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LESSON PLAN

FOR

FREQUENCY SHIFT EXCITER

MODEL XFK

THE TECHNICAL MATERIEL CORPORATION

MAMARONECK, N.Y. OTTAWA, ONTARIO

Title: Model XFK Frequency Shift Exciter

Objectives:

a) to discuss the functions, characteristics, capabilities and limitations of the Model XFK Frequency Shift Converter.

b) to discuss the circuitry of the Model XFK, pointing up significant circuit parameters.

c) to discuss the operation of the Model XFK in a general manner, without reference to specific associated transmitters.

d) to discuss the interconnection and operation of the Model XFK with associated transmitters to meet individual customer requirements. These individual discussions will appear as appendices to this basic lesson plan.

e) to demonstrate, with appropriate test equipment, the alignment of the unit.

References:

a) Technical Manual for Model XFK.

b) S-155: Production Test Specifications for Model XFK.

c) CK-140: Production Schematic, Model XFK.

d) Technical Manual for Model GPT-750-(C)-2 transmitter: section on the Model XFK.

Training Aids:

a) Model XFK, set up for operation.

b) VTVM: H.P. Model 410B, or equivalent.

c) Oscilloscope: Tektronics Model 545A, or equivalent.

d) Frequency Counter: H.P. Model 524C, or equivalent.

e) Signal Generator: Measurements Corp. Model 82, or equivalent. Fixed crystals may be used in lieu of the signal generator.

f) 70 ohm dummy load.

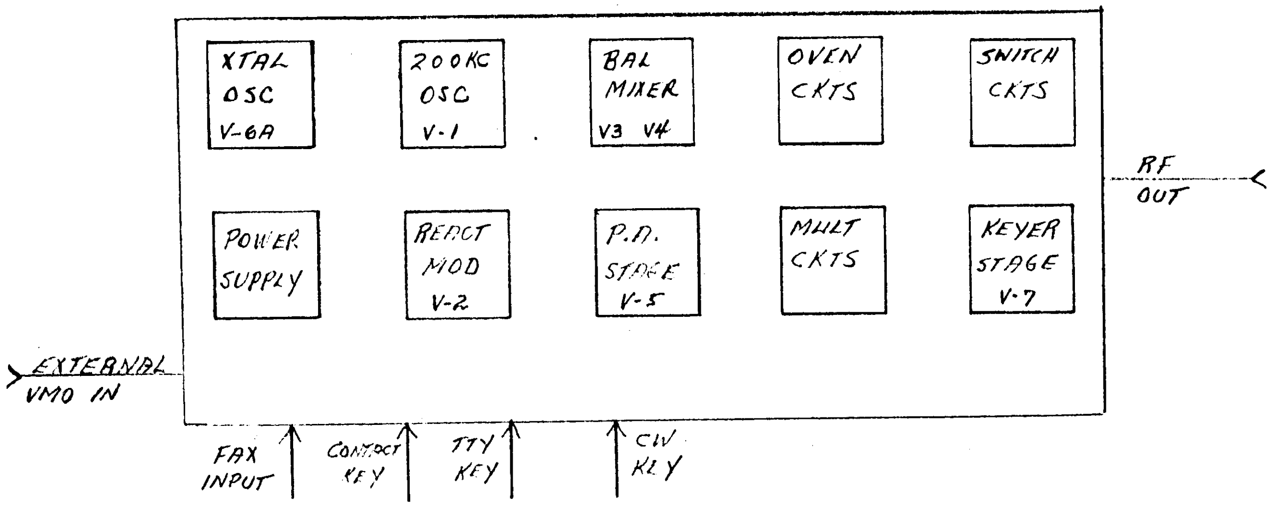
Introduction:

The Model XFK Frequency Shift Exciter is a complete, integral unit; it may be purchased as such, or in combination with other TMC transmitting equipment.
This lesson plan is designed to cover the theory and operation of the Model XFK only; it is not "slanted" toward any particular installation. Separate lesson plans, appendixed to this basic lesson plan, will "tie in" the Model XFK with particular installations, as required.

Presentation:

A. General Orientation:

1. General Discussion:



a) The Model XFK is a frequency shift exciter unit which contains:

(1) an internal crystal oscillator circuit, capable of operating in the range .8 - 6.7 mcs; provision is made for installation of three crystals, any one of which may be selected by a front panel switch.

(2) a 200 KC oscillator, the frequency of which may be shifted up to plus or minus 500 cycles by means of a reactance modulator circuit actuated by keying or facsimile signals. The frequency of the 200 KC oscillator may also be shifted plus or minus 600 cycles independently of the reactance circuit by means of a front panel control.

(3) a reactance modulator circuit, designed to shift the frequency of the 200 KC oscillator in accordance with certain characteristics of input teletype or facsimile signals.

(4) a keyer circuit, which accepts teletype signals or contact signals, and produces a frequency shift control voltage independent of the amplitude of the keying signals.

(5) a balanced mixer circuit, which adds the output of the internal crystal oscillator and the 200 KC oscillator circuit.
Since the range of the crystal oscillator circuit is .8 - 6.7 mcs, and the range of the 200 KC oscillator is 200 KC $\pm\Delta f$, the total final range of the Model XFK is 1.0 - 6.9 mc, $\pm\Delta f$, where Δf is the frequency shift.

(6) a tuned power amplifier stage, which raises the signal to the desired output level.

(7) a self contained power supply, which furnishes all voltages required.

(8) a "multiplier" circuit arranged in patch panel fashion to compensate the frequency shift control voltage when frequency multiplication vice frequency translation is employed in subsequent transmitter stages.

(9) temperature controlled oven circuits.

(10) switching circuits for operating the equipment in various modes and under different conditions.

b) The RF output frequency is produced in two bands:

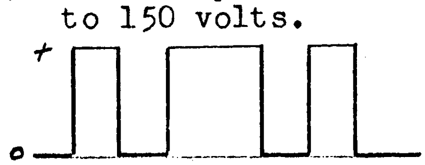
Band 1: 1.0 - 2.5 mc $\pm\Delta f$

Band 2: 2.5 - 6.9 mc $\pm\Delta f$

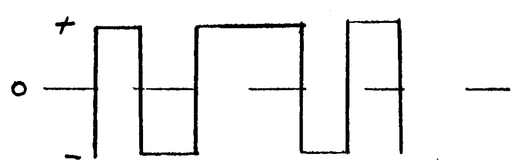
c) The frequency shift is continuously variable from $\pm$ 0 cycles to $\pm$ 500 cycles, for a total shift of 1000 cycles. The total frequency shift is shown on a front panel indicator, geared to the FREQ SHIFT CPS control.

d) The Model XFK will accept the following types of inputs:

(1) neutral positive teletype signals of amplitude 25 to 150 volts.



(2) polar teletype signals.



(3) keyed "ground" signals for CW operation.

(4) keyed "ground" signals for FS operation.

(5) facsimile signals from a demodulator unit.

e) The power output of the Model XFK is variable to a maximum of 3 watts, referred to an output impedance of 50 to 70 ohms.

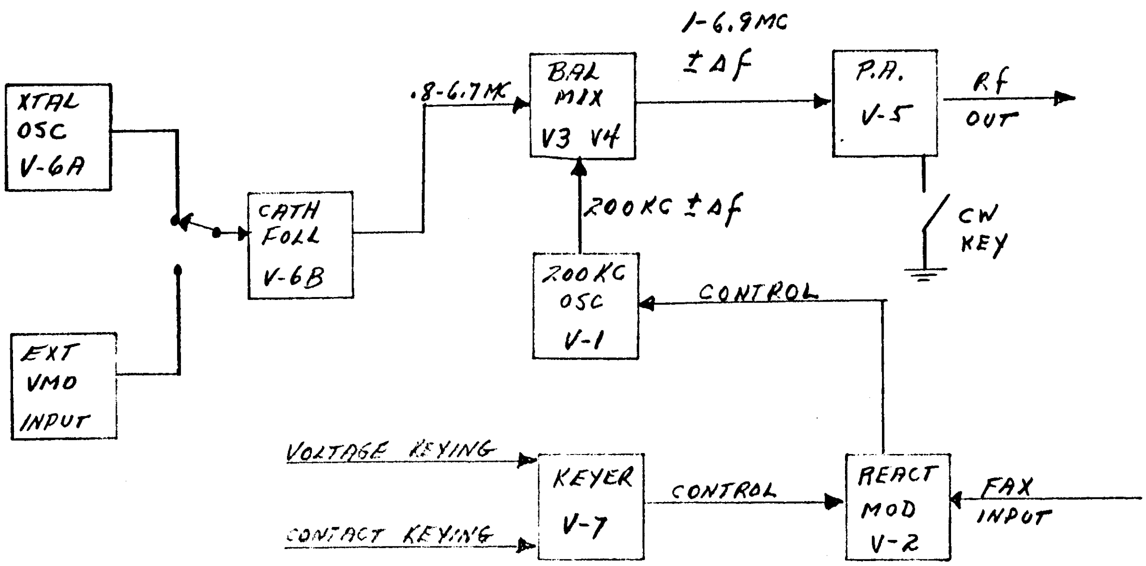
f) maximum keying speed is 1000 words per minute.

g) keying bias is not greater than 10% at 1000 WPM.

h) an external variable frequency oscillator with a range of .8 - 6.7 mc may be used in lieu of the internal crystal oscillator. Since the internal crystal oscillator circuit has provisions for switching among three crystals only, the VMO would be preferred when operation over a wide range of frequencies is required.

B. Discussion of the Circuitry of the Model XFK:

1. Block Diagram Illustrating the Operation of the Model XFK



a) crystal oscillator V-6A or an external VMO supplies the balanced mixer circuit, V-3, V-4, with a frequency in the range .8 - 6.7 mcs.

b) cathode follower stage V-6B provides buffer action between the primary frequency source and the balanced mixer circuit.

c) keyer tube V-7 receives contact or voltage signals and converts these to a balanc d, polarized control voltage, which is independent of the amplitude of the keying signals.

d) reactance modulator stage V-2 acts on the 200 KC oscillator to shift its frequency higher or lower by an amount determined by the operator, at a rate determined by the characteristics of the keying signals in voltage or contact keying operation.

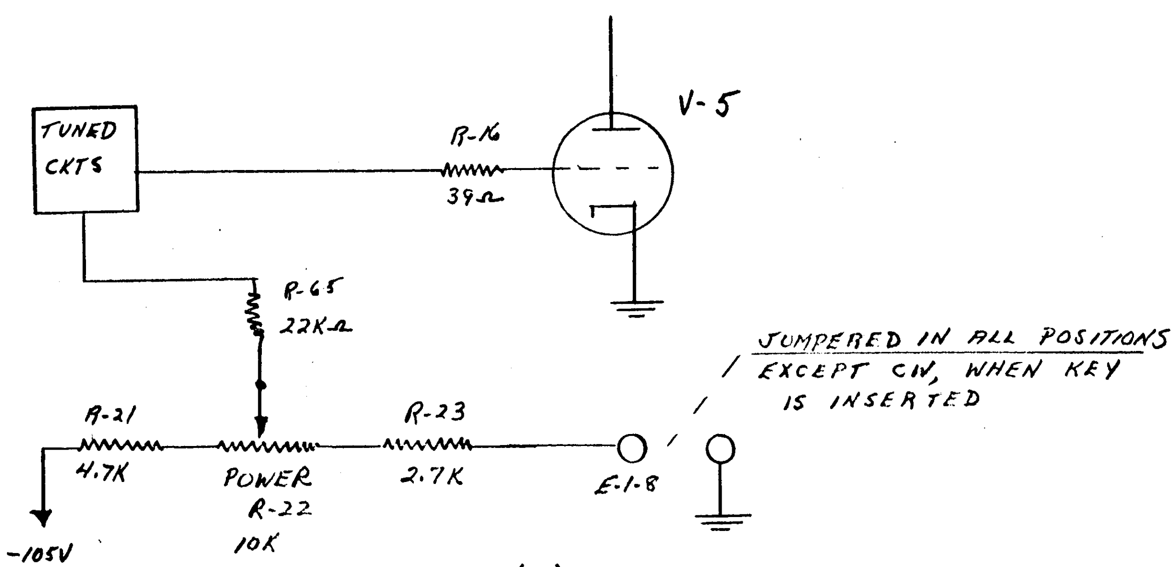
e) in facsimile operation, the keyer circuit is disconnected; the facsimile input causes the reactance tube to shift the frequency of the 200 KC oscillator by an amount and at a rate determined by the characteristics of the facsimile input signal.

f) 200 KC oscillator V-1 supplies the balanced mixer with a frequency of 200 KC $\pm\Delta f$.

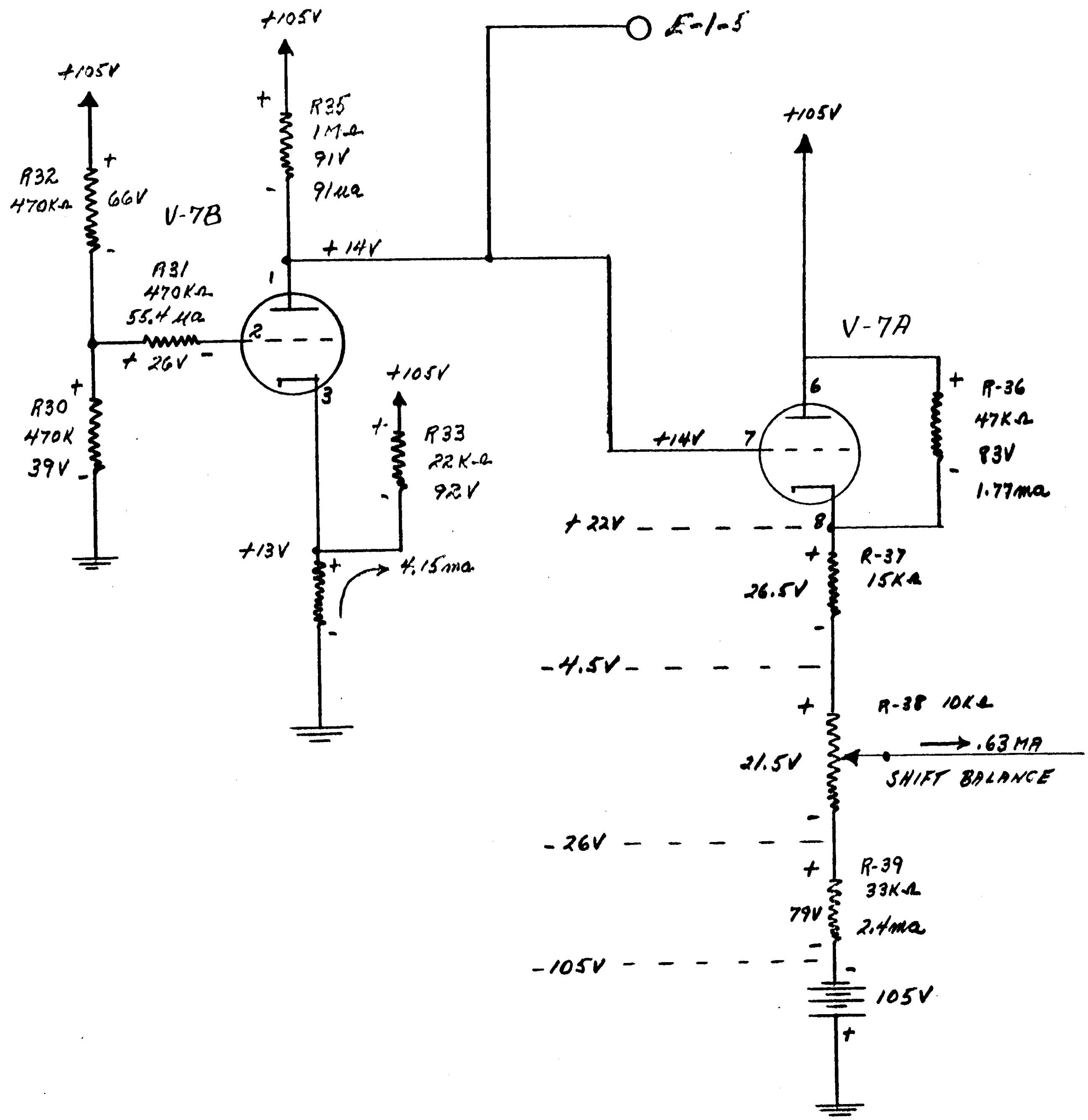
g) the balanced mixer adds the frequencies of the crystal or VMO and the 200 KC oscillator to produce an output frequency of 1.0 - 6.9 mc $\pm\Delta f$.

h) power amplifier stage V-5 raises the signal from the balanced mixer circuit to the required level.

i) in CW operation, grid block keying causes the power amplifier stage to operate and cutoff in accordance with the CW keying signals. Thus, the CW circuit is totally independent of the frequency shift circuits

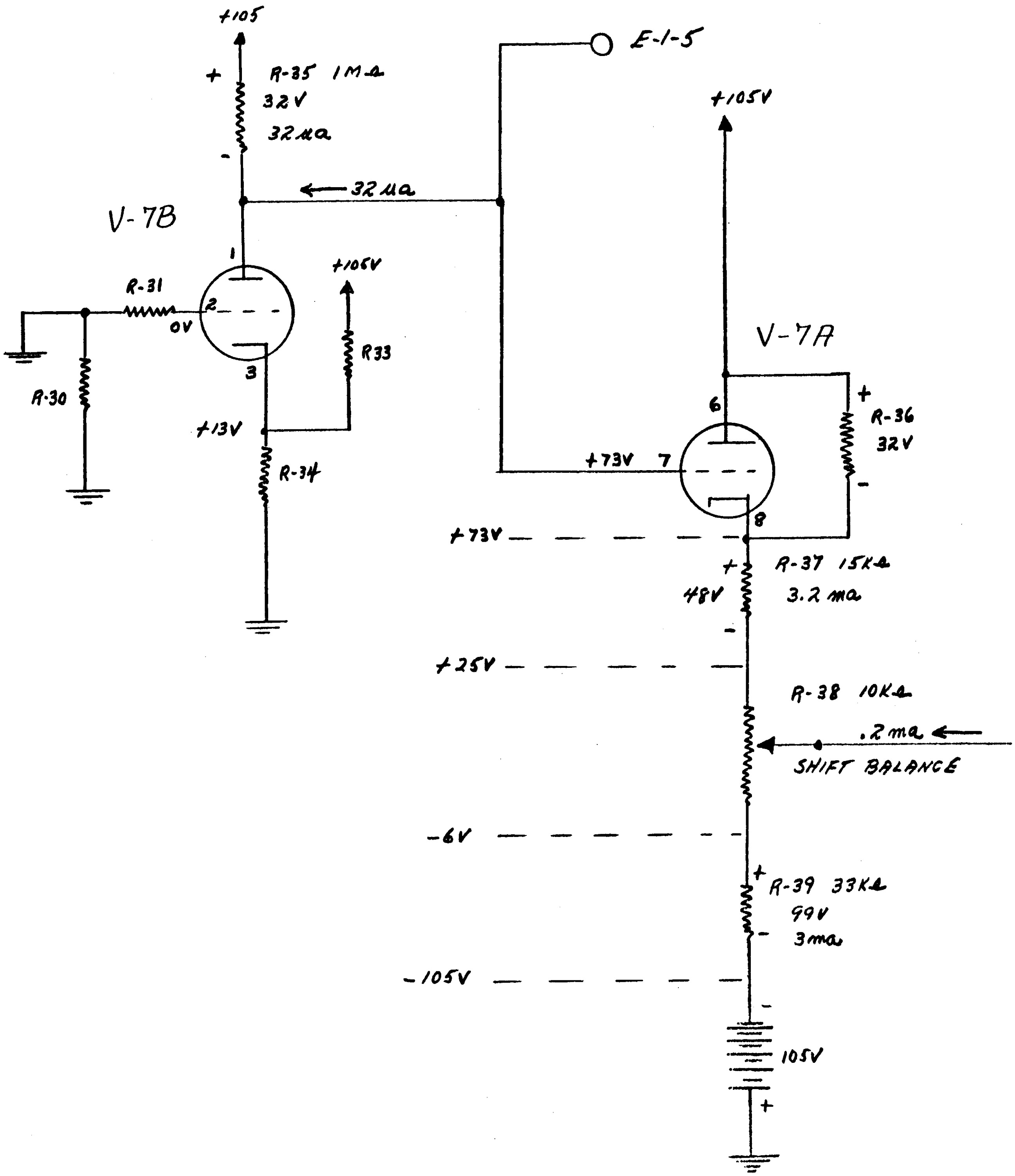


Simplified circuit of the keyer, V-7 in MARK operation.



CONDITIONS SHOWN ARE APPROXIMATE ONLY

Simplified circuit of the keyer, V-7, in SPACE operation.



CONDITIONS SHOWN ARE APPROXIMATE ONLY

2. Keyer Circuit, V-7:

Refer to the complete circuit schematic, Model XFK, and the simplified circuits of the keyer in MARK and SPACE condition on the two preceding pages.

a) the control grid, pin 2, of keyer stage V-7, receives MARK AND SPACE signals from terminal 4 of E-1, when the MODE switch, S-3, is in the LINE position. These teletype signals may be polar, or neutral positive.

b) control grid pin 7 may receive CONTACT keying signals from terminal 5 of E-1. The keying device supplies a ground to terminal 5 when it is desired to key in this manner. This line must be open circuited when teletype signals are being received at terminal 4. Conversely, when CONTACT keying is employed, the VOLTAGE input at terminal 4 should be removed.

c) when the MODE switch, S-3, is placed in the MARK position, the control grid, pin 2, is connected to a positive 105 volts source via a divider network, thus simulating a MARK condition for test purposes.

d) when the MODE switch, S-3, is placed in the SPACE position, the control grid, pin 2, is grounded. This also is a test position, simulating a SPACE condition.

e) when the MODE switch is placed in the FAX position, the keyer tube, V-7, is bypassed and the facsimile signal is introduced directly to the reactance modulator circuit from terminal 6 of E-1.

f) keyer circuit V-7 in MARK condition:

(1) the cathode, pin 3, of V-7B, is maintained at plus 13 volts by voltage divider R-33, R-34. With V-7B cut off, voltage divider current is 4.15 ma. With V-7B conducting, total plate and grid current is 146 ua. Thus, pin 3 is maintained at 13 volts at all times.

(2) in MARK condition, the voltage divider to plus 105. volts in the control grid circuit of V-7B causes grid limiting. Thus, pin 2 is held to the voltage at pin 3, and egk V-7B is 0 volts.

(3) the high grid drive and the large value of plate load resistance drops the plate voltage at pin 1 to 14 volts; epk V-7B is 1 volt.

(4) the plate, pin 1, of V-7B, is connected directly to the control grid, pin 7, of V-7A. V-7A is one resistance in a voltage divider network with plus 105 volts at one end and minus 105 volts at the other end.

(5) in MARK condition, with plus 14 volts at pin 7, V-7A is cut off. Voltage divider current flows up from the minus 105 volt source, through R-39, R-38, R-37, and R-36 to the positive 105 volt source. The voltage at pin 8, the cathode of V-7A, is plus 22 volts.

(6) Since V-7A is cut off, R-36 is shunted by an open circuit, and the wiper of R-38, the SHIFT BALANCE potentiometer, will pick off a negative voltage.

(7) the wiper of R-38 is connected to another voltage divider network to ground, and a small current will flow in this branch.

(8) note that the negative voltage picked off the wiper of R-38 may be varied from minus 26 volts to minus 4.5 volts.

(9) if CONTACT keying is employed, there will be no signal into pin 2 of V-7B. Terminal E-1-5 will be grounded by the keying device; this will cut off V-7A and the same conditions will prevail .

g) keyer circuit V-7 in SPACE condition:

(1) in SPACE condition, the grid, pin 2, of V-7B is grounded. With plus 13 volts at the cathode, pin 3, V-7B is cut off.

(2) with V-7B cut off, the grid circuit of V-7A is returned to B Plus through R-35, and V-7A conducts.

(3) with V-7A conducting, R-36, a 47 K ohm resistance, is shunted by the dynamic plate resistance of V-7A, and the total resistance combination equals about 10 K ohms. The current in the voltage divider increases.

(4) with V-7A conducting, the voltage available at the wiper of R-38 may be varied from minus 6 volts to plus 25 volts. A small current flows in the wiper circuit of R-38 as before.

(5) if contact keying is employed, there will be no signal at pin 2 of V-7B, and the key at terminal E-1-5 will be open. Thus, the same conditions in V-7A will prevail.

h) the following points are significant:

(1) for a large variation in the amplitude of input MARK and SPACE voltages, the voltage picked off R-38 at any particular setting will be the same. Thus, the frequency shift in LINE, MARK and SPACE positions of the MODE switch will be unaffected by amplitude variations at the input.

(2) contact keying signals introduced at terminal E-1-5 will also produce the same MARK and SPACE voltages at R-38.

(3) a MARK input results in a NEGATIVE voltage at R-38.

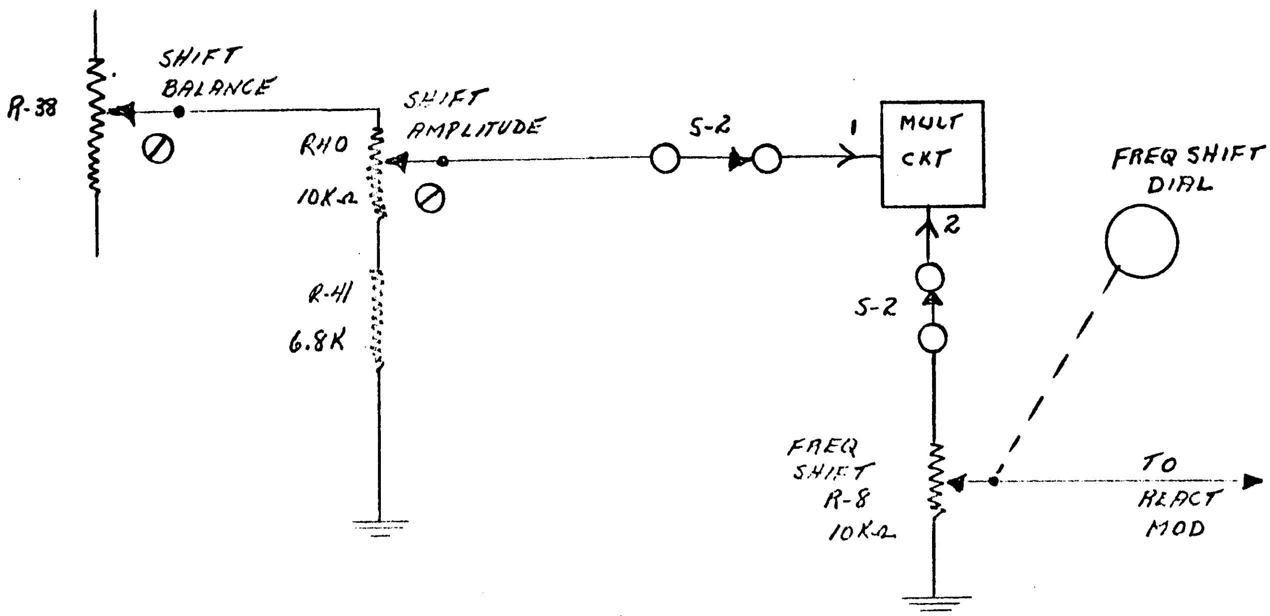
(4) a SPACE input results in a POSITIVE voltage at R-38.

(5) a keyed contact at E-1-5 creates a MARK condition, resulting in a NEGATIVE voltage at R-38.

(6) an unkeyed contact at E-1-5 creates a SPACE condition, resulting in a POSITIVE voltage at R-38.

i) During the alignment procedure, R-38, the SHIFT BALANCE potentiometer, is adjusted so that equal positive and negative voltages are picked off the wiper for space and mark condition. This adjustment is necessary, because the voltage from the keyer circuit to the reactance modulator circuit must be polar and perfectly balanced.

3. Shift Amplitude, Multiplier and Frequency Shift Circuit:



a) the MARK or SPACE voltage picked off R-38 is applied to the reactance modulator circuit via the scheme shown on the preceding page.

b) thus, the amplitude of the signal at R-38 is further controlled by SHIFT AMPLITUDE control R-40, the plug in multiplier circuit, and the front panel FREQ SHIFT CPS control.

c) during the alignment procedure, R-40, the shift amplitude control, is adjusted to furnish the proper amplitude of polarized, balanced voltage to shift the frequency of the reactance modulator by the proper amount.

d) The FREQUENCY SHIFT CPS control, R-8, is a front panel control geared to the FREQUENCY SHIFT dial. When R-8 is at minimum resistance, the dial reads 0 and no voltage is sent to the reactance modulator circuit. When R-8 is at maximum, the dial reads 1000 and sufficient voltage is applied to the reactance modulator to shift the frequency of the 200 KC oscillator plus and minus 500 cycles.

e) the "multiplier" circuits are actually attenuators, which reduce the frequency shift voltages at R-8 when the XFK feeds a transmitter which employs frequency multiplier circuits instead of frequency translation circuits to step up the output frequency.

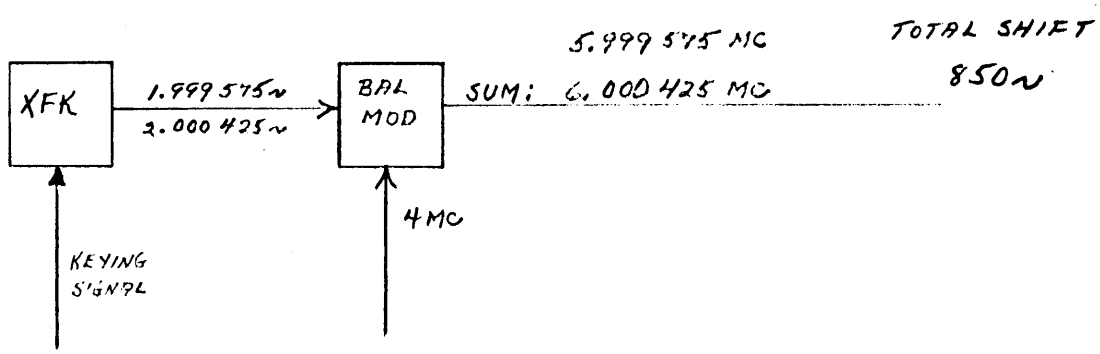
f) when the XFK feeds a transmitter employing frequency translation circuits, a X1 multiplier circuit (short) is plugged into the multiplier jacks.

g) a brief discussion of frequency shift in multiplier and frequency translation circuits follows:

(1) frequency translation:

XFK output: 2MC ± 425~ XMTR RF OUTPUT: 6 mc nominal

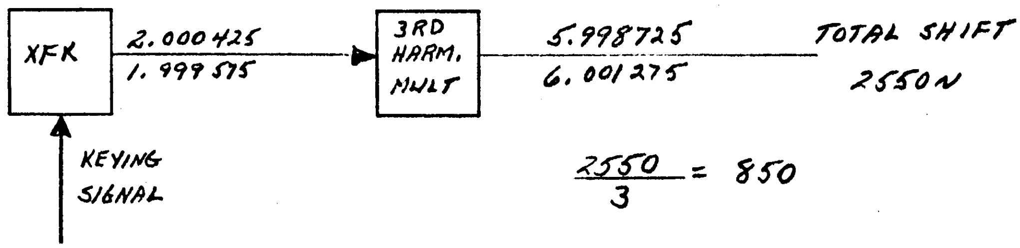
Total Frequency Shift Desired: 850 cycles.



(2) frequency multiplication:

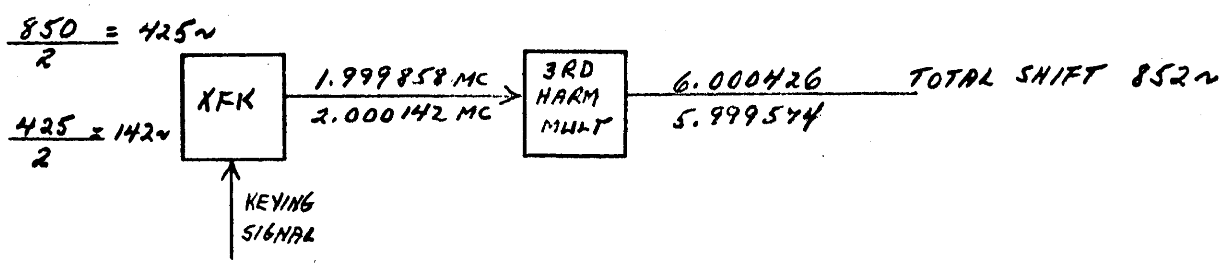
XFK output: 2 MC ± 425~ XMTR RF OUTPUT 6 mc nominal

Total Frequency Shift Desired: 850 cycles



Thus, with a frequency multiplication of 3, the frequency shift is also multiplied by 3. However, if the original frequency shift were divided by a factor of 3 in the XFK, the final frequency shift would be correct.

(3) frequency multiplication, using divider circuit in XFK:



Thus, when frequency translation circuits are employed, the MULTIPLIER jacks are shorted with a X1 multiplier.

When frequency multiplication circuits are employed, a X2, X3, X4, X6, X9 or X 12 "MULTIPLIER" circuit is plugged in which actually divides the total frequency shift by 2, 3, 4, 6, 8, 9 or 12, as required.
The "multiplier" units will be discussed in detail in a subsequent section of this lesson plan.

4. Facsimile Input to the Reactance Modulator Circuit:

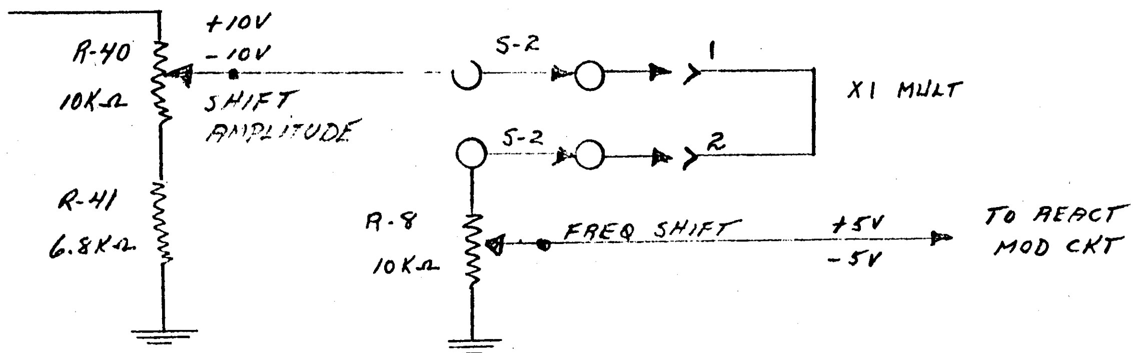
a) note that the wiper of R-8, the FREQUENCY SHIFT CPS control, connects to one section of S-3, the MODE switch. The wiper of this section of S-3 connects to the input of the reactance modulator circuit.

b) in MARK, SPACE and LINE positions of S-3, a positive or negative voltage is applied to the reactance modulator circuit; this voltage is polar, and balanced. It is independent of the amplitude of the input MARK and SPACE signals.

c) in the FAX position of this section of S-3, the reactance modulator circuit receives its input from FAX terminal E-1-6, which may be connected for voltage or current operation.
The signal from a facsimile demodulator unit varies continuously in amplitude and frequency with the "light" and "dark" areas of the "picture" being scanned.
Thus, the FAX input causes a linear shift of the 200 KC oscillator. The frequency shift in this case will be affected by the amplitude and frequency variations of the FAX input signal.

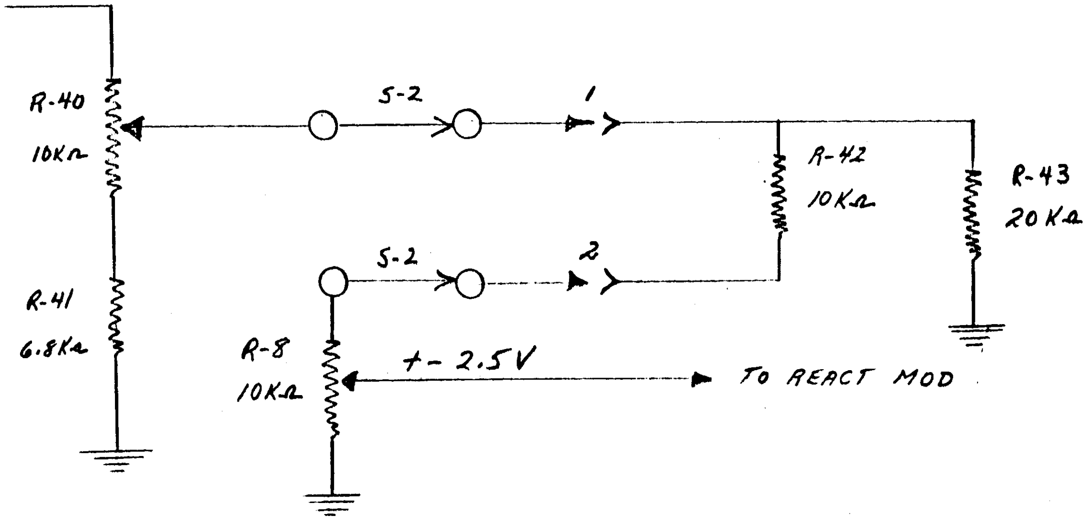
5. Multiplier Circuits:

a) assume that SHIFT AMPLITUDE control R-40 picks off plus 10 volts for a space condition and minus ten volts for a mark condition, as shown in the circuit below. The X1 multiplier is shown inserted.



b) assume that R-8, the FREQUENCY SHIFT control, is at mid position; that is, the wiper is set at 5 K ohms.
Then: the actual voltage passed to the reactance modulator circuit will be plus and minus 5 volts.
The impedance presented to the wiper of R-40 will be 10 K ohms.

c) now assume that the X2 multiplier is switched into the circuit in place of the X1 multiplier.



(1) the wiper of R-40 continues to see an impedance of 10 K ohms to ground.

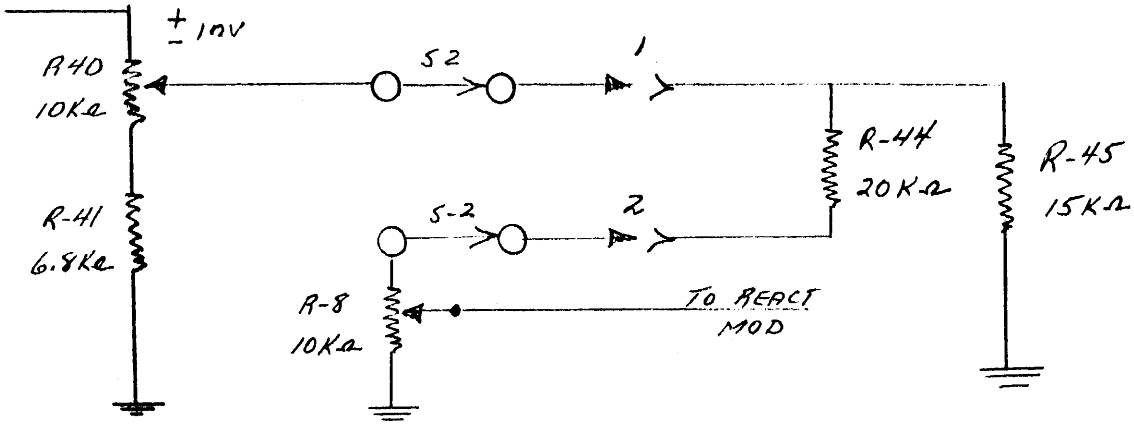
$$\frac{(R42 + R8) \times R43}{R42 + R8 + R43} = \frac{2\times10^4 \times 2\times10^4}{4\times10^4} = \frac{4\times10^8}{4\times10^4} = 1\times10^4 = 10K\Omega$$

(2) the voltage available at R-8 has been halved; since R-8 is at mid position, the voltage will be plus and minus 2.5 volts.

$$\frac{10 \times 5K}{20K} = \frac{50K}{20K} = 2.5$$

(3) the frequency shift caused by the halving of the voltage to the reactance modulator circuit will divide the frequency shift by a factor of 2.

d) now assume that the X3 multiplier is switched into the circuit in place of the X2 multiplier.



(1) the wiper of R-40 continues to see an impedance of 10 K ohms.

$$\frac{(R\text{-}44 + R8) \times R\text{-}45}{R44 + R8 + R\text{-}45} = \frac{30K \times 15K}{45K} = \frac{450 \times 10^6}{45 \times 10^3} = .10 K\Omega$$

(2) the voltage available at R-8 will be reduced by 1/3 of that originally available.

$$\frac{10}{30K} \times 5K = \frac{50K}{30K} = 1.66V$$

e) the multiplier circuits, when used, reduce the amount of frequency shift in accordance with the multiplying factor of the transmitter stages that follow.

f) the multiplier units are configured to present a constant impedance of 10 K ohms to the wiper of R-40, to insure that the voltages will not shift with a change of impedance.

g) the multiplier circuits are used only when frequency multiplication vice frequency translation is employed in the transmitter stages that follow the Model XFK.

h) when an external VMO is used, and frequency multiplication circuits follow the XFK, a new multiplier must be inserted whenever the multiplication factor changes.

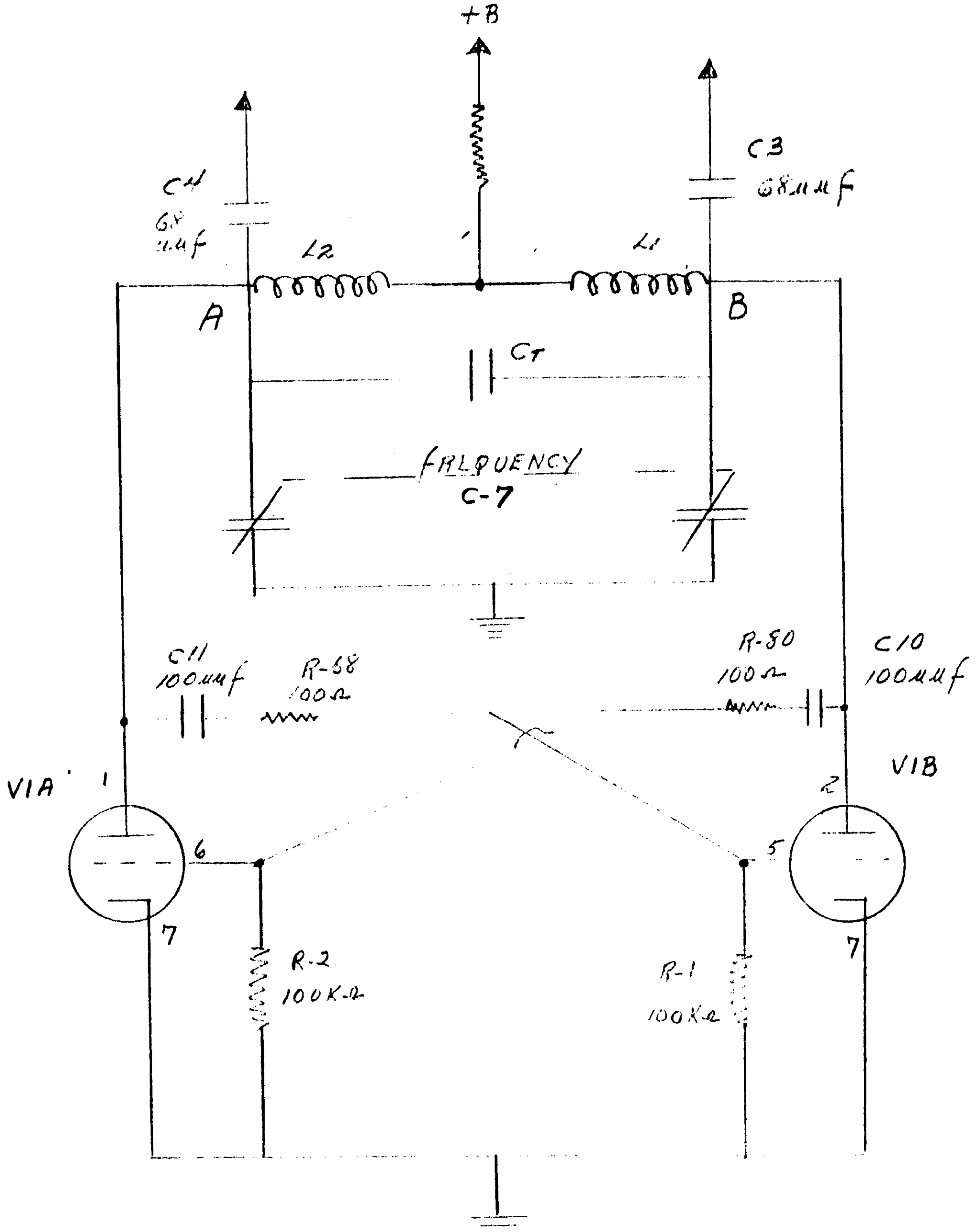
i) Figure 2-3 of the XFK technical manual illustrates the patching arrangement.

6. 200 KC Oscillator Circuit:

a) V-1 together with its associated circuitry forms a push pull oscillator circuit with a nominal frequency output of 200 KCS.

b) the circuit is a modified Kallitron oscillator; this type of negative resistance oscillator is used to provide a constant amplitude, high stability sine wave output.

c) the simplified schematic is shown below. Note that the circuit is essentially a symetrical plate coupled multivibrator circuit with a tuned tank connected between the plates.



d) the operation of the circuit is as follows:

(1) assume that plate current in V-1A is increasing. Then eb V-1A is decreasing, and the sine wave at point A is decreasing.

(2) if eb V-1A is decreasing, C-11, R-68 and R-1 will couple a negative going voltage to the grid, pin 5, of V-1B.

(3) if eg V-1B is decreasing, then ib V-1B is decreasing and eb V-1B is increasing. The sine wave at point B is increasing.

(4) if eb V-1B is increasing, C-10, R-80 and R-2 will couple a positive going voltage to the grid of V-1A, causing a further increase of ib V-1A.

(5) at the peak of the negative excursion at A, corresponding to the peak of the positive excursion at B, the action switches; current in V-1A decreases, causing an increase in eb V-1A. C-11 attempts to charge, via R-68 and R-1, causing a positive going signal at the grid, pin 5, of V-1B.

(6) ib V-1B increases, causing eb V-1B to decrease; this causes C-10 to discharge via R-80 and R-2, causing a negative going voltage at pin 6 of V-1A. This further decreases ib V-1A, and the action continues.

(7) C-7, the "fine" frequency adjust, is a front panel control calibrated from minus 600 cycles to plus 600 cycles.

(8) two outputs are taken off, 180 degrees out of phase, from points A and B via coupling capacitors C-4 and C-3. These outputs are fed to the balanced mixer circuit.

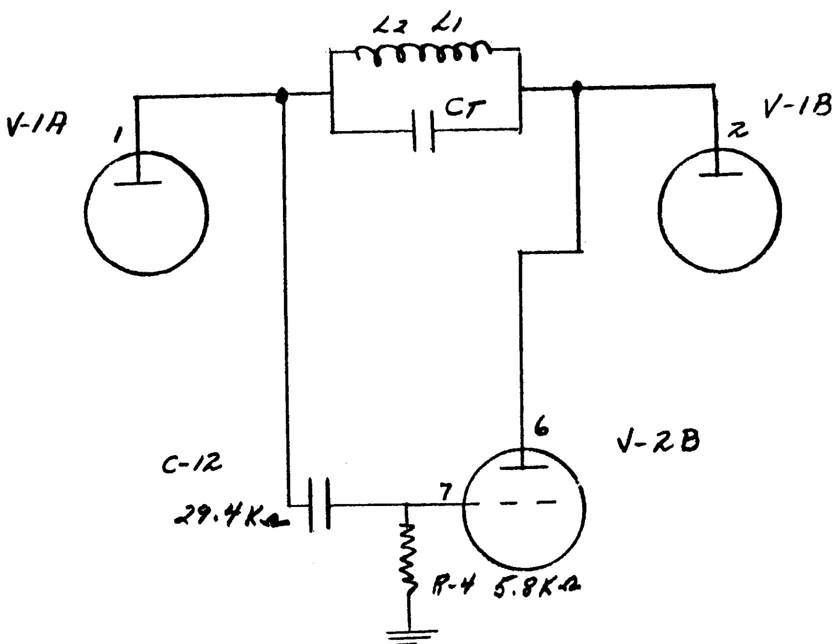
7. The Reactance Modulator Circuit, V-2:

a) the reactance modulator circuit receives a control voltage at pin 2 of V-2, and acts to change the frequency of the 200 KC oscillator by a definite and predetermined amount.

b) when the control voltage originates in the keying circuit of V-7, it shifts the frequency of the 200 KC oscillator up or down, by an amount determined by circuit controls, and at a rate determined by the keying signals.

c) when the control voltage originates in the FAX circuit, it shifts the frequency of the 200 KC oscillator by an amount and at a rate determined by the characteristics of the input FAX signal.

d) simplified circuit of the 200 KC oscillator and V-2B:

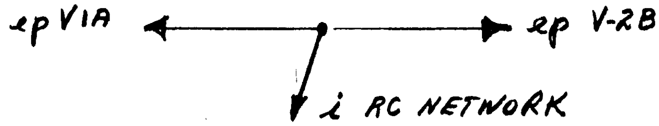


$\tan\theta = \frac{X}{R} = \frac{29.4}{5.8} \quad \theta \approx 79°$

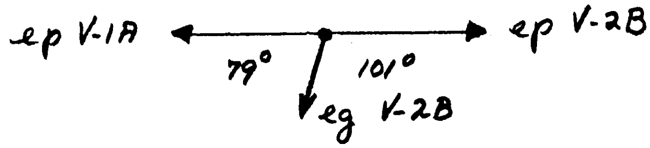
(1) the plate, pin 6, of V-2B connects to the plate, pin 2 of V-1B. This will be the reference vector.

(2) the signal voltage applied to the grid, pin 7, of V-2B is applied from the opposite side of the 200 KC tank. This is ep V-1A.

(3) the phase angle, Θ, of C-12, R-4, is 79 degrees; that is, the current in this network will lead the applied voltage by 79 degrees.



(4) since the voltage across R-4 is in phase with the current through it, and, since this voltage is also eg V-2B, the relationship between ep V-2B and eg V-2B may be drawn as follows:

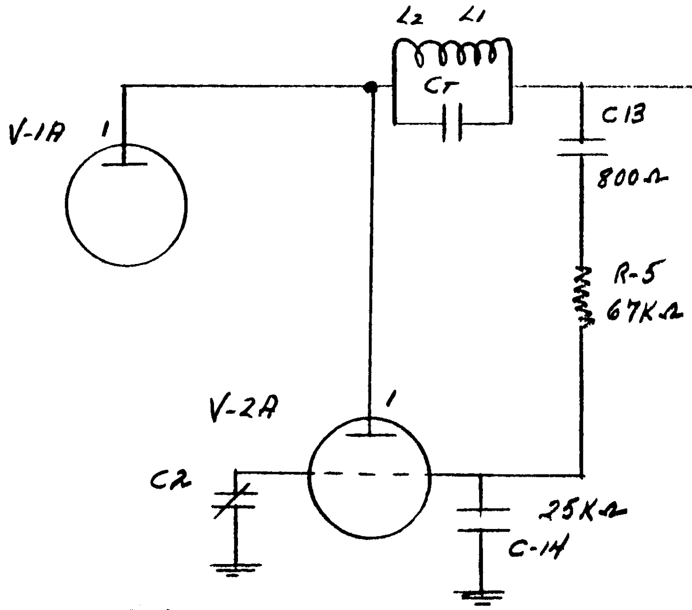


(5) the plate current of V-2B will be in phase with the grid voltage of V-2B. Since this plate current will lag the plate voltage, the tube is acting as an inductive reactance.

$$\frac{e_p\ V\text{-}2B\ \angle 0^\circ}{i_p\ V\text{-}2B\ \angle -101^\circ} = Z\ V\text{-}2B = X_L\ \angle +101^\circ$$

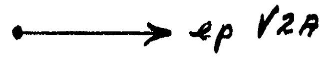
(6) thus, the current in V-2B is an inductive current.

e) simplified circuit of V-2A and the 200 KC oscillator:



$$Tan\ \theta = \frac{X}{R} = \frac{25}{67} \therefore \theta = 21^\circ$$

(1) the plate, pin 1, of V-2A, is connected to the plate, pin 1 of V-1A. This will be the reference vector.

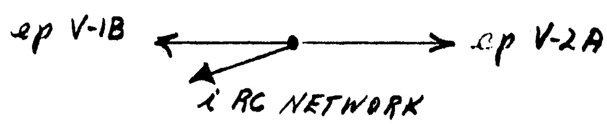


(2) the signal applied to the phase shift network in the grid circuit of V-2A is obtained from the opposite side of the 200 KC tank. This is ep V-1B.

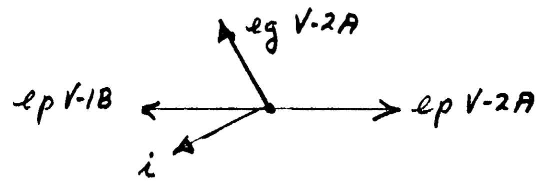
(3) C-13, with a relatively low reactance of 800 ohms, has little effect on the phase shift.

(4) the capacitive reactance of C-2 in parallel with C-14 is about 25 K ohms.

(5) the phase angle of the circuit of R-5, C-2, C-14, is about 21 degrees; that is, the current in this network will lead the applied voltage by 21 degrees.



(6) eg V-2A is the voltage across capacitors C-2, C-14; this voltage will lag the current in this network by 90 degrees.



(7) eg V-2A now leads ep V-2A by 111 degrees. Since the plate current will be in phase with the grid voltage, the plate current of V-2A will lead the plate voltage of V-2A by 111 degrees.

(8) V-2A acts as a capacitive reactance.

f) when a positive voltage is applied at pin 2 of V-2A, the capacitive current increases, as would be the case if capacity were increased. This lowers the frequency of the 200 KC oscillator. In addition, an increase of current in V-2A causes increased bias on V-2B, due to the common cathode bias arrangement. This reduces the inductive current in V-2B, which would be the case if inductive reactance had increased. This also assists in lowering the frequency.

g) when a negative voltage is applied at pin 2 of V-2A, the capacitive current in V-2A decreases; this would be the case if capacity were decreased. This tends to raise the frequency of the 200 KC oscillator. In addition, the reduced bias on V-2B causes an increase of inductive current, which would be the case if the inductance were decreased; this assists in increasing the frequency.

h) C-2 adjusts the phase shift at the grid, pin 2, of V-2A. During the alignment procedure, equal positive and negative voltages are alternately applied to the grid circuit of V-2A, and the linearity of the frequency shift of the 200 KC oscillator is noted. C-2 is adjusted for best linearity.

i) approximate voltage inputs to the grid circuit of V-2A are shown below, together with the corresponding shift of 200 KC oscillator frequency:

Voltage Applied	200 KC frequency Shift
Plus 1 volt	minus 130 cycles
Minus 1 volt	plus 130 cycles
Plus 3 volts	minus 370 cycles
Minus 3 volts	plus 370 cycles

8. The Balanced Mixer Circuit:

a) V-3 and V-4 operate as a balanced mixer circuit.

b) the two outputs of the 200 KC oscillator, 180 degrees out of phase, are fed to grid 3, pin 7, of each tube.

c) the primary crystal or VMO frequency is applied to the control grids, pin 1, of each tube, via a tuned circuit. The tuned circuit consists of C-18A, and either T-1 or T-2, depending on the band in use.

d) the plates of the mixer tubes are connected to a tuned circuit consisting of C-18B, and either T-3 or T-4, depending on the band in use.

e) C-18A and C-18B are ganged to the OUTPUT TUNING MC control, along with the tuning capacitor in the Power amplifier stage.

f) the tuned circuits are tuned to pass the sum of the primary frequency and the 200 KC oscillator frequency. The primary frequency is cancelled in the balanced mixer. MIXER BALANCE controls R-13 and R-84 are included to obtain as perfect a balance as possible.

9. The Power Amplifier Stage:

a) V-5 is a tuned Class B power amplifier, which raises the signal from the balanced mixer circuit to the maximum 3 watt level.

b) the control grid of V-5, pin 5, is connected to a voltage divider to a negative 105 volts. When terminal 8 of E-1 is ungrounded, V-5 will be cut off. This terminal is used for CW operation; under all other conditions, this terminal is grounded. The bias on V-5 is adjusted by POWER control R-22.

c) The output circuit at the plate of V-5 is a tuned tank, consisting of C-18C and either T-5 or T-6, depending on the band in use.

d) a feedback network is employed between the output and the control grid to neutralize the circuit should the load be removed. The feedback voltage is adjusted by C-27.

e) the plate current is monitored by PA PLATE CURRENT meter M-1.

f) a reduced output is available at MONITOR jack J-2.

g) C-27 is also used to eliminate parasitic oscillations.

10. The Power Supply:

Refer to Figure 8-1 in Model XFK Technical Manual

a) POWER ON OFF switch, S-8, applies power to the ovens and the power supply.

b) Two conventional full wave rectifier circuits are employed. The rectifier supplying the positive voltage employs a PI filter with choke. The rectifier supplying the negative voltage employs an RC filter network.

c) Both rectifiers use voltage regulator tubes to maintain the 105 volt supplies constant.

d) An unregulated 300 volts is applied to the power amplifier stage when PLATE ON OFF switch, S-4, is closed.

e) Two voltages are taken out to the terminal board, E-1, at the rear of the equipment. They are:

Plus 105 volts, regulated.

6.3 V. AC

These voltages are used when the Facsimile demodulator unit, Model XFD, is used in conjunction with the XFK.

DATE 10/19/51 SHEET 1 OF 10		TMC SPECIFICATION NO. S-155	A
AJJ (11-9-54) COMPILED	CHECKED	TITLE: TEST PROCEDURE: MODEL XFK	
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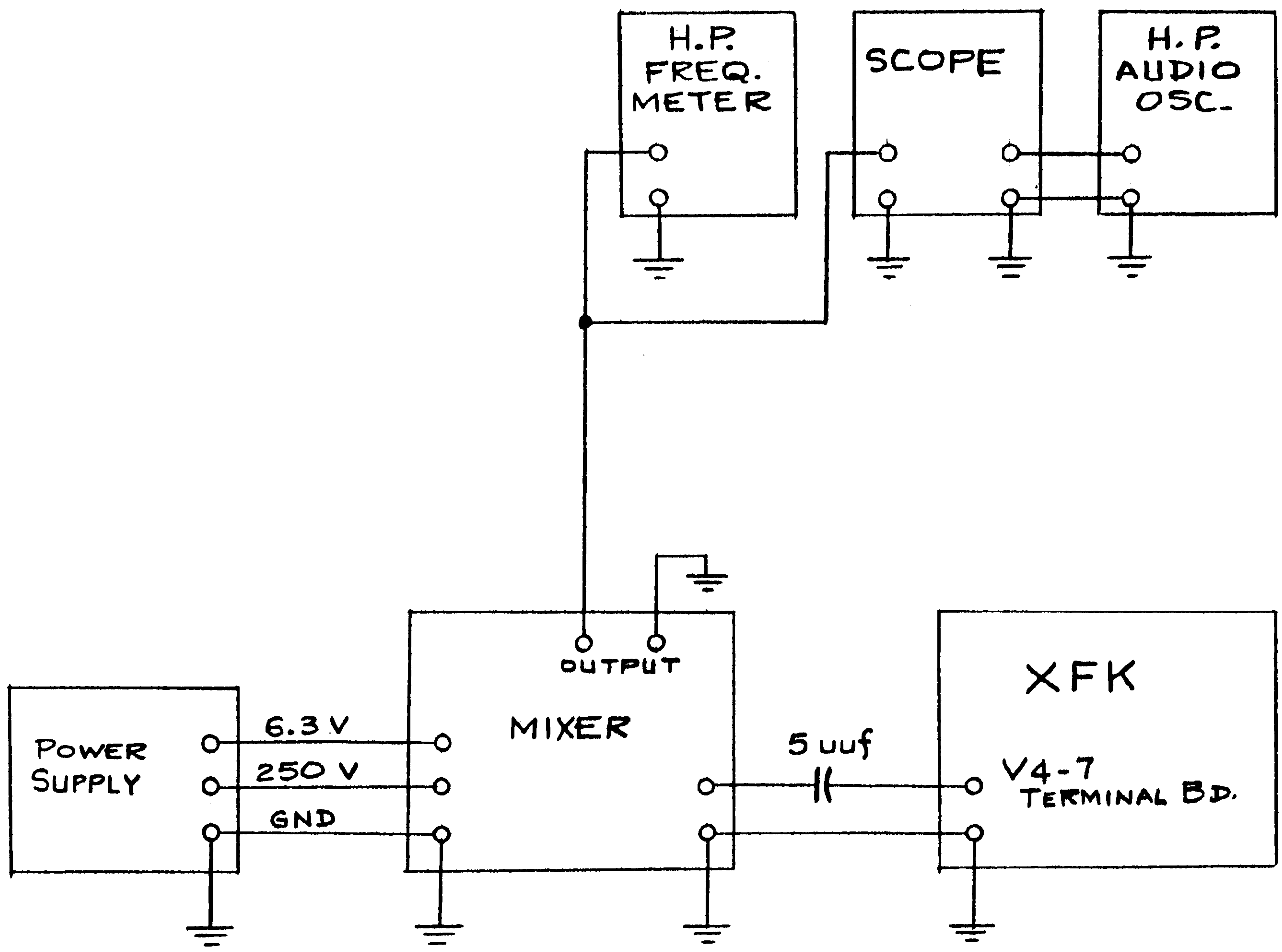
DIAGRAM NO. 1



DATE 10/19/51 SHEET 2 OF 10	TMC SPECIFICATION NO. S-155	A
COMPILED / CHECKED	TITLE: TEST PROCEDURE: MODEL XFK	
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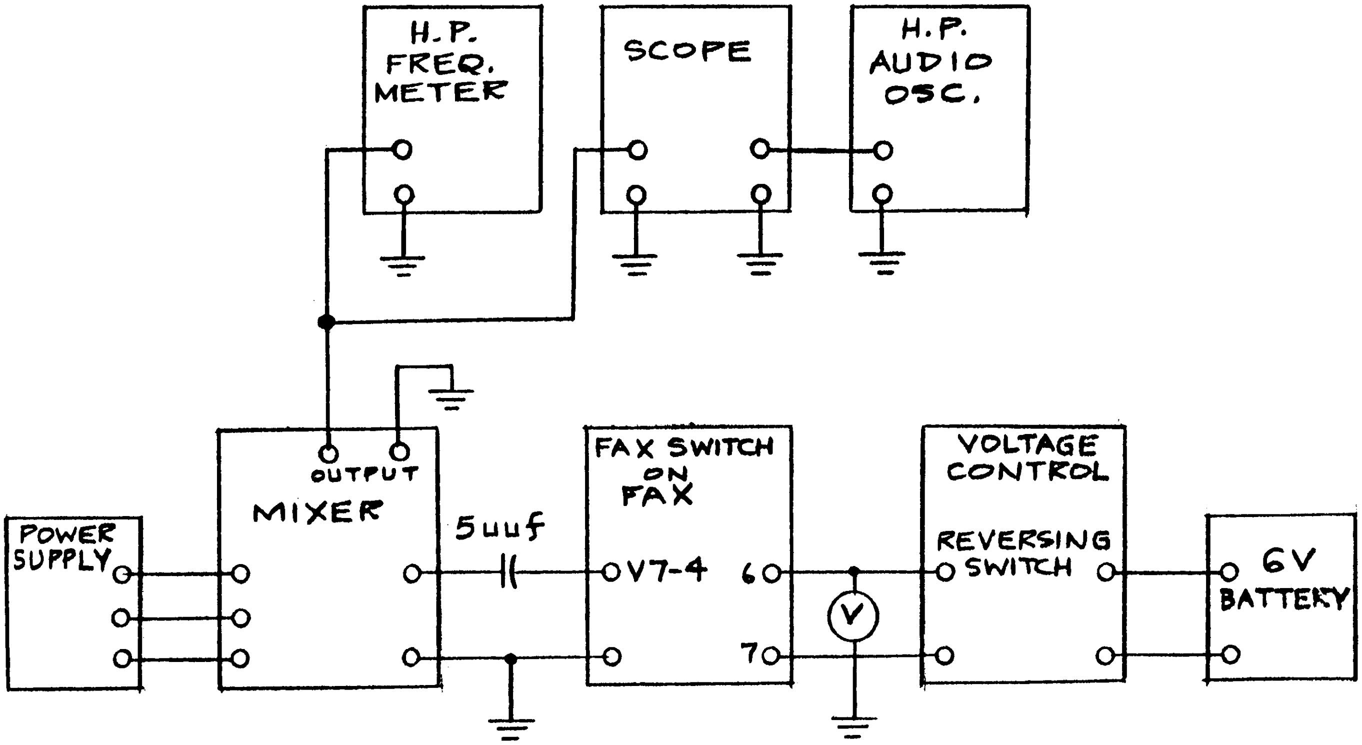
DIAGRAM NO. 2



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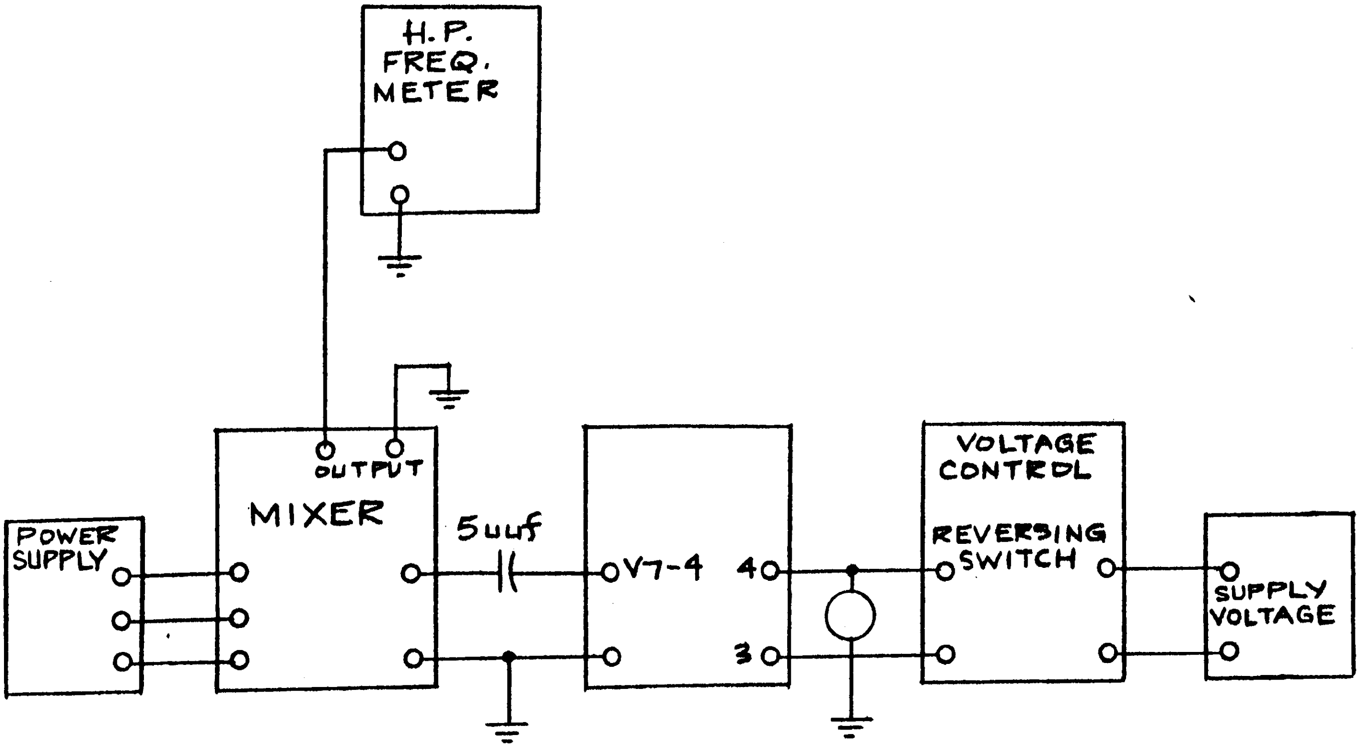
DATE 10/19/51 SHEET 3 OF 10	**TMC SPECIFICATION NO. S-155**	A
COMPILED / CHECKED	TITLE: TEST PROCEDURE: MODEL XFK	
APPROVED		

DIAGRAM NO. 3



FREQUENCY SHIFT EXCITER MODEL XFK

FREQUENCY CONTROL ELEMENTS

Test 1 (a) Remove F1 from fuse holder, with power switch on measure resistance at AC input terminals. -------- Ohms.

(b) Re-insert F1, place power on unit, note operation of both xtal and 200 KC ovens. From cold start ovens should reach operating temp. in 10 to 15 minutes.

(c) Check following voltages (50 ma plate current)

1. Output L4 310 volts
2. Pin 1 V10 105 volts
3. Pin 2 V11 105 volts

Test 2 200 KC Osc. test. Set up equipment as per Diagram # 1

SEE NOTE SHEET 7

(a) Record voltage (VTVM) pin 5, V 1 -25 to -30 volts
(b) REcord voltage " pin 6, V 1 -25 to -30 volts.
(c) Set C7 approx. 7 deg. out of full mesh, adjust dial calibration to -600 cycles. Rotate dial to 0 cycles. Set padder C8 for 0 beat.
(d) Set dial to plus 200 cycles record shift 200-220 cycles.
(e) " # " " 400 cycles record shift 400-440 cycles.
(f) Set dial to plus 600 cycles record shift 600-700 cycles.
(g) Set dial to minus 200 cycles record shift 200-220 cycles
(H) Set dial to minus 400 cycles record shift 400-440 cycles.
(i) Set dial to minus 600 cycles record shift 600-700 cycles.

Test 3 Reactance Tube Liniarity Test. Set up equipment as per Dwg #2

(a) Switch "Mode" switch to FAX
(b) Initial setting of C2 at half capacity point. Apply 1 volt to Fax terminals note liniarity on plus and minus voltages. Apply 3 volts and note liniarity. Recheck liniarity over voltage range adjusting C2 if necessary to produce the best results.
(c) Apply plus 1 volt Record shift 130-150 cycles
(d) Apply minus 1 volt " " 130-150 cycles
(e) Apply plus 2 volts " " 260-300 cycles
(f) Apply minus 2 volts " " 260-300 cycles
(g) Apply plus 3 volts " " 390-450 cycles
(h) Apply minus 3 volts " " 390-450 cycles
(i) Apply plus 4 volts " " 500-600 cycles
(J) Apply minus 4 volts " " 500-600 cycles
(k) Record voltage required for 1000 cycle shift 3.2-4 volts.

note: whenever C2 is reset to obtain better liniarity the 0 beat must be reset before applying test voltages.

Test 4 Keying Circuit Test. Set up eqipment as per Dwg. # 3.

Test 4 (con't)

(a) Switch " Mode" switch to Key.
(b) Connect all crystal positions to x 1 on the multiplier patch panel.
(c) Test switch on "Space" Record voltage pin 8 V7 70-75 volts
(d) Test switch on "Mark " Record voltage pin 8 V7 20-25 v olts
(e) Set ohmmeter to center arm of shift pot R8. Adjust pot to 400 ohms to ground. set dial to 50 cycles shift.
(f) Re-set shift dial to 500 cylces , Alternately switching from mark to space on test switch adjust R38 " Ballance Shift" so that mark and space shifts are equal. Adjust Shift Amplitude pot untill shift is plus/minus 250 cycles. readjust ballance pot if necessary.

(g)	Set shift dial to 100 cycles	Mark	45-55	cycles
(h)	" " " " " "	Space	45-55	cycles
(i)	" " " " 300 "	Mark	140-160	cycles
(j)	" " " " " "	Space	140-160	cycles
(k)	" " " " 900 "	Mark	440-460	cycles
(l)	" " " " " "	Space	440-460	cycles

(m) Set test switch to line. check minimum and maximum keying voltages

Test 5 Multiplication Panel Check

(a) Set shift dial to 800 cycles. Test switch to space. zero beat output. switch to mark note that shift is 800 cycles.
(b) Test each crystal position jack in x 1 multiplier , shift should remain at 800 cycles shift.
(c) Set jack to xtal # 1 multiplication x 1
(d) Recheck space zero beat and mark 800 cycle setting.

(e)	Plug into x 2	Record shift	400	cycles
(f)	Plug into x 3	" "	266	cycl es
(g)	Plug into x 4	Record shift	200	cycles
(h)	Plug into x6	Record shift	133	cycles
(i)	Plug into x 8	Record shift	100	cycles
(J)	Plug into x 9	Record shift	88	cycles

Upon completion of the above tests. Re-set zero setting with shift dial on zero. Place glyptol on ballance and amplitude shift pots.

Periodically during above tests glance at the oven indicators and note proper operation of both ovens.

DATE 10/19/51	Test Procedure XFK	THE TECHNICAL MATERIEL CORPORATION MAMARONECK, NEW YORK
DRN.		
CHKD.		
APPD. AJJ (11/9/54)		SHEET 5 OF 10 NO. S-155

REV. A

TEST PROCEDURE

FREQUENCY SHIFT EXCITER MODEL XFK

R.F. ALIGNMENT

Test 1 Alignment of Band 2

(a) Set up equipment as per dwg. No 1
(b) Switch band switch to Band No 2
(c) Set all ceramic trimmers in R.F. stages to minimum capacity.
(d) Check full mesh position of tuning condenser C 18 with indicator line on tuning dial.
(e) Insert 2.6 mc. xtal in socket # 1
(f) Insert 4.8 Mc. xtal in socket # 2
(g) Insert 6.3 mc. xtal in socket # 3
(h) Switch to xtal position # 1 , set dial to 2.8 mc.
(i) Connect VTVM (neg) to pin 1 V 4, Tune T1 for maximum voltage Record 5.5-10.0 volts
(j) Set R.F. probe to pin 5 of V5, tune T3 for maximum voltage, select first peak going in from minimum inductance. 5.5-10.0 volts
(k) Tune T5 for maximum current in thermocouple meter. retune T3

(l) Switch to xtal position 3, tuning dial to 6.5mc.
(m) Set VTVM to pin 1 V4, tune C30 for maximum voltage 7-11 volts
(n) Set R.F. probe to pin 5 V5 , tune C43 for maximum output 8-13 volts
(o) Tune C 46 for maximum output on thermocouple meter.
(p) Remove 6J6 200 kc. osc. tube. and ballance out carrier.
(q) Disconnect Thermocouple ammeter, rotate tuning condenser over entire tuning range note prescense of parasitics (xtal switch to Ext position) Presence of parasitics will be indicated by apparent tuning of plate current with no drive from crystal. Tune to such parasitic and remove such by tuning condenser trimmer C 27.
(r) RE-track both ends of bands.
(s) Switch to xtal position 2 tune tuning condenser for output peak note calibration of dial near 5 mc.
(t) Check for proper side band selection in alignment.

(u)	Tune xtal # 1	2.8 mc	15 V.	Across 70 Ω
(v)	Tune xtal # 2	2.8 mc	15 V.	Output
(w)	Tune xtal # 3	6.5 mc	18-25 V.	Load

DATE 10/19/51	Test Procedure XFK	THE TECHNICAL MATERIEL CORPORATION MAMARONECK, NEW YORK
DRN.		
CHKD.		
APPD. AJJ (11/9/54)		SHEET 6 OF 11 NO. S-155

Test 2 Alignment of Band 1

(a) Insdrt 1.0 mc xtal in socket # 1
(b) Insert 1.5 mc xtal in socket # 2
(c) Insert 2.1 mc xtal in socket # 3
(d) Switch to band No 1, set dial to 1.2 mc.
(e) Connect VTVM(neg) to pin 1 V4, Tune T2 for maximum voltage record 10-15 volts
(f) Set R.F. probe to pin 5 V5, Tune T4 for maximum voltage select first peak going in from minimum inductance. 8-13 volts
(g) Tune T6 for maximum output on thermocouple meter.
(h) Switch to xtal position #3, Tumimg dial to 2.3mc.
(i) Set VTVM to pin 1 V4, tune C19 for maximum voltage 10-15 volts
(j) Set R.F. probe of VTVM to pin 5 of V5, tune C24 for maximum voltage 11-17 volts
(k) Tune C 28 for maximum output on thermocouple.
(l) Re-check band for parasitics.
(m) RE-track both ends of band.
(n) switch to xtal #2, check calibration at output, 1.7 mc
(o) check for proper side band selection.

(p)	Tune xtal #1	1.2 mc	18-25 V.	Across 70 Ohm Output Load
(q)	Tune xtal #2	1.6 mc	18-25 V.	
(r)	Tune xtal #3	2.3 mc	20-30 V.	

DATE 10/19/51	TMC SPECIFICATION NO. S-155	A
SHEET 8 OF 10		
COMPILED / CHECKED	TITLE: TEST PROCEDURE: MODEL XFK	
APPROVED		

TEST DATA SHEET, MODEL XFK

Test 1
(a) AC input 175 ohms

Test 2
(a) Pin 5 V1 ______volts
(b) Pin 6 V1 ______volts
(d) Plus 200 cycles ______cycles
(e) Plus 400 cycles ______cycles
(f) Plus 600 cycles ______cycles
(g) Minus 200 cycles ______cycles
(h) Minus 400 cycles ______cycles
(i) Minus 600 cycles ______cycles

Test 3
(c) Plus 1 volt ______cycles
(d) Minus 1 volt ______cycles
(e) Plus 2 volts ______cycles
(f) Minus 2 volts ______cycles
(g) Plus 3 volts ______cycles
(h) Minus 3 volts ______cycles
(i) Plus 4 volts ______cycles
(j) Minus 4 volts ______cycles
(k) 1000 cycle shift ______volts

Test 4
(c) Pin 8 V7---Space ______volts
(d) Pin 8 V7---Mark ______volts
(g) 100 cycles Mark ______cycles
(h) 100 cycles Space ______cycles
(i) 300 cycles Mark ______cycles
(j) 300 cycles Space ______cycles
(k) 900 cycles Mark ______cycles
(l) 900 cycles Space ______cycles
(m) minimum keying voltage space ______volts
(n) minimum keying voltage mark ______volts

Test 5
(e) X2 ______cycles
(f) X3 ______cycles
(g) X4 ______cycles
(h) X6 ______cycles
(i) X8 ______cycles
(j) X9 ______cycles

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TEST DATA SHEET, MODEL XFK

R.F. Alignment

Test 1

(i) Tune T1		______volts DC
(j) Tune T5		______volts RF
(m) Tune C30		______volts DC
(n) Tune C43		______volts RF
(p) Balance out Carrier		______OK
(q) Parasitics		______OK
(u) Tune xtal #1	______mc	______volts
(v) Tune xtal #2	______mc	______volts
(w) Tune xtal #3	______mc	______volts

Test 2

(e) Tune T2		______volts DC
(f) Tune T4		______volts RF
(i) Tune C19		______volts DC
(j) Tune C24		______volts RF
(l) Parasitics		______OK
(p) Tune xtal #1	______mc	______volts
(q) Tune xtal #2	______mc	______volts
(r) Tune xtal #3	______mc	______volts

FREQUENCY SHIFT EXCITER
MODEL XFK

SERIAL NO. 121
DATE ________

TYPICAL VOLTAGE DATA SHEET

TUBE SYM.	FUNCTION	TYPE	PIN	VOLTS	PIN	VOLTS	PIN	VOLTS	PIN	VOLTS	PIN	VOLTS	PIN	VOLTS	PIN	VOLTS
V1	200 KC OSC.	6J6	1	85	2	85	5	-29	6	-29	7	0	4	AC 6.3		
V2	REACTANCE TUBE	12AU7	1	85	2	0	3	8.2	6	85	7	0	8	7.8	5	AC 6.3
V3	MIXER	6BE6	1	-6	2	2	5	320	6	100	7	-7.3	4	AC 6.3		
V4	MIXER	6BE6	1	-6	2	2	5	320	6	100	7	-7.3	4	AC 6.3		
V5	RF AMPLIFIER	2E26	3	150	5	-11	CAP	360	7	AC 6.3						
V6	XTAL OSC. & BUFFER	12AU7	1	80	2	-7.7	6	250	7	0	8	11.5	5	AC 6.3		
V7	KEYER(SPACE)	12AU7	1	70	2	0	3	12	6	105	7	70	8	70	5	AC 6.3
V7	KEYER(MARK)	12AU7	1	13	2	13	3	13	6	105	7	13	8	21		
V8	RECTIFIER	5UG4	8	360	4	AC 360	6	AC 360	2-8	AC 5						
V9	RECTIFIER	6X4	1	380	6	380	7	AC 360	4	AC 6.3						
V10	REGULATOR	OB2	1	105												
V11	REGULATOR	OB2	2	100												

ALL VOLTAGES TAKEN TO GROUND WITH VTVM
2.3 CRYSTAL TUNED TO 2.5 mc BAND 2

DATE 3-18-53
DRN. C.D.D.
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APPD. ATJ 11/9/54

TYPICAL VOLTAGE DATA SHEET
REV. A

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SHEET 10 OF 10 NO. S-155