

★
UNCLASSIFIED

TECHNICAL MANUAL

for

FREQUENCY SHIFT EXCITER MODEL XFK-2

(CONTROL, ELECTRICAL FREQUENCY)

(C-2749/URT)



THE TECHNICAL MATERIEL CORPORATION
MAMARONECK, N.Y.

OTTAWA, CANADA

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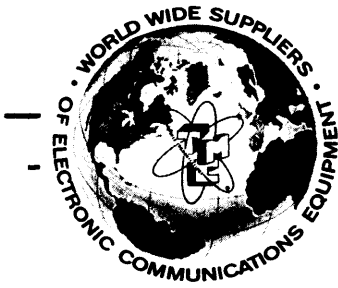
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IN 2020/260

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THE TECHNICAL MATERIEL CORPORATION

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700 FENIMORE ROAD

MAMARONECK, N. Y.

Warranty

The Technical Materiel Corporation, hereinafter referred to as TMC, warrants the equipment (except electron tubes,*fuses, lamps, batteries and articles made of glass or other fragile or other expendable materials) purchased hereunder to be free from defect in materials and workmanship under normal use and service, when used for the purposes for which the same is designed, for a period of one year from the date of delivery F.O.B. factory. TMC further warrants that the equipment will perform in a manner equal to or better than published technical specifications as amended by any additions or corrections thereto accompanying the formal equipment offer.

TMC will replace or repair any such defective items, F.O.B. factory, which may fail within the stated warranty period, PROVIDED:

1. That any claim of defect under this warranty is made within sixty (60) days after discovery thereof and that inspection by TMC, if required, indicates the validity of such claim to TMC's satisfaction.
2. That the defect is not the result of damage incurred in shipment from or to the factory.
3. That the equipment has not been altered in any way either as to design or use whether by replacement parts not supplied or approved by TMC, or otherwise.
4. That any equipment or accessories furnished but not manufactured by TMC, or not of TMC design shall be subject only to such adjustments as TMC may obtain from the supplier thereof.

Electron tubes*furnished by TMC, but manufactured by others, bear only the warranty given by such other manufacturers. Electron tube warranty claims should be made directly to the manufacturer of such tubes.

TMC's obligation under this warranty is limited to the repair or replacement of defective parts with the exceptions noted above.

At TMC's option any defective part or equipment which fails within the warranty period shall be returned to TMC's factory for inspection, properly packed with shipping charges prepaid. No parts or equipment shall be returned to TMC, unless a return authorization is issued by TMC.

No warranties, express or implied, other than those specifically set forth herein shall be applicable to any equipment manufactured or furnished by TMC and the foregoing warranty shall constitute the Buyers sole right and remedy. In no event does TMC assume any liability for consequential damages, or for loss, damage or expense directly or indirectly arising from the use of TMC Products, or any inability to use them either separately or in combination with other equipment or materials or from any other cause.

*Electron tubes also include semi-conductor devices.

PROCEDURE FOR RETURN OF MATERIAL OR EQUIPMENT

Should it be necessary to return equipment or material for repair or replacement, whether within warranty or otherwise, a return authorization must be obtained from TMC prior to shipment. The request for return authorization should include the following information:

1. Model Number of Equipment.
2. Serial Number of Equipment.
3. TMC Part Number.
4. Nature of defect or cause of failure.
5. The contract or purchase order under which equipment was delivered.

PROCEDURE FOR ORDERING REPLACEMENT PARTS

When ordering replacement parts, the following information must be included in the order as applicable:

1. Quantity Required.
2. TMC Part Number.
3. Equipment in which used by TMC or Military Model Number.
4. Brief Description of the Item.
5. The *Crystal Frequency* if the order includes crystals.

PROCEDURE IN THE EVENT OF DAMAGE INCURRED IN SHIPMENT

TMC's Warranty specifically excludes damage incurred in shipment to or from the factory. In the event equipment is received in damaged condition, the carrier should be notified immediately. Claims for such damage should be filed with the carrier involved and not with TMC.

All correspondence pertaining to Warranty Claims, return, repair, or replacement and all material or equipment returned for repair or replacement, within Warranty or otherwise, should be addressed as follows:

THE TECHNICAL MATERIEL CORPORATION
Engineering Services Department
700 Fenimore Road
Mamaroneck, New York



CHANGE NO. 1



INSTRUCTION BOOK CHANGE NOTICE

Date 12/21/62

Manual affected: FREQUENCY SHIFT EXCITER MODEL XFK IN -260

Page 2-0

After paragraph 2-1b add the following:

NOTE

When the XFK is rewired for 230 volt operation, POWER fuse F1 and OVENS fuse F2 should be replaced with fuses having a 1.5 ampere rating.

Page 4-14 figure 4-10 NOTE 2

Delete T8

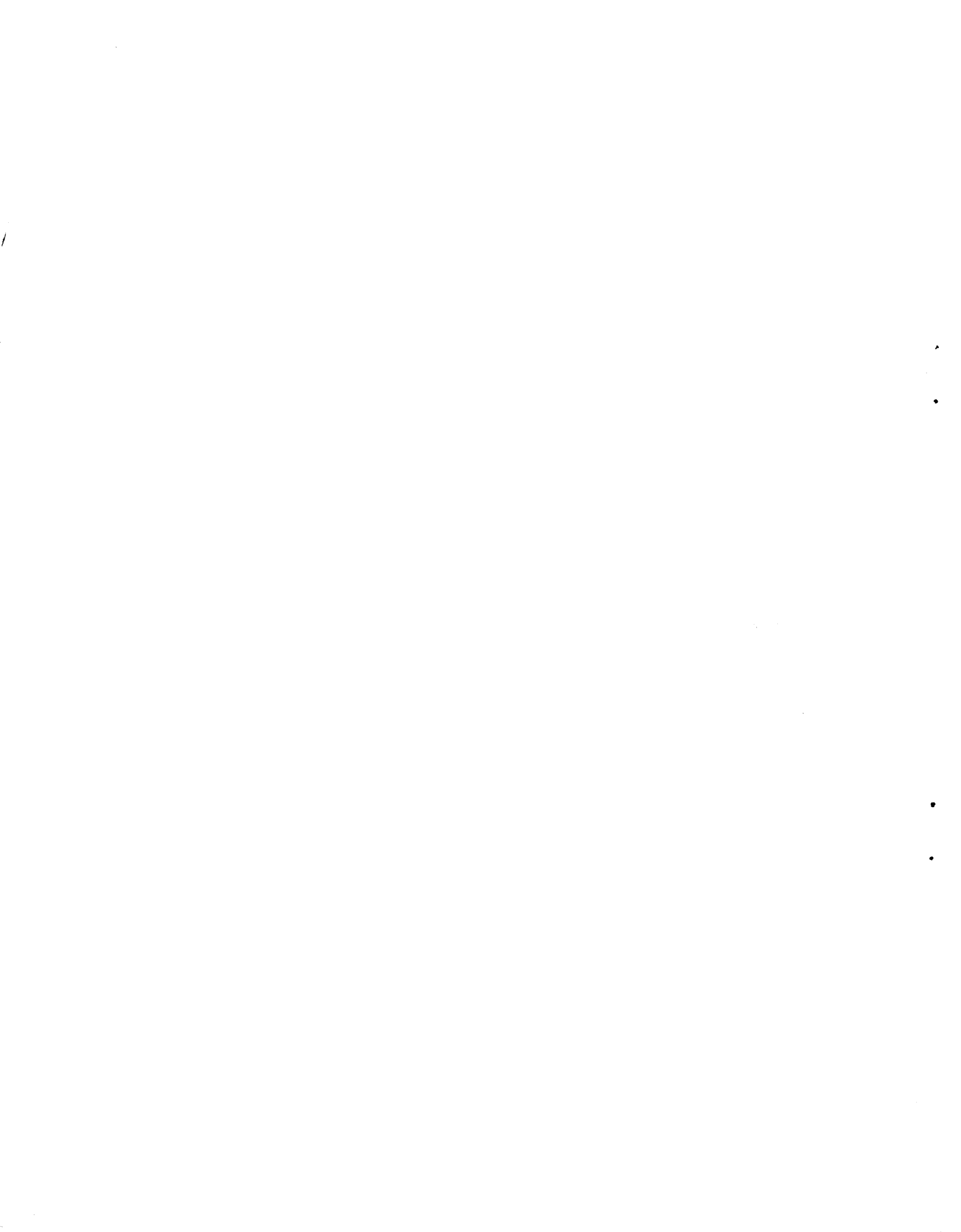
Page 8-3/8-4 figure 8-1 NOTE 3

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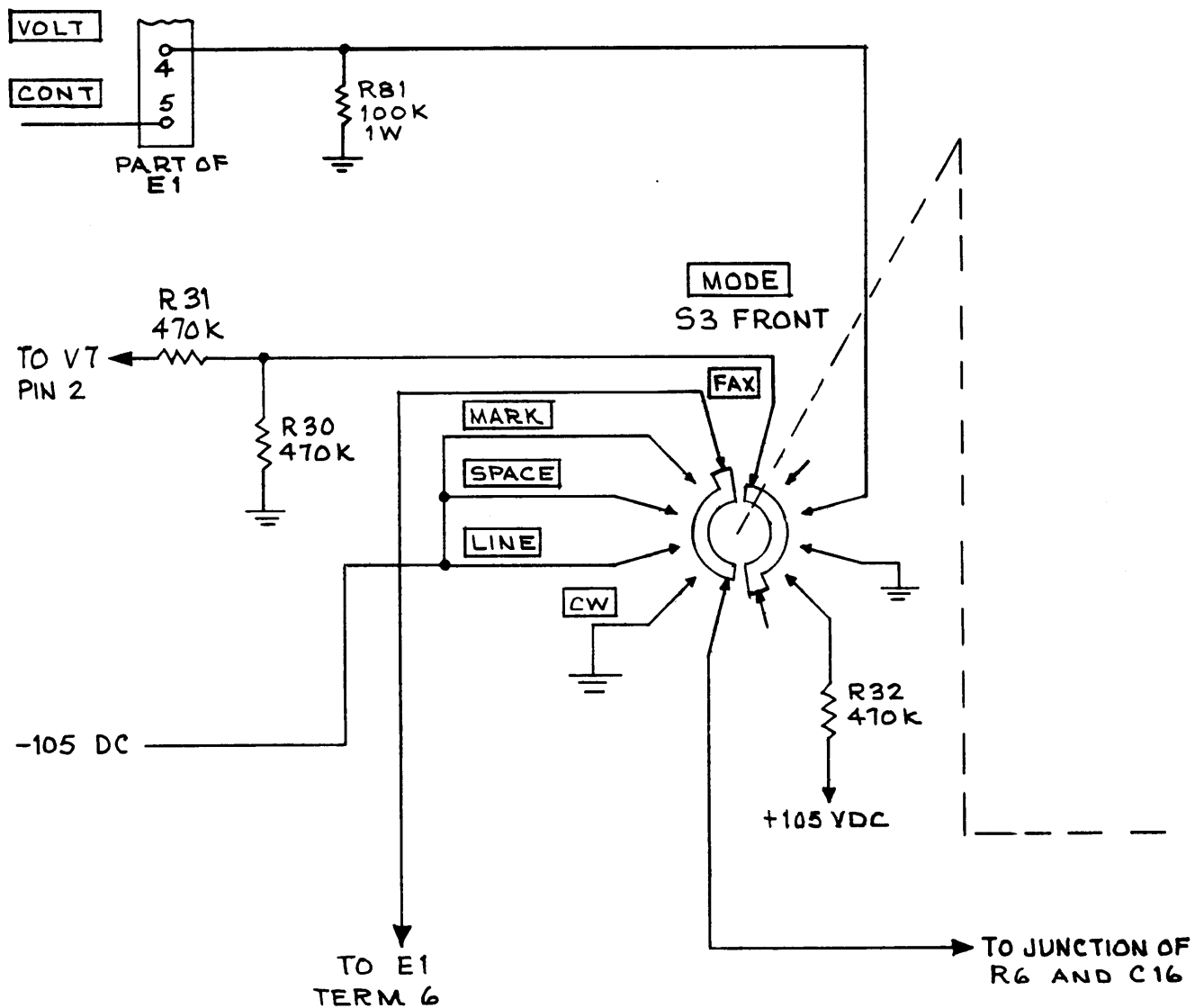
INSTRUCTION BOOK CHANGE NOTICE

Date 12/26/63

Manual affected: Frequency Shift Exciter Model XFK-2 IN 2020/260

Page 8-3/8-4 Figure 8-1 Sheet 1

Change circuitry for front segment of MODE switch S3
as indicated below:



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SECTION I GENERAL DESCRIPTION

1-1. PURPOSE AND PRINCIPLES.

The Frequency Shift Exciter, Model XFK (hereafter referred to as XFK), is a single unit frequency shift exciter designed for fixed station use. The XFK is a high stability radio frequency oscillator which provides a means of shifting an RF carrier in accordance with the variations of an audio or pulse signal. It provides frequency shift telegraph signals in two bands, 1 to 2.5 mc and 2.5 to 6.9 mc.

The XFK replaces the crystal oscillator in a transmitter and provides "mark" and "space" carrier-shift transmission of teleprinter, telegraph, FM telephone, facsimile or telephoto intelligence. Carrier shift up to 1,000 cycles is available within the range of 1.0 to 6.9 megacycles. The output may be linear with applied voltage or independent of applied voltage amplitude variations.

Carrier-shift has become the most accepted means of transmitting the above mentioned types of intelligence. The transmitter frequency is changed from a low "space" frequency to a higher "mark" frequency in accordance with the input intelligence. At the receiver, the r-f (radio-frequency) signals are detected, and a suitable converter changes the a-f (audio-frequency) variations to an audio or pulse signal, which conveys the intelligence to the terminal equipment. For receiving, a Dual Diversity Receiver, such as the TMC Model DDR-2, is recommended in conjunction with a Frequency Shift Converter such as the TMC Model CFA.

1-2. DESCRIPTION.

The XFK is illustrated in Figure 1-1. The panel is 3/16-inch thick by 19 inches long by 10-1/2 inches high, and is finished in TMC gray enamel. The chassis extends 15 inches behind the panel (including the rear panel control protrusions) and is attached to each side of the panel by brackets. Two convenience handles are mounted on the front panel. The controls most used are located on the front panel. The crystals are accessible through an access door in the center of the front panel. Input, output, seldom used controls, and power connections are located at the rear of the XFK chassis. The dust cover has been designed for quick removal to provide ready access to all vacuum tubes from the rear of the unit. The power supply for the XFK is contained within the unit, making one compact package, simply and quickly installed.

All frequency determining elements are enclosed within a new and highly improved temperature controlled oven. Frequency modulation is accomplished by a newly developed circuit technique offering many advantages over any existing XFK. Some of the details are indicated below:

a. Crystal and 200 kc ovens have fast heating characteristics in order that their temperatures may be stable approximately 10 minutes after a cold start.

b. New multiplication circuit provides a means of presetting output shift for all three crystal frequencies. Transmitter multiplications of 1, 2, 3, 4, 6, 8, 9, 12 are accommodated. Once set, multiplications and proper output shift are controlled by crystal selector switch.

c. All control dials are directly calibrated in frequency.

d. Single control output tuning eliminates possible error of tuning to lower sideband.

1-3. REFERENCE DATA.

- a. Output Frequency Range
 - Band 1 - 1-2.5 mc
 - Band 2 - 2.5-6.9 mc
- b. Frequency Shift
 - Linear to 1,000 cycles.
- c. Output Power
 - Adjustable to 3 watts.
- d. Output Impedance
 - 50-70 ohms.
- e. Keying Sources
 - (1) Contact closing to ground.
 - (2) Polar or neutral positive.
 - (3) Linear input 30,000 ohms impedance.
- f. Keying Speed
 - 1,000 wpm maximum.
- g. Keying Input Impedance
 - Polar or neutral operation 100,000 ohms, may be bridged by external 1800 ohms loop resistance. Contact closing to ground must be open circuit.
- h. RF Source
 - Internal crystal oscillator or external oscillator.
- i. Input Impedance for External RF Source
 - 70 ohms, 6 to 8 volts RMS.
- j. Frequency Control
 - High frequency crystal oscillator 0.8 to 6.6 mc. High stability 200 kc osc.

- k. Crystal Holders
FT-243 three positions and HC-6/U three positions.
- l. Oven Temperature
70 degrees Centigrade held constant within plus or minus 0.1 degree C.
- m. Keying Bias
Not greater than 10% at 1,000 wpm.
- n. Overall Stability
(1) 10 cps for ambient temperature change of 0 to 50 degrees C.
(2) 10 cps for line voltage change of 10%.
(3) No drift for input signal variations of plus 25 volts to plus 150 volts (Mark frequency).
- o. Crystal Frequency
$$\left(\frac{\text{Assigned transmitter frequency}}{\text{Transmitter multiplication}} \right) - 200 \text{ Kcs}$$

~~minus 200 kc~~
- p. Metering
PA plate current (tuning).
- q. Monitoring
100 millivolts across 70 ohm coaxial connector.
- r. Operating Controls (front panel)
See Table 1-1
- s. Operating Controls (rear chassis)
(1) Coarse Frequency Adjust Control
(2) Multiplier Preset Selector
(3) Key - Fax switch.
- t. Primary Power
115/270 v, 50/60 cps
Both ovens off - 100 watts
Each oven - 40 watts.
- u. Weight
48 pounds.

TABLE 1-1. FRONT PANEL CONTROLS OF THE XFK

CONTROL	FUNCTION
POWER ON-OFF toggle switch	Energizes or deenergizes XFK's power supply circuit. With switch in ON position, POWER indicator should light.
PLATE ON-OFF toggle switch	Energizes or deenergizes XFK's vacuum tubes with DC plate voltage.
200 KC OVEN indicator	When lighted, indicates oven is receiving power; when off, the oven is not receiving power.
XTAL OVEN indicator	When lighted, indicates oven is receiving power; when off, the oven is not receiving power.
PA PLATE CURRENT meter	Measures PA plate DC supply.
OUTPUT TUNING MC knob	Varies capacitors in XFK's output network. Dip in PA PLATE CURRENT meter indicates optimum tuning.
FREQUENCY SHIFT CPS potentiometer	Provides a means to vary DC voltages to the XFK's reactance tube in order to obtain a given shift. For a shift of ± 425 cycles, set dial to 850. With a multiplier of unity, the actual frequency shift is ± 425 cps. When a GPT-10K has a multiplier of two and its desired output is a frequency shift of ± 425 cps, set the dial as before to 850 but place the XFK's multiplier to 2. Under this condition, the XFK's frequency shift is $\frac{\pm 425}{2}$ cps but the GPT-10K's frequency shift is ± 425 cps.
BAND CHANGE selector switch	Switches XFK's tuning networks associated with mixer and PA tubes from band 1 (1 to 2.5 mc) to 2 (2.5 to 6.9 mc).
FREQUENCY selector switch	Varies trimmer capacitors in input and output tuning networks in mixer and PA tube circuits.
XTAL selector switch	Selects whether XFK's output is produced by MF crystals (located in XFK) or by an EXT MF supply.
POWER potentiometer	Controls XFK's output power.
TEST selector switch (old model)	In the older model, provides input voltages to XFK's keyer vacuum tube as MARK, SPACE, or operating LINE signals.
MODE selector switch (new model)	In the newer model, provides input voltages to XFK's keyer vacuum tube as FAX, MARK, SPACE, LINE, and CW.

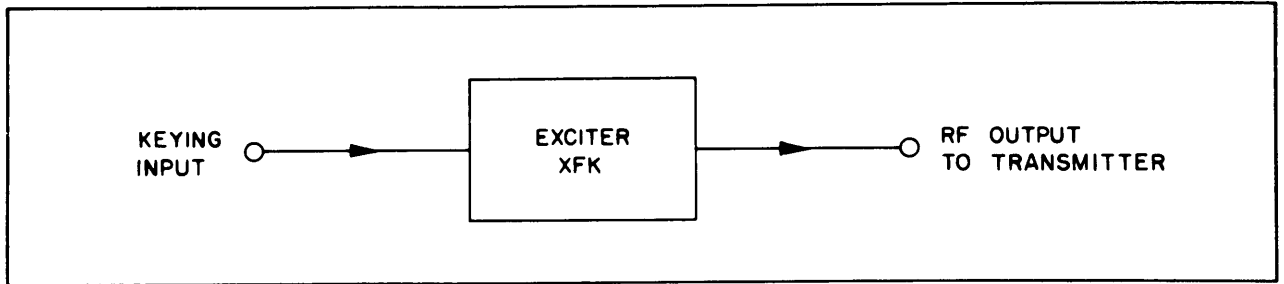


Figure 1-2. Simplified Block Diagram of Application

TABLE 1-2. VACUUM TUBE COMPLEMENT

REF DESIG	TYPE	FUNCTION
V1	6J6	200 KC Oscillator
V2	12AU7	Reactance Tube
V3	6BE6	Mixer
V4	6BE6	Mixer
V5	2E26	Power Amplifier
V6	12AU7	Crystal Oscillator-Buffer
V7	12AU7	Keyer
V8	5U4G	High Voltage Rectifier
V9	6X4	Bias Voltage Rectifier
V10	OB2/VR	Voltage Regulator
V11	OB2/VR	Voltage Regulator

SECTION 2 INSTALLATION

2-1. FREQUENCY SHIFT EXCITER MODEL XFK.

a. INITIAL INSPECTION. This unit was tested and calibrated before shipment. Only minor preparations are required prior to operating the unit.

Inspect the case and its contents for possible damage immediately after unpacking. Unpack the equipment carefully. Inspect all packing material for parts which may have been shipped as "loose items". Although the carrier is liable for any damage to the equipment, Technical Materiel Corporation will assist in describing and providing for repair or replacement of damaged items. The equipment is shipped with all tubes installed. Check that all such components are properly seated in their sockets.

b. 115-VOLT, 230-VOLT POWER SUPPLY CONNECTIONS. The power supply is designed for 115- and 230-volt, 50- and 60-cps, single-phase power; it is factory wired for 115 volts. If 230-volt operation is required (which sometimes occurs when XFK is used as an end item), minor wiring changes to the power supply and ovens are necessary. These are shown in figure 2-1.

c. INTERCONNECTING PROCEDURE. When the XFK forms part of the GPT-10K assembly, the interconnecting procedures are as follows:

(1) Referring to wiring diagram of the test and exciter frame (see part VII of Volume II of the manual), two single-conductor coaxial signal conductor's interconnect the XFK's r-f output/input to selector switch contacts on the MCP as follows: XFK's output to XFK contact of SBE VMOIN selector switch, and XFK's input to XFK contact of VOX RF OUT selector switch. These r-f cable interconnections form part of a larger cable (CA-427).

(2) Referring to wiring diagram of the test and exciter frame (see part VII of Volume II of the manual), six conductors (numbers 24, 25, 26, 27, 28, and 49) interconnect the XFK to a terminal board via part of cable CA-427. Each terminal of these six conductors is provided with a terminal lug to facilitate the interconnection.

(3) Connect power supply cord between 115-volt regulated 50- and 60-cps power supply accessory multiple outlet and power supply 115-volt input.

When the XFK is an "end item", the equipment supplied and the interconnecting instructions are as follows:

<u>Description</u>	<u>Quantity</u>
Frequency Shift Exciter Model XFK	1
Cable Assembly CA-103	1
Terminal Bar for 8 connections	1
Terminal Strip TM-105-AL	1
Plugs (coaxial) UG-176/U	2
Plugs PL-259	2

Equipment required but not supplied consists of the following: two coaxial cables, each utilizing one Plug UG-176/U on one terminal and one Plug PL-259 on the other terminal; and eight conductors interconnecting the XFK's eight-conductor terminal bar to the customer's supplied Terminal Strip TM-105-AL.

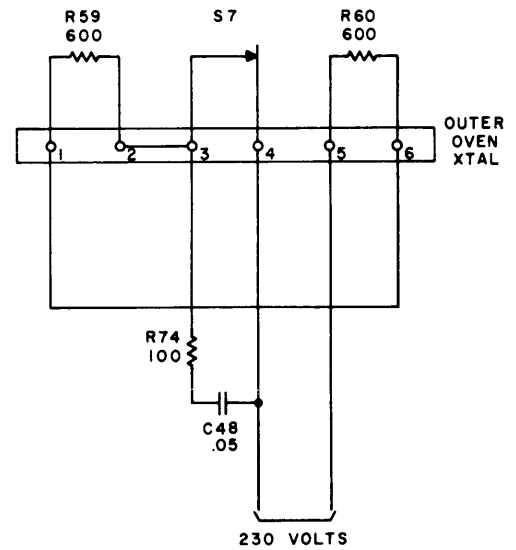
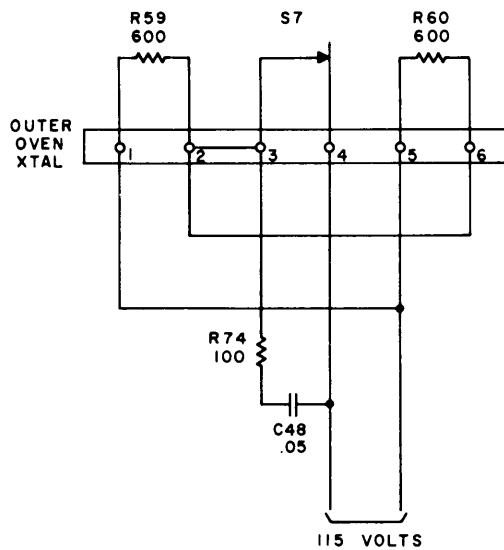
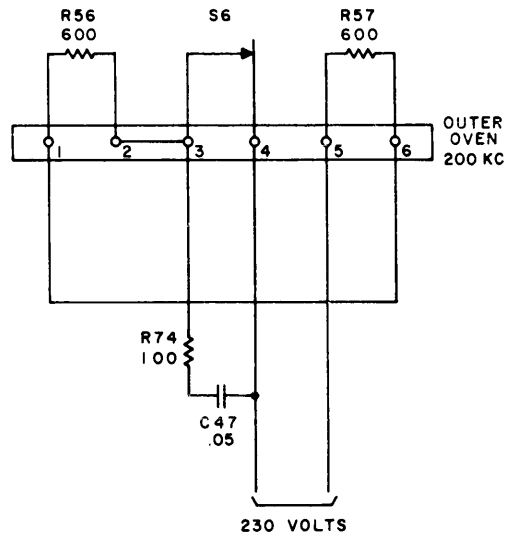
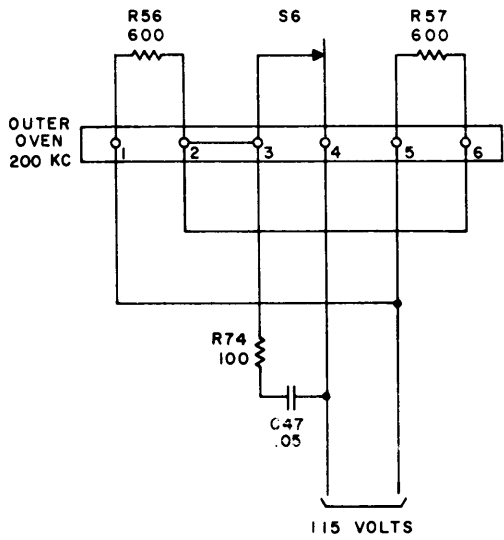
The XFK may be mounted in a standard 19-inch relay rack or other housing as desired. Figure 2-2 is an outline dimensional drawing of the XFK.

The input keying line may be a twisted pair of standard telephone-type line. The line should be connected between terminals marked VOLT and GND at the rear of the chassis and should be connected so that a positive voltage appears at VOLT on "mark" condition. The input impedance of the keying line is 100,000 ohms. However, the line should be terminated in as low an impedance into which the keying source may operate. For this reason a 2000-ohm, 10-watt resistor is supplied with each XFK, attached to the appropriate terminals.

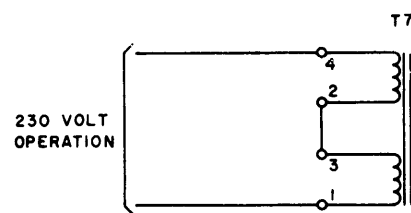
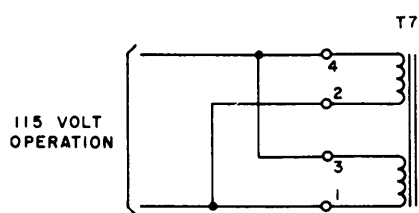
A twisted pair may be brought into the terminals marked CONT and GND. This line may be used to key the XFK merely by shorting it ("mark" condition). In order for the regular keying line to function properly, care must be taken to see that this line is kept open when not in use.

The facsimile line should be connected to FAX and GND terminals on the terminal board. When using a facsimile demodulator, such as TMC's Model XFD, +105 volts is supplied from the XFK and should be wired along with a ground to the appropriate terminals on the XFD.

The OUTPUT jack should be connected by a suitable length of 72-ohm cable to the frequency shift input terminal on the associated GPT-10K.



SKETCH A - OVENS



SKETCH B - POWER SUPPLY

Figure 2-1. 115- vs 230-Volt Power Supply Connections, XFK

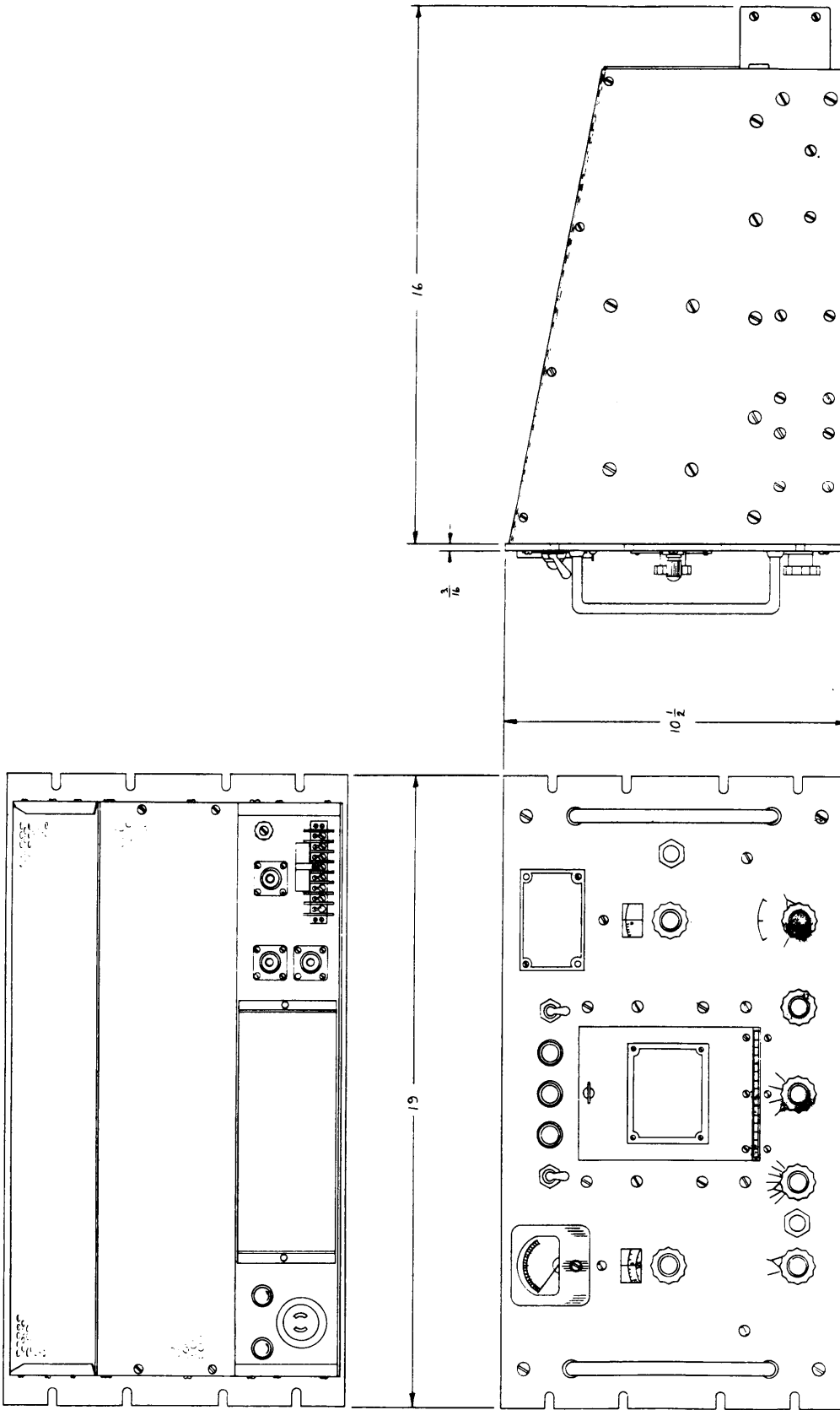


Figure 2-2. Outline Dimensional Drawing, XFK

If an external oscillator is used to replace the crystal oscillator within the unit, a coaxial cable of 72 ohms carrying the required signal level and frequency should be connected to the jack labeled EXT INPUT on the chassis rear panel.

A jack labeled MONITOR is also available at the rear of the chassis and taps off a very small portion of the output of the XFK. This may be connected through a 72-ohm coaxial cable to any suitable monitoring system.

d. CRYSTAL SELECTION. Before operating the equipment, it is necessary to select the proper crystal for the desired output frequency. (See Table 2-1.) This may be done by the following formula:

$$f_x = \frac{f_o}{n} - 200 \text{ kc} \text{ (Because XFK uses upper side-band in RF/200-KC oscillator Mixer's Output).}$$

Where f_x = crystal frequency in mc

f_o = output frequency of transmitter in mc

n = GPT-10K multiplication ratio

The crystal used should preferably be the new hermetically sealed JAN unit CR-17/U (Military Specification MIL-C-3098). The crystal should be inserted in one of the appropriate crystal sockets inside the

oven. The oven may be reached by opening the small thumb screw on the door located on the front panel. Wiring space for the crystal frequency and output frequency of the XFK is available on the front of the oven door to aid in selection of the crystal channel.

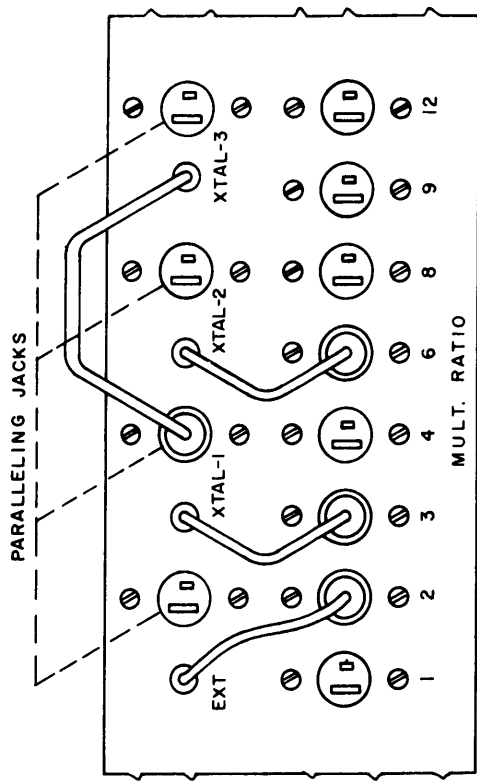
e. MULTIPLICATION PRESET. The proper GPT-10K multiplication ratio should be set at the rear of the chassis by means of the plug corresponding to the crystal position used on the front panel. Should the jack for any ratio be in use by another position, the plug may be inserted into the jack which is in parallel with the plug inserted into this particular ratio. (See figure 2-3.) For further details, refer to paragraph 3-2.

f. KEY-FAX SWITCH. This switch, located on the chassis rear panel on the older model, must be set in KEY position to work on either voltage or contact keying. In this position, the multiplier pre-set plugs must be properly inserted as explained in the preceding paragraph in order that the unit may "shift." In FAX position, a facsimile signal may be applied as explained more fully in paragraphs 3-2 and 4-8 of the manual.

On the new model, the MODE switch is a five-position selector switch on the front panel and performs the same overall functions as the three-position selector TEST switch and two-position KEY-FAX switch on the old model.

TABLE 2-1. QUARTZ CRYSTAL UNITS, SUPPLIED ONLY ON CUSTOMER REQUEST

DESIGNATION	SOCKET INSTALLED	TYPE	FREQ. CHAR.	FUNCTION	CHASSIS
No. 1	XY1 and XY2	CR-27/U	800 to 6700 kc	Oscillator	Inner Oven
No. 2	XY3 and XY4	CR-27/U	800 to 6700 kc	Oscillator	Inner Oven
No. 3	XY5 and XY6	CR-27/U	800 to 700 kc	Oscillator	Inner Oven



A TYPICAL PATCHING ARRANGEMENT

XTAL SELECTOR POSITION	XMTR MULTI-RATIO	XMTR. OUTPUT FREQ. SHIFT (DIAL SET) CPS	XFK FREQ. SHIFT
EXT	2	850	425
XTAL-1	3	850	283
XTAL-2	6	850	142
XTAL-3	3	850	283

Figure 2-3. Diagram Illustrating Multiplication Preset, XFK

SECTION 3 OPERATOR'S SECTION

3-1. GENERAL.

This section consists of detailed step-by-step operation procedures for the XFK. The assumption is made that the XFK is in good operating condition.

To obtain the best results with the XFK, the ovens should be allowed to run continuously. This means that the power switch on the front panel should always remain on.

3-2. TUNE UP PROCEDURE ON TELEGRAPH SIGNALS.

a. XFK ASSOCIATED WITH TMC'S SIDE-BAND TRANSMITTERS SUCH AS GPT-10K, GPT-40K, SBT-1K, ETC. Since sideband transmitters, as referenced in the caption, operate on the basis of frequency translation rather than frequency multiplication, the MULTIPLICATION PRESET RATIO should be set to unity at the rear of the chassis by means of the plug corresponding to the crystal position used on the front panel.

Table 3-1 is a chart showing crystal selection in terms of the transmitter's output frequency and the setting of SBE's BAND MCS switch.

Tune-up procedure of XFK on telegraph signals is given in paragraph 3-2. c.

b. XFK ASSOCIATED WITH CONVENTIONAL FREQUENCY MULTIPLICATION TRANSMITTER. Since conventional frequency multiplication transmitters, as referenced in caption, operate on the basis of frequency multiplication, the MULTIPLICATION PRESET RATIO should be set to the transmitter multiplication ratio at the rear of the chassis by means of the plug corresponding to the crystal position used on the front panel.

Table 3-2 is a chart showing crystal selection in terms of the transmitter's output frequency.

Tune-up procedure of XFK on telegraph signals is given in following paragraph 3-2. c.

c. DETAILED TUNE UP PROCEDURE.

Step	Panel Serial Desig.	Operation	Purpose
1	3, 4, 5, 6	Set POWER ON-OFF switch 6 to ON position.	POWER indicator 4, XTAL OVEN indicator 5 and 200 KC OVEN indicator 3 should light. Allow at least a 6-hour warm-up time.
2	1, 2, 9	Set PLATE ON-OFF switch 2 to ON position and turn POWER control 141 to limit PA plate current to 50 ma.	Supplies B+ to mixer and PA stages.
3	10	Set XTAL selector switch 10 to the desired crystal.	Multiplication ratio should have been set as already discussed (in paragraphs 3-5. <u>a</u> and <u>b</u>).
4	12	Set BAND CHANGE switch 12 to the proper band for XFK's output frequency for the crystal selected.	
5	1, 13, 9	Set OUTPUT TUNING MC control 13 so that its dial shows the correct output frequency. PA PLATE CURRENT meter 1 reading should be set at 50 ma.	Only a slight readjustment of OUTPUT TUNING MC control 13 should now be required to cause PA PLATE CURRENT meter 1 current to dip. At the higher frequencies on band 2, the incorrect sideband may cause a smaller dip at 400 kc below the proper output frequency. This is of no practical consequence providing the operator reads the dial correctly.

Step	Panel Serial Desig.	Operation	Purpose
6	9	Adjust POWER control 9 until the desired output power is reached, being certain not to increase PA PLATE CURRENT 2 over 50 ma.	Desired output power is reached when XFK's drive is sufficient to operate and associated SBE and GPT-10K units properly.
7	7	Set FREQUENCY SHIFT CPS control 7 to the desired shift of the associated transmitter. No allowance for frequency multiplication need be made if the patch panel at the rear of the chassis has been properly connected.	Example 1: desired shift is 840 cps; transmitters frequency multiplication is 1 and patch panel is so connected; set FREQUENCY SHIFT CPS control 7 to 840 Example 2: desired shift is 840 cps; transmitters frequency multiplication is 2 and patch panel is so connected; set FREQUENCY SHIFT CPS control 7 to 840.
8	8	Turn TEST selector switch 8 to LINE. The XFK is now ready to operate on keyed or contact signals.	
9	14	Turn FREQUENCY control 14 to 0 and the unit will now be "on frequency" within ± 50 cps plus the grinding error of the crystal used. If the frequency is monitored more accurately, the frequency may be changed by as much as ± 600 cps with this control.	This control adjusts a small capacitor in parallel with the crystal so as to "pull" the crystal's frequency by as much as ± 600 cps.

To convert the XFK from keyed signals to facsimile, it is only necessary to switch the KEY-FAX switch to FAX (early model). In the later model, place the MODE switch (control 8) in the FAX position. The XFK should be timed exactly as in preceding paragraph. It must, however, be kept in mind that FREQUENCY SHIFT CPS dial 130 and the automatic multiplication ratio are now bypassed.

A signal at the FAX input of approximately ± 4 volts then shifts the carrier ± 500 cycles linear with applied voltage. TMC Model XFD converts an amplitude-modulated tone carrier to the DC modulation required to operate the XFK and has the required controls on its front panel. Complete instructions are supplied with TMC Model XFD for proper interconnection and adjustment for use with the XFK.

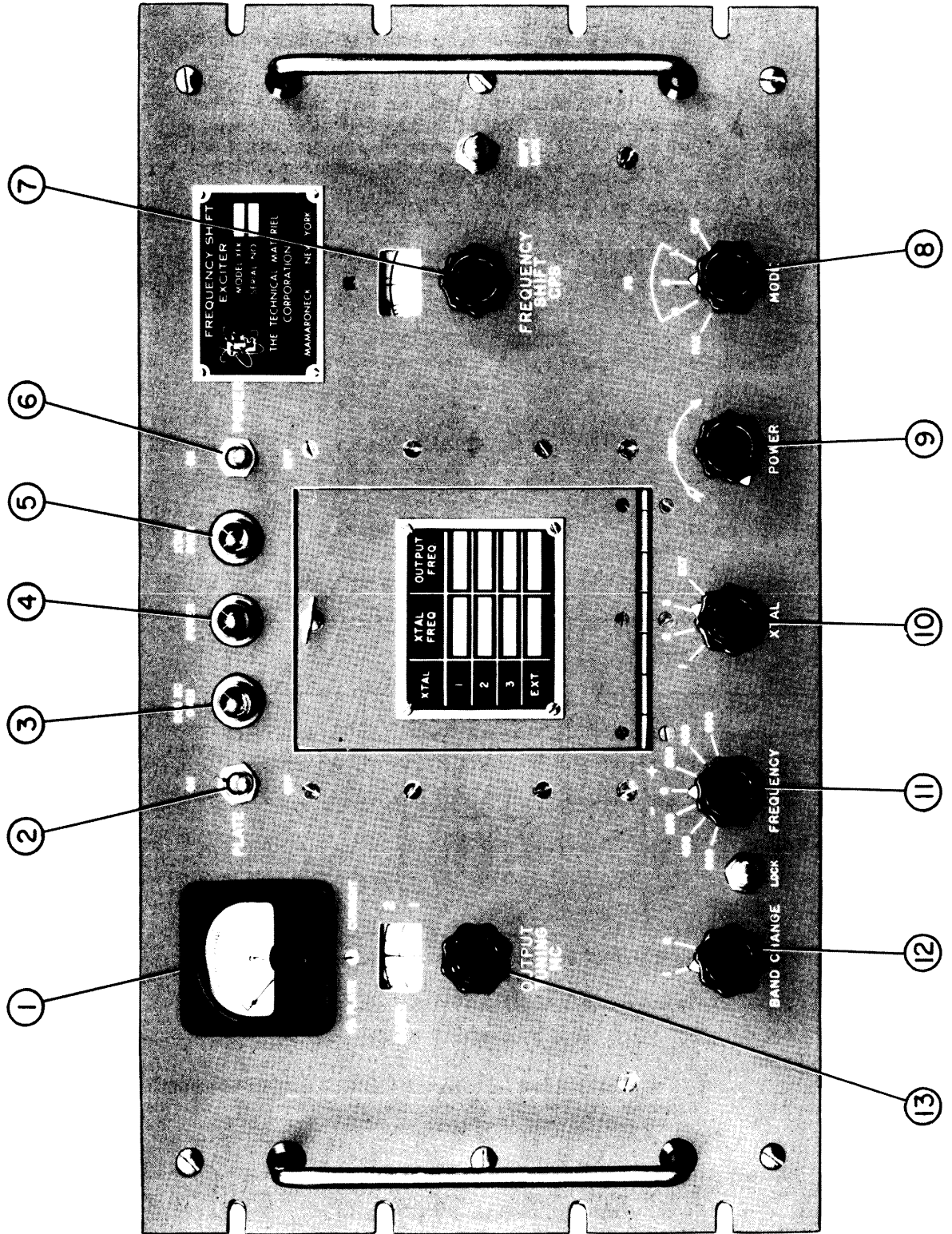
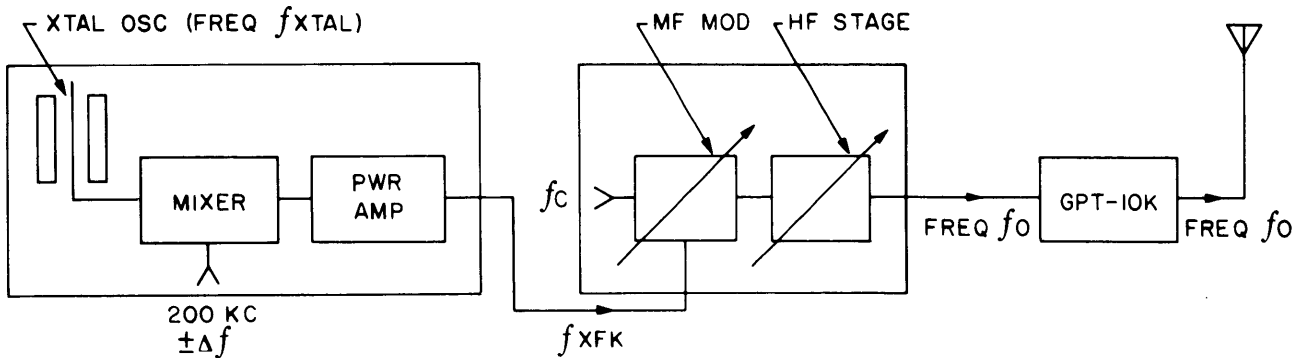


Figure 3-1. Front Panel View of XFK

**TABLE 3-1. FREQUENCY PARAMETERS FOR SIDEBAND TRANSMITTERS
CHART SHOWING CRYSTAL SELECTION AND SBE SETTING OF
BAND MCS SWITCH FOR TRANSMITTER OUTPUT FREQUENCY f_o .**

Frequency translation from output of XFK (frequency range of 2 to 4 mcs) to output of associated GPT-10K (frequency range of 2 to 28 mc) is accomplished with HF stage of GPT-10K and the addition of the proper setting of SBE's BAND MCS 18-position selector switch. The dial associated with this switch indicates frequency bands and a number N as follows:

<u>MODULATOR BAND (SBE-2)</u>	<u>MODULATOR BAND (SBE-3)</u>	<u>N</u>	<u>HFO</u>
4.27 - 6.27	4.25 - 6.25	4	8 mc
6.27 - 8.27	6.25 - 8.25	5	10
8.27 - 10.27	8.25 - 10.25	6	12
10.27 - 12.27	10.25 - 12.25	7	14
12.27 - 14.27	12.25 - 14.25	8	16
14.27 - 16.27	14.25 - 16.25	9	18
16.27 - 18.27	16.25 - 18.25	10	20
18.27 - 20.27	18.25 - 20.25	11	22
20.27 - 22.27	20.25 - 22.25	12	24
22.27 - 24.27	22.25 - 24.25	13	26
24.27 - 27.27	24.25 - 26.25	14	28
26.27 - 28.27	26.25 - 28.25	15	30
28.27 - 30.27	28.25 - 30.25	16	32
30.27 - 32.27	30.25 - 32.25	17	34



Note: $f_{XFK} = f_{XTAL} + (200 \text{ kc} \pm \Delta f)$.

Output frequency of MF MODE = $f_{XFK} - f_c = f_{MF}$

Where $f_c = 270 \text{ kc}$ for SBE-2 and 250 kc for SBE-3.

$f_o = \text{modulator band frequency } (f_{HFO}) - \text{output frequency of MF modulator } (f_{MF})$.

Substituting item 1 into item 2:

$$f_{MF} = f_{XTAL} + (200 \text{ kc} \pm \Delta f) - f_c$$

For SBE-2: $f_{XTAL} - (70 \text{ kc} \pm \Delta f) = f_{MF}$

For SBE-3: $f_{XTAL} - (50 \text{ kc} \pm \Delta f) = f_{MF}$

**TABLE 3-1. FREQUENCY PARAMETERS FOR SIDEBAND TRANSMITTERS
 CHART SHOWING CRYSTAL SELECTION AND SBE SETTING OF
 BAND MCS SWITCH FOR TRANSMITTER OUTPUT FREQUENCY F (c nt)**

Substituting for f_o :

$$f_o = \text{modulator band frequency (} f_{\text{HFO}} \text{)} = f_{\text{XTAL}} + (70 \text{ kc} \pm \Delta f)$$

for SBE-2; modulator band frequency (f_{HFO}) - f_{XTAL}
 + (50 kc \pm Δf) for SBE-3.

The last item may be re-written in terms of dial settings (end equation):

$$\left. \begin{array}{l} \text{For SBE-2: } f_{\text{XTAL}} = f_{\text{HFO}} - f_o + 70 \text{ kc} \\ \text{For SBE-3: } f_{\text{XTAL}} = f_{\text{HFO}} - f_o + 50 \text{ kc} \end{array} \right\} \text{----- (1)}$$

Example #1: $f_o = 11 \text{ mc}$; determine SBE-3 setting and f_{XTAL}

To get f_{XTAL} in 2-4 mc range

$$\begin{aligned} f_{\text{XTAL}} &= f_{\text{HFO}} - 11000 \text{ kc} + 50 \text{ kc} \\ &= 14000 - 10950 \\ &= 3050 \text{ kc} = 3.050 \text{ mc} \end{aligned}$$

Example #2: $f_o = 18 \text{ mc}$; determine SBE-3 setting and f_{XTAL}

To get f_{XTAL} in 2-4 mc range

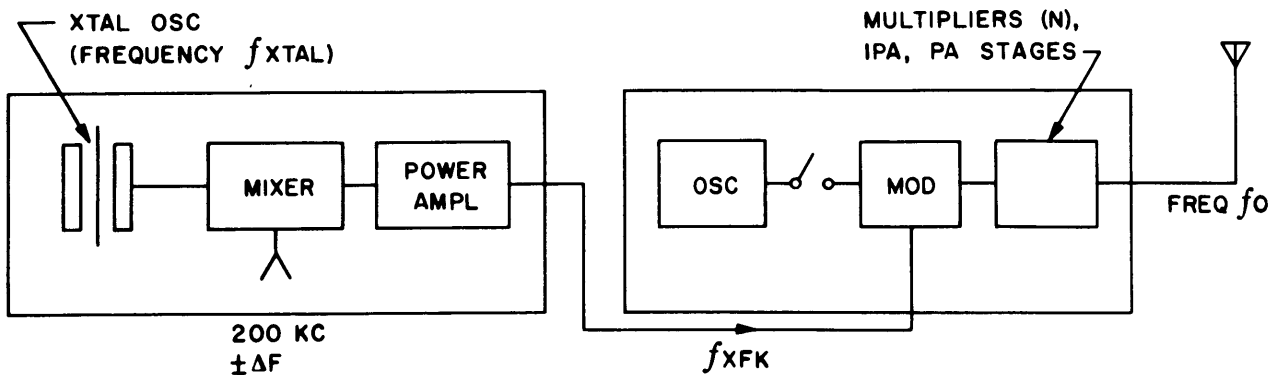
$$\begin{aligned} f_{\text{XTAL}} &= f_{\text{HFO}} - 18000 + 50 \text{ kc} \\ &= 20000 - 17950 \\ &= 2050 \text{ kc} = 2.050 \text{ mc} \end{aligned}$$

Example #3: $f_o = 5 \text{ mc}$; determine SBE-3 setting and f_{XTAL}

To get f_{XTAL} in 2-4 mc range

$$\begin{aligned} f_{\text{XTAL}} &= f_{\text{HFO}} - 5000 + 50 \text{ kc} \\ &= 8000 - 4950 \\ &= 3050 \text{ kc} = 3.050 \text{ mc} \end{aligned}$$

**TABLE 3-2. FREQUENCY PARAMETERS FOR CONVENTIONAL TRANSMITTERS
CHART SHOWING CRYSTAL SELECTION FOR TRANSMITTER OUTPUT
FREQUENCY f_o**



Note that: $f_{XFK} = f_{XTAL} + (200 \text{ kc} \pm \Delta f)$

Output frequency of transmitter = $(f_{XFK}) N = f_o$

Hence $f_o = (f_{XTAL} + 200 \text{ kc} \pm \Delta f) N$

$$f_{XTAL} = \frac{f_o}{N} - 200 \text{ kc}$$

To get f_{XTAL} in 2-4 mc range

$$\begin{aligned} f_{XTAL} &= f_{HFO} - 11000 \text{ kc} + 50 \text{ kc} \\ &= 14000 - 10950 \\ &= 3050 \text{ kc} = 3.050 \text{ mc} \end{aligned}$$

Example #2: $f_o = 18 \text{ mc}$; determine SBE-3 setting and f_{XTAL}

To get f_{XTAL} in 2-4 mc range

$$\begin{aligned} f_{XTAL} &= f_{HFO} - 18000 + 50 \text{ kc} \\ &= 20000 - 17950 \\ &= 2050 \text{ kc} = 2.050 \text{ mc} \end{aligned}$$

Example #3: $f_o = 5 \text{ mc}$; determine SBE-3 setting and f_{XTAL}

To get f_{XTAL} in 2-4 mc range

$$\begin{aligned} f_{XTAL} &= f_{HFO} - 5000 + 50 \text{ kc} \\ &= 8000 - 4950 \\ &= 3050 \text{ kc} = 3.050 \text{ mc} \end{aligned}$$

**TABLE 3-3. RELATIONSHIP OF PANEL SERIAL DESIGNATIONS,
PANEL MARKINGS AND SYMBOLS ON SCHEMATIC DRAWINGS**

PANEL SERIAL DESIGNATION	PANEL MARKING	SYMBOL ON SCHEMATIC DRAWING
1	PA PLATE CURRENT meter	M1
2	PLATE ON/OFF switch	S4
3	200 KC OVEN indicator	I2
4	POWER indicator	I1
5	XTAL OVEN indicator	I3
6	POWER ON/OFF switch	S8
7	FREQUENCY SHIFT CPS knob/dial	R8
8	MODE FAX/M/S, L/CW switch	S3
9	POWER INCR potentiometer	R22
10	XTAL 1/2/3/EXT selector switch	S2
11	FREQUENCY	C7
12	BAND CHANGE 1/2 switch	S1
13	OUTPUT TUNING MC knob/dial	C18



SECTION 4

PRINCIPLES OF OPERATION

4-1. INTRODUCTION. (See figure 4-1.)

As shown in figure 4-1, the XFK is an eight-stage electronic device with two ovens; it consists of a keyer, multiplier preset, crystal oven with three crystals, r-f crystal oscillator and buffer, oven with reactance tube and 200-kc oscillator, mixer, power amplifier, and power supply. In radio teletype (RATT) operation, the teletype input signal will cause keyer tube V7 to key reactance tube V2 which, in turn, shifts the frequency of 200-kc oscillator V1 between "marks" and "spaces." The 200-kc frequency shift signal is fed to a mixer along with the r-f crystal oscillator output. The resulting r-f output frequency shift signal is fed to a GPT-10K which amplifies and/or modifies it for transmission over the air.

For radio teletype operation, a sequence of two frequencies, corresponding to "mark" (closed key) and "space" (open key) conditions of the teletypewriter, is transmitted. The assigned frequency of the radio transmitter is the mean of the mark and space frequencies. The mark frequency is higher than the assigned frequency, and the space frequency is lower. The difference between the mark and space frequencies is termed "shift." Usually the XFK will be used to produce a total shift of 850 cycles. The mark frequency will be 425 cycles higher than the assigned frequency, and the space frequency will be 425 cycles lower than the assigned frequency.

4-2. KEYER TUBE V7. (See figure 4-2.)

Teletypewriter or hand keying signals enter the XFK via terminals 4 or 5, respectively. (See figure 4-2.) For either type of keying, it is necessary that the same voltage be consistently impressed upon the reactance tube for any given shift. Since this voltage must be polar and perfectly balanced, keyer tube V7 generates the actual internal keying voltage for either type of external keying. This is accomplished in the following manner: When using teletypewriter or voltage keying, "space" voltage (either 0 or negative voltage) is applied to the grid of section 1 of V7 (pin 2). This section will then be cutoff due to the cathode bias applied through voltage divider R33 and R34. As a result, a high positive voltage, which causes the second section to draw current and to act as a low resistance across R36 is impressed on the grid of section 2 of V7 (pin 7). R36, R37, R38, and R39, in series, act as a voltage divider (from +105 to -105 volts) to apply a small positive voltage to R40 and R41. When "mark" voltage (+25 to +150 volts) is applied to the grid of section 1, the tube will conduct and its plate voltage will drop. Since the grid of section 2 is tied directly to the plate of section 1, section 2 will be "cutoff." R36, R37, R38, and R39, in series,

again act as a voltage divider to apply a small negative voltage to R40 and R41.

R38, a chassis-mounted screwdriver control, is an adjustment to balance the positive and negative voltage; R40, also a chassis-mounted screwdriver control, regulates the amplitude of positive or negative voltage fed to the reactance tube.

When using hand or contact keying, the operation of the second section is identical to radio teletype operation, but the grid is directly controlled by grounding for the "mark" condition.

For test purposes, provision is made via TEST selector switch S3, a front panel control, to set "space" by grounding the grid of section 1 of "mark" by putting +105 volts on the same grid.

Functions of front panel control that apply to this section are as follows:

MODE S3, (late model). Switch control designated 8 on figure 3-1. Provides the XFK (late model) with "space" or "mark" pulses for test purposes, or with line teletype signals for operation. Provides for FAX or CW operation. In the early model of the XFK, this switch consisted of a front panel switch designated TEST and a rear chassis switch designated FAX-CW.

Chassis-mounted controls that apply to this section are as follows:

a. Shift-balance screwdriver potentiometer R38.

b. Shift-amplitude screwdriver potentiometer R40.

4-3. MULTIPLIER PRESET STAGE. (See figure 4-3.)

The multiplier preset plugs and jacks (sketch 2) provides a series of voltage dividers which may be inserted between the keyer and the reactance tube (sketch 1). There is a separate jack for each multiplication ratio commonly used between the output frequency of the XFK and the output frequency of the associated GPT-10K, namely, 1, 2, 3, 4, 6, 8, 9, and 12. Each divider consists of two resistors, one reducing the output from the keyer tube to the reactance tube by exactly the multiplication ratio, the other resistor shunting the original tap from R40 so as to maintain a constant input resistance of 10,000 ohms. For each position of the crystal selector switch, there is a small cable which may be plugged into any multiplier ratio desired (sketch 3). Should it be re-

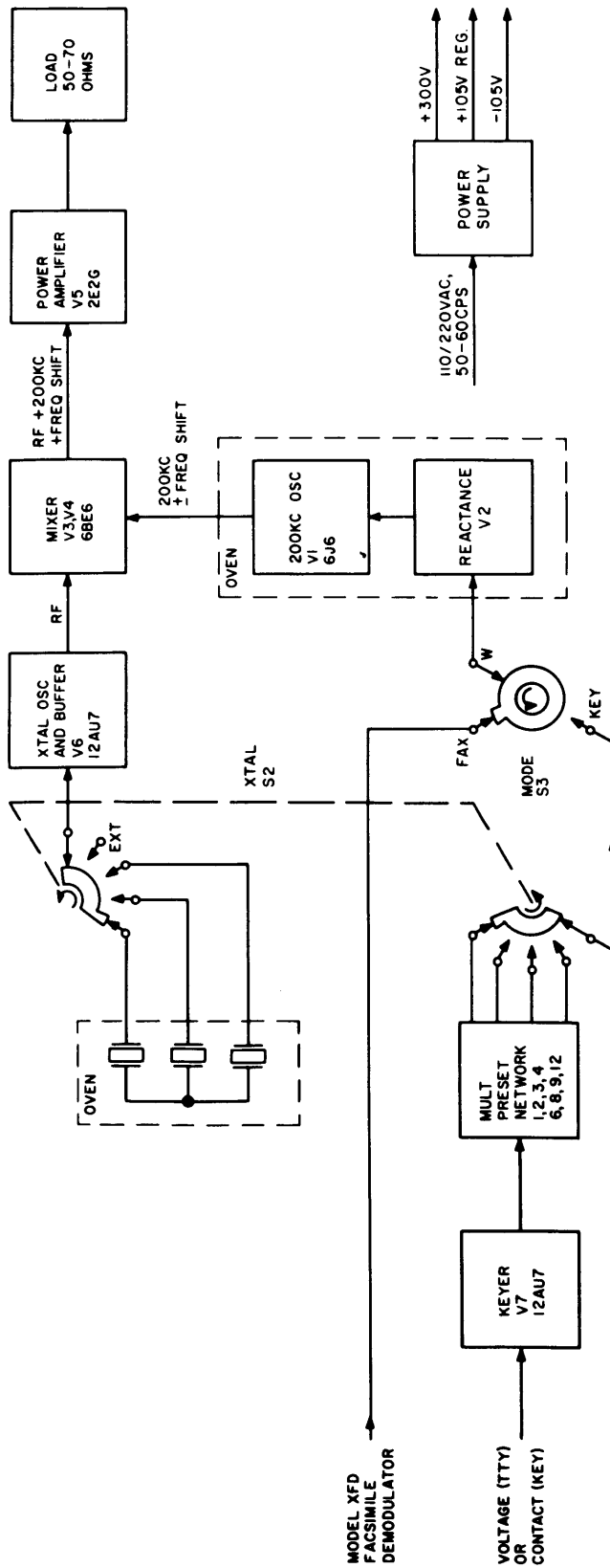


Figure 4-1. Block Diagram, XFK

quired that two or more crystals require identical multiplication ratios, a jack is provided in parallel with each cable. If the desired shift at the output of the GPT-10K is now directly set on the dial (figure 3-1, control designated 7), the proper shift of the XFK will be set automatically. Figure 4-4 is a brief circuit analysis of the conditions of two of the cases illustrated in figure 4-3.

A function of a front panel control that applies to this section is FREQUENCY SHIFT CPS R8. (Potentiometer control designated 7 on figure 3-1.) This knob should be set for the desired shift at the output of the GPT-10K. The multiplier preset associated with potentiometer R8 reduces the potential at R8 to compensate for any frequency multiplication in the GPT-10K receiving XFK's signals. For example, assume the desired shift at the output of the GPT-10K is 850 cps and that the GPT-10K has a frequency multiplication of 3. Set control 7 to 850 and patch the XTAL 1 plug to MULT RATIO 3 jack. (See figure 4-4, sketch 3.) In this example, XTAL 1 is the selected crystal for the GPT-10K. This means XTAL selector switch, designated 10 on figure 3-1, should be set to XTAL 1.

Chassis-mounted controls that apply to this section are as follows:

a. Multiplier preset cables. (See discussion earlier in this paragraph.)

b. FAX-KEY switch S5. Toggle switch mounted on rear of chassis (early model XFK only).

4-4. RF CRYSTALS AND OVENS. (See figure 4-5.)

Sections 1, 2, and 3 of the XTAL selector switch (a front panel control designated 10 on figure 3-1) select r-f crystal 1, 2, 3 or an external r-f injection circuit for the XFK's r-f output. Sections 4 and 5 of the XTAL selector switch connect to the multiplier preset circuits.

Two separate ovens are used in the XFK. One is used for the 200-kc reactance oscillator while the other is used for the r-f crystals. The ovens are very similar, the main difference being the cover of the crystal oven which is hinged and which may be opened from the front panel. Figure 4-5 shows the general features of this oven. Two cartridge type heaters are used in each oven, sunk into a well at the bottom of a thick aluminum casting. The thermostat is sunk in the same well as one of the heaters ensuring close thermal coupling. The thermostat is a bimetallic strip with high sensitivity and extremely long life. Replacement of either heaters or thermostats is a very simple operation. The thermostat is set at 70°C to allow for a 15°C rise within the equipment above a 55°C ambient. Heater operation may be observed by means of neon lamps in parallel with both sets of heaters.

Front panel XTAL switch selector designated 10 on figure 3-1, selects the proper r-f crystal for the GPT-10K associated with the XFK. The crystal, in turn, should be associated with the proper multi-

plication ratio for the GPT-10K. This ratio is set at the rear of the XFK unit as discussed in paragraph 4-3.

A chassis-mounted control that applies to this section is EXT INPUT jack J15, a coaxial jack mounted on rear of chassis.

4-5. CRYSTAL OSCILLATOR AND BUFFER V6. (See figure 4-6.)

Section 1 of V6 (pins 1, 2, and 3) is used as a modified Pierce crystal-controlled oscillator, while section 2 (pins 6, 7, and 8) is used as a cathode follower buffer. Since the output frequency of the XFK is determined by the sum frequency of the 200-kc oscillator and the r-f crystal oscillator, the crystals are controlled in an oven and the plate voltage of the crystal oscillator section is stabilized. Crystals may be easily exchanged, as the oven is accessible through a small door in the front panel. XTAL selector switch, designated 10 on figure 3-1, allows selection of any one of three crystals or an external signal. The crystals may be either type FT243 or the new CR-27/U, as sockets are provided for either type. The larger sockets house FT243 crystals, and the smaller sockets house CR-27/U crystals. The XTAL selector switch also selects the multiplication ratio which is set at the rear of the unit as discussed in paragraph 4-3.

4-6. REACTANCE TUBE V2 AND 200-KC OSCILLATOR TUBE VI. (See figure 4-7.)

V1 is a push-pull modified Colpitts oscillator operating at 200 kc. The major part of its tank circuit is located within a temperature stabilized oven with a fast heating characteristic; this portion of the tank circuit is temperature compensated and utilizes only components having very uniform retrace characteristics. In addition, the plate voltage is regulated and the oscillator is compensated external to the oven for changes in ambient temperature. External to the oven are two air-spaced, ceramic-supported trimmers C7 and C8 used, respectively, as fine and coarse frequency adjustments. C7 is designated control 11 on figure 3-1; C8 is chassis-mounted (on rear) and designated COARSE FREQ ADJ.

Reactance tube V2 receives the intelligence signal at the grid of section 1 (pins 1, 2, and 3); section 2 (pins 6, 7, and 8) is an inverter. The two sections vary the reactance across the 200-kc push-pull oscillator tank and, therefore, shift the frequency of the oscillator in accordance with the incoming intelligence. The magnitude of the reactance variation, and consequently the oscillator frequency change, depends on the magnitude and polarity of the incoming signal on pin 2 of tube V2. Over a narrow frequency range (200-kc \pm 500 cps), this frequency change will be linear with respect to applied voltage, positive or negative. This system provides the advantage of having the reactance tube currents contribute a negligible amount to the center frequency of the 200-kc oscillator. C2 adjusts the phase shift of section 1 so that for a given positive or negative signal voltage, the amount of shift will be equal. C2 is chassis-mounted (on top) and designated C2.

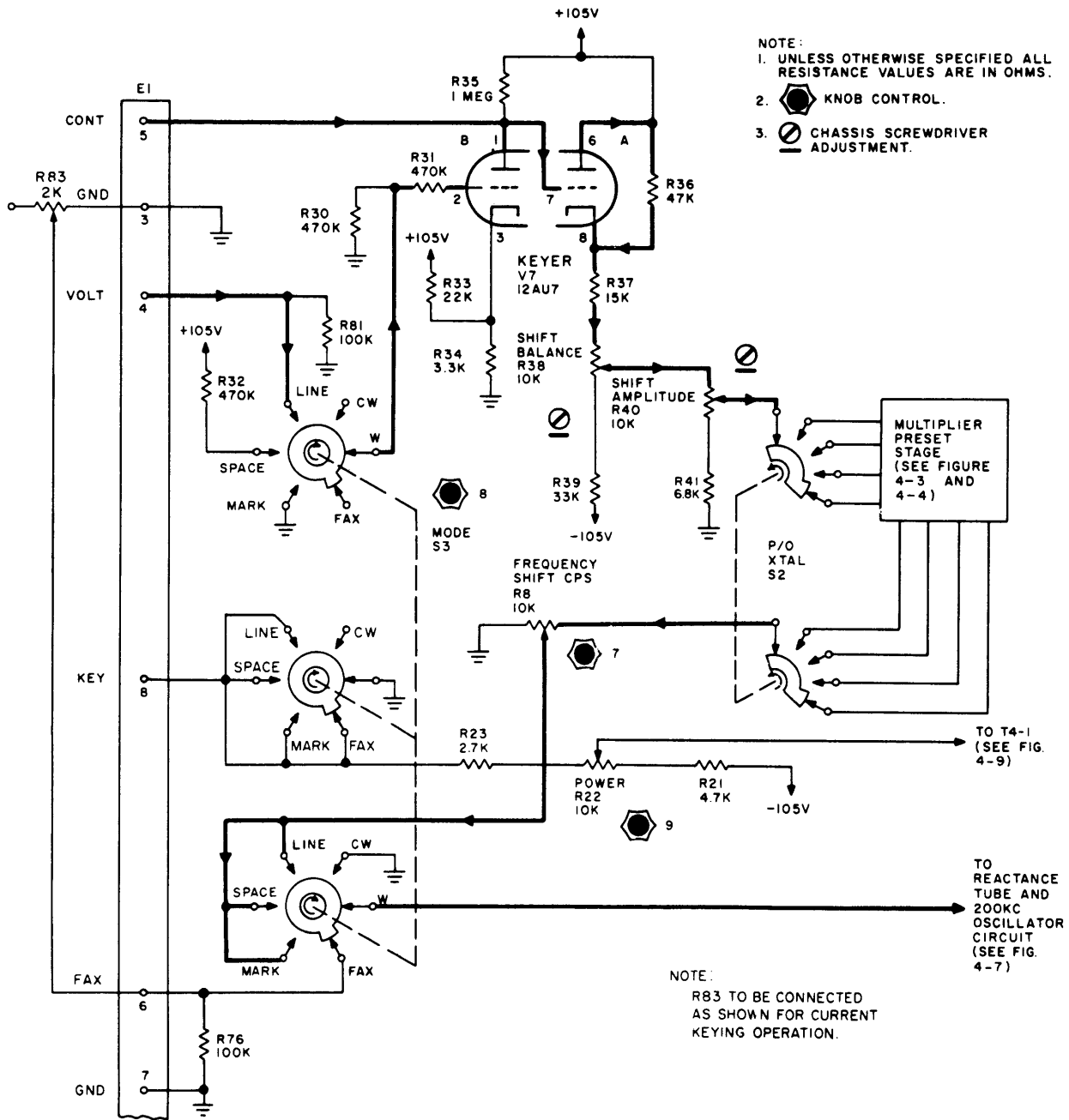


Figure 4-2. Schematic Diagram, XFK, Keyer Tube V7

Front panel control FREQUENCY C7 is a variable capacitor control designated 11 on figure 3-1. It adjusts the frequency of the 200-kc oscillator.

Chassis-mounted controls that apply to this section are as follows:

- a. COARSE FREQ ADJ. C8. Mounted on rear chassis. Adjusts frequency of 200-kc oscillator.
- b. C2. Mounted on top chassis. Adjusts the phase shift of the reactance tube so that for a given positive or negative signal the amount of shift will be equal.

4-7. MIXER TUBES V3 AND V4. (See figure 4-8.)

V3 and V4 operate together as a balanced mixer to add r-f crystal frequency and the 200-kc shift frequency from the reactance tube oscillator. Since the crystal frequency is fed in phase to both grids of V3 and V4, it is cancelled in the secondaries of transformers T3 and T4 on bands 1 and 2, respectively. To obtain exact cancellation in the secondaries, balancing adjustments R13 and R84, which vary the relative gains of V3 and V4, are provided.

The input from the crystal oscillator is tuned by C18A and the output, or sum frequency, is tuned by C18B. Band switching is used to cover two frequency ranges, 0.8 to 2.3 mc and 2.3 to 6.6 mc for the crystal frequencies and 1 to 2.5 mc and 2.5 to 6.9 mc for the output frequencies. These are bands 1 and 2, respectively. Capacitors C19 and C30 are factory set trimmers, but are accessible on the top chassis for readjustment when necessary.

Functions of front panel controls that apply to this section are as follows:

- a. BAND CHANGE S1. Switch control designated 12 on figure 3-1. Selects tuning circuits for MIXER and PA stages for band 1 (0.8 to 2.3 mc) or band 2 (2.3 to 6.7 mc).
- b. OUTPUT TUNING MC C18. Variable capacitor control designated 13 on figure 3-1. Tunes MIXER and PA stages to peak r-f for any given setting of POWER potentiometer R22, designated control 9 on figure 3-1.

Chassis-mounted controls that apply to this section are as follows:

- a. Screwdriver adjusted potentiometer R13 designated MIXER BALANCE on top chassis.
- b. Screwdriver adjusted potentiometer R84 accessible from bottom chassis.
- c. Trimmer capacitors C19 and C30 accessible on top chassis.

4-8. POWER AMPLIFIER TUBE V5. (See figure 4-9.)

V5 is a 2E26 class B tuned radio frequency power amplifier fed from the output of mixers V3 and V4. Fixed bias is used and power output is controlled by adjusting bias voltage with POWER potentiometer R22, designated control 9 on figure 3-1. Plate current is metered and tuning is indicated by a 50-ma M1. A small portion of the output voltage is fed back to the grid in proper phase and amplitude to neutralize the amplifier should the load be removed. Its amplitude is adjusted by means of C27. The output is tuned by C18C which is ganged with C18B and C18A.

Functions of front panel controls that apply to this section are as follows:

- a. POWER R22. Potentiometer control designated 9 on figure 3-1. Controls the output of the XFK.
- b. BAND CHANGE S1. Potentiometer control designated 12 on figure 3-1. Selects tuning circuits for MIXER and PA stages for band 1 (0.8 to 2.3 mc) or band 2 (2.3 to 6.7 mc).
- c. OUTPUT TUNING MC C18. Variable capacitor control designated 13 on figure 3-1. Tunes MIXER and PA stages to peak r-f for any given setting of POWER potentiometer R22, designated control 9 on figure 3-1.
- d. PA PLATE CURRENT M1. Meter designated 1 on figure 3-1. Indicates tuning of XFK.

Chassis-mounted controls that apply to this section are as follows:

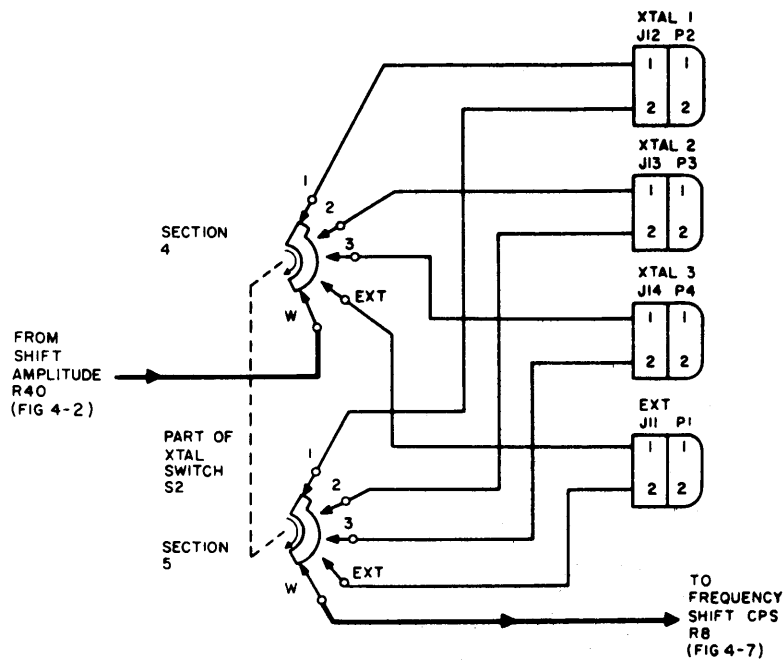
- a. Neutralizing capacitor C27, factory set, accessible on top chassis.
- b. Trimmer capacitors C43, C24, C46, and C28 accessible on top chassis.

4-9. POWER SUPPLY. (See figure 4-10.)

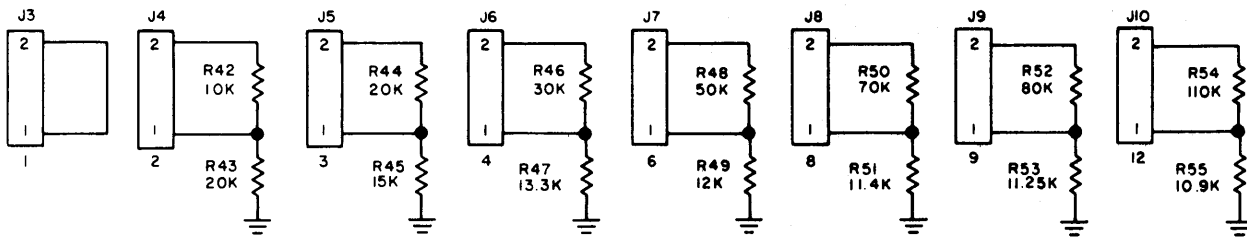
The power supply is a conventional full-wave rectifier supply with capacitor input and an unregulated output voltage of approximately 300 volts. R71 and V10 (OB2) supply regulated +105 volts to the 200-kc oscillator and reactance tube, crystal oscillator, keyer and for external use with a facsimile demodulator. A regulated -105-volt supply is obtained through a 6X4 half-wave rectifier, an rc filter, and an OB2 regulator tube. This voltage is used in the keying circuit and also to provide bias for the power amplifier.

Functions of front panel controls that apply to this section are as follows:

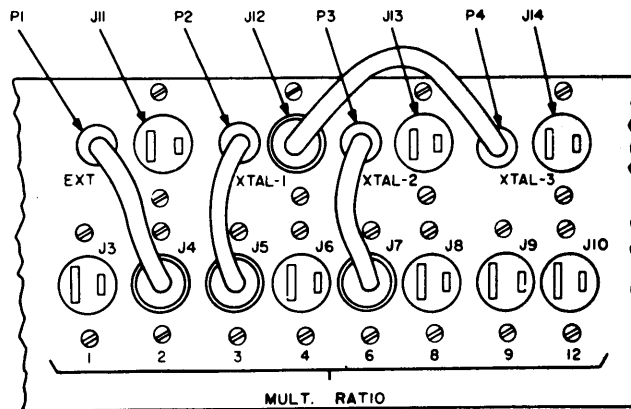
- a. POWER ON-OFF S8. Toggle switch control designated 6 on figure 3-1. Powers the XFK.



SKETCH 1 - INTERCONNECTIONS BETWEEN KEYER V7 AND MULTIPLIER PRESET SECTIONS 4 AND 5



SKETCH 2 - MULTIPLIER PRESET VOLTAGE DIVIDERS



A TYPICAL PATCHING ARRANGEMENT

XTAL SELECTOR POSITION	XMTR. MULT. RATIO	XMTR. OUTPUT FREQ. SHIFT (DIAL SET) CPS	XFK FREQ. SHIFT
EXT	2	850	425
XTAL-1	3	850	283
XTAL-2	6	850	142
XTAL-3	3	850	283

SKETCH 3 - ILLUSTRATING A SPECIFIC PATCHING ARRANGEMENT TO OBTAIN FREQUENCY SHIFTS SHOWN UNDER CONDITIONS STATED IN TABLE

Figure 4-3. Schematic Diagram, XFK, Multiplier Preset Stage

b. XTAL OVEN I3. Indicator designated 5 on figure 3-1. Lights when XTAL OVEN is lighted.

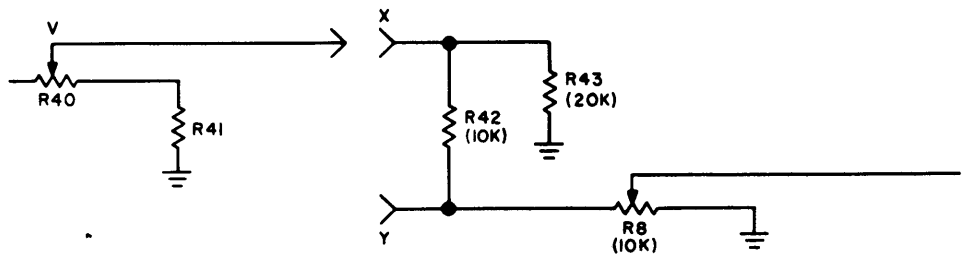
c. POWER I1. Indicator designated 4 on figure 3-1. Lights when vacuum tube filaments receive 6.3 volts.

d. 200 KC OVEN I2. Indicator designated 3 on figure 3-1. Lights when 200-kc oven is lighted.

e. PLATE ON-OFF S4. Toggle-switch control designated 2 on figure 3-1. Energizes and deenergizes 300-volt B+ supply.

f. POWER R22. Potentiometer control designated 9 on figure 3-1. Controls the output of the XFK.

CASE 1-EXT TO 2



1. IMPEDANCE TO GROUND AT R40

"Y" WIRING: 10K.

"X" WIRING: (R42+R8)(20K) PARALLELED BY R43 (20K): 10K.

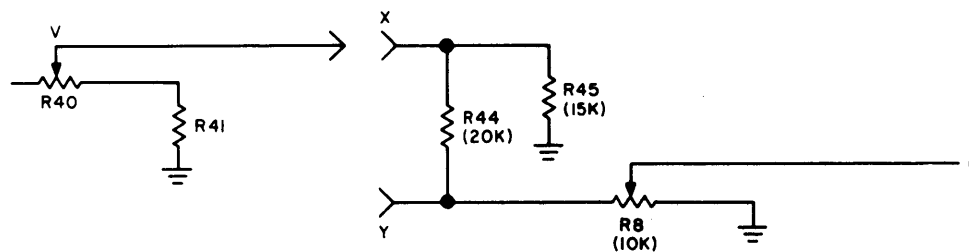
HENCE POTENTIAL AT R40 (V) IS UNCHANGED BY OPTIONS X, Y.

2. VALUE OF e

"Y" WIRING: POTENTIAL AT POINT Y IS V; e = P/O(V).

"X" WIRING: POTENTIAL AT POINT Y IS V/2; e = P/O(V/2).

CASE 2 -XTAL 1 TO 3



1. IMPEDANCE TO GROUND AT R40

"Y" WIRING: 10K.

"X" WIRING: (R44 + R8)(30K) PARALLELED BY R45 (15K); 10K.

HENCE POTENTIAL AT R40 (V) IS UNCHANGED BY OPTIONS X, Y.

2. VALUE OF e

"Y" WIRING: POTENTIAL AT POINT Y IS V; e = P/O(V).

"X" WIRING: POTENTIAL AT POINT Y IS V/3; e = P/O(V/3).

Figure 4-4. Circuit Diagram Illustrating Proper Setting of Shift, XFK

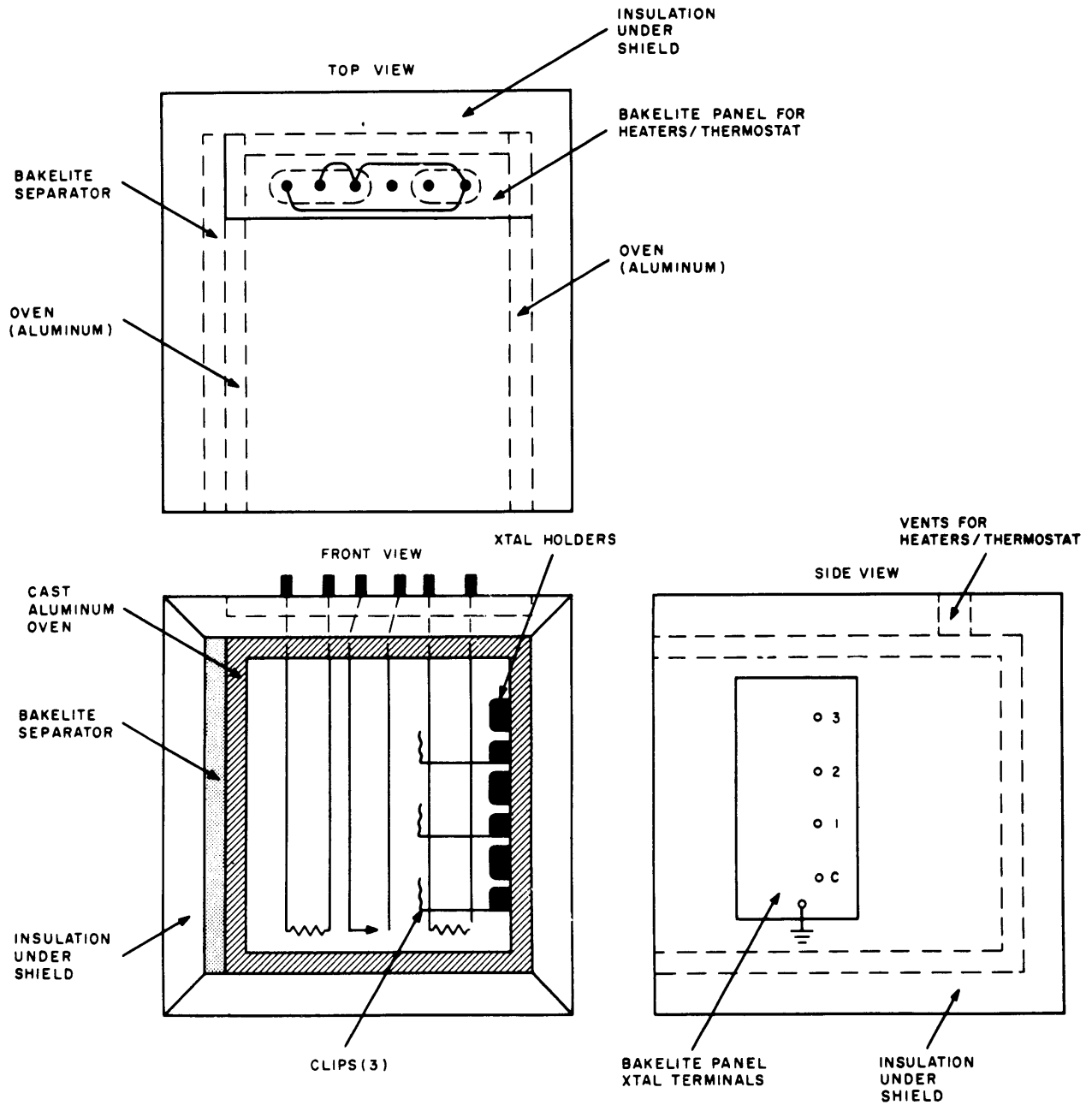


Figure 4-5. Diagram Illustrating Ovens, XFK

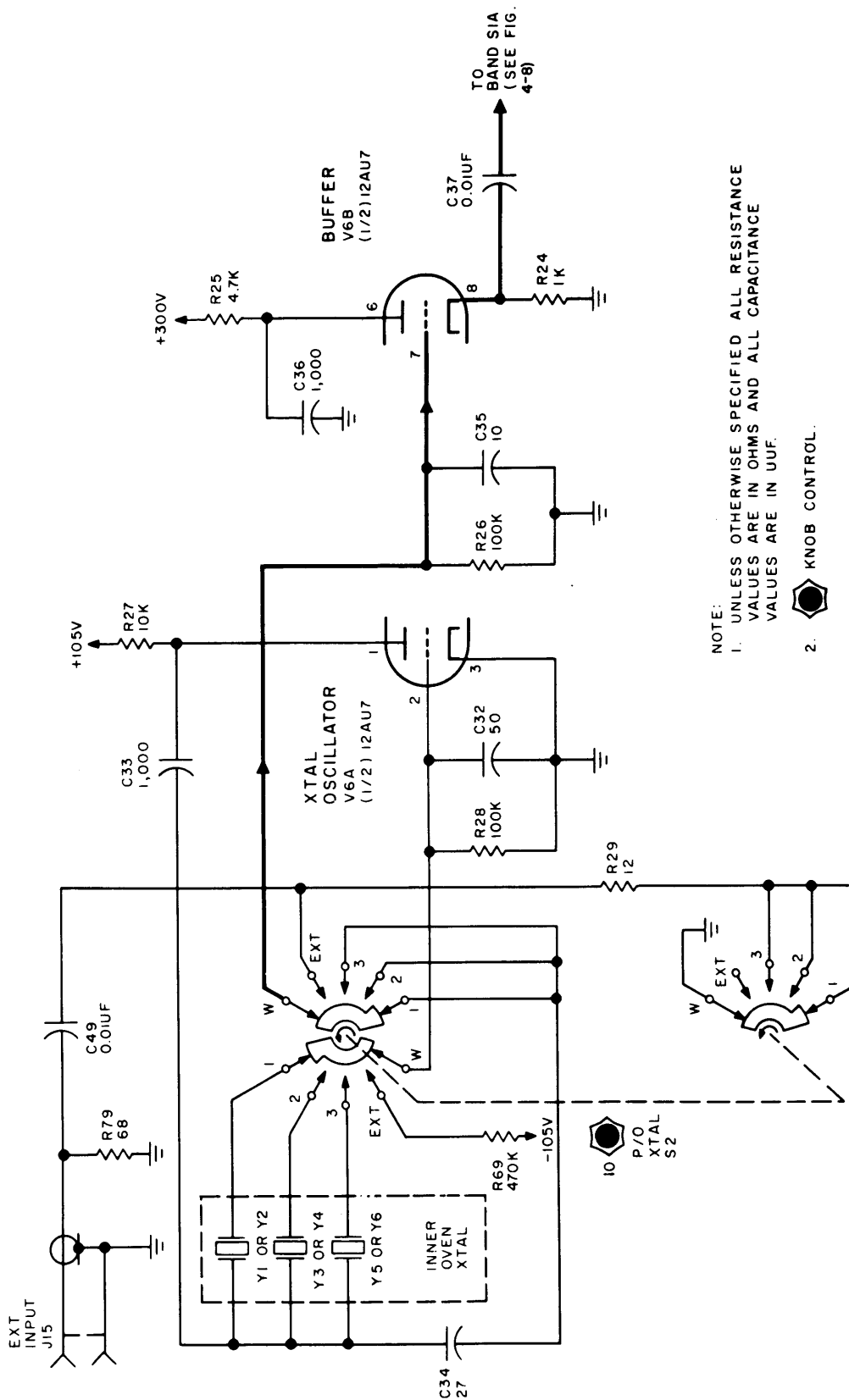


Figure 4-6. Schematic Diagram, XPK, Crystal Oscillator and Buffer V6

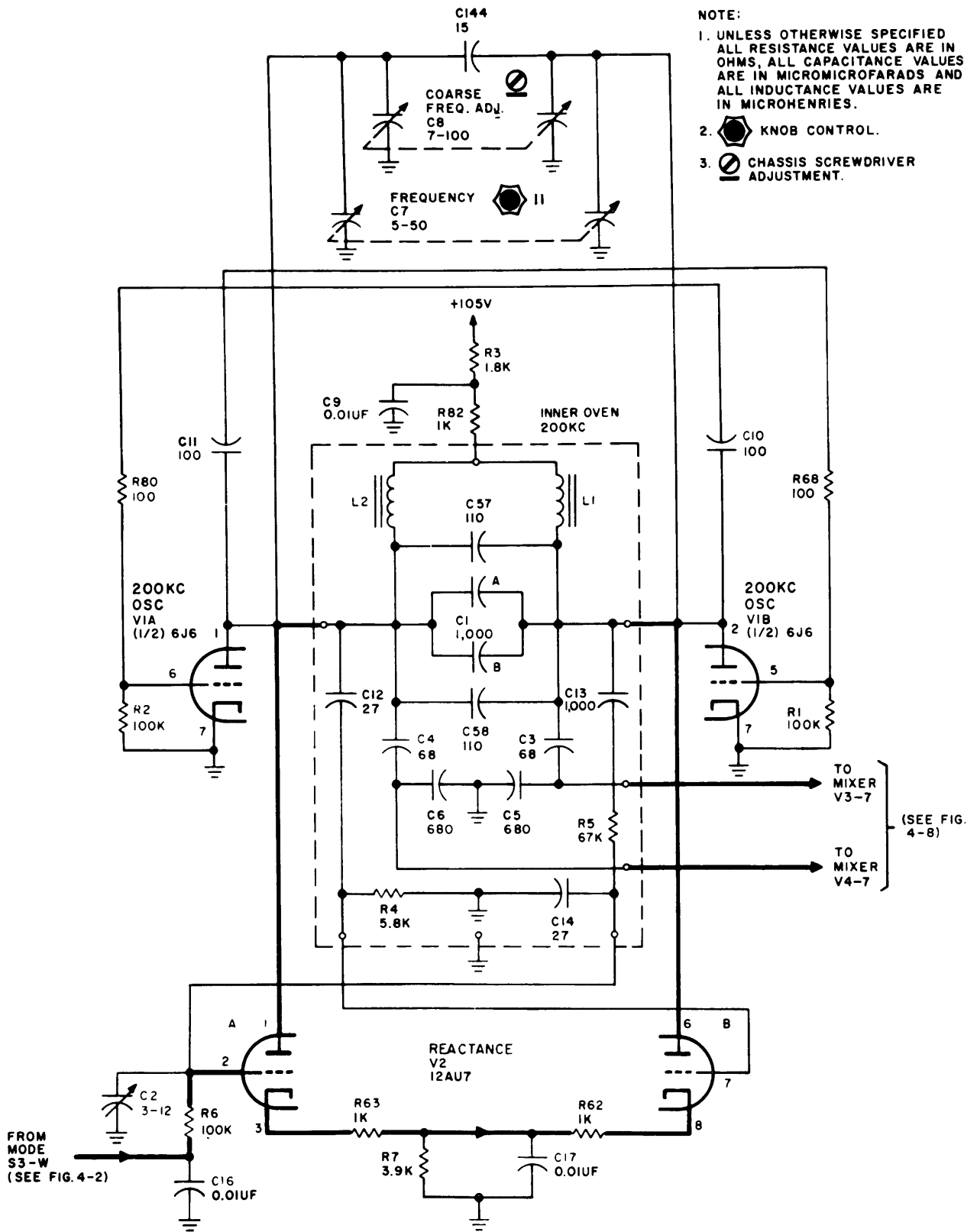


Figure 4-7. Schematic Diagram, XFK, Reactance Tube V2 and 200-KC Oscillator Tube V1

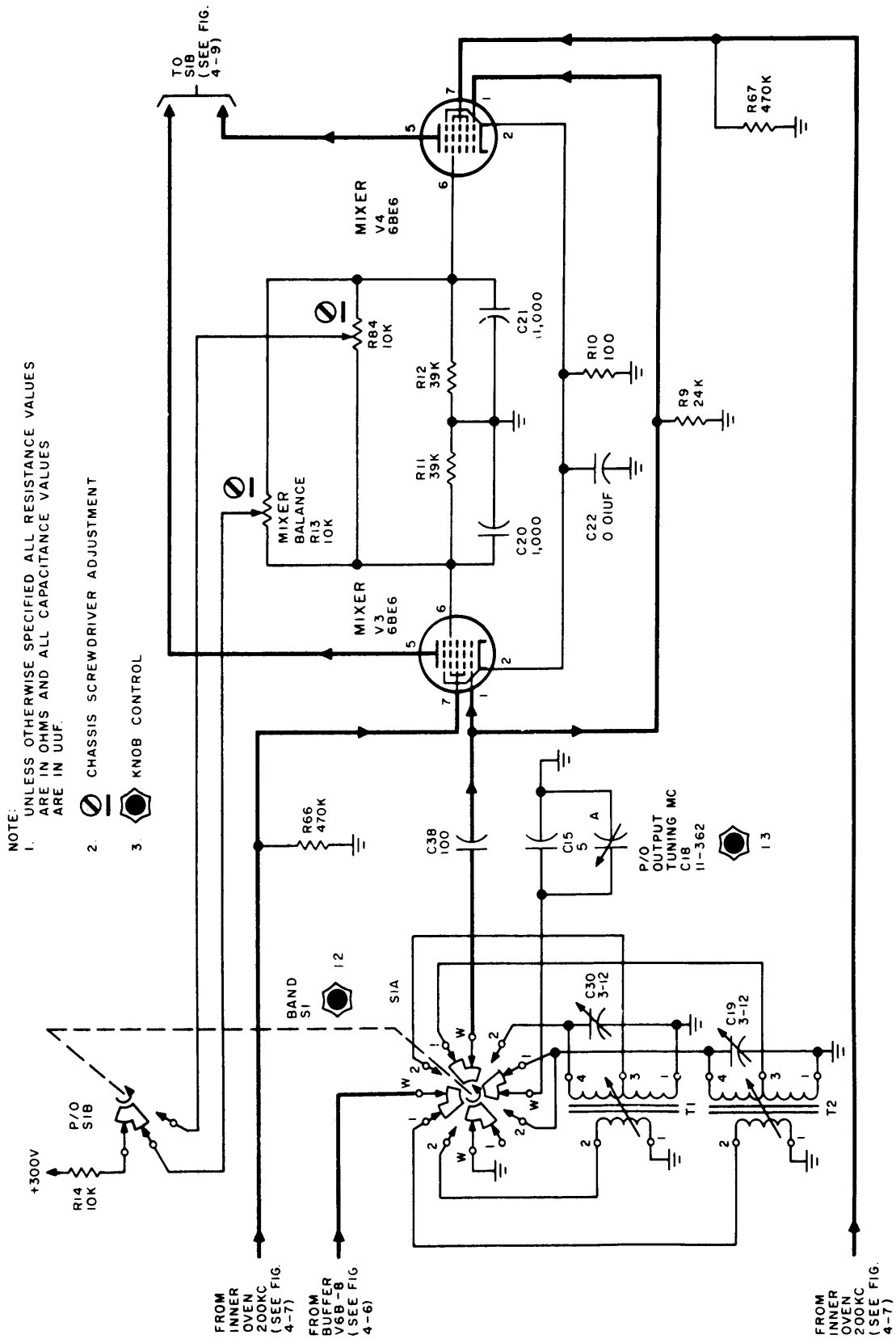
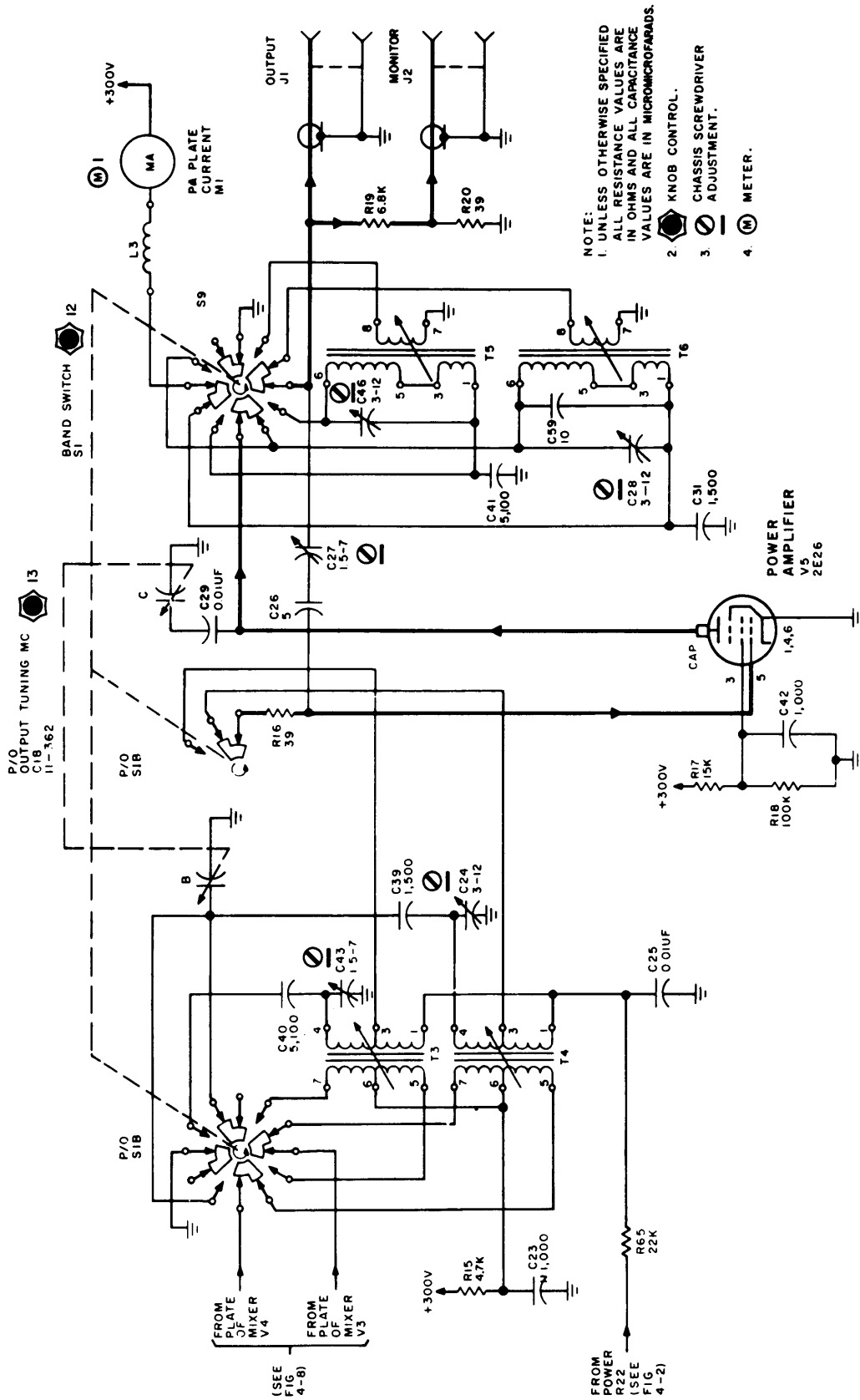


Figure 4-8. Schematic Diagram, XFK, Mixer Tubes V3 and V4



NOTE:
 1. UNLESS OTHERWISE SPECIFIED ALL RESISTANCE VALUES ARE IN OHMS AND ALL CAPACITANCE VALUES ARE IN MICROMICROFARADS.
 2. KNOB CONTROL.
 3. CHASSIS SCREWDRIVER ADJUSTMENT.
 4. METER.

Figure 4-9. Schematic Diagram, XFK, Power Amplifier Tube V5

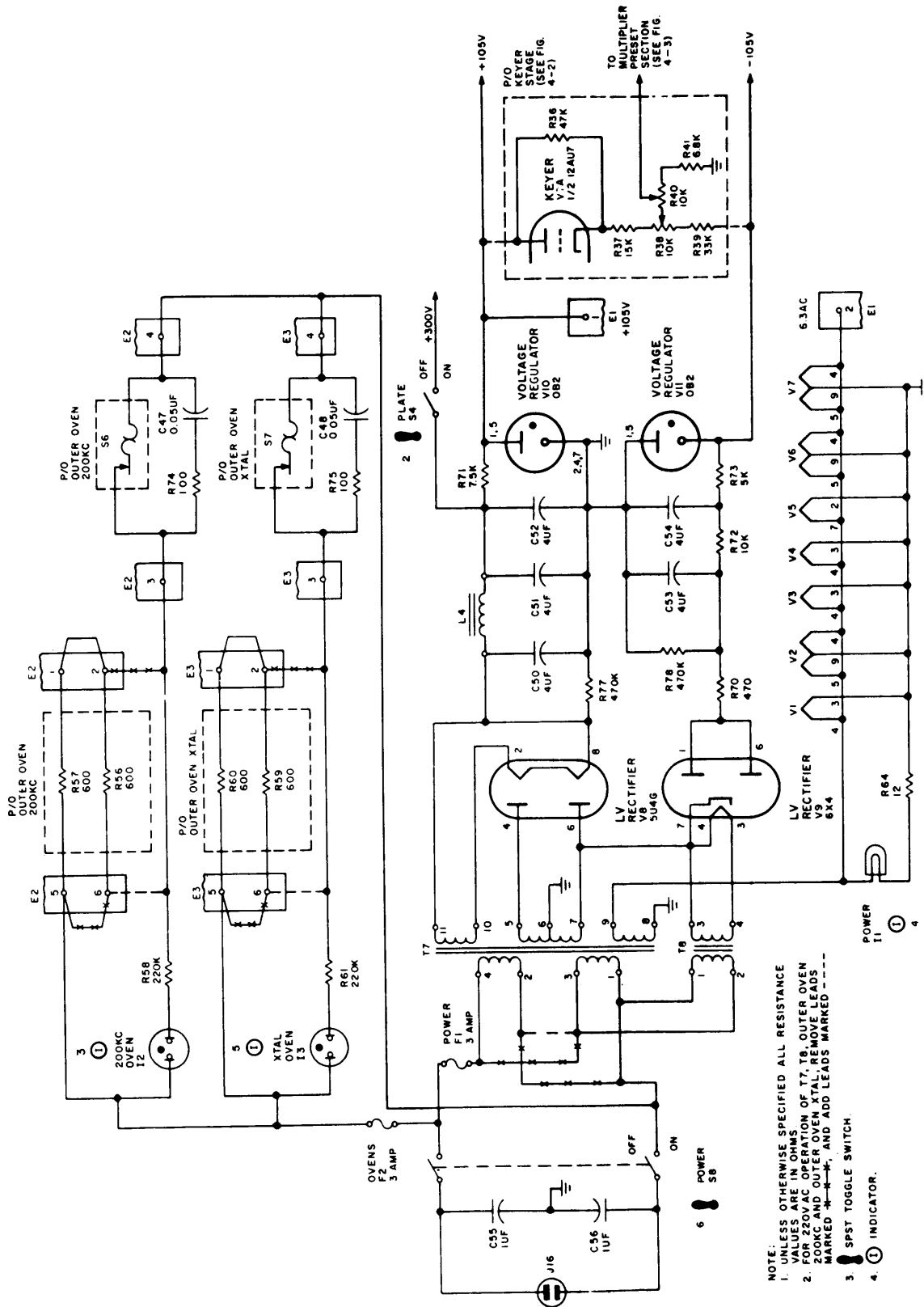


Figure 4-10. Schematic Diagram, XFK, Power Supply

SECTION 5 TROUBLE-SHOOTING

5-1. GENERAL.

Trouble-shooting is the art of locating and diagnosing equipment troubles and maladjustments. The information necessary to remedy the equipment troubles and maladjustments is located in Section 6 of the manual under the heading Maintenance.

Trouble-shooting tools may, for convenience, be divided into the following six categories:

- a. Accurate schematic diagrams.
- b. Tables of voltage and resistance; waveform data.
- c. Location data (photograph with call-outs of the major electronic equipment elements).
- d. Trouble-shooting techniques.
- e. Trouble-shooting charts based on operating procedures.
- f. Trouble-shooting procedures based on circuit sectionalization.

Trouble-shooting techniques are about the same for all types of electronic equipment and are covered briefly in the following paragraph.

5-2. TROUBLE-SHOOTING TECHNIQUES.

a. **GENERAL CONSIDERATIONS.** When a piece of equipment has been working satisfactorily and suddenly fails, the cause of failure may be apparent either because of circumstances occurring at the time of failure or because of symptoms analogous to past failures. In this case, it is unnecessary to follow a lengthy and orderly course of trouble-shooting in order to localize and isolate the faulty part.

A second short cut in trouble-shooting is to ascertain that all tubes and fuses are in proper working order; also that the equipment receives proper supply voltages. Many times this will eliminate further investigation.

A third short cut is to examine the equipment, section by section, for burned out elements, charring, corrosion, arcing, excessive heat, dirt, dampness, etc.

It is important to recognize that defective elements may have become defective due to their own weakness or to some contributing cause beyond their control.

b. **TROUBLE-SHOOTING CHARTS BASED ON OPERATING PROCEDURES.** The general purpose of these charts is to narrow the area of trouble to one or more sections of the equipment in order to minimize the labor of locating the source of trouble. These charts present a prescribed order "to turn on" the equipment, indicate what to expect as each step is taken, and give clues as to possible "troubled areas" when some expectation is not realized.

c. **TABLES OF VOLTAGE AND RESISTANCE; WAVEFORM DATA.** These tables give nominal values of voltage-to-frame and resistance-to-frame, generally at tube elements and sometimes at connectors and terminal board elements. Large deviations from the nominal values should be carefully investigated. During this process, accurate schematic diagrams and location data are highly essential. Schematic diagrams of all equipments will be found in Section 8.

A good oscilloscope is a good trouble-shooting tool. It may be connected to a number of critical points along a circuit to detect extraneous voltages, distorted wave forms, and other symptoms of trouble.

d. **TROUBLE - SHOOTING PROCEDURES BASED ON CIRCUIT SECTIONALIZATION.** Equipments usually consist of a number of subassemblies or sections. It is frequently helpful to treat these subassemblies or sections as independent entities. In so doing, however, they must be properly powered. Observations may then be made with VTVMs, CROs, or other test equipment at selected points under given types and magnitudes of injection voltages. Again, the subassemblies or sections may be examined for rated performance according to specification, for the presence of extraneous grounds, for opens, or unusual voltages.

5-3. VOLTAGE AND RESISTANCE DIAGRAM.

Figure 5-1 shows voltage and resistance-to-chassis measurements at vacuum tube pins and other selected points in the XFK, under the conditions stated.

5-4. LOCATION DATA.

Figures 5-2-a through 5-2-c are photographs of the major electronic equipment elements of the XFK.

5-5. TROUBLE-SHOOTING CHART BASED ON OPERATING PROCEDURES

Refer to table 5-1 for trouble-shooting for the XFK.

5-6. TROUBLE-SHOOTING PROCEDURES BASED ON CIRCUIT SECTIONALIZATION.

Careful observation of the performance of the XFK on the various frequencies, while operating various controls, may sectionalize the faults to a particular stage or circuit. The XFK may be divided into four main operating sections:

- a. 200-kc oscillator and reactance tube circuitry.
- b. Keyer circuit including automatic multiplication section.
- c. Radio frequency section.
- d. Power supply.

The section in which the trouble is located will be apparent from the symptoms.

A major fault in the power supply will be indicated on the PA PLATE CURRENT meter. If there is no plate current when PLATE ON-OFF switch S4

is set to ON position, the power supply is malfunctioning. Should the PA PLATE CURRENT meter read over 50 ma and cannot be controlled, check the PA neutralization.

Correct performance of the keyer circuit may be determined by measuring the DC voltage at the grid of V2, pin 2. With 1000 cycles shift applied, the voltage should be approximately +4 volts with MODE switch S3 in the S position, and -4 volts when the MODE switch is in the M position.

Proper performance of the 200-kc oscillator and reactance tube may be easily determined by use of a frequency meter. The frequency should be close to 200-kc and shift approximately ±500 cps. If so, the 200-kc oscillator and reactance tube are operating properly. If there is no output from the XFK, the malfunction may be traced to the r-f section.

With any crystal within the operating range of the XFK, there should be 10 volts of r-f at the grid of cathode follower stage (buffer) V6. If the unit has checked satisfactorily to this point, the trouble is in the r-f section.

TABLE 5-1. TROUBLE-SHOOTING CHART, MODEL XFK

STEP	CONTROL OPERATED	NORMAL INDICATION	REMEDY
1	Set POWER ON-OFF switch S8 to ON position	POWER (red) indicator, the 200 KC OVEN indicator lamp I2, and XTAL OVEN indicator lamp I3 should all go on After a sufficient time lapse, the operator will see the XTAL OVEN and 200 KC OVEN pilot indicators alternately go off. NOTE Each oven is independent of the other; the alternate illumination of each pilot indicator had no direct relationship to the other. This will merely indicate visually to the operator that the ovens are operating properly.	Turn POWER ON-OFF switch S8 to OFF position. Check continuity of fuses F1 and F2, and the power cord. Check the incoming power. In the event the XTAL OVEN pilot indicator remains on the 70°C (S7) thermostat is sticking. Should the 200 KC OVEN pilot indicator remain on the 70°C (S6) thermostat is sticking. If either the XTAL OVEN or 200 KC OVEN pilot indicator will not go on, check each indicator lamp and lamp connections.
2	Set PLATE ON-OFF switch S4 to ON position. Next, position MODE switch S3 to FAX position.	PA PLATE CURRENT meter M1 needle should deflect to the right and read approximately 50 ma.	If there is no output indicated on the meter, rotate MODE switch S3 to the M (MARK) S (SPACE) or L (LINE) position. Check the position of POWER control R22.

TABLE 5-1. TROUBLE-SHOOTING CHART, MODEL XFK (c nt)

STEP	CONTROL OPERATED	NORMAL INDICATION	REMEDY
2 (cont)	Rotate POWER control R22 clockwise and observe PA PLATE CURRENT meter.		<p>If there is still no output indicated on PA PLATE CURRENT meter, output control may be defective. Check continuity and connection of PA PLATE CURRENT meter and control.</p> <p>Should the needle deflect over 50 ma and cannot be controlled, check neutralization of PA tube to "kill" oscillation; the fault may also be in the power supply circuitry.</p>
3	<p>Preset the multiplication ratio at the rear of the chassis at unity.</p> <p>Set XTAL selector switch S2 to desired crystal.</p> <p>Set BAND CHANGE switch S1 to proper band.</p> <p>Rotate OUTPUT TUNING MC dial to correct output frequency</p>	PA PLATE CURRENT meter needle will dip at the proper output frequency desired.	<p>In the event of a malfunction, check the plug connection in the patch panel at the rear of the chassis.</p> <p>Check the setting of XTAL selector switch S2 and make sure that the crystal is inserted.</p> <p>Check BAND CHANGE switch S1 setting and wire connections.</p> <p>Check tubes V1 and V2. If these are normal, the fault remains in the r-f section.</p>
4	Turn FREQUENCY SHIFT CPS control to the desired frequency.	Frequency indicated on the frequency meter should be close to the setting of the FREQUENCY SHIFT CPS control.	If the previous operational tests performed in steps 1 through 3 are normal, the trouble may be traced to the r-f section.



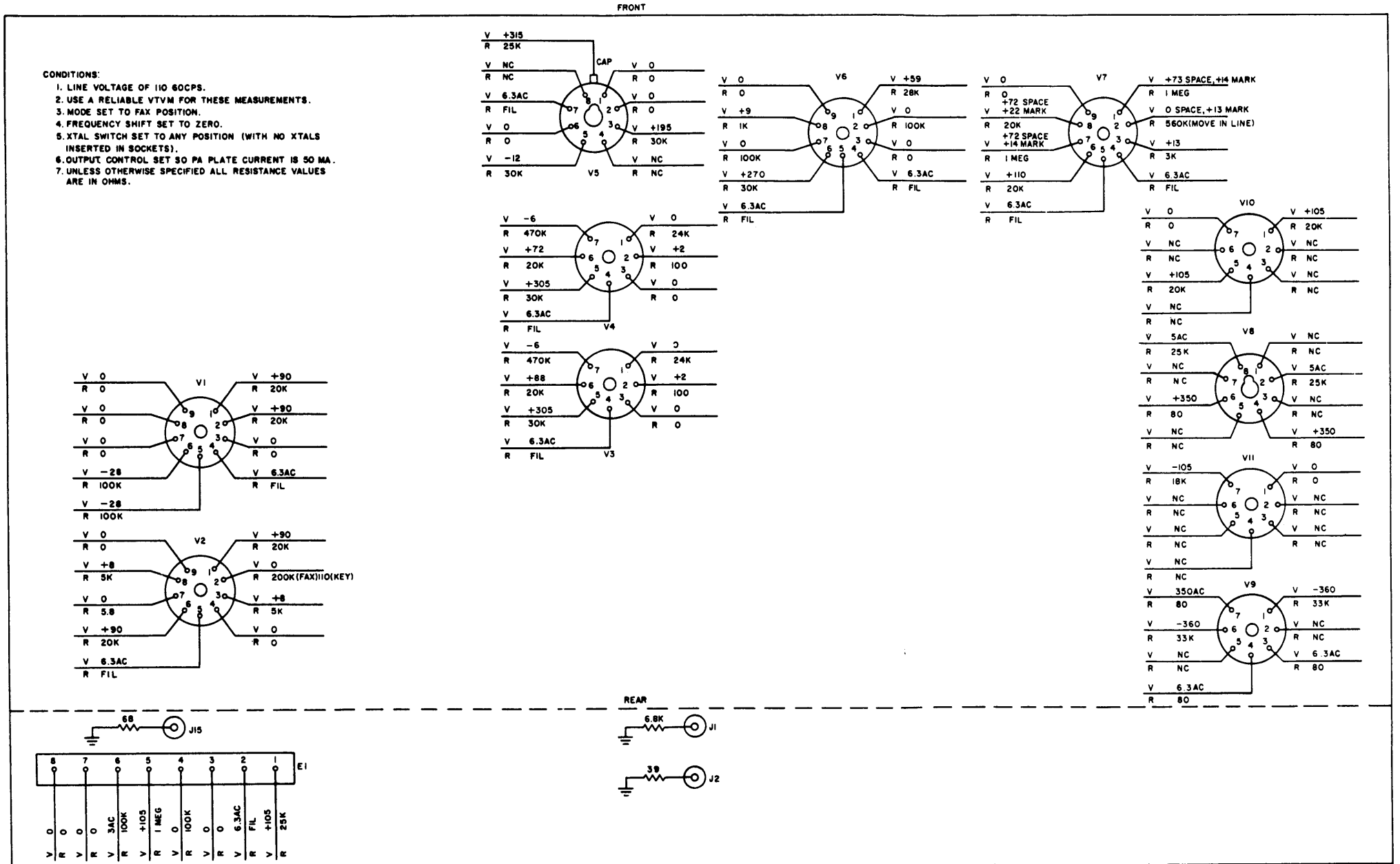


Figure 5-1. Voltage and Resistance Diagram, XFK

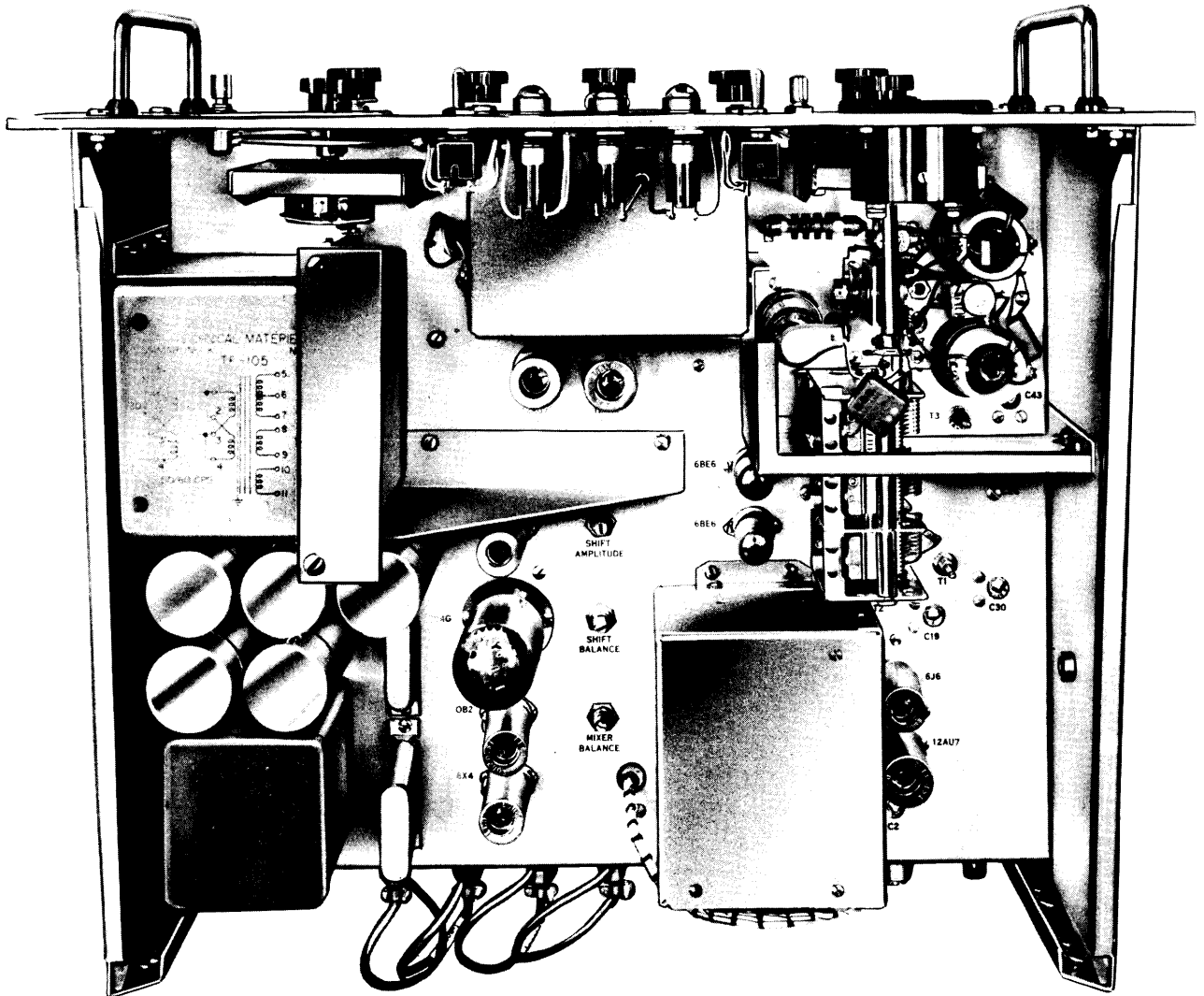


Figure 5-2-a. Location of Major Electronic Equipment Components, XFK, Top View

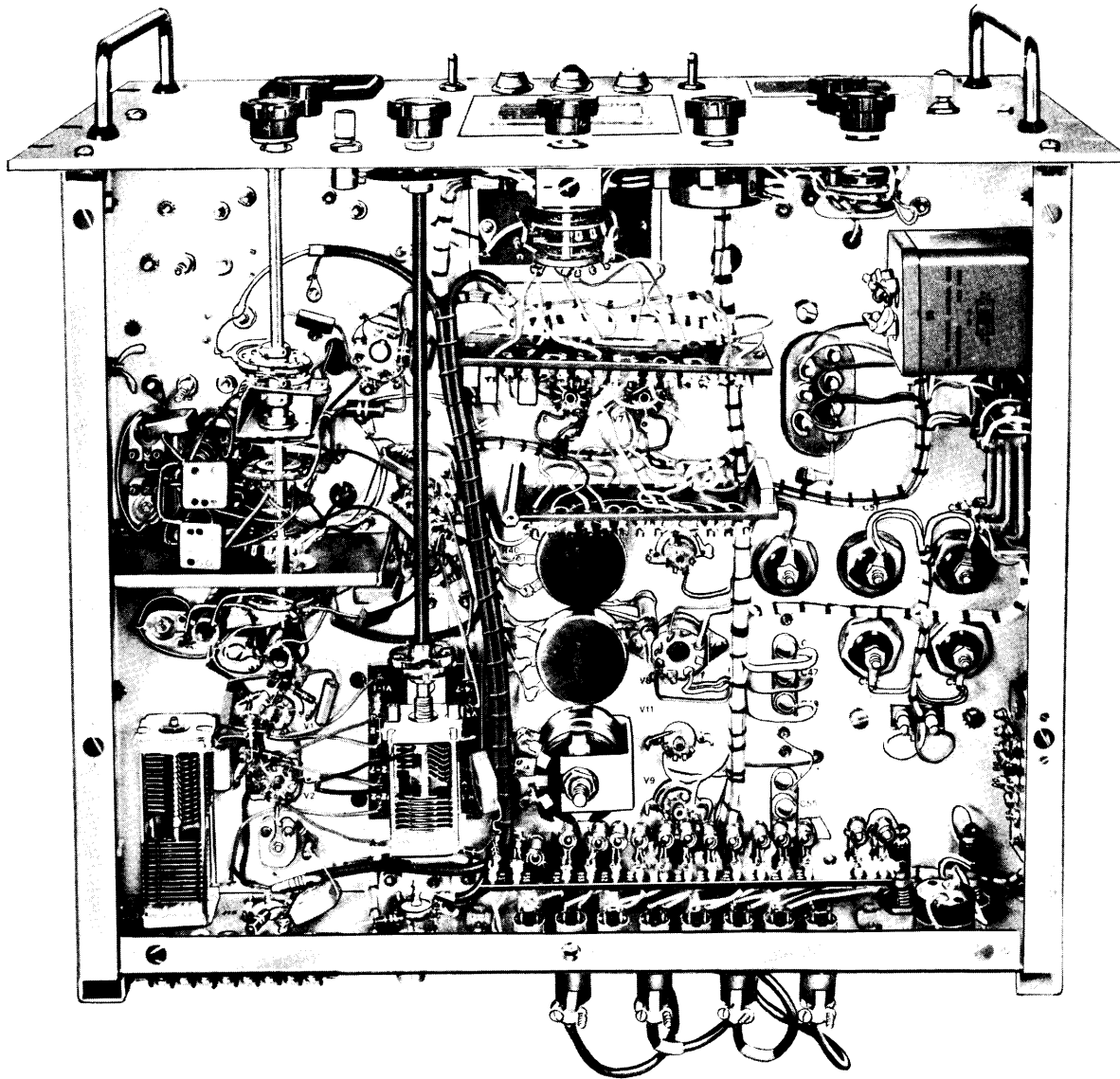


Figure 5-2-b. Location of Major Electronic Equipment Components, XFK, Bottom View

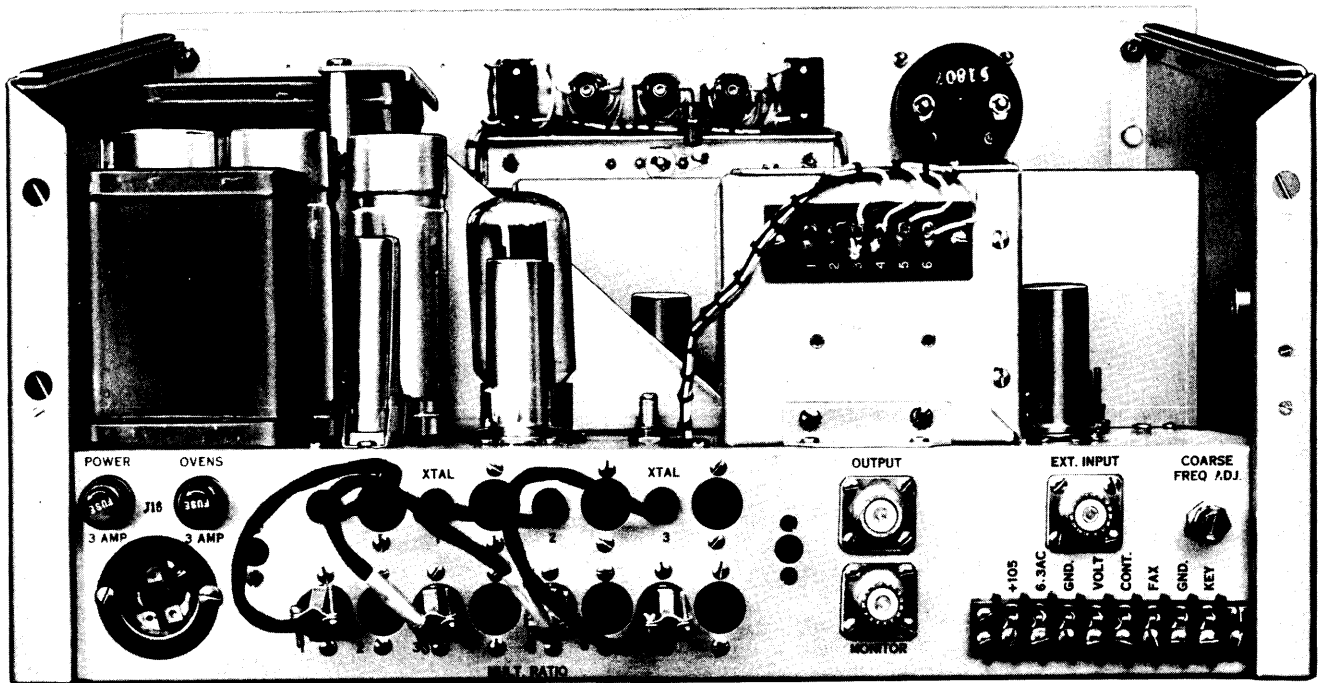


Figure 5-2-c. Location of Major Electronic Equipment Components, XFK, Rear View

SECTION 6 MAINTENANCE

6-1. GENERAL.

Maintenance may be divided into three categories: operator's maintenance, preventive maintenance, and corrective maintenance. Corrective maintenance is sometimes considered as consisting of information used in locating and diagnosing equipment troubles and maladjustments, existing and/or pending, and information necessary to remedy the equipment troubles and maladjustments. For the reasons stated in Section 5 of this manual, the remedial type of information is presented under corrective maintenance (Section 6) while the diagnosis type of information is presented under trouble-shooting (Section 5).

The XFK has been designed to provide long term, trouble free operation under continuous duty conditions. It is recommended that any necessary maintenance be done by a competent maintenance technician familiar with sideband techniques.

6-2. OPERATOR'S MAINTENANCE.

The operator should make minor adjustments of tuning controls to verify that the XFK's output frequency and level are proper. He should note general condition of panel switches, observe whether panel indicator lamps light properly, and check the condition of the oven and power fuses as well as that of all tubes. Operators should not perform any emergency measures unless properly authorized to do so. If such authorization is given it should be preceded by a short course of instruction.

a. REPLACEMENT OF FUSES.

CAUTION

Never replace a fuse with one of higher rating unless continued operation is more important than probable damage to the equipment. If a fuse burns out immediately after replacement, do not replace it a second time until the cause has been located and corrected.

Power fuse failure in the XFK is normally indicated by failure of the red pilot lamp (designated POWER, control 4 on figure 3-1) to go on when the POWER switch (control designated 6 on figure 3-1) is set to ON. In addition to the pilot lamp not going on, the vacuum tubes in the XFK do not go on. In this case, the 3-ampere power fuse on the rear panel should be checked and replaced if defective.

Oven fuse failure in the XFK is normally indicated by failure of two clear pilot lamps (designated XTAL OVEN and 200 KC OVEN, controls 5 and 3, respectively, on figure 3-1) to go on, at least intermittently, when the POWER switch is set to ON. In addition to the pilot lamps not going on, the ovens of the XFK are cold. In this case, the 3-ampere oven fuse on the rear panel should be checked and replaced if defective.

b. REPLACEMENT OF TUBES.

The locations of all tubes in the XFK are indicated in figure 5-2. The tubes may be checked visually to see if they are on or warm. When necessary, the tubes should be carefully removed and tested, and when replaced, care should be taken to install tube shields.

6-3. PREVENTIVE MAINTENANCE.

In order to prevent actual failure of the equipment due to corrosion, tube failure, dust, or other destructive elements, it is suggested that a schedule of preventive maintenance be set up and adhered to.

a. At periodic intervals (at least every six months) the equipment should be removed from the rack for cleaning and inspection. All accessible covers should be removed and the wiring of all components inspected for dirt, corrosion, charring, discoloring, or grease; in particular, the tube sockets should be carefully inspected for deterioration. Dust may be removed with a soft brush or a vacuum cleaner, if one is available. Remove dirt or grease from other parts with any good dry cleaning fluid.

WARNING

Carbon tetrachloride (CCl₄) may be used if great care is exercised because it is a toxic substance. Do not inhale its fumes. Avoid contact with skin. Chloroethane (Stabilized 1, 1, 1 trichloroethane) is a safer substitute for carbon tetrachloride.

b. 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 manufacturer's tolerances (usually ± 20 percent from tube manual values). Replace only those tubes which are found to be below par; recommended procedure is once every six months.

c. No special tube selection is necessary in the event of tube replacement. However, for optimum results, the paragraph on corrective maintenance should be carefully read to determine the extent of adjustment necessary in replacing any particular tube. These adjustments, necessary for changing only four tubes, are not recommended unless performed by competent technical personnel using accurate equipment.

d. When replacing the XFK in the rack, ensure that all terminal board screws at the rear of the equipment are tight.

6-4. CORRECTIVE MAINTENANCE.

NOTE

Only competent technical personnel using proper equipment should attempt to tamper with any adjustments and then only if there is specific reason to suspect that the adjustment is the cause of the difficulty. If unit is to be worked on, it should be removed from its rack and placed on a convenient work bench. The dust covers should be removed. All controls and adjustments should now be readily accessible.

The least likely source of trouble should be the misalignment of the r-f section. Should this be suspected, due to either reduced power output or the output frequency dial showing a marked deviation from the indicated frequency calibration, the following procedure is recommended:

a. IF ALIGNMENT OF BAND 2.

(1) Connect a 50- to 70-ohm load to the OUTPUT jack. Either meter current through the load with an r-f thermocouple or connect an r-f voltmeter across the load.

(2) Set BAND CHANGE switch to band 2. Rotate main tuning capacitor (OUTPUT TUNING MC knob) to full-mesh position (lowest frequency). Note that the hairline on the dial matches the indicator line. If this is not so, leave the capacitor in the full-mesh position. Loosen the set screws fastening the flexible coupling to the capacitor and rotate the dial until the hairline on the dial matches the indicator line.

(3) Set ceramic trimmers C30, C43, and C46 (on top of chassis) to minimum capacity.

(4) The following indicated frequencies should either be supplied by means of crystals or by an external source. To simplify the procedure, it will be assumed that the crystals will be used. If an external source is used, connect the signal source to the EXT jack on the rear of the chassis and turn the XTAL selector switch (front panel control designated 10 on figure 3-1) to EXT.

(5) Insert 2.6-mc crystal in socket No. 1; 6-3-mc crystal in socket No. 2.

(6) Turn XTAL selector switch to crystal
1. Turn OUTPUT TUNING MC dial to 2.8 mc. Place r-f voltmeter on pin 1 of V4; tune transformer T1 for maximum voltage by adjusting slug (accessible on top chassis). Place r-f voltmeter at pin 5 of V5; tune transformer T3 for maximum voltage by adjusting slug (accessible on top chassis). Select first peak going in from minimum inductance. Tune transformer T5 for maximum output indication in load, adjusting slug (accessible on top chassis). Remove r-f voltmeter and retrim transformers T1, T3, and T5 for maximum output in load.

(7) Turn XTAL selector switch to crystal
2. Turn OUTPUT TUNING MC dial to 6.5 mc. Tune capacitors C30, C43, and C46 for maximum output indication in load.

(8) Remove tube V1, 200-kc oscillator tube. Tune main tuning capacitor (OUTPUT TUNING MC knob) for maximum output indication in load. This will occur at the crystal frequency. Trim mixer balance potentiometer R84 (on bottom chassis) for minimum indication in load.

(9) Remove load. Remove crystal or external excitation. Set plate current to 50 ma by turning POWER knob (front panel control designated 9 on figure 3-1). Rotate OUTPUT TUNING MC knob over entire upper range of band and note spurious excitation, if any. Parasitics may be evidenced by dip in plate current of final amplifier when rotating OUTPUT TUNING MC knob. If parasitics are evidenced, neutralize same by tuning capacitor C27.

(10) Replace tube V1 and repeat steps (6) and (7).

(11) Check tuning dial for proper sideband selection. If the above procedure has been performed properly, there will be no indication above 6.5 mc and the lower sideband will appear at 6.1 mc.

b. RF ALIGNMENT OF BAND 1.

(1) Set BAND CHANGE switch to band 1. Insert 1.0-mc crystal in socket No. 1 and 2.1-mc crystal in socket No. 2.

(2) Set ceramic trimmers C19, C24, and C28 (on top of chassis) to minimum capacity.

(3) Turn XTAL selector switch to crystal
1. Turn OUTPUT TUNING MC dial to 1.2 mc. Place r-f voltmeter to pin 1 of V4. Turn transformer T2 for maximum voltage by adjusting slug (accessible on top chassis). Place r-f voltmeter to pin 5 of V5. Tune transformer T4 for maximum voltage by adjusting slug (accessible on top chassis). Select first peak going in from minimum inductance. Tune transformer T6 for maximum output indication in load by adjusting slug (accessible on top chassis). Remove r-f voltmeter and retrim transformers T2, T4, and T6 for maximum output indication in load.

(4) Turn XTAL selector switch to crystal 2. Turn OUTPUT TUNING MC dial to 2.3 mc. Tune capacitors C19, C23, and C28 for maximum output indication in load.

(5) Repeat steps (3) and (4).

(6) Check OUTPUT TUNING MC dial for proper sideband selection. If the above procedure has been performed properly, there will be no indication above 2.3 mc, and the lower sideband will appear at 1.9 mc.

c. ADJUSTMENT OF REACTANCE TUBE AND 200-KC OSCILLATOR. The proper alignment of this section of the XFK requires accurate frequency measurements. This is readily possible in cases where primary standards, such as a Hewlett-Packard Electronic Counter Model 524C, are available. Otherwise, it is recommended that the equipment and method outlined in figure 6-1 be adopted for best accuracy and ease of measurement. The following procedure applies to the older XFK equipments; the same procedure applies to the newer units when allowance is made for the KEY-FAX switch being incorporated into the TEST switch (front panel control designated 8 on figure 3-1).

(1) Set up equipment as shown in figure 6-1.

(2) Observe that the pointer on the FREQUENCY knob (front panel control designated 11 on figure 3-1) reads -600 cycles when the fine frequency adjust trimmer capacitor C7 is approximately 7 degrees from being fully meshed. Capacitor C7 should then move toward decreasing capacity as the knob is turned toward the +600-cycle position.

(3) Set KEY-FAX switch on rear chassis to FAX. Return FREQUENCY knob to 0 cycles. By means of the coarse frequency adjust screwdriver capacitor control on the rear of the chassis, "zero beat" 200-kc oscillator with 200-kc crystal in mixer.

(4) Connect a small variable voltage source (6 volts) to the FAX terminals on terminal board at rear of chassis. This source should be capable of alternately impressing equal positive and negative voltages at the FAX terminal.

(5) Set C2 on top of chassis at one-half its capacity. With zero voltage at FAX input terminal, "zero beat" 200-kc oscillator with crystal. Apply sufficient positive voltage to cause a 500-cycle shift (approximately 4 volts). Reverse polarity, maintaining same amplitude. Note shift. If second shift is over 500 cycles, slightly increase capacity of C2. Again, "zero beat" 200-kc oscillator with mixer crystal with no DC (FAX) input voltage; then repeat above procedure until both shifts are equal.

d. ADJUSTMENT OF KEYSER CIRCUIT.

(1) Set KEY-FAX switch on rear chassis to KEY. With power OFF, set ohmmeter to center arm of shift potentiometer R8 (designated FREQUENCY SHIFT CPS, front panel control 7 on figure 3-1). When dial reads 50 cycles, resistance to ground on ohmmeter should be 400 ohms.

(2) Set XTAL selector switch (front panel control designated 10 on figure 3-1) to crystal 1, and plug in to multiplication ratio 1 on rear of chassis.

(3) Again, "zero beat" 200-kc oscillator in XFK (refer to paragraph 6-4c). Set FREQUENCY SHIFT CPS dial to 500 cycles. Vary TEST switch (front panel control designated 8 on figure 3-1) from M to S and note frequency shift using setup of preceding item (refer to paragraph 6-4c). Adjust shift balance screwdriver potentiometer R38 (chassis mounted) until shifts are equal. Adjust shift amplitude screwdriver potentiometer R40 (chassis mounted) until shift on either side is 250 cycles. Recheck shift balance. The total shift is now 500 cycles, 250 cycles on either side of carrier.

e. REPLACEMENT OF HEATERS AND THERMOSTAT IN 200-KC OVEN ASSEMBLY. (See figure 6-2.)

(1) Loosen four screws that hold the XFK top access cover; remove top access panel.

(2) Loosen and remove two screws that hold the heater terminal board strip (with heating thermostat attached). This allows access to both heaters and thermostat switch for necessary inspection and repairs.

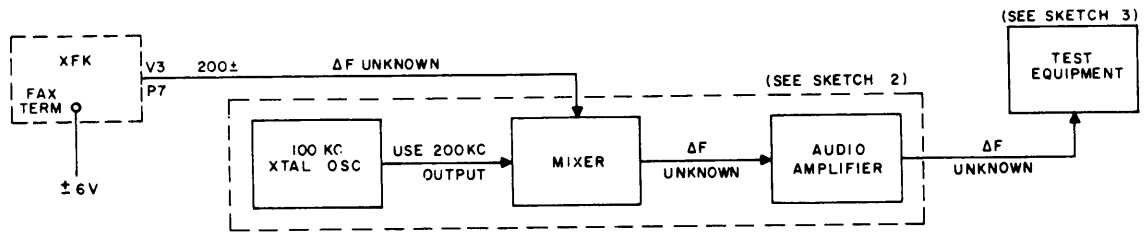
(3) The heater and the thermostat can easily be replaced by simply unsoldering the leads connected to the heater terminal board strip.

(4) For inspection and repair of any one 200-kc oscillator oven stabilized component, the entire 200-kc oven assembly must be removed.

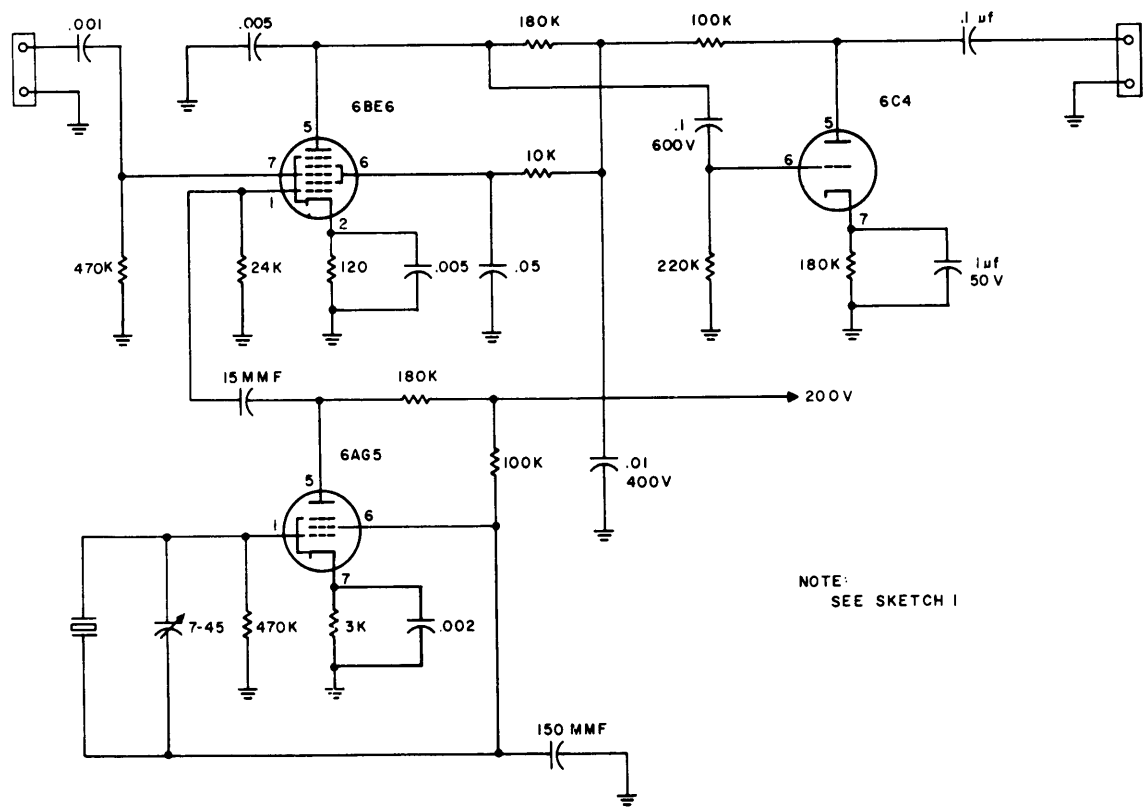
(5) Loosen and remove four screws that hold the 200-kc oscillator oven outer shell to the XFK chassis.

(6) From the underside of the XFK chassis four port holes can be observed. They provide access to four machine metal screws that hold the oven casting to the XFK chassis.

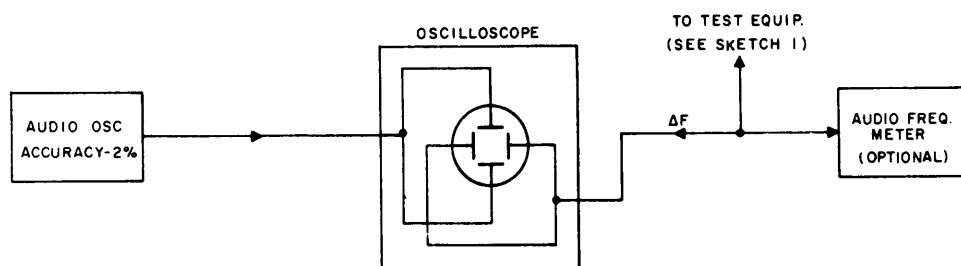
(7) Insert a screwdriver through each port hole. While supporting the oven casting with one hand, loosen and remove each screw. This will expose the inner component terminal board for the necessary inspection and repairs.



SKETCH 1 BLOCK DIAGRAM



SKETCH 2 SCHEMATIC DIAGRAM OF MIXER AND 200 KC XTAL OSC.



SKETCH 3 DETAIL OF TEST EQUIPMENT

Figure 6-1. Maintenance Diagram Showing Procedure of Adjusting Reactance Tube and 200-KC Oscillator, XFK

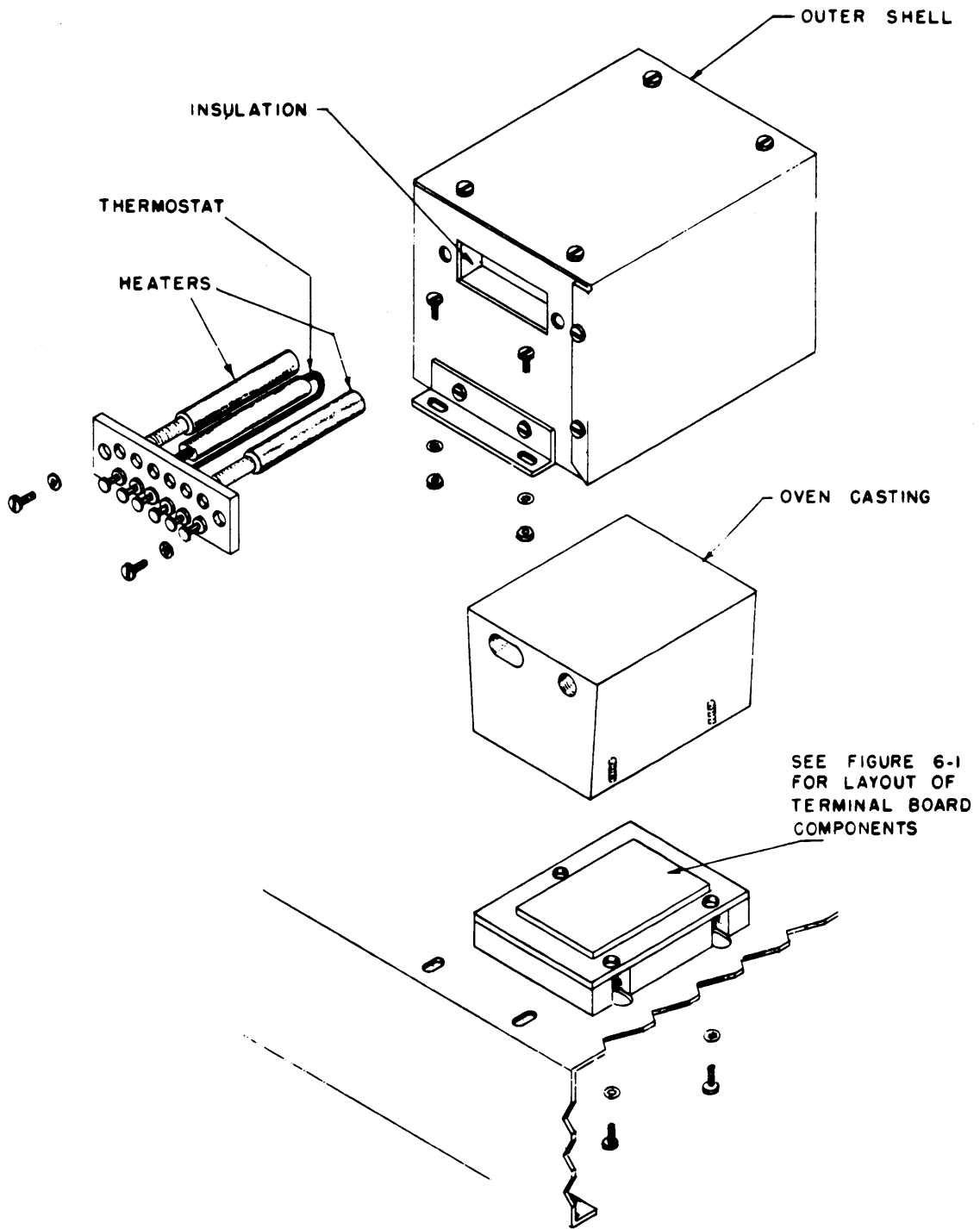


Figure 6-2. Maintenance Diagram Showing 200-KC Oven Assembly, XFK

SECTION 7 PARTS LIST

7-1. INTRODUCTION.

Reference designations have been assigned to identify all maintenance parts of the system. They are used for marking the equipment (adjacent to the part they identify) and are included on drawings, diagrams and the parts list. The letters of a reference designation indicate the kind of part (generic group) such as resistor, capacitor electron tube, etc. The number differentiates between parts of the same generic group. Sockets are identified by a reference

designation which contains the reference designation of the plug-in device preceded by an X. Column 1 lists the reference designations of the various parts in numerical and alphabetical order. Column 2 gives the names and describes the various parts. Major part assemblies are listed in their entirety; subparts of a major assembly are listed in alphabetical and numerical order with reference to the major assembly. Column 3 indicates how each part is used within a major component. Column 4 lists each Technical Materiel Corporation part number.

SYM.	DESCRIPTION	FUNCTION	TMC DWG. OR PART NO.
C1	CAPACITOR, fixed: ceramic; 1000 uuf, $\pm 1\%$, 500 wvdc.	200 Kc Osc. Tank	CC-102-4
C2	CAPACITOR, variable: ceramic; 3-12 uuf, 500 wvdc.	React. Tube Linear Adj.	CV11A120
C3	CAPACITOR, fixed: ceramic; 68 uuf, $\pm 5\%$, 500 wvdc.	Output Coupling	CC-102-1
C4	Same as C3.	Output Coupling	
C5	CAPACITOR, fixed: mica; 680 uuf, $\pm 2\%$, char. E; 500 wvdc.	Output Divider	CM20E681G
C6	Same as C5.	Output Divider	
C7	CAPACITOR, variable: air dielectric; dual section, 26 plates; 6.5 to 51 uuf, each section.	200 Kc Osc. Fine Control	CB-103-2
C8	CAPACITOR, variable: air dielectric; dual section, 50 plates; 9.8 to 99 uuf, each section.	200 Kc Osc. Coarse Adj.	CB-103-3
C9	CAPACITOR, fixed: mica, .01 uf, $\pm 10\%$; char. B, 300 wvdc.	200 Kc Osc. Plate Bypass	CM35B103K
C10	CAPACITOR, fixed: mica, 100 uuf, $\pm 5\%$; char. C, 500 wvdc.	200 Kc Osc. Grid	CM20C101J
C11	Same as C10.	200 Kc Osc. Grid Coupling	
C12	CAPACITOR, fixed: mica; 27 uuf, $\pm 2\%$, char. E, 500 wvdc.	React. Tube Phase	CM20E270G
C13	CAPACITOR, fixed: mica; 1000 uuf, $\pm 10\%$, char. B, 500 wvdc.	React. Tube Phase Shift	CM20B102K
C14	CAPACITOR, fixed: mica; 27 uuf, $\pm 5\%$; char. C, 500 wvdc.	React. Tube Phase Shift	CM20C270J

SYM.	DESCRIPTION	FUNCTION	TMC DWG. OR PART NO.
C15	CAPACITOR, fixed: mica; 5 uuf, $\pm 20\%$; char. B, 500 wvdc.	Mixer Input Padder	CM20B050M
C16	Same as C9.	200 Kc Plate Bypass	
C17	Same as C9.	200 Kc Plate Bypass	
C18 A, B, C	CAPACITOR, variable: air dielectric; three sections, 19 plates per section; 11 to 362 uuf each section.	Mixer Input, Mixer Output Ampl. Output Tuning	CB-107
C19	Same as C2.	Band 1 Mixer Input Trimmer	
C20	Same as C13	Bal. Modulator Screen Bypass	
C21	Same as C13.	Bal. Modulator Screen Bypass	
C22	Same as C9.	200 Kc Osc. Plate Bypass	
C23	Same as C13	Bal. Modulator Screen Bypass	
C24	Same as C2.	Band 1 Mixer Output Trimmer	
C25	CAPACITOR, fixed: mica; .01 uf, $\pm 5\%$; char. C, 300 wvdc.	Mixer Output Grid	CM35C103J
C26	Same as C15.	Ampl. Neutralizing	
C27	CAPACITOR, variable: ceramic; 1.5-7 uuf, 500 wvdc.	Ampl. Neutralizing	CV11A070
C28	Same as C2.	Band 1 Ampl. Tuning	
C29	Same as C25.	Ampl. Plate	
C30	Same as C2.	Band 2 Mixer Input Trimmer	
C31	CAPACITOR, fixed: mica; 1500 uuf, $\pm 2\%$; char. C, 500 wvdc.	Band 1 Ampl. Padder	CM30C152G
C32	CAPACITOR, fixed: mica; 51 uuf, $\pm 10\%$; char. B, 500 wvdc.	Xtal Osc. Grid	CM20B510K
C33	Same as C13.	Xtal Osc. Grid	
C34	CAPACITOR, fixed: mica; 27 uuf, $\pm 10\%$; char. B, 500 wvdc.	Xtal Osc. Output Coupling	CM20B270K
C35	CAPACITOR, fixed: mica; 10 uuf, $\pm 10\%$; char. B, 500 wvdc.	Xtal Osc. Output Divider	CM20B100K
C36	Same as C13.	Cath. Follower Plate Bypass	
C37	Same as C9.	Cath. Follower Output Coupling	

SYM.	DESCRIPTION	FUNCTION	TMC DWG. OR PART NO.
C38	Same as C10.	Mixer Xtal Input Coupling	
C39	Same as C31.	Band 1 Ampl. Padder	
C40	CAPACITOR, fixed: mica; 5100 uuf, $\pm 2\%$; char. C, 500 wvdc.	Band 2 Ampl. Input Padder	CM35C512G
C41	Same as C40.	Band 2 Ampl. Output Padder	
C42	Same as C13.	Ampl. Screen Bypass	
C43	Same as C27.	Band 2 Mixer Output Tuning Trimmer	
C44	CAPACITOR, fixed: ceramic; 15 uuf, $\pm .5$ mmfd; char. N750, 600 wvdc.	200 Kc Osc. Compensator	CC-103-1
C45	NOT USED		
C46	Same as C2.	Band 2 Ampl. Output Tuning Trimmer	
C47	CAPACITOR, fixed: paper; dual unit; .05 uf, $\pm 15\%$ each section; char. E; 600 wvdc; oil filled and impregnated, hermetically sealed metal case.	Thermostat Osc. Suppressor	CP69B4EF503L
C48	Same as C47.	Thermostat Osc. Suppressor	
C49	Same as C9.	External Osc. Coupling	
C50	CAPACITOR, fixed: paper; 4 uf, $\pm 10\%$; char. E; 600 wvdc; oil filled and impregnated, hermetically sealed cylindrical metal case.	Power Supply Filter	CP40C2EF405K
C51	Same as C50.	Power Supply Filter	
C52	Same as C50.	Power Supply Filter	
C53	Same as C50.	Power Supply Filter	
C54	Same as C50.	Power Supply Filter	
C55	CAPACITOR, fixed: paper; dual unit, .5 uf, $\pm 15\%$ each section; char. E, 600 wvdc; oil filled and impregnated hermetically sealed metal case.	Line Filter	CP69B4EF504L
C56	Same as C55.	Line Filter	
C57	CAPACITOR, fixed: ceramic; 110 uuf, $\pm 2\%$; char. N750; 500 wvdc.	200 Kc Osc. Temp. Compositor	CC26UJ111G
C58	Same as C57.	200 Kc Osc. Temp. Compositor	
C59	Same as C35.	Coupling	

SYM.	DESCRIPTION	FUNCTION	TMC DWG. OR PART NO.
E1	BOARD, terminal: general purpose barrier type; eight brass nickel plated 6-32 binding head machine screws; molded phenolic body.	Input-Output Terminals	TM-100-8
F1	FUSE, cartridge: 3 amps.	Power Supply Fuse	FU-100-3
F2	Same as F1.	Power Supply Fuse	
I1	LAMP, incandescent: 6-8 volts, 250 ma DC; T-3-1/4 clean bulb; miniature bayonet base.	Power Indicator	BI-101-44
I2	LAMP, neon: 110 volts, 1/25 watt; T-3-1/4 clear bulb; miniature bayonet base.	200 Kc Osc. Oven Indicator	BI-100-51
I3	Same as I2.	200 Kc Osc. Oven Indicator	
J1	CONNECTOR, jack: female, coaxial; 75 ohms; mica filled bakelite dielectric.	Output Jack	SO-239
J2	Same as J1.	Test Jack	
J3	CONNECTOR, receptacle: female; polarized; two contacts.	Mult. Ratio 1 Patch Jack	JJ-119-2
J4	Same as J3.	Mult. Ratio 2 Patch Jack	
J5	Same as J3.	Mult. Ratio 3 Patch Jack	
J6	Same as J3.	Mult. Ratio 4 Patch Jack	
J7	Same as J3.	Mult. Ratio 6 Patch Jack	
J8	Same as J3.	Mult. Ratio 8 Patch Jack	
J9	Same as J3.	Mult. Ratio 9 Patch Jack	
J10	Same as J3.	Mult. Ratio 12 Patch Jack	
J11	Same as J3.	External Patch Jack	
J12	Same as J3.	External Patch	
J13	Same as J3.	Xtal #1 Patch Jack	
J14	Same as J3.	Xtal #1 Patch Jack	
J15	Same as J1.	Output Jack	
J16	CONNECTOR, receptacle: male; two contacts, 10 amps at 250 volts, 15 amps at 125 volts; twist lock type.	Line Input	JJ-100

SYM.	DESCRIPTION	FUNCTION	TMC DWG. OR PART NO.
L1	COIL, R. F.: fixed; 193 turns of #34 DSC wire; 5 pi; 250 microhenries, ± 2 microhenries, Q greater than 100; ceramic coil form, 1/4 in. dia. x 1-3/4 in. lg.	200 Kc Osc. Tank Coil	CL-265
L2	Same as L1.	200 Kc Osc. Tank Coil	
L3	COIL, R. F.: 2.5 millihenries; 125 ma max. current; DC resistance approx. 44 ohms; ceramic body.	Ampl. Plate Choke	CL-104-1
L4	REACTOR, filter: 10 henries, 125 ma DC, DC resistance approx. 150 ohms; steel case, ceramic insulated terminals, insulated for 1000 volts in accordance with MIL-T-27, GR. 1, CL. A. FAM. 04.	Power Supply	TF-5001
M1	METER, milliammeter: DC; 0-50 ma; square case.	Output Tuning Meter	MR-100-2
P1	CONNECTOR, plug: male; polarized; two contacts, w/cable clamps. (P1 - Part of W5)	External Mult. Patch Plug	PL-105-1
P2	Same as P1. (Part of W2)	Xtal 1 Mult. Patch Plug	
P3	Same as P1. (Part of W3)	Xtal 2 Mult. Patch Plug	
P4	Same as P1. (Part of W4)	Xtal 3 Mult. Patch Plug	
R1	RESISTOR, fixed: composition; 100,000 ohms, $\pm 10\%$; 1/2 watt.	200 Kc Osc. Grid Leak	RC20GF104K
R2	Same as R1.	200 Kc Osc. Grid Leak	
R3	RESISTOR, fixed: composition; 1800 ohms, $\pm 10\%$; 1/2 watt.	200 Kc Osc.	RC20GF182K
R4	RESISTOR, fixed: metallized film, 5800 ohms, $\pm 1\%$; 1/2 watt.	React. Tube Phase Shift	RR-104-582
R5	RESISTOR, fixed: metallized film; 67,000 ohms, $\pm 1\%$; 1/2 watt.	React. Tube Phase Shift	RR-104-673
R6	Same as R1.	200 Kc Osc Grid Leak	
R7	RESISTOR, fixed: composition; 3900 ohms, $\pm 10\%$; 1/2 watt.	React. Tube Cath. Bias	RC20GF392K
R8	RESISTOR, variable: wire wound; 10,000 ohms, $\pm 10\%$; 3 watts	FS Control	RA100ASRL103A
R9	RESISTOR, fixed: composition; 24,000 ohms, $\pm 5\%$; 1/2 watt.	Mixer Grid Leak	RC20GF243J
R10	RESISTOR, fixed: composition; 100 ohms, $\pm 10\%$; 1/2 watt.	Mixer Cathode Bias	RC20GF101K

SYM.	DESCRIPTION	FUNCTION	TMC DWG. OR PART NO.
R11	RESISTOR, fixed: composition; 39,000 ohms, $\pm 10\%$; 1/2 watt.	Screen Voltage Divider	RC20GF393K
R12	Same as R11.	Screen Voltage Divider	
R13	RESISTOR, variable: wire wound, 10,000 ohms, $\pm 10\%$; 3 watts.	Mixer Balance	RA100ASSC103A
R14	RESISTOR, fixed: wire wound; 10,000 ohms, $\pm 5\%$; 10 watts.	Mixer Screen Dropping	RW-109-34
R15	RESISTOR, fixed: composition; 4700 ohms, $\pm 10\%$; 1 watt.	Mixer Plate Fil.	RC32GF472K
R16	RESISTOR, fixed: composition; 39 ohms, $\pm 10\%$; 1/2 watt.	Power Ampl. Parasitic Suppressor	RC20GF390K
R17	RESISTOR, fixed: composition; 15,000 ohms, $\pm 10\%$; 2 watts.	P.A. Screen Dropping	RC42GF153K
R18	RESISTOR, fixed: composition; 100,000 ohms, $\pm 10\%$; 1 watt.	P.A. Screen Bleeder	RC32GF104K
R19	RESISTOR, fixed: composition; 6800 ohms, $\pm 10\%$; 1/2 watt.	Monitor Voltage Divider	RC20GF682K
R20	Same as R16.	Monitor Voltage Divider	
R21	RESISTOR, fixed: composition; 4700 ohms, $\pm 10\%$; 1/2 watt.	P.A. Bias Div.	RC20GF472K
R22	RESISTOR, variable: wire wound; 10,000 ohms, $\pm 10\%$; 3 watts.	FS Control	RA100ASRD103A
R23	RESISTOR, fixed: composition; 2700 ohms, $\pm 10\%$; 1/2 watt.	P.A. Bias Divider	RC20GF272K
R24	RESISTOR, fixed: composition; 1000 ohms, $\pm 10\%$; 1/2 watt.	Cath. Follower Bias	RC20GF102K
R25	Same as R15.	Cath. Follower Plate Filter	
R26	Same as R1.	Cath. Follower Grid Leak	
R27	RESISTOR, fixed: composition; 10,000 ohms, $\pm 10\%$; 1/2 watt.	Xtal Osc. Plate Load	RC20GF103K
R28	Same as R1.	Xtal Osc. Grid Leak	
R29	RESISTOR, fixed: composition; 12 ohms, $\pm 10\%$; 2 watts.	Xtal Osc. Input Short	RC42GF120K
R30	RESISTOR, fixed: composition; 470,000 ohms, $\pm 10\%$; 1/2 watt.	Voltage Divider	RC20GF474K
R31	Same as R30.	Voltage Divider	
R32	Same as R30.	Voltage Divider	

SYM.	DESCRIPTION	FUNCTION	TMC DWG. OR PART NO.
R33	RESISTOR, fixed; composition; 22, 000 ohms, $\pm 10\%$; 1 watt.	Voltage Divider	RC32GF223K
R34	RESISTOR, fixed; composition; 3300 ohms, $\pm 10\%$; 1/2 watt.	Keyer Fixed Bias	RC20GF332K
R35	RESISTOR, fixed; composition; 1 megohm, $\pm 10\%$; 1/2 watt.	Keyer Plate Load	RC20GF105K
R36	RESISTOR, fixed; composition; 47, 000 ohms, $\pm 5\%$; 1 watt.	Voltage Divider	RC32GF473J
R37	RESISTOR, fixed; composition; 15, 000 ohms, $\pm 5\%$; 1 watt.	Voltage Divider	RC32GF153J
R38	Same as R13.	Phase Shift Balance Control	
R39	RESISTOR, fixed; composition; 33, 000 ohms, $\pm 10\%$; 1 watt.	Voltage Divider	RC32GF333K
R40	Same as R13.	Phase Shift Ampl	
R41	RESISTOR, fixed; composition; 6800 ohms, $\pm 10\%$; 2 watts.	Voltage Divider	RC42GF682K
R42	RESISTOR, fixed; metallized film; 10, 000 ohms, $\pm 1\%$; 1/2 watt.	Mult. Ratio 2 Series Divider	RR-104-103
R43	RESISTOR, fixed; metallized film; 20, 000 ohms, $\pm 1\%$; 1/2 watt.	Mult. Ratio 2 Shunt Divider	RR-104-203
R44	Same as R43.	Mult. Ratio 3 Series Divider	
R45	RESISTOR, fixed; metallized film; 15, 000 ohms, $\pm 1\%$; 1/2 watt.	Mult. Ratio 3 Shunt Divider	RR-104-153
R46	RESISTOR, fixed; metallized film; 30, 000 ohms, $\pm 1\%$; 1/2 watt.	Mult. Ratio 4 Series Divider	RR-104-303
R47	RESISTOR, fixed; metallized film; 13, 300 ohms, $\pm 1\%$; 1/2 watt.	Mult. Ratio 4 Shunt Divider	RR-104-1332
R48	RESISTOR, fixed; metallized film; 50, 000 ohms, $\pm 1\%$; 1/2 watt.	Mult. Ratio 6 Shunt Divider	RR-104-503
R49	RESISTOR, fixed; metallized film; 12, 000 ohms, $\pm 1\%$; 1/2 watt.	Mult. Ratio 8 Shunt Divider	RR-104-123
R50	RESISTOR, fixed; metallized film; 70, 000 ohms, $\pm 1\%$; 1/2 watt.	Mult. Ratio 8 Series Divider	RR-104-703
R51	RESISTOR, fixed; metallized film; 11, 400 ohms, $\pm 1\%$; 1/2 watt.	Mult. Ratio 8 Shunt Divider	RR-104-1142
R52	RESISTOR, fixed; metallized film; 80, 000 ohms, $\pm 1\%$; 1/2 watt.	Mult. Ratio 9 Series Divider	RR-104-803
R53	RESISTOR, fixed; metallized film; 11, 250 ohms, $\pm 1\%$; 1/2 watt.	Mult. Ratio 9 Shunt Divider	RR-104-11251

SYM.	DESCRIPTION	FUNCTION	TMC DWG. OR PART NO.
R54	RESISTOR, fixed: metallized film; 110,000 ohms, $\pm 1\%$; 1/2 watt.	Mult. Ratio 12 Series Divider	RR-104-114
R55	RESISTOR, fixed: metallized film; 10,900 ohms, $\pm 1\%$; 1/2 watt.	Mult. Ratio 12 Shunt Divider	RR-104-1092
R56	RESISTOR, fixed: wire wound; cartridge heater type; 20 watts at 115 volts AC, $\pm 10\%$; 1000 v insulated to shell.	200 Kc Osc. Oven Heater	RR-102-1
R57	Same as R56.	200 Kc Osc. Oven Heater	
R58	RESISTOR, fixed: composition; 220,000 ohms, $\pm 10\%$; 1/2 watt.	Neon Current Limiting	RC20GF224K
R59	Same as R56.	200 Kc Osc. Oven Heater	
R60	Same as R56.	200 Kc Osc. Oven Heater	
R61	Same as R58.	Neon Current Limiting	
R62	Same as R24.	React. Tube Cath. Bias	
R63	Same as R24.	React. Tube Cath. Bias	
R64	Same as R29.	Pilot Current Limiting	
R65	RESISTOR, fixed: composition; 22,000 ohms, $\pm 10\%$; 1/2 watt.	Ampl. Grid Leak	RC20GF223K
R66	Same as R30.	Mixer Grid Leak	
R67	Same as R30.	Mixer Grid Leak	
R68	Same as R10.	Parasitic Suppressor	
R69	Same as R30.	Voltage Divider	
R70	RESISTOR, fixed: composition; 470 ohms, $\pm 10\%$; 2 watts.	Bias Supply	RC42GF471K
R71	RESISTOR, fixed: wire wound; 7500 ohms, $\pm 5\%$; 20 watts.	Series Supply Filter	RW-110-32
R72	RESISTOR, fixed: wire wound; 10,000 ohms, $\pm 5\%$; 20 watts.	Bias Supply Filter	RW-110-33
R73	RESISTOR, fixed: wire wound; 5000 ohms, $\pm 5\%$; 20 watts.	Bias Supply Filter	RW-110-30
R74	Same as R10.	Thermostat Arc Suppressor	
R75	Same as R10.	Thermostat Arc Suppressor	

SYM.	DESCRIPTION	FUNCTION	TMC DWG. OR PART NO.	
R76	Same as R1.	Fax. Input Load	RC42GF680K	
R77	Same as R30.	Power Supply Bleeder		
R78	Same as R30.	Power Supply Bleeder		
R79	RESISTOR, fixed: composition; 68 ohms, $\pm 10\%$; 2 watts.	External Osc. Load		
R80	Same as R10.	Parasitic Suppressor		
R81	Same as R18.	Keying Line Load		
R82	Same as R24.	Plate Filter		
R83	RESISTOR, adjustable: wire wound; 2000 ohms, $\pm 10\%$; 10 watts.	Keying Bridging		RA108-202-10
R84	Same as R13.	Balance Control Bnad 2		SW-110
S1	SWITCH, rotary: non-shorting; three sections, two positions; mycalex insulation; contacts and wipers silver plated; 1/4 in. dia. drive shaft, 1 in. lg flatted 3/8 in.	Band Switch		
S2	SWITCH, rotary: non-shorting; three sections, four positions; sections 1 and 2, bakelite insulation; section 3, mycalex insulation; contacts and wipers silver plated; 1/4 in. dia. drive shaft, 1 in. lg., flatted 3/8 in.	Xtal Selector	SW-109	
S3	SWITCH, rotary: non-shorting; one section, five positions; bakelite insulation; contacts and wipers silver plated; 1/4 in. dia. drive shaft, flatted 3/8 in.	Mode Switch	SW-264	
S4	SWITCH, toggle: SPST; 3 amp, 250 volts; phenolic body.	Plate Power Switch	ST12A	
S5	NOT USED			
S6	SWITCH, thermostatic; operates at 70 deg. C, ± 2 deg. C; 1-1/2 in. lg x 3/8 in. dia; solder type terminals.	200 Kc Oven Control	SS-100-2	
S7	Same as S6.	Xtal Oven Control		
S8	SWITCH, toggle: DPST; 3 amp, 250 volts, phenolic body.	Power ON/OFF Switch	ST22K	
S9	SWITCH, rotary: non-shorting; one section, two positions; mycalex insulation; contacts and wipers silver plated; 1/4 in. dia. drive shaft, 3/4 in. lg.	P.A. Band Switch	SW-116	
T1	TRANSFORMER, R.F.: primary, 7 turns of #30 DSC; 1.2 microhenries min. L, Q = 65; secondary, winding 1-3, 20 turns of #30 DSC, 5 microhenries min. L, Q = 90; winding 1-4, 13.0 microhenries, ± 3.5 microhenries, Q = 105, ± 15 .	Band 2 Mixer Input	A-338	

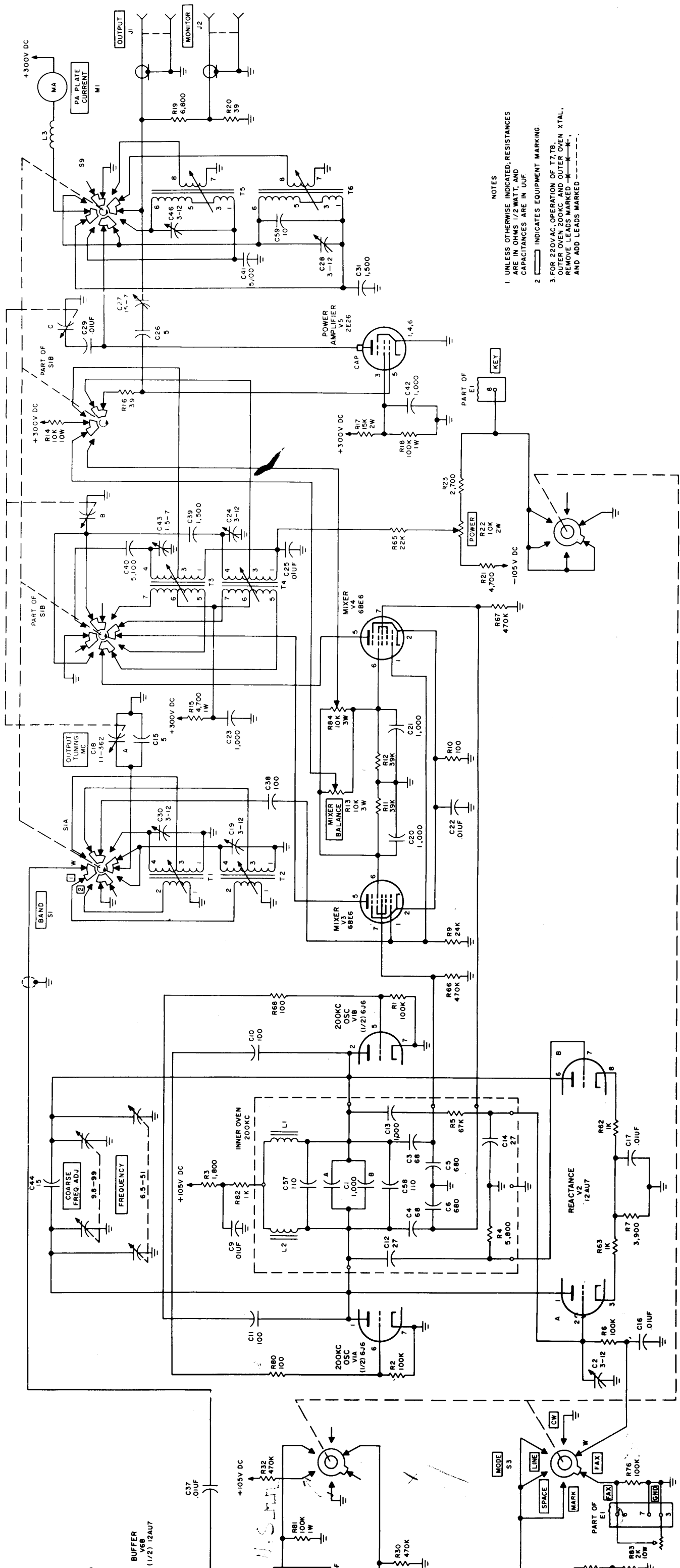
SYM.	DESCRIPTION	FUNCTION	TMC DWG. OR PART NO.
T2	TRANSFORMER, R.F.: primary, 15 turns of #5/41 SSC, Q = 20; secondary, winding 1-3, 45 turns of #5/41 SSC, 47 microhenries min. L, Q = 45; winding 1-4, 115.5 microhenries \pm 14.5 microhenries, Q = 67.5, \pm 22.5, slug tuned.	Band 1 Mixer Input	A-339
T3	TRANSFORMER, R.F.: primary, 18 turns of #36 DSC, 4 microhenries, center tapped, Q = 35; secondary, winding 1-3, 20 turns of #30 DSC, 5.2 microhenries min. L, Q = 90; winding 1-4, 31 turns of #30 DSC, 13.3 microhenries, \pm 3.5 microhenries, Q = 108, \pm 12, slug tuned.	Band 2 Mixer Output	A-340
T4	TRANSFORMER, R.F.: primary, winding 5-6, 21 turns of #5/41 SSC, 10.6 microhenries min. L, Q = 50; winding 6-7, 21 turns of #5/41 SSC, 10.9 microhenries min L, Q = 36; secondary, winding 1-3, 42 turns of #5/41 SSC, 40 microhenries min. L, Q = 50; winding 1-4, 60 turns of #5/41 SSC, 95.5 microhenries, \pm 13.5 microhenries, Q = 70, \pm 25; slug tuned.	Band 1 Mixer Output	A-341
T5	TRANSFORMER, R.F.: slug tuned; two sections, Main and Tuning; Main section, winding 5-6, 9.2 microhenries, Q = 160; winding 7-8, .75 microhenries, Q = 25; Tuning section, winding 1-3, 1.35 microhenries, \pm .35 microhenries, Q = 92.5, \pm 2.5.	Band 2 Ampl. Output	A-752
T6	TRANSFORMER, R.F.: slug tuned; two sections, Main and Tuning; Main section, winding 5-6, 59 microhenries, Q = 170; winding 7-8, 3 microhenries, Q = 50; Tuning section, winding 1-3, 9.75 microhenries, \pm 2.35 microhenries, Q = 110, \pm 60.	Band 1 Ampl. Output	A-753
T7	TRANSFORMER, power and filament: primary, 110/220 VAC, 50/60 cps; secondary #1, 350-0-350 volts, 125 ma, secondary #2, 6.3 volts, 4 amps, secondary #3, 5 volts, 3 amps; insulated for 1250 volts, in accordance with MIL-T-27, GR. 1, CL. A, FAM. 03; electrostatic shield between pri. and sec., hermetically rectangular metal case.	Power Xformer	TF-105
T8	TRANSFORMER, filament: primary, 115 VAC, 60 cps.; secondary 6.3 volts, 1.2 amps; insulated for 2500 volts.	Filament Xformer	TF-111
V1	TUBE, electron: duo triode; 7 pin miniature.	200 Kc Osc.	6J6
V2	TUBE, electron: medium mu duo triode; 9 pin miniature.	Reactance Tube	12AU7
V3	TUBE, electron: heptode converter; 7 pin miniature.	Mixer	6BE6

SYM.	DESCRIPTION	FUNCTION	TMC DWG. OR PART NO.
V4	Same as V3.	Mixer	
V5	TUBE, electron: beam power amplifier; 8 pin octal.	Amplifier	2E26
V6	Same as V2.	Xtal Osc. Cath. Follower	
V7	Same as V2.	Keying Tube	
V8	TUBE, electron: full-wave rectifier; 8 pin octal.	Rectifier	5U4G
V9	TUBE, electron: full-wave rectifier; 7 pin miniature.	Rectifier	6X4
V10	TUBE, electron: voltage regulator; 7 pin miniature.	Regulator	0B2
V11	Same as V10.	Regulator	
W1	CABLE, power: consists of one molded non-polarized male plug; six feet of 16/30 SJ cable; and one phenolic twist lock connector, female. (PL-100)	AC Input Cable	CA-103-72
W2	CABLE, patch, R.F.: consists of 9-1/4 in. of shielded cable, two conductor, WI-109-6; tape, vinyl plastic; and one connector, male, two prong, PL-105-1. Consists of P2.	Patch Cord, Xtal 1	CA-209-1
W3	Same as W2. Consists of P3.	Patch Cord, Xtal 2	
W4	CABLE, patch, R.F.: consists of 10-1/4 in. of shielded cable, two conductor, WI-109-6; tape, vinyl plastic; and one connector, male, two prong, PL-105-1. Consists of P4.	Patch Cord, Xtal 3	CA-209-2
W5	Same as W4. Consists of P1.	Patch Cord, External	
XF1	HOLDER, fuse: extractor post type for single AGC type fuse; stationary and terminals.	F1 Socket	FH-100-2
XF2	Same as XF1.	F2 Socket	
XI1	LIGHT, indicator: w/red frosted lens, for miniature bayonet base T-3-1/4 bulb.	I1 Socket	TS-106-1
XI2	LIGHT, indicator: w/clear white lens, for miniature bayonet base T-3-1/4 bulb.	I2 Socket	TS-106-2
XI3	Same as XI2.	I3 Socket	
XV1	SOCKET, tube: 7 pin miniature.	V1 Socket	TS102P01
XV2	SOCKET, tube: 9 pin miniature.	V2 Socket	TS103P01
XV3	Same as XV1.	V3 Socket	
XV4	Same as XV1.	V4 Socket	

SYM.	DESCRIPTION	FUNCTION	TMC DWG. OR PART NO.	
XV5	SOCKET, tube: octal; ceramic.	V5 Socket	TS101P01	
XV6	Same as XV2.	V6 Socket		
XV7	Same as XV2.	V7 Socket		
XV8	Same as XV5.	V8 Socket		
XV9	Same as XV1.	V9 Socket		
XV10	Same as XV1.	V10 Socket		
XV11	Same as XV1.			
XY1	SOCKET, crystal: .487 in. spacing for .095 in. dia. pins; oval shaped, steatite; 1-3/8 in. lg. x 7/16 in. wide x 7/8 in. high o/a; phosphor bronze contacts, silver plated.	Xtal #1 Socket Socket A		TS-105-1
XY2	SOCKET, crystal: .487 in. spacing for .050 in. dia. pins; oval shaped, steatite; 55/64 in. lg. x 3/38 in. wide x 43/64 in. high o/a; phosphor bronze contacts, cadmium plated.	Xtal #1 Socket Socket B		TS-104-1
XY3	Same as XY1.	Xtal #2 Socket Socket A		
XY4	Same as XY2.	Xtal #2 Socket Socket B		
XY5	Same as XY1.	Xtal #3 Socket, Socket A		
XY6	Same as XY2.	Xtal #3 Socket, Socket B		
	CRYSTAL UNIT, quartz: 800-15,000 kcs., ±0.002%. (Supplied only on customers request, frequency to be specified by customer).	Xtal	CR-27/U	

SECTION 8
OVERALL EQUIPMENT SCHEMATIC DRAWINGS

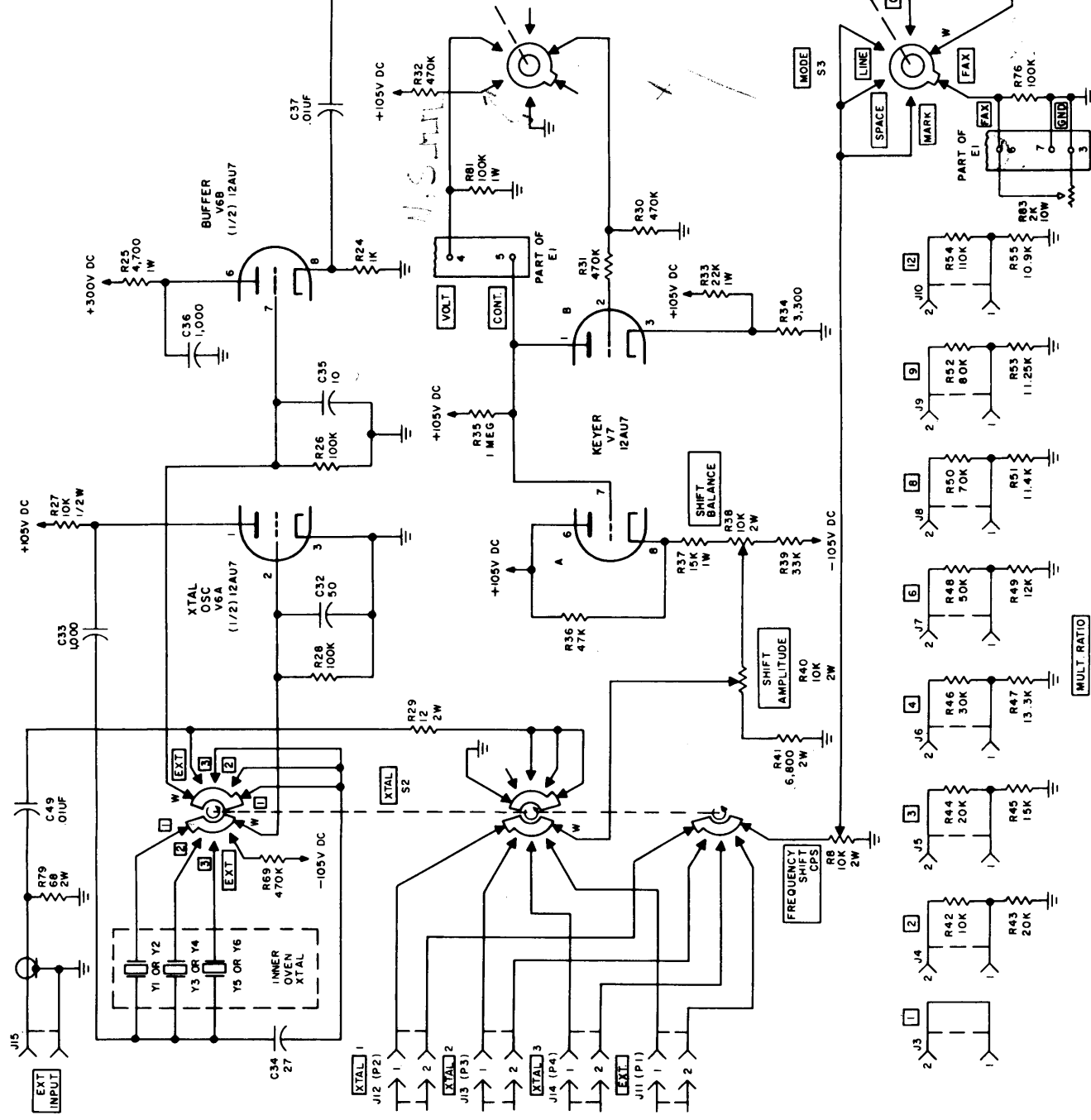




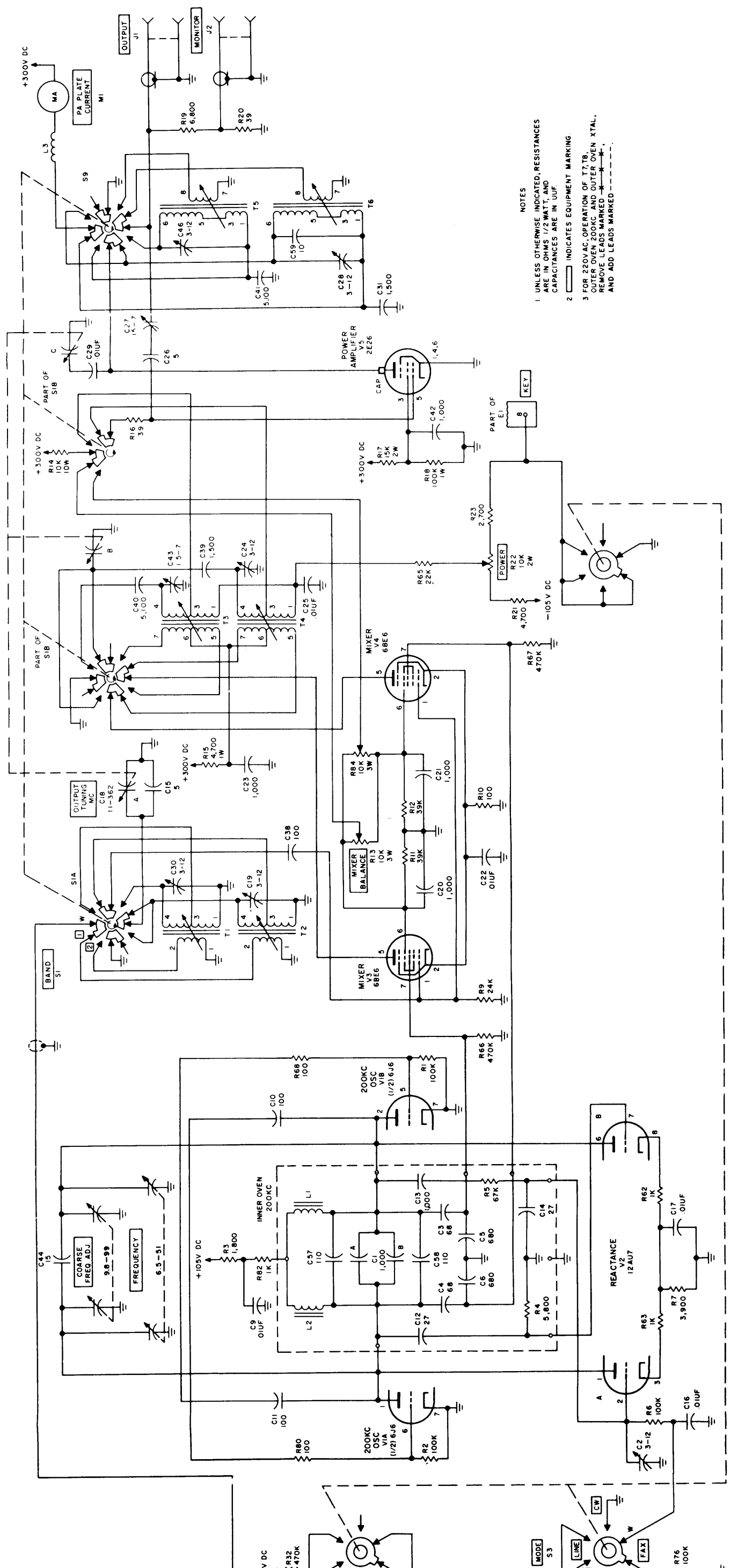
- NOTES
1. UNLESS OTHERWISE INDICATED, RESISTANCES ARE IN OHMS 1/2 WATT, AND CAPACITANCES ARE IN UF.
 2. INDICATES EQUIPMENT MARKING
 3. FOR 220VAC, OPERATION OF T7, T8, OUTER OVEN 200KC, AND OUTER OVEN XTAL, REMOVE LEADS MARKED AND ADD LEADS MARKED .

Figure 8-1. Overall Schematic Diagram, XFK (Sheet 1 of 2)

NOTE: R83 TO BE CONNECTED AS SHOWN ONLY FOR CURRENT KEYING OPERATION



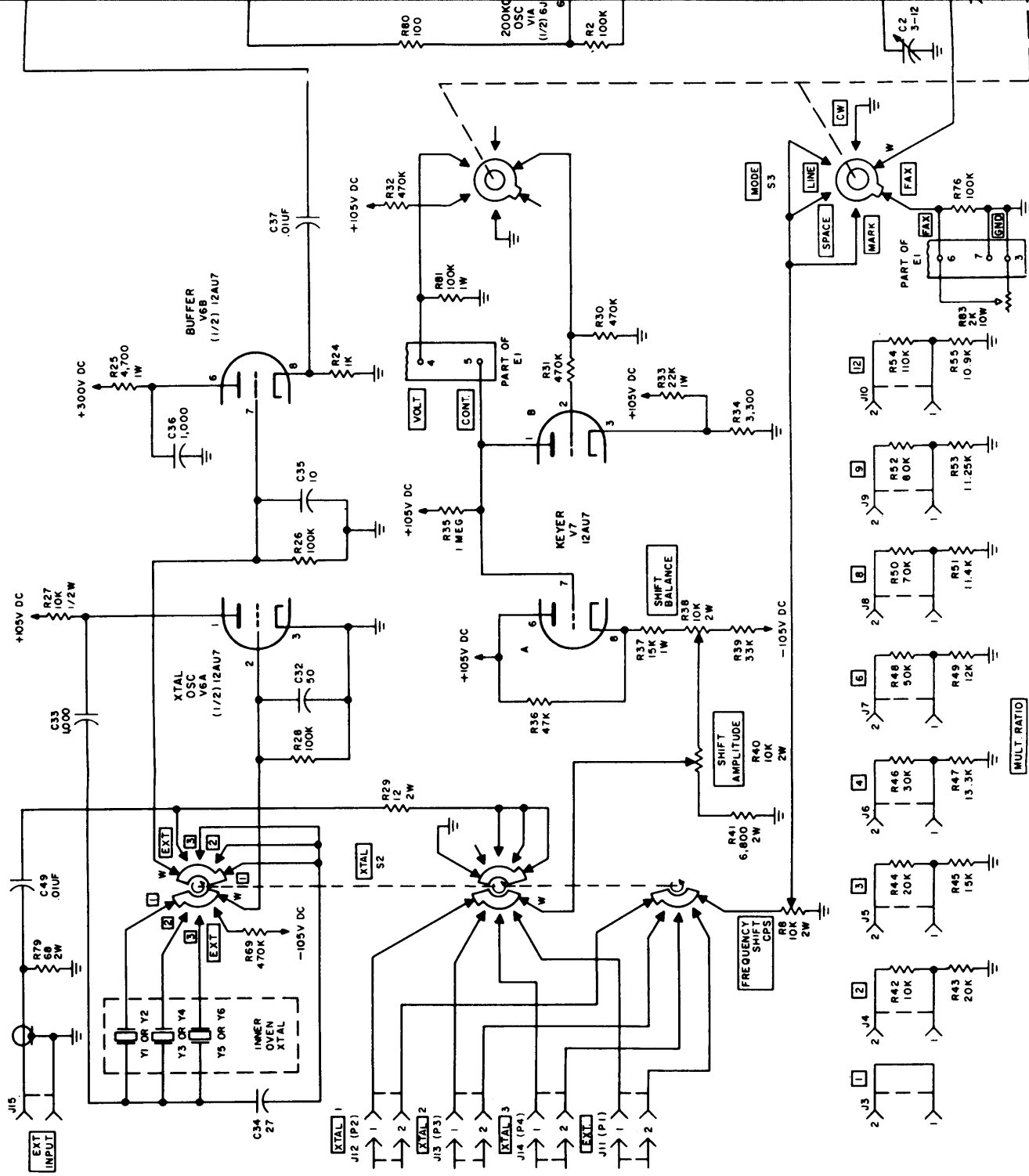
NOTE: R83 TO BE CONNECTED AS SHOWN ONLY FOR CURRENT KEYING OPERATION



- NOTES
1. UNLESS OTHERWISE INDICATED, RESISTANCES ARE IN OHMS, CAPACITANCES ARE IN P.F. CAPACITANCES ARE IN UUF.
 2. INDICATES EQUIPMENT MARKING.
 3. FOR 220V AC OPERATION OF T7, T8, OUTER OVEN COOKING AND OUTER OVEN XTAL., ADD LEADS AS MARKED WITH "A", AND ADD LEADS MARKED "-----".

Figure 8-1. Overall Schematic Diagram, XFK (Sheet 1 of 2)

RECTED FOR 16 OPERATION



NOTE: R83 TO BE CONNECTED AS SHOWN ONLY FOR CURRENT KEYING OPERATION

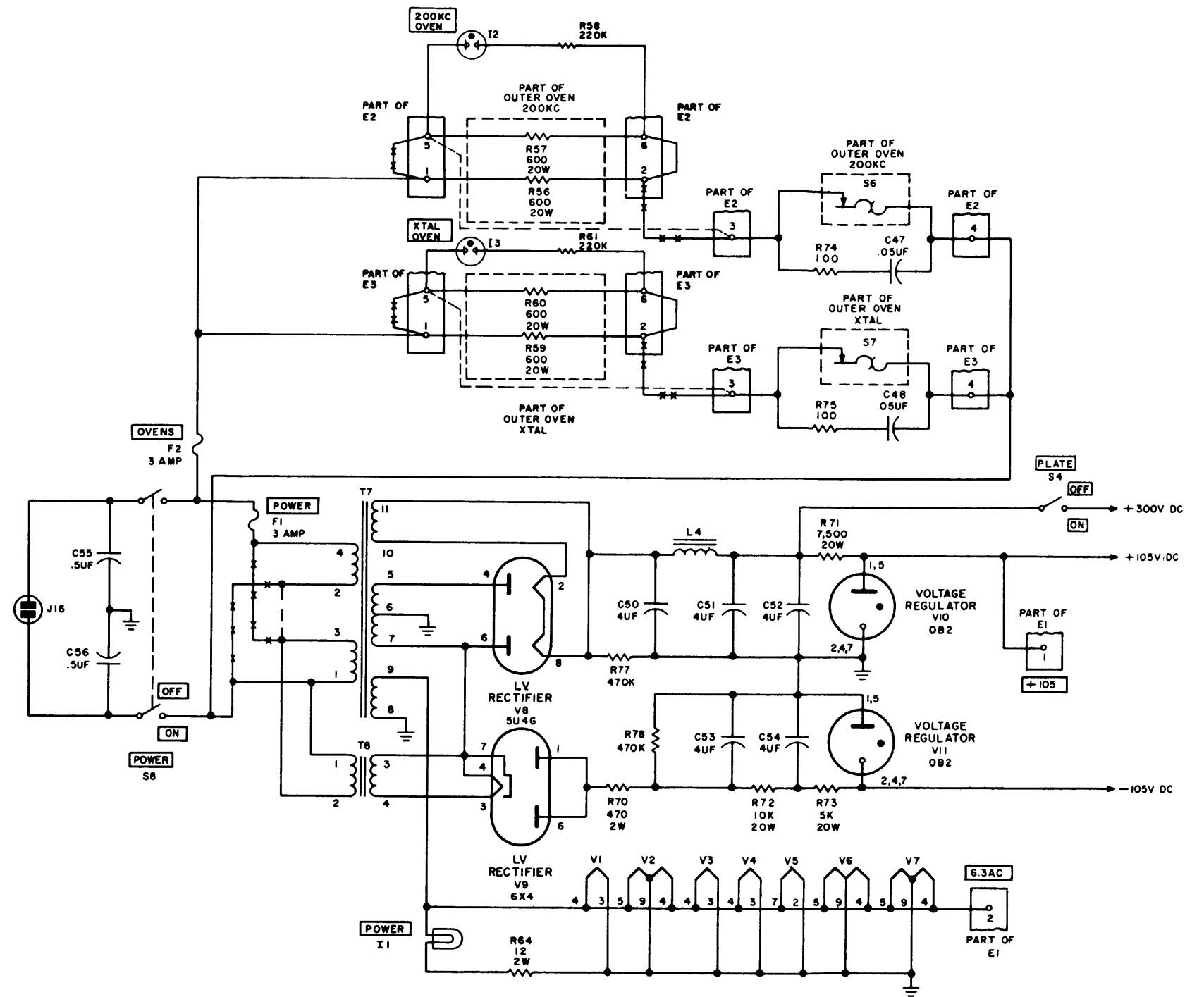


Figure 8-1. Overall Schematic Diagram, XFK (Sheet 2 of 2)