnect	JJ121-2
J102	CONNECTOR, coaxial: female contact; BNC type, single hole mounted	B.F.O. Output	UG-625/U
J103	Same as J102	B.F.O. Output	UG-625/U
J104	Same as J102	B.F.O. Output	UG-625/U
J105	JACK, open circuit:	Phone Input	JJ034
L101	REACTOR, filter: 10 henries, 125 ma DC, 1000 volts RMS test.	B± Filter Choke	TF-5001
L102	INDUCTOR, variable: 174-320 micro.	B.F.O. Tank Coil	A-250
P101	CONNECTOR, male contact: polarized; twelve contact, w/cable clamps	PS-RF Interconnect	PL102-1
P102	CONNECTOR, coaxial: male contact; BNC type, for RC-58/U cable.	V.M.O. Input	UG-88/U
R101	RESISTOR, fixed: wire wound; 4500 ohms, ±10%, 10 watts.	B+ Dropping	RW104
R102	RESISTOR, fixed: composition; 12000 ohms, ±10%, $\frac{1}{2}$ watt.	Diode Load(CR101)	RC20GF123K
R103	RESISTOR, fixed: composition; 100,000 ohms, ±10%, $\frac{1}{2}$ watt.	Mixer Grid Leak	RC20GF104K

SYM	DESCRIPTION	FUNCTION	TMC PART NO.
R104	RESISTOR, fixed: composition; 10,000 ohms, ±10%, ½ watt.	Mixer Grid Leak	RC20GF103K
R105	Same as R103	Mixer Screen Dropping	RC20GF104K
R106	RESISTOR, fixed: composition; 220,000 ohms, ±10%, ½ watt.	Mixer Plate Load	RC20GF224K
R107	RESISTOR, fixed: composition; 56,000 ohms, ±10%, ½ watt.	Mixer Plate Filter	RC20GF563K
R108	Same as R103	Mixer Output Filter	RC20GF104K
R109	Same as R103	Audio Plate Filter	RC20GF104K
R110	RESISTOR, fixed: composition; 470,000 ohms, ±10%, ½ watt.	Audio Grid Leak	RC20GF474K
R111	Same as R106	Audio Plate Load	RC20GF224K
R112	RESISTOR, variable: composition; 500,000 ohms, ±20%, 2 watts, w/SPST switch (S104)	Audio Volume Control	RV3BTRD504B
R113	RESISTOR, fixed: composition; 100 ohms, ±10%, ½ watt.	Audio Cathode Res.	RC20GF101K
R114	RESISTOR, fixed: composition; 82,000 ohms, ±10%, ½ watt.	Audio Plate Load	RC20GF823K
R115	RESISTOR, fixed: composition; 24,000 ohms, ±5%; ½ watt.	B.F.O. Output Diode Load	RC20GF243J
R116	RESISTOR, variable: composition potentiometer; 30,000 ohms, ±20%, 2 watts.	B.F.O. Output Control	RV4ATSA303D
R117	Same as R110	B.F.O. Grid Leak	RC20GF474K
R118	RESISTOR, fixed: composition; 2200 ohms, ±10%, 1 watt.	B.F.O. Plate Filter	RC30GF222K
S101	SWITCH, toggle: DPST; 3 amp, 250 volts, phenolic body.	Main Power	ST22K
S102	SWITCH, toggle: SPST; 3 amp, 250 volts, phenolic body.	I.F.O. - Plate	ST12A
S103	Same as S102	H.F.O. Plate	ST12A
S104	SWITCH, rotary: SPST (part of R112)	100 kc osc. on - off	
S105	SWITCH, toggle: DPDT; 3 amp, 250 volts phenolic body.	B.F.O. - Crystal	ST22N

SYM	DESCRIPTION	FUNCTION	TMC PART NO.
S106	Same as S102	B.F.O. - Plate	ST12A
S107	SWITCH, rotary: nonshorting; single section, two pole, 5 position.	Meter Switch	SW-107
T101	TRANSFORMER, filament & power: primary; 110/220 volts, 50/60 cps, Secdy #1, 5 volts, 3 amps, Secdy #2, 350-0-350 volts, 125 ma, Secdy # 3, 6.3 volts, 4.0 amps, hermetically sealed case.	Main Power	TF-105
V101	TUBE, electron: 5V4G; octal.	HV Rectifier	5V4G
V102	TUBE, electron: OA2; miniature 7 pin.	Voltage Regulator	OA2
V103	TUBE, electron: 6BE6; miniature 7 pin.	Mixer	6BE6
V104	TUBE, electron: 12AU7; miniature 9 pin.	Audio Amp	12AU7
V105	TUBE, electron: 6C4; miniature 7 pin.	B.F.O.	6C4
XF101	HOLDER, fuse: extractor post type for single AGC type fuse.	F101 socket	FH100-2
XF102	Same as XF101	F102 socket	FH100-2
XV101	SOCKET, tube: octal.	Socket for V101	TS101P01
VX102	SOCKET, tube: 7 pin miniature.	Socket for V102	TS102P01
XV103	Same as XV102	Socket for V103	TS102P01
XV104	SOCKET, tube: 9 pin miniature.	Socket for V104	TS103P01
XV105	Same as XV102	Socket for V105	TS102P01
XY101	SOCKET, crystal: .487'' spacing, for .050'' pins.	Socket for Y101	TS104-1
XY102	Same as XY101	Socket for Y102	TS104-1
Y101	CRYSTAL UNIT: quartz; (Supplied only on customer request).	B.F.O. Crystal	CR-25/U
Y102	CRYSTAL UNIT: quartz; (Supplied only on customer request).	B.F.O. Crystal	CR-25/U
C201	Same as C122	I.F.O. Xtal Load	CM20C270J
C202	Same as C105	I.F.O. Plate Filter	CM20A102K
C203	Same as C105	I.F.O. Plate Filter	CM20A102K
C204	Same as C105	I.F.O. Grid Coupling	CM20A102K

SYM	DESCRIPTION	FUNCTION	TMC PART NO.
C205	Same as C101	V.M.O. Coupling	CM35A103K
C206	Same as C101	I.F.O. Amp Plate Filter	CM35A103K
C207	CAPACITOR, fixed: mica; 150 mmfd, ±5%, char C, 500 wvdc.	I.F.O. Amp Tank	CM20C151J
C208	Same as C105	I.F.O. Meter Coupling	CM20A102K
C209	Same as C101	I.F.O. Meter Bypass	CM35A103K
C210	CAPACITOR, variable: air dielectric 3.5-54 mmfd, 500 wvdc.	H.F.O. Xtal Trimmer	CT-100-1
C211	Same as C105	RF Amp Plate Filter	CM20A102K
C212	Same as C105	RF Amp Grid Coupling	CM20A102K
C213	Same as C105	RF Amp Plate Filter	CM20A102K
C214	Same as C105	RF Amp Cathode Bypass	CM20A102K
C215	Same as C105	RF Amp Screen Bypass	CM20A102K
C216	Same as C105	RF Amp Screen Bypass	CM20A102K
C217	Same as C105	RF Amp Grid Coupling	CM20A102K
C218	Same as C105	RF Amp Cathode Bypass	CM20A102K
C219	Same as C105	RF Mult. Grid Coupling	CM20A102K
C220	Same as C101	2-4 Mc Plate Filter	CM35A103K
C221	Same as C101	4-8 Mc Plate Filter	CM35A103K
C222	Same as C101	8-16 Mc Plate Filter	CM35A103K
C223	Same as C105	RF Mult. Screen Bypass	CM20A102K
C224	CAPACITOR, variable: ceramic; 1.5-7 mmfd, 500 wvdc	4-8 Mc Trimmer	CV11A070
C225	CAPACITOR, variable: air dielectric; four section	HFO Tuning	CB-100
C226	Same as C105	RF Mult Cathode Bypass	CM20A102K
C227	CAPACITOR, variable: ceramic; 3-12 mmfd, 500 wvdc	8-16 Mc Trimmer	CV11A120
C228	Same as C105	16-32 Mc Grid Coupling	CM20A102K
C229	Same as C105	16-32 Mc Screen Bypass	CM20A102K
C230	Same as C101	16-32 Mc Plate Filter	CM35A103K

SYM	DESCRIPTION	FUNCTION	TMC PART NO.
C231	Same as C105	32-64 Mc Grid Coupling	CM20A102K
C232	CAPACITOR, variable: ceramic; 3-12 mmfd, 500 wvdc	16-32 Mc Trimmer	CV11A120
C233	Same as C105	32-64 Mc Screen Bypass	CM20A102K
C234	Same as C101	32-64 Mc Plate Filter	CM35A103K
C235	Same as C224	32-64 Mc Trimmer	CV11A070
C236	Same as C105	32-64 Mc Coupling	CM20A102K
C237	Same as C105	HFO Meter Filter	CM20A102K
C238	Same as C105	HFO Meter Coupling	CM20A102K
C239	Same as C105	RF Chassis filament Bypass	CM20A102K
C240	Same as C105	16-32 Cathode Bypass	CM20A102K
C241	Same as C105	32-64 Mc Cathode Bypass	CM20A102K
C242	Same as C105	IFO Xtal Coupling	CM20A102K
C243	Same as C105	HFO Xtal DC Blocking	CM20A102K
C244	CAPACITOR, fixed: ceramic; 2.5 mmfd, ±.25 mmfd, 500 wvdc.	4-8 Mc Trimmer	CC101-1
CR201	Same as CR101	I.F.O. Output Rectifier	IN34
CR202	Same as CR101	H.F.O. Output Rectifier	IN34
J201	CONNECTOR, female contact: polarized; twelve contact, chassis mounted.	Power Supply & RF chassis	JJ118-2
J202	Same as J102	V.O.M. Interconnect	UG-625/U
J203	Same as J102	V.M.O. Interconnect	UG-625/U
J204	Not used		
J205	Same as J102	I.F.O. Output	UG-625/U
J206	Same as J102	I.F.O. Output	UG-625/U
J207	Same as J102	I.F.O. Output	UG-625/U
J208	Same as J102	H.F.O. Output	UG-625/U
J209	Same as J102	H.F.O. Output	UG-625/U
J210	Same as J102	H.F.O. Output	UG-625/U
L201	INDUCTOR, variable:	I.F.O. Tank Coil	A-242

SYM	DESCRIPTION	FUNCTION	TMC PART NO.
L202	INDUCTOR, fixed:	RF AMP Peaking Coil	A-244
L203	INDUCTOR, variable: slug tuned 26-44 microhenries.	Tank (2-4 Mc)	A-245
L204	CHOKE, RF: 765, ±20%,microhenries, ±20%.	RF Choke	CL-100-5
L205	INDUCTOR, variable: slug tuned 7.4-13 microhenries.	Tank (4-8 Mc)	A-246
L206	INDUCTOR, variable: slug tuned 1.84-3. microhenries.	Tank (8-16 Mc)	A-247
L207	INDUCTOR, variable: slug tuned .5-.84 microhenries.	Tank (16-32 Mc)	A-248
L208	INDUCTOR, variable: slug tuned .18-.26 microhenries.	Tank (32-64 Mc)	A-249
R201	Same as R110	I.F.O. Grid Leak	RC20GF474K
R202	Same as R103	I.F.O. Plate Load	RC20GF104K
R203	RESISTOR, fixed: composition; 47,000 ohms, ±10%, $\frac{1}{2}$ watt.	I.F.O. Decoupling	RC20GF473K
R204	RESISTOR, fixed: composition; 3300 ohms, ±10%, $\frac{1}{2}$ watt.	I.F.O. Decoupling	RC20GF332K
R205	Same as R203	I.F.O. AMP Grid Leak	RC20GF473K
R206	Same as R102	I.F.O. Output Diode Load	RC20GF123K
R207	Same as R110	H.F.O. Grid Leak	RC20GF474K
R208	Same as R104	H.F.O. Plate Load	RC20GF103K
R209	RESISTOR, fixed: composition; 22,000 ohms, ±10%, $\frac{1}{2}$ watt.	H.F.O. Decoupling	RC20GF223K
R210	Same as R103	RF AMP Grid Leak	RC20GF104K
R211	RESISTOR, fixed: composition; 470 ohms, ±10%, $\frac{1}{2}$ watt.	RF Amp Cathode Res.	RC20GF471K
R212	RESISTOR, fixed: composition; 10,000 ohms, ±10%, 2 watts.	RF Amp. Plate Load	RC42GF103K
R213	RESISTOR, fixed: composition; 1000 ohms, ±10%, 1 watt.	RF Amp. Decoupling	RC30GF102K
R214	Same as R103	RF Amp. Screen Drop	RC20GF104K
R215	RESISTOR, variable: wire wound; 50,000 ohms, ±10%, 3 watts.	H.F.O. Output Control	RA-100-31-R-C-N

SYM	DESCRIPTION	FUNCTION	TMC PART NO.
R216	RESISTOR, fixed: composition; 2200 ohms, ±10%, 2 watts.	Screen Dropping	RC42GF222K
R217	RESISTOR, fixed: composition; 1000 ohms, ±10%, ½ watt.	Screen Dropping	RC20GF102K
R218	Same as R103	Mult Grid Leak	RC20GF104K
R219	Same as R211	Mult Cathode Bias	RC20GF471K
R220	RESISTOR, fixed: composition; 1200 ohms, ±10%, 2 watts.	Mult Decoupling	RC42GF122K
R221	Same as R216	8-16 Mc Mult Decoupling	RC42GF222K
R222	Same as R203	8-16 Mc Mult Screen Drop	RC20GF473K
R223	RESISTOR, fixed: composition; 680 ohms, ±10%, 2 watts.	Amp Parasitic Suppressor	RC42GF681K
R224	Same as R103	8-16 Mc Mult Grid Leak	RC20GF104K
R225	Same as R211	8-16 Mc Mult Cathode Bias	RC20GF471K
R226	RESISTOR, fixed: composition; 33,000 ohms, ±10%, ½ watt.	16-32 Mc Mult Grid Leak	RC20GF333K
R227	Same as R203	16-32 Mc Mult Screen Drop	RC20GF473K
R228	Same as R220	16-32 Mc Mult Decoupling	RC42GF122K
R229	Same as R115	32-64 Mc Mult Screen Drop	RC20GF243J
R230	Same as R220	32-64 Mc Mult Decoupling	RC42GF122K
R231	Same as R103	32-64 Mc Mult Grid Leak	RC20GF104K
R232	Same as R115	H.F.O. Output Diode Load	RC20GF243J
R233	RESISTOR, fixed: composition; 82,000 ohms, ±10%, 2 watts.	Band Change Screen Drop	RC42GF823K
R234	Same as R211	16-32 Mc Mult Cathode Bias	RC20GF471K
R235	Same as R211	32-64 Mc Mult Cathode Bias	RC20GF471K
S201	SWITCH, rotary: non-shorting; two section, two polies, 4 position.	Crystal Switch	SW-106
S202	SWITCH, rotary: four section, five position.	H.F.O. Band Switch	SW-108
V201	Same as V104	I.F.O. & I.F.O. Amp	12AU7
V202	Same as V105	H.F.O. & RF Amp	6C4

SYM	DESCRIPTION	FUNCTION	TMC PART NO.
V203	TUBE, electron: 6AQ5; miniature 7 pin.	RF Amp	6AQ5
V204	Same as V203	RF Amp - mult	6AQ5
V205	Same as V203	8-16 Mc Multiplier	6AQ5
V206	Same as V203	16-32 Mc Multiplier	6AQ5
V207	Same as V203	32-64 Mc Multiplier	6AQ5
XV201	Same as XV104	Socket for V201	TS103P01
XV202	Same as XV102	Socket for V202	TS102P01
XV203	Same as XV102	Socket for V203	TS102P01
XV204	Same as XV102	Socket for V204	TS102P01
XV205	Same as XV102	Socket for V205	TS102P01
XV206	Same as XV102	Socket for V206	TS102P01
XV207	Same as XV102	Socket for V207	TS102P01
XY201	Not used		
XY202	Same as XY101	Socket for Y202	TS104-1
XY203	Same as XY101	Socket for Y203	TS104-1
XY204	Same as XY101	Socket for Y204	TS104-1
Y201	CRYSTAL UNIT: quartz; 3.5 mcs, wire leads.	I.F.O. Crystal	CR-18/U
Y202	CRYSTAL UNIT: quartz; (Supplied only on customer request.)	H.F.O. Crystal	CR-18/U
Y203	CRYSTAL UNIT: quartz; (Supplied only on customer request.)	H.F.O. Crystal	CR-18/U
Y204	CRYSTAL UNIT: quartz; (Supplied only on customer request.)	H.F.O. Crystal	CR-18/U
B301	MOTOR, reversible: 2500 RPM; 115 volts, 50/60 cycles AC, 35 watts.	V.M.O. Drive	MO-100
C301	CAPACITOR, variable: air dielectric; 21.0 to 220 mmfd.	V.M.O. Tuning	CB-106
C302	CAPACITOR, variable: air dielectric; 5.0 to 25.0 mmfd, ±5%mmfd.	V.M.O. Correction	CB105
C303	CAPACITOR, variable: air dielectric; 2.8 to 11.0 mmfd, ±5% mmfd.	V.M.O. Trimmer	CB102-1
C304	CAPACITOR, fixed: ceramic; 15 mmfd, ±5%; 500 wvdc.	V.M.O. Padder	CC-102-2

SYM	DESCRIPTION	FUNCTION	TMC PART NO.
C305	CAPACITOR, fixed: mica; 270 mmfd, ±5%, char D, 500 wvdc.	V.M.O. Grid Coupling	CM20D271J
C306	Same as C305	V.M.O. Cathode Coupling	CM20D271J
C307	CAPACITOR, fixed: mica; .01 mfd, ±5%, char C, 300 wvdc.	V.M.O. Plate Bypass	CM35C103J
C308	Same as C101	Cathode Follower Plate Bypass	CM35A103K
C309	Same as C105	100 Kc Plate Coupling	CM20A102K
C310	Not used		
C311	CAPACITOR, variable: air dielectric; 3.5 to 50 mmfd.	100 Kc Adjust	CT103
C312	CAPACITOR, fixed: mica; 240 mmfd, ±5%, char C, 500 wvdc.	100 Kc Output Coupling	CM20C241J
C313	Not used		
C314	Same as C101	Inner Oven Thermostat Arc Suppresser.	CM35A103K
C315	Same as C101	Relay Arc Supp.	CM35A103K
C316	CAPACITOR, fixed: paper; .1 mfd, +20, -10%; 400 wvdc; plastic tubular case.	Outer Oven Thermostat Arc Supp.	CN-100-4
C317	Same as C316	Motor Switch Arc Suppresser	CN-100-4
C318	Same as C101	Meter Bypass	CM35A103K
C319	CAPACITOR, fixed: ceramic; 2.5 mmfd, ±.25 mmfd, 500 wvdc.	V.M.O. Temperature Compensation	CC101-1
E301	BOARD, terminal: barrier type; eight 6-32 x 1/4'' binding head machine screw.	Inner Oven Connections	TM102-8
E302	Same as E301	Outer Oven Connections	TM102-8
I301	LAMP, neon: 105-125 volts, 1/25 watt, bayonet base.	Inner Oven Indicator	BI100-51
I302	LAMP, incandescent: 6-8 volts, 250 ma DC, bayonet base.	Power Indicator	BI101-44
I303	Same as I302	Dial Illuminator	BI101-44
I304	Same as I301	Outer Oven Indicator	BI100-51
J301	Not used		

SYM	DESCRIPTION	FUNCTION	TMC PART NO.
J302	Same as J201	Internal V.M.O. Connector	JJ118-2
K301	RELAY, sensitive: 4500 ohms, DC res. hermetically sealed.	Mercury Thermostat Control	A-123
L301	INDUCTOR, variable: 27 -29 microhenries.	V.M.O. Tank	A-243
L302	CHOKE, RF: 1 millihenry, 50 ma.	V.M.O. Cathode Choke	CL-101-2
M301	METER, millimeter: 0-1, DC, $2\frac{1}{2}$'' sq. case.	Testmeter	MR100-1
P301	CONNECTOR, male contact: polarized; six contact	V.M.O. Power Connector	PL100-1
P302	Same as P101	V.M.O. Connector	PL102-1
P303	Same as P102	V.M.O. Output	UG-88/U
R301	RESISTOR, fixed: composition; 3900 ohms, ±10%, 1 watt.	V.M.O. Plate Filter	RC30GF392K
R302	Same as R217	Cathode Follower Load	RC20GF102K
R303	RESISTOR, fixed: composition; 22,000 ohms, ±10%, 2 watts.	Cathode Follower Plate Filter	RC42GF223K
R304	RESISTOR, fixed: composition; 47,000 ohms, ±10%, $\frac{1}{2}$ watt.	100 Kc Plate Filter	RC20GF473K
R305	RESISTOR, fixed: composition; 4700 ohms, ±10%, $\frac{1}{2}$ watt.	100 Kc Cathode Load	RC20GF472K
R306	Same as R110	100 Kc Grid Leak	RC20GF474K
R307	RESISTOR, fixed: wire wound; heater element, two sections, 1300 ohms each sect, insulated.	Inner Heater Element	RR-105
R308	Same as R307	Inner Heater Element	RR-105
R309	RESISTOR, fixed: wire wound; heater element, two sect, 160 ohms each sect, insulated.	Outer Oven Heater	RR-106
R310	Same as R309	Outer Oven Heater	RR-106
R311	Same as R113	Inner Thermostat Arc Supp.	RC20GF101K
R312	RESISTOR, fixed: composition; 240,000 ohms, ±5%, $\frac{1}{2}$ watt.	Inner Oven Indicator Protector	RC20GF244J
R313	Same as R113	Relay Arc Supp.	RC20GF101K

SYM	DESCRIPTION	FUNCTION	TMC PART NO.
R314	Same as R113	Outer Oven Thermostat Arc Supp.	RC20GF101K
R315	Same as R312	Outer Oven Indicator Protector	RC20GF244J
R316	Same as R113	Motor Switch Arc Suppresser	RC20GF101K
R317	Same as R107	Relay Bleeder	RC20GF563K
R318	RESISTOR, fixed: composition; 9100 ohms, ±5%, 2 watts.	Voltage Dropping Resistor	RC42GF912J
R319	Same as R244	Voltage Dropping Resistor	RC42GF912K
R320	Same as R209	V.M.O. Grid Leak	RC20GF223K
R321	RESISTOR, fixed: composition; 12 ohms, ±10%, 2 watts.	Power Indicator Series Dropping	RC42GF120K
R322	Same as R321	Dial Illuminat. Series Dropping	RC42GF120K
R323, 324	RESISTOR, fixed: wire wound; 100 ohms; 55 watts.	Motor Series Res.	RW-115-101-55
S301	SWITCH, thermostatic: Mercury; operate at 70° C, ±0.2°C.	Inner Oven Thermostat	SS101
S302	SWITCH, thermostatic: bimetallic; operate at 80°C, ±2°C.	Inner Oven Safety Thermostat	SS100-3
S303	SWITCH, thermostatic: bimetallic, operate at 60°C, ±2°C.	Outer Oven Thermostat	SS100-1
S304	SWITCH, lever action: two position, two form as each position, center off, momentary contact.	Motor Control	SW-103
V301	Same as V105	V.M.O.	6C4
V302	Same as V104	Cathode Follow & 100 Kc Crystal Oscillator	12AU7
XI301	LIGHT, indicator: with clear white lens, for min bay base T-3-1/4 bulb.	Socket for I301	TS106-2
XI302	LIGHT, indicator: with red frosted lens, for min bay base T-3-1/4 bulb.	Socket for I302	TS106-1
XI303	LAMPHOLDER, without lens: for min bay base T-3-1/4 bulb.	Socket for I303	TS107-1
XI304	Same as XI301	Socket for I304	TS106-2

SYM	DESCRIPTION	FUNCTION	TMC PART NO.
XK301	SOCKET, tube: octal.	Socket for K301	TS101P01
XV301	Same as XV102	Socket for V301	TS102P01
XV302	Same as XV104	Socket for V302	TS103P01
XY301	SOCKET, crystal: .487'' spacking, for .095'' pins.	Socket for Y301	TS105-1
Y301	CRYSTAL UNIT: quartz; 100 kcs.	100 Kcs Osc.	CR100

SECTION VI
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* The frequencies obtained by the mixing of the master oscillator (2 to 4 megs) and the 100 kc crystal oscillator, may be picked off at such intermittent values as to provide easily-heard check points, for calibrating the Model VOX. For more accurate results, it is recommended that the audible check points listed in Table 6-1 be used in calibrating this unit. The values of Master Oscillator Frequency were determined by the following relationships:

1. $\frac{.1\ H_S}{H_O} = f_O$, where f_O is the Master Oscillator Frequency.

   H_S is the number harmonic of the 100 kc Standard.

   H_O is the number harmonic of the Master Oscillator.

2. H_S 20, 21, 22, ... to infinity

   H_O 1, 2, 3, 4, ... to infinity

3. $\frac{H_S}{H_O}$ = greater than 20.

TABLE 6-1 RECOMMENDED CHECK POINTS

H_S	H_O	f_O	
20	1	2.0	00000
141	7	thru	14286
121	6	3.9	16667
101	5		20000
81	4		25000
142	7		28571
122	6		33333
102	5		40000
82	4		50000
103	5		60000
124	6		66667
145	7		71428
83	4		75000
104	5		80000
125	6		83333
146	7		85714

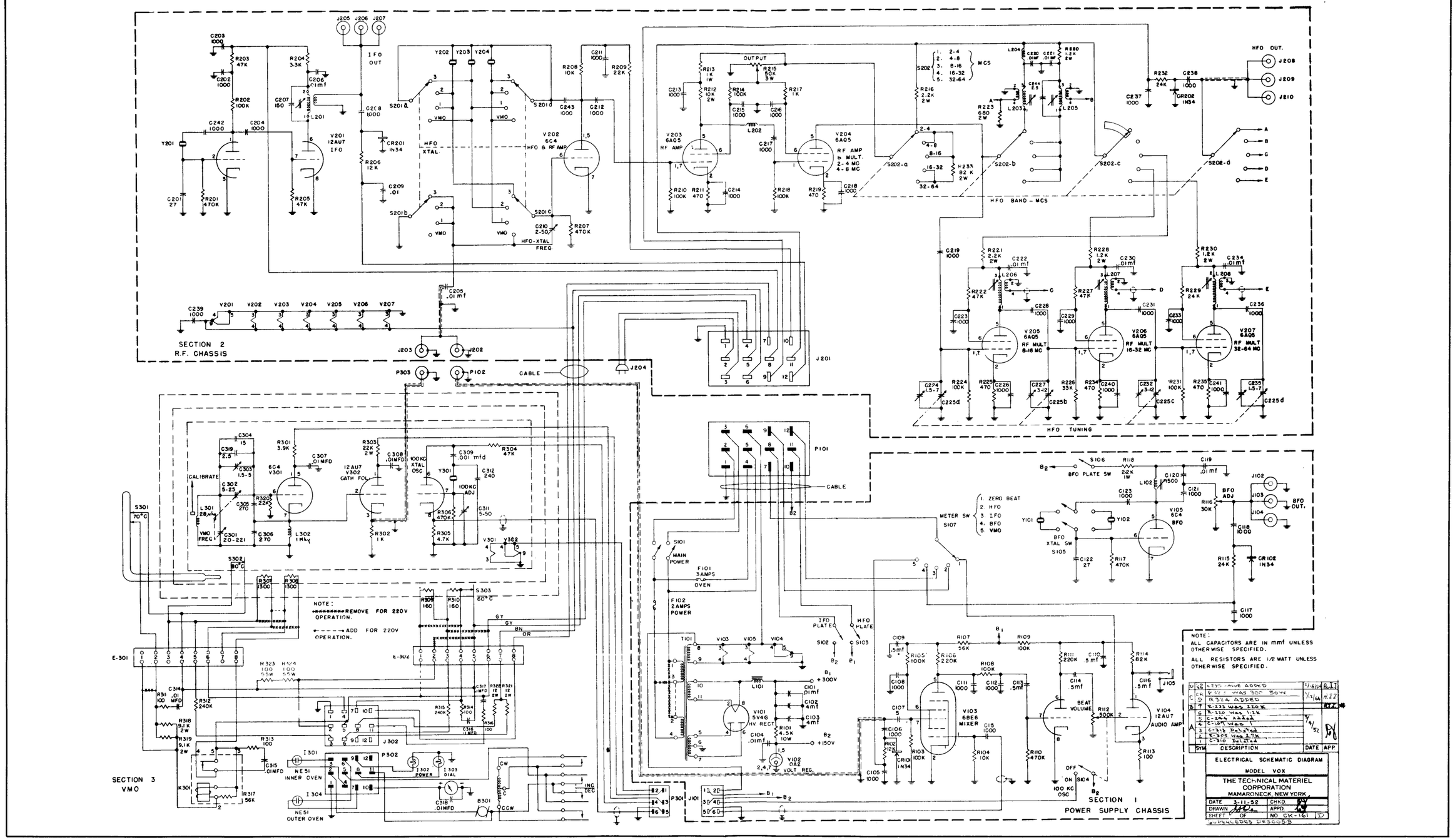

Figure 6-1. Schematic Diagram, Model VOX