INSTRUCTION BOOK

for

FREQUENCY SHIFT CONVERTER MODEL CFA

●

THE TECHNICAL MATERIEL CORP.
Mamaroneck, N. Y.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

SECTION 1
GENERAL DESCRIPTION

1. PURPOSE AND BASIC PRINCIPLES

a. The MODEL CFA Frequency Shift Converter is a device used in radio frequency shift receiving systems to convert the mark and space tones from the output of a single receiver or receivers in diversity into DC pulses capable of operating a teleprinter, tape recorder or any device requiring make and break signals.

b. The Model CFA accomplishes its purpose by completely electronic means and has incorporated in it the capacity to easily correct for bias distortion of appreciably more than plus or minus 30%.

c. The Model CFA contains a newly engineered drift compensating circuit, which will accomodate total receiver drifts up to 1500 cps with no interruptions in service. Specifically, a total drift of 1200 cps will be tolerated when the input signal is being shifted 850 cps.

d. Every effort has been made to take advantage of the FM nature of the frequency shift principle. Maximum integration or de-emphasis, as it is called in FM terminology, has been employed to assist in the rejection of noise.

e. As a further illustration of point (d.), above, each channel has incorporated within it a series of limiter-amplifiers to effectively eliminate amplitude modulation and noise peaks superimposed on the signal carrier.

f. A CR type visual monitor is provided to permit extremely simple, straightforward, and rapid "setting up" and to facilitate receiver tuning in. By observation of the visual monitor the operator will know when he is precisely at the discriminator center, but also in which direction he has drifted and may judge approximately how far off center he has drifted.

g. The output is made available for external use through a special all electronic keying stage which operates exactly as neutral relay contacts. The output terminals may then operate floating or either side grounded with external battery.

2. DESCRIPTION OF UNIT

a. The Model CFA converter is illustrated in Figure 1-1. The front panel is 3/16" thick by 19" long and is only $3\frac{1}{2}$" high and is finished in TMC Gray enamel. The total dimensions into the rack, including rear panel control protrusions, is 16".

b. Weight: 30 pounds.

c. The controls are so placed as to permit the

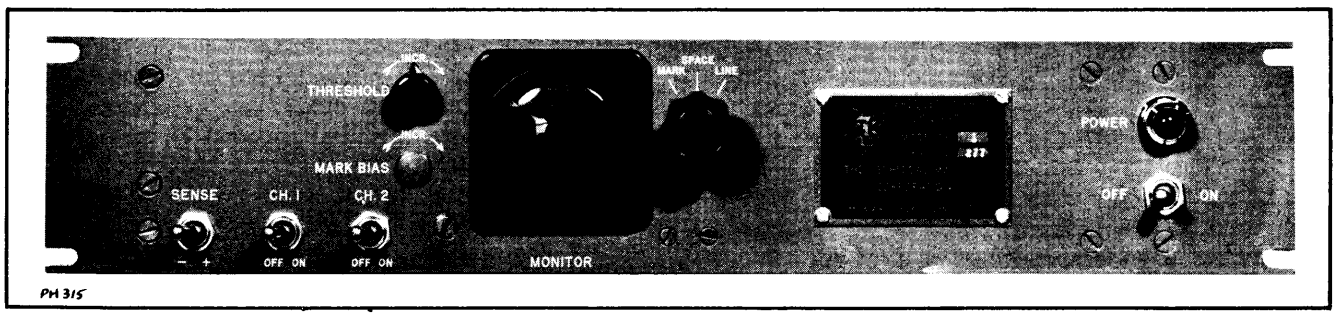


Figure 1-1. Frequency Shift Converter, Model CFA-1.

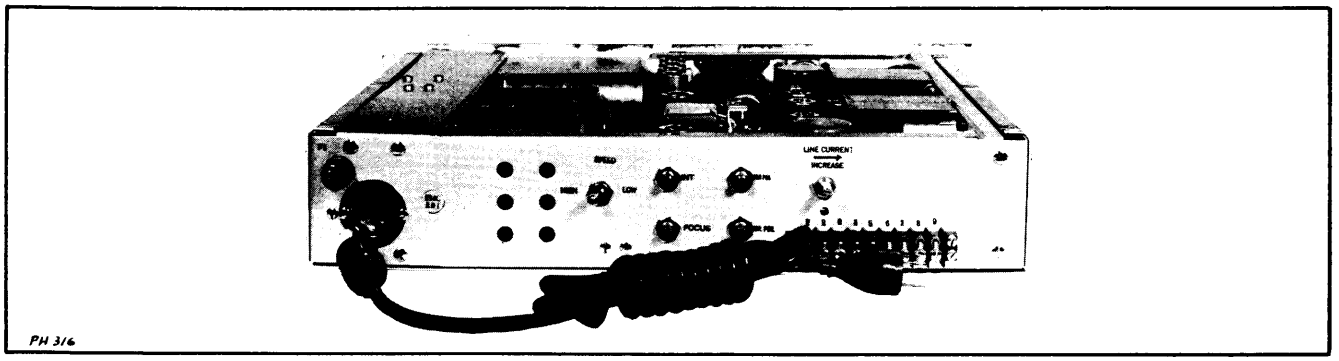


Figure 1-2. Frequency Shift Converter, Model CFA-1. Rear View

greatest degree of simplicity in operation. The front panel controls are:

1. Primary Power Switch.
2. Channel #1 ON/OFF Switch.
3. Channel #2 ON/OFF Switch.
4. Monitor Intensity.
5. Monitor Focus.
6. Mark/Space/Line Test Switch.
7. Mark Bias Control.
8. Threshold Control.

The rear panel controls are:

1. High/Low Speed Switch.
2. Line Current
3. Monitor Vertical Positioning.
4. Monitor Horizontal Positioning.
5. Sense Switch.
6. Pulse Restorer Bias Control. (R59)

d. The components are so mounted that troubleshooting and corrective maintenance may easily be accomplished.

e. Tube Complement: All JAN miniature and octal tubes as follows:

V1 - 6AU6, Tone Amplifier (Channel #1).
V2 - 6J6, Tone Limiter (Channel #1).
V3 - 12AU7, Tone Power Amplifier (Channel #1 & 2).
V4 - 6AU6, Tone Amplifier (Channel #2).
V5 - 6J6, Tone Limiter (Channel #2).
V6 - 6AL5, Discriminator Rectifier (Channel #1).
V7 - 6AL5, Discriminator Rectifier (Channel #2).
V8 - 6AL5, Clamp
V9 - 6AU6, Pulse Amplifier.
V10 - 6AU6, Pulse Amplifier.
V11 - 12AU7, Monitor D.C. and A.C. Amplifiers.
V12 - 6J6, Pulse Restorer.
V13 - 12AU7, Cathode Follower, Oscillator.
V14 - 6Y6G, Pulse Output.
V15 - 5Y3GT, Positive Supply Rectifier.
V16 - 6X4, Negative Supply Rectifier.
V17 - OB2, Voltage Regulator.
V18 - OA2, Voltage Regulator.
V19 - OB2, Voltage Regulator.
V20 - OB2, Voltage Regulator.
V21 - 2BP1, Monitor.
V22-6AL5, Output Rectifier.

SECTION 2
THEORY OF OPERATION

1. GENERAL DESCRIPTION OF CIRCUITS

Because the frequency shift principle is in no way dependent upon amplitude modulation for the conveying of intellegence, it is possible to exploit every advantage inherent in frequency modulation systems. That this was done in the Model CFA will become evident in the discussion which follows: Figure 2-1 is a functional Block Diagram of the CFA showing the routing of signal from input to output. NOTE: For additional information regarding wave shapes refer to Fig. 4.

a. THE LIMITER-AMPLIFIERS.- (V1, V2, and V3 or V4, V5, and V3) Superimposed upon every carrier will be noise peaks, the degree of amplitude modulation of the carrier by these noise peaks being a function of the signal to noise ratio. It is the purpose of the limiter to rid an incoming signal of these peaks so that the remainder of the circuits will not interpret them as being mark or space pulses. The limiter, by the same token, rejects interference from nearby voice or music modulated signals.

For this reason, therefore, a twin set-up is utilized whereby each channel from the dual diversity receiver system passes through discreet limiter stage.

The limiter proper (V2 or V5) may be broken down into two triode stages, the first being a cathode follower and the second being cathode coupled to the first.

When a small positive signal swing appears at the grid of the first section, this positive voltage is translated through the cathode coupling to the second section. The effect is to quickly cut-off the second section so that any additional voltages such as noise peaks do not appear in the limiter output. When a small negative signal swing appears at the grid of the first section, the first section is quickly cut off and, again, the noise peaks are eliminated.

The limiter proper (V2 or V5) is preceeded by an additional limiter-amplifier (V1 or V4) which operates at very low signal levels. The circuit is so designed that the tube easily reaches grid current saturation and plate current cut-off on positive and negative peaks respectively. The cumulative effect of these two stages (i.e., V1 & V2 or V4 & V5) in tandem is to remain "choked up", so to speak, as long as an audio tone of better than approximately 20 millivolts is present at the input. The power amplifier (V3) therefore sees only the "phase" portion of the original noise.

The power amplifier amplifies the limited audio

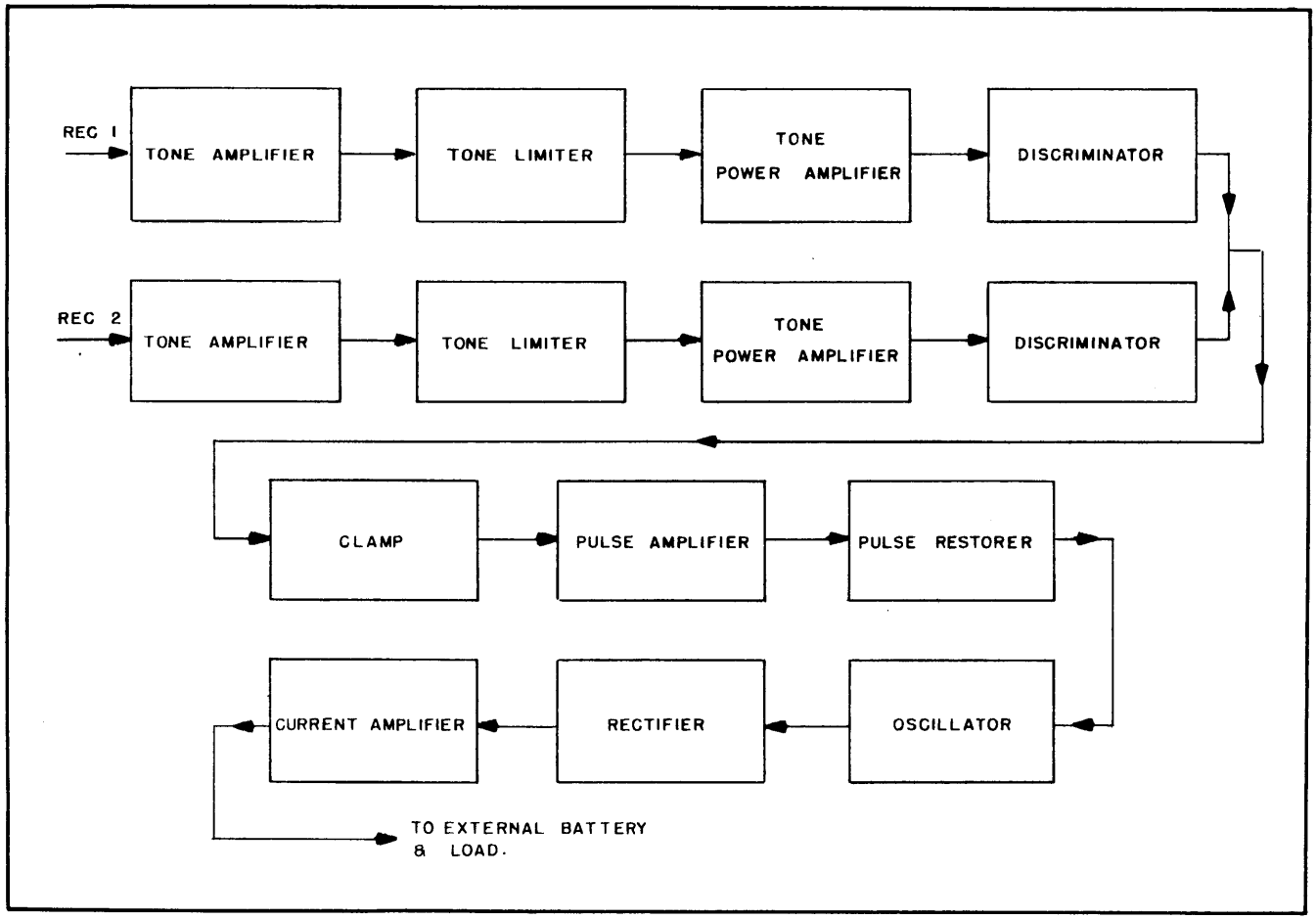


Figure 2-1. Functional Block Diagram

tone and feeds it to the discriminator resonant circuits.

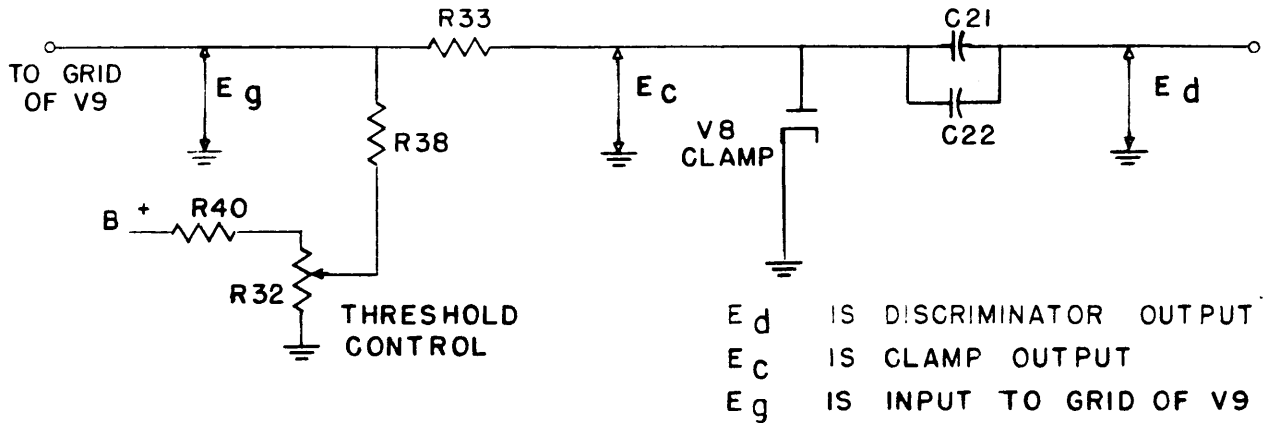
b. THE DISCRIMINATOR.- The discriminator consists of two resonant circuits, one resonated above and the other resonated below center frequency in such a manner that maximum shift and drift conditions may be met without exceeding the distance between the resonant peaks. The voltage across each circuit is a function of the tone frequency.

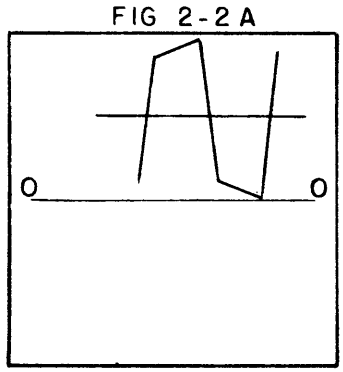
c. THE DISCRIMINATOR RECTIFIERS.- (V6 and V7) The tone voltage across each resonant circuit is rectified by the discriminator rectifiers and then added in the discriminator load (R92, R93, C17, and C18). A shift in frequency from mark to space would then cause a change in voltage across the resonant circuits. This change in voltage, which is proportional to the amount of shift, is rectified, diversity combined, filtered, and fed to the clamp. Its form approaches a square wave because the shift from one frequency to another is an abrupt one.

As an additional precaution against noise, a low pass filter or de-emphasis network is included in the form of C19 and C20.

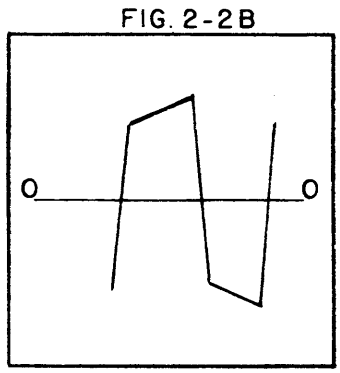
d. THE CLAMP.- (V8) The voltage produced at the output of the discriminator load is symmetrical to an axis which may be positive or negative with respect to ground. The potential magnitude and polarity represented by this axis is a function of the degree and direction of drift. (Fig 2-2 AB & C) The object of the clamp is, to treat this drift produced voltage in such a manner that the remaining pulse circuits are unaware of its presence. Otherwise, the quiescent operating point of V9 would be shifted over a wide range thus producing varying degrees of bias distortion.

Observation of the Schematic Diagram Figure 6-6 will show that the clamp is connected so that it conducts whenever a positive potential appears at its plate. Imagine, for the moment, that the threshold control has been turned counter-clockwise to zero. It can then be seen that, due to the presence of the clamp, no positive voltage will ever appear at the grid of V9. C21 and C22 will permit the passage of no D.C. and the clamp allows the charging of these condensers in such a manner that the waveform which is passed will have its uppermost peak at ground potential. (Fig. 2-2D) When the threshold control is properly adjusted, a fixed positive potential will appear at

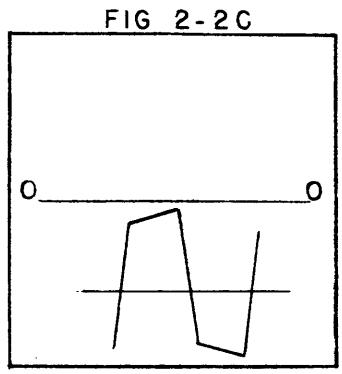




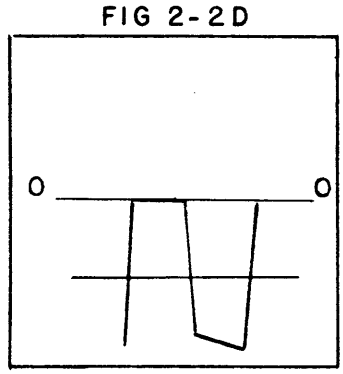
E d WITH DRIFT



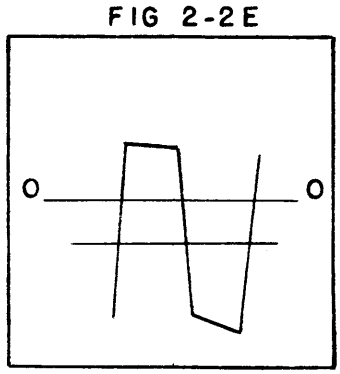
E d WITH NO DRIFT



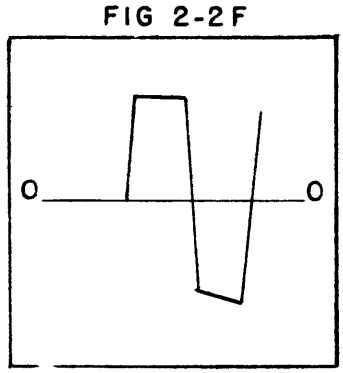
E d WITH DRIFT



E c DOES NOT
CHANGE WITH DRIFT



E g WITH INSUFFICIENT
THRESHOLD



E g WITH PROPER
THRESHOLD SETTING

NOTE:
(E g SEEN WHILE V9 IS REMOVED FROM SOCKET.)
ALL PATTERNS SEEN USING HIGH IMPEDANCE SCOPE
WITH DC AMPLIFIER (SUCH AS DUMONT 304 H
WITH 2507 PROBE)

Figure 2-2. Illustration of the Clamp & Threshold Operation

the grid of V9 and the waveform from the clamp will be symmetrically superimposed on this voltage. Since the clamp output is a function of shift, then the amount of threshold necessary to symmetrically orient this output waveform with respect to ground will also be a function of shift. (Fig 2-2 E&F)

When keying stops or the signal drops out the threshold voltage serves to bring V9 into a state of grid saturation so that random noise or a nearby amplitude modulated signal will not force the teleprinter from its standby condition.

e. V9, THE PULSE AMPLIFIER (V9).- V9 is a high gain amplifier which reaches grid saturation and plate current cut-off at very low input voltages. Its output will then be an essentially square wave. The first pulse amplifier feeds an integrating network which serves to give its output a "saw-tooth" slope.

f. V10, THE SECOND PULSE AMPLIFIER (V10).- This tube operates essentially like the one which preceeds it. The Mark Bias Control, by shifting the input waveform with respect to ground, determines the length of the time axis between the points where this waveform approaches zero potential. These points are very nearly where V10 goes into grid saturation and plate current cut-off so that the width of the output waveform is then a function of the setting of the Mark Bias Control.

The output waveform then passes through a differentiating network so that the front and back edges of this square wave produce sharp positive and negative voltage pips.

g. THE PULSE RESTORER (V12).- The pulse restorer is a "one shot" multivibrator which, when keyed in a given direction, will remain in one state until an opposite impulse sends it into another state, where it will again remain. The sharp wave front from the differentiating network serves to key this stage. Due to the action of the threshold circuit, this stage will automatically receive a Mark pulse when keying stops or the signal drops out completely.

h. THE CATHODE FOLLOWER ($\frac{1}{2}$V13).- The cathode follower simply serves as an isolating stage between the oscillator and the pulse restorer. Its output is precisely like its input with the exception of a loss in signal amplitude.

i. THE OSCILLATOR ($\frac{1}{2}$V13).- A conventional Hartley circuit is used here, the stage being permitted to oscillate only when the cathode follower does not force the oscillator grid into the cut-off region. The reason for having provided this additional stage is to allow for complete D.C. isolation of the pulse circuit which feeds the teleprinter. This is done through transformer coupling to the oscillator output (T7) which is rectified by four crystal diodes and then filtered and fed to the pulse output stage.

j. THE PULSE OUTPUT (V14).- The Pulse Output stage operates at either grid saturation or plate current cutoff. The teleprinter constitutes the plate load, the current being adjustable by use of the series rheostat, R77.

k. THE MONITOR SECTION (VII AND V21).- A constant amplitude vertical sweep for the monitor is obtained by utilizing both the tone input to V3 and a part of the Oscillator output. Each horizontal plate is fed by an amplifier, both amplifiers deriving their inputs from the same point on the discriminator output. It is the difference voltage between these two amplifier outputs which produces a horizontal sweep.

As has already been discussed in the Clamp section (Para. #4), an average D.C. potential appears at the discriminator output when drift takes place. Since one of the Monitor amplifiers is a D.C. amplifier, its output will differ from the other amplifier by an amount proportional to this D.C. potential. (The gain of each amplifier is adjusted to be exactly equal to the other). It can be seen, therefore, that the greater the drift becomes, the more sweep voltage will be produced. When the tone input is being keyed about the discriminator center frequency, there will be no horizontal sweep voltage and only a vertical line will appear on the Monitor face. As drift occurs, the line will open to the left or right into a rectangle of varying horizontal dimension, depending upon the direction and degree of drift.

SECTION 3
INSTALLATION AND OPERATION

1. INSTALLATION

a. The Model CFA Frequency Shift Converter has been so designed that its installation and operation will require a minimum of effort from the user. Because of the wide permissible drift range, the receivers feeding the CFA need not be disturbed over long periods of time. All controls have been preset at the factory testing laboratory for nominal 850 cps shift, however, if it becomes necessary

to change these controls to accomodate other shifts, or correct for distorted signals, the necessary instructions will be found in this section.

b. Connect the CFA to a line source of 110 volts, 50/60 cps. For 220 volt operation the power transformer taps must be changed.

c. Referring to Terminal Board E-1 (Rear panel):

(1) Connect the dual diversity receiver audio outputs (600 ohms) to the terminals marked Channel 1 (Posts 1&2) and Channel 2 (Posts 3&4). For single receiver operation, the audio output should be connected to feed both channels simultaneously.

(2) Connect a power supply capable of reasonable regulation and having an output of approximately 200 volts at 70 mills to terminals 6 (Plus) and 7 (Minus). The TMC Model PSP-1 Power Supply has been expressly designed to fulfill this function.

2. INITIAL ADJUSTMENTS

After the converter has been installed and wired in accordance with Section 3-1 the converter should be operated and checked. Adjustments should be made only if checks indicate such a need.

a. Initial Check - Make an initial check on the converter as follows:

(1) Turn the line current rheostat (R-77, Rear Panel) in the full counter-clockwise direction for minimum current.

(2) Place a 100 ma. milliammeter in series with the teleprinter load and connect the series combination to terminals 8&9.

When using the PSP-1, the milliammeter may be ommited since one has already been provided on the PSP-1 front panel.

(3) Turn the CFA and the teleprinter power supply power switches to ON. The pilot lamps should light. Permit a sixty second minimum warm-up period.

(4) Place Test Switch (S6, Front panel) in Mark position.

(5) Adjust Line Current Rheostat (R77, Rear Panel) for 60 ma to the teleprinter load. If the printer does not revert to standby or mark condition, then the connections to the printer load must be reversed for proper operation.

(6) Return Test Switch to Line condition.

NOTE

In dual diversity receivers it is possible to improperly set one of the BFO controls so that one diversity channel output shows Mark while the other shows Space. For this reason, it is recommended that receivers be used which have common BFO's and high frequency oscillators similar to the arrangement contained in the TMC Model DDR-2 Dual Diversity Receiver.

3. OPERATIONAL CHECKS AND ADJUSTMENTS

a. RECEIVER TUNING

(1) Turn Channel 1 Switch (S2, Front panel) to On position.

(2) Turn Channel 2 Switch (S3, Front panel) to Off position.

(3) Tune Channel 1 receiver until it is properly centered on the discriminator as indicated by the visual monitor.

When properly centered on a keyed signal, the pattern approaches a thin vertical line on the face of the Monitor tube. As the receiver is tuned to one side of the discriminator the pattern will open into a rectangle to the left or right depending upon the direction of tuning. The operator should so tune the receiver that he may see one rectangle appear after the other rectangle disappears upon passing through the discriminator center. Only then may he be certain that he is operating in the region of the discriminator center rather than on one of its outer slopes. (Figure 3-1)

Similarly, when drift occurs, the center line will expand into a rectangle as in the case of tuning.

(4) Receiver One, Channel One, is now properly tuned. In order to repeat this process for Channel Two, Channel One switch should be turned to the OFF position and Channel Two switch to the ON position. Using the visual monitor, repeat the tuning process for Channel Two. Both channels are now properly tuned and may be used simultaneously for diversity action by placing both channel switches in the ON position.

(5) For single receiver operation, only the channel used (usually both) should be left in the ON position.

(6) For normal teleprinter speeds, not exceeding 100 wpm, the Speed Switch (S5, Rear Panel) should be left in the LOW position.

(7) The position of the Sense Switch (S4, Rear panel) is correct when the receiving printer functions properly.

b. SHIFT AND BIAS ADJUSTMENT.- As stated in the introductory paragraph, the CFA Con-

verter was set up at the factory for optimum operation on a circuit using 850 cps shift fed from an undistorted source. The equipment may be adjusted to accomodate other shifts and biased or distorted signals in the following manner:

(1) **SHIFT ADJUSTMENT.-** The Threshold Control (R32, Front panel) has been so designed that full clockwise rotation is proper for 1 kc. shift. Other shifts may be set by linear clockwise rotation of the Threshold Control in proportion to the amount of shift. (i.e., full rotation is 300 degrees. For 850 cps shift, the Threshold Control would be rotated clockwise by 850/1000 of 300 or about 250 degrees.)

This setting is by no means critical except at very low shifts.

(2) **BIAS ADJUSTMENT.-** The CFA has in-

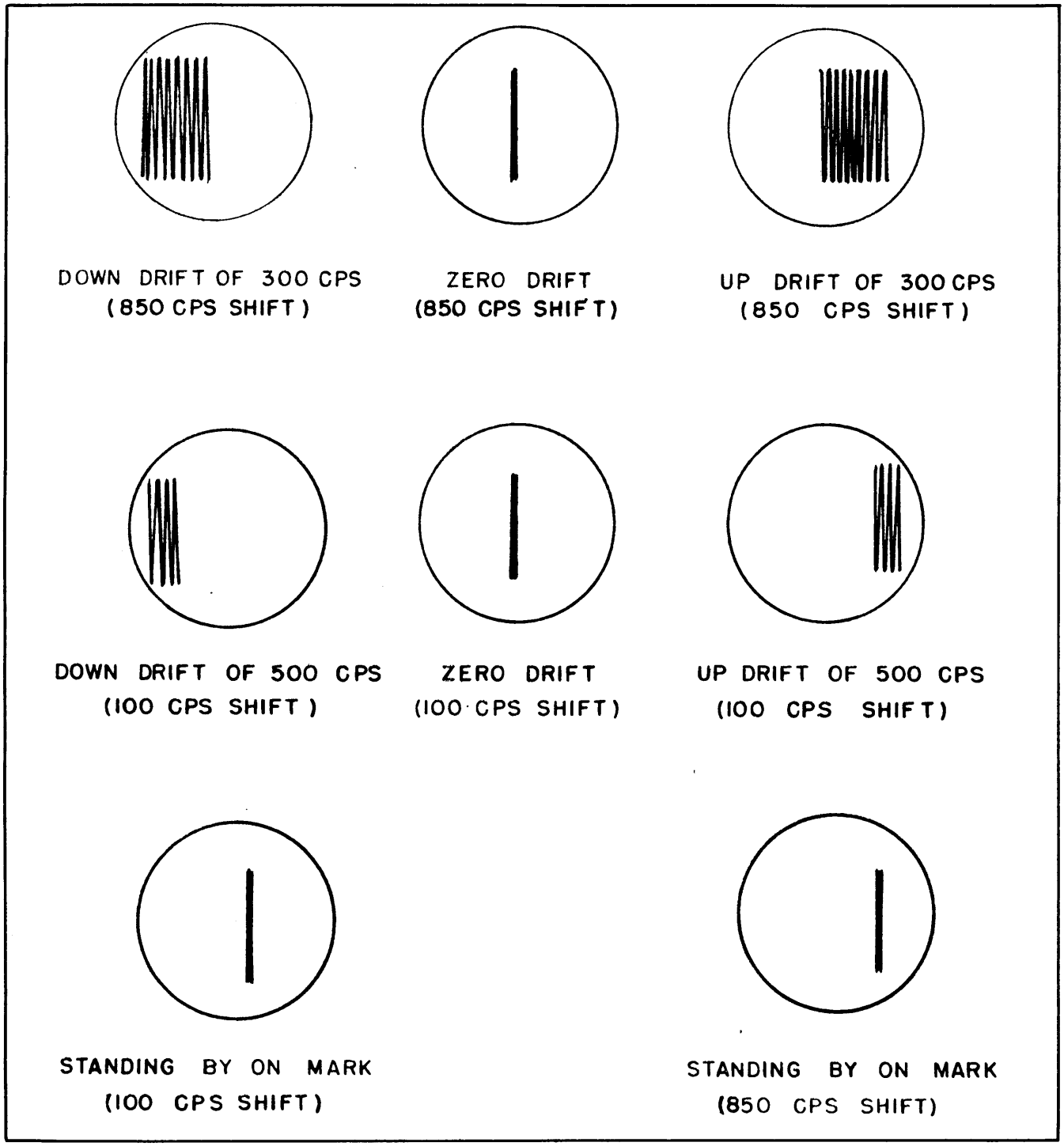


Figure 3-1. Monitor Patterns

corporated in it a Mark Bias Control (Bias Correction Control) which enables the operator to correct for fixed mark or space distortion in the received signal or in the teleprinter.

After the Threshold Control has been properly set for the shift of the received signal, the Mark Bias Control (R45, Front panel) should be set near its center point. The range of the teleprinter should then be determined. If the teleprinter range is satisfactory, no further adjustment is necessary. If the range is not satisfactory, proper rotation of the Mark Bias Control will produce the desired results. It is suggested that several adjustments of the Mark Bias Control be made and range readings taken after each setting. A Distortion Test Set, if available, will more easily facilitate these adjustments.

If, when very low shifts are used, the proper range is not obtainable by use of the Mark Bias Control, then the Threshold Control should be rotated slightly clockwise or counter-clockwise until the teleprinter commences to print. The Mark Bias Control may then be properly adjusted as has already been described.

c. C.W. OR F.S. MORSE OPERATION.-

(1) FREQUENCY SHIFT MORSE.- Set up exactly as for teleprinter service. The distortion control (Mark Bias Control) is no longer of great importance and may simply be set to give the operator a choice in the relative spacing of dots and dashes.

(2) CARRIER KEYED C.W.- Set up exactly as for teleprinter service with the exception that the receiver or receivers are tuned to one of the slopes of the discriminator curve rather than the discriminator center. The side of the curve used will depend upon the setting of the Sense Switch. The operator should vary the BFO control on his receiver until output pulses are obtained and optimum copying occurs.

The phase relationship in the CFA has been so arranged that dots and dashes will produce spaces in the Pulse Output tube.

NOTE

R59 (Rear Panel) sets the Pulse Restorer bias so that the stage will remain stable. It should be set so that the teleprinter remains in Mark condition when keying stops. (Usually about 250 degrees clockwise).

SECTION 4
OPERATORS MAINTENANCE

The Model CFA Frequency Shift Converter has been designed to provide long term, trouble free, continuous 24 hour a day operation. It is recommended that any maintenance to the equipment be done by a competent maintenance technician.

1. EMERGENCY MAINTENANCE

a. NOTICE TO OPERATORS.- Operators should not perform any of the following emergency maintenance procedures without proper authorization.

b. REPLACEMENT OF TUBES AND FUSES.

(1) Replacement of Fuses

WARNING

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

(a) Fuse failure in the Converter would normally be indicated by failure of the pilot lamp to be on when the power switch is turned on. The Pilot lamp in the equipment is operated at 1/2 voltage and therefore would not ordinarily be the cause of no indication. In addition to the pilot lamp not lighting, the Vacuum tubes in the converter would not be lighted. In this case, the 2 ampere fuse on the rear panel should be checked and replaced if defective.

(2) REPLACEMENT OF TUBES.- The Location of all tubes in the CFA is indicated in Figure 4-1. The tubes may be checked visually to see if they are lighted, or for warmth. When necessary the tubes should be carefully removed and tested and when replaced care should be taken to install tube shields.

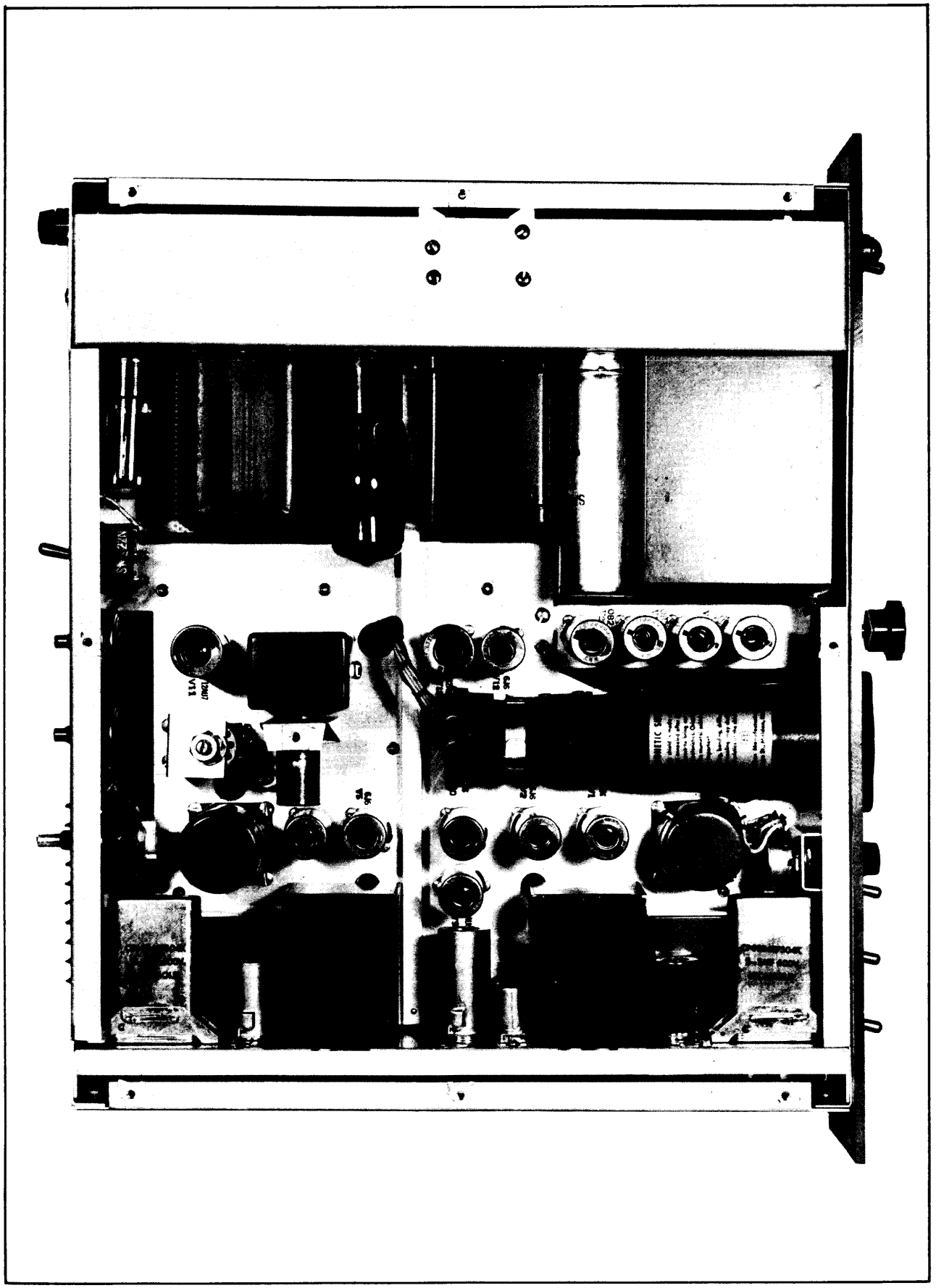


Figure 4-1. Frequency Shift Converter, Model CFA-1. Top View

SECTION 5
PREVENTIVE MAINTENANCE

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

1. ROUTINE MAINTENANCE

a. Remove equipment from the rack, and thoroughly inspect the insides of chassis for signs of dirt, dampness, moulding, charring and corrosion. Correct any defect found. A recommended cleaning agent is clean carbon tetrachloride applied with a soft brush. Recommended SEMI-ANNUALLY.

b. Test all DC and AC voltages as indicated on the respective tube voltage data sheets and investigate any serious descrepancies. Recommended SEMI-ANNUALY.

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

d. When replacing the CFA in the rack, be certain that all terminal board screws at the rear of the equipment are tight.

SECTION 6
CORRECTIVE MAINTENANCE

1. SYSTEM TROUBLE SHOOTING

a. Input Circuit. If the monitor scope on the front panel of the converter does not show any indication when the converter is properly adjusted and powered for operation, there is probably a defect in the input line or in the equipment supplying input signals to the converter. The input signal to the converter should be checked by suitable means.

b. Output Circuits. If there is signal input to the converter and the monitor scope shows a proper pattern, the teleprinter to which the converter is connected should be printing. If it does not print make the following checks:

(1) Check that the teleprinter is in operating condition.
(2) Check the external printer battery source.
(3) Check the signal voltage at the output terminals of the converter with an oscilliscope or DC meter. If no signal voltage is found here, the Converter is defective.

2. UNIT TROUBLE SHOOTING AND REPAIR

a. A functional Block Diagram, Figure 6-5, shows point to point wave forms throughout the CFA under actual operating conditions, this chart together with the Voltage Charge Figure 6-2, will assist in locating troubles.

b. Procedure.

(1) Reset the Distortion and Bias Controls to be sure that they have not been tampered with and improperly set and may, therefore, be responsible for the trouble.
(2) Remove the top cover plate and check all tubes.
(3) Check the power supply voltages against those in the Voltage Chart.
(4) If the power supply voltages are correct, a quick check on all the circuits associated with V12, V13, and V14, may be made by rotating the Test Switch. If the teleprinter follows the switch to Mark and Space, it most likely that these circuits are operating properly.
(5) The CFA may then be connected to the output of a frequency shift oscillator, if it is available, or to a receiver system which is tuned to a frequency shift signal. The operating conditions stated on Block Diagram Figure 6-5 should be fulfilled and an attempt be made starting with the input stage, to obtain the waveforms shown. If one of the waveforms is seriously different from what it should be, the stage at fault should be checked against Voltage Chart Figure 6-2 where the operating conditions are, again, to be fulfilled.

The component at fault may then be easily located and replaced.

NOTE

R85 is preset at the factory. If it should become necessary replace this resistor,

the following steps must be taken:

a. Place a 'scope (using a D.C. amplifier) or a high impedance D.C. voltmeter from the junction of C21 and R36 to ground.

b. Tune in a frequency shift signal which is relatively free of noise and apply it to the CFA input.

c. Tune the signal until the 'scope indicates that the discriminator output is centered symmetrically with the zero or ground axis. The voltmeter, if it is used, will show zero D.C. output at the same point.

d. Make R85 of such a value that the Monitor will show thin straight line. The nominal value of this resistor is usually very close to 56,000 ohms.

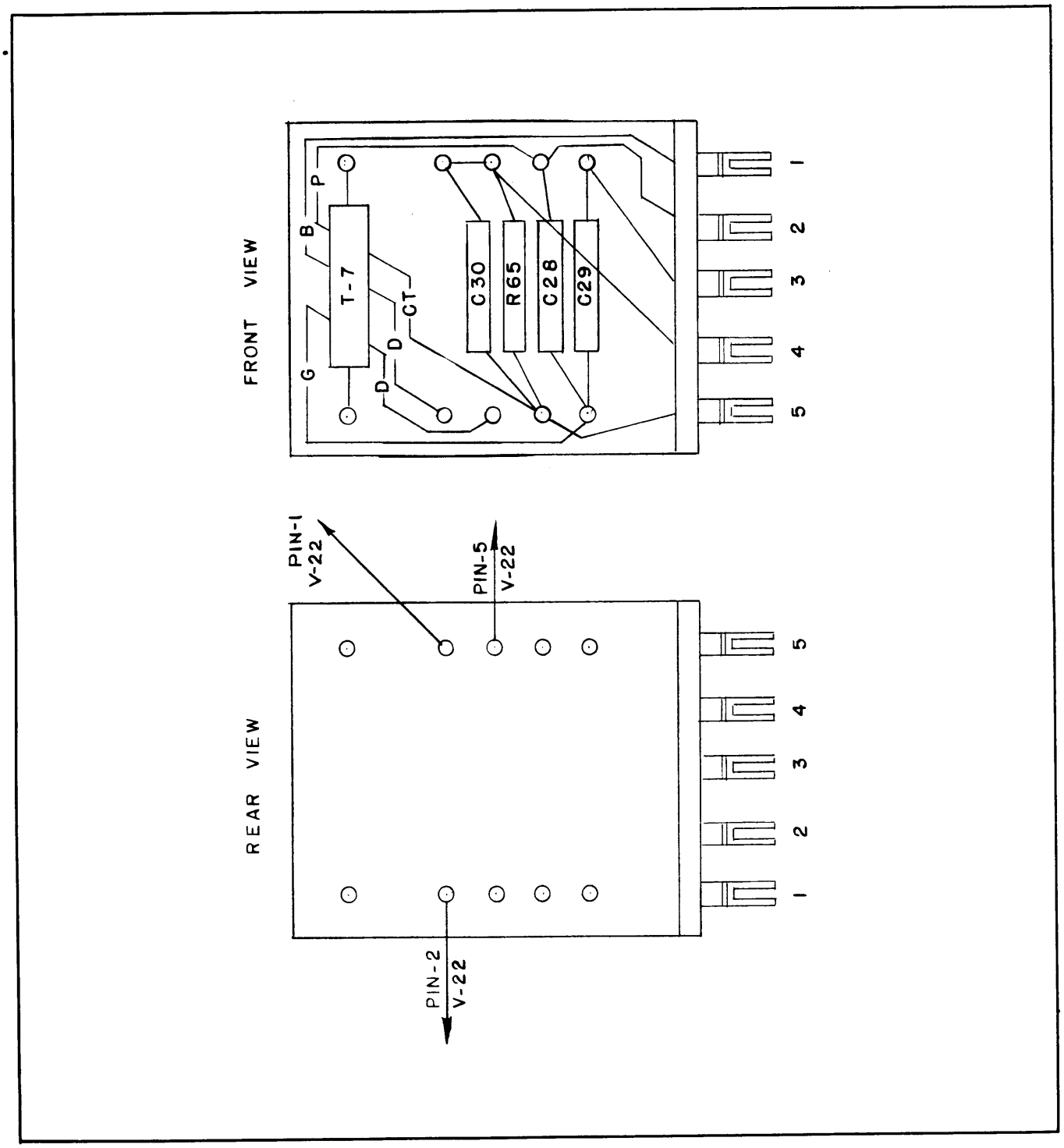


Figure 6-1. Wiring Diagram Oscillator Assembly

VOLTAGE CHART

TUBE SYMBOL	FUNCTION	TYPE	PINS	VOLTS	PINS	VOLTS	PINS	VOLTS	PINS	VOLTS	PINS	VOLTS	PINS	VOLTS	PINS	VOLTS
V1	Tone Amplifier	6AU6	1	-4.4	2	+1	5	+80	6	+15	7	+1	3	AC 6.3		
V2	Limiter	6J6	1	+265	2	+220	5	0	6	0	7	+42	3	AC 6.3		
V3	Tone Amplifier	12AU7	1	+250	2	+36	3	+52	6	+250	7	+31	8	+48	4	AC 6.3
V4	Tone Amplifier	6AU6	1	-3.9	2	+1.1	5	+70	6	+13	7	+1.1	3	AC 6.3		
V5	Limiter	6J6	1	+265	2	+230	5	0	6	0	7	+35	3	AC 6.6		
V6	Tone Rectifier	6AL5	1	0	2	-22	5	+5	7	-22	4	AC 6.3				
V7	Tone Rectifier	6AL5	1	0	2	-22	5	+5	7	-22	3	AC 6.3				
V8	Clamper	6AL5	2	-.6	1	0	3	AC 6.3								
V9	Pulse Amplifier	6AU6	1	-.25	2	0	5	+4.5	6	+18	7	0	3	AC 6.3		
V10	Pulse Amplifier	6AU6	1	-48	2	0	5	+250	6	+53	7	0	3	AC 6.3		
V11	Monitor Amplifier	12AU7	1	+210	2	11.6	3	+13	6	+140	7	+6	8	+13	9	AC 6.3
V12	Pulse Restorer	6J6	1	-80	2	+205	5	-170	6	-145	7	-145	3	AC 6.3	4	AC 6.3
V13	Oscillator Cathode Follower	12AU7	1	-265	2	-150	3	-130	6	+265	7	-128	8	0	4	AC 6.3

V14	Pulse Generator	6Y6	3-8	+60	4-8	+60	5-8	0	7	AC 6.3						
V15	Rectifier	5Y3	4	AC 300	6	AC 300	2	+285	2-8	AC 5.0						
V16	Rectifier	6X4	7	AC 300	1	-310	6	-310	4	AC 6.3						
V17	Voltage Regulator	OB2	2	-255	5	-150										
V18	Voltage Regulator	OA2	4	-150	1	0										
V19	Voltage Regulator	OB2	7	0	5	+105										
V20	Voltage Regulator	OB2	2	+105	5	+210										
V21	Monitor	2BP1	2	-180	3	-175	4	-95	6	+165	7	+210	8	+13	9	+170
		2BP1	10	+165	12	AC 6.3	1	AC 6.3								

Figure 6-2. Tube Voltage Chart

CONDITIONS:

1. Line voltage of 110 @ 60 cps.
2. Both Channel Switches in ON position.
3. Both Channels fed simultaneously by a fixed Mark audio tone of about 3 Kc. at 1 volt RMS.
4. Sense Switch (S4) in plus condition.
5. Test Switch (S6) in Line condition.
6. Threshold Control (R32) set for 850 cps operation.
7. Bias Control (R45) set for minimum distortion or near its center point.
8. Speed Switch (S5) set for Low speed operation.
9. Line Current (R77) set for maximum current into a 2000 ohm load with an external source of 200 volts.
10. Voltmeter used should be a high impedance instrument having an input of 5 megohm or more.

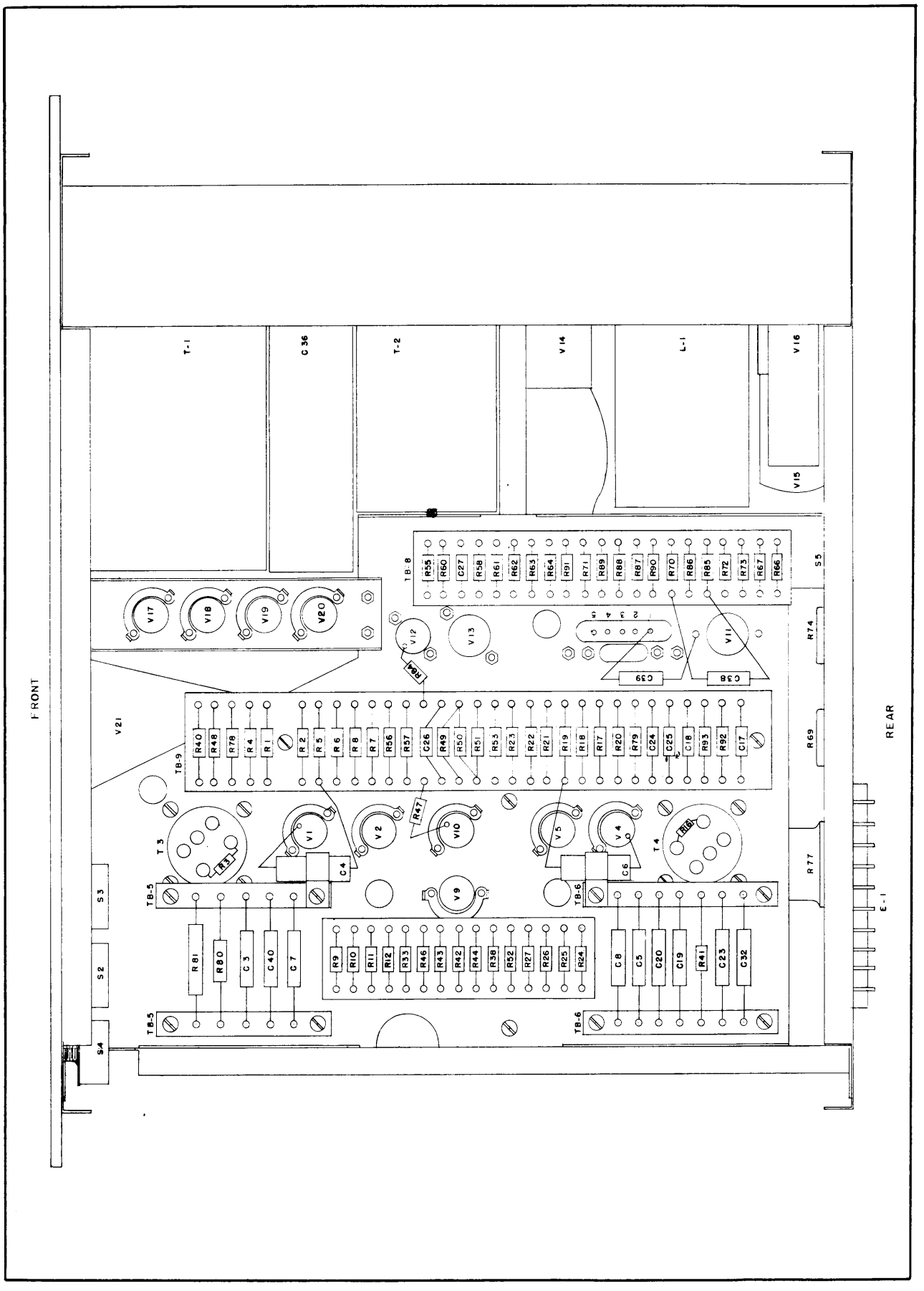


Figure 6-3. Component Layout-Bottom View. Model CFA-*.

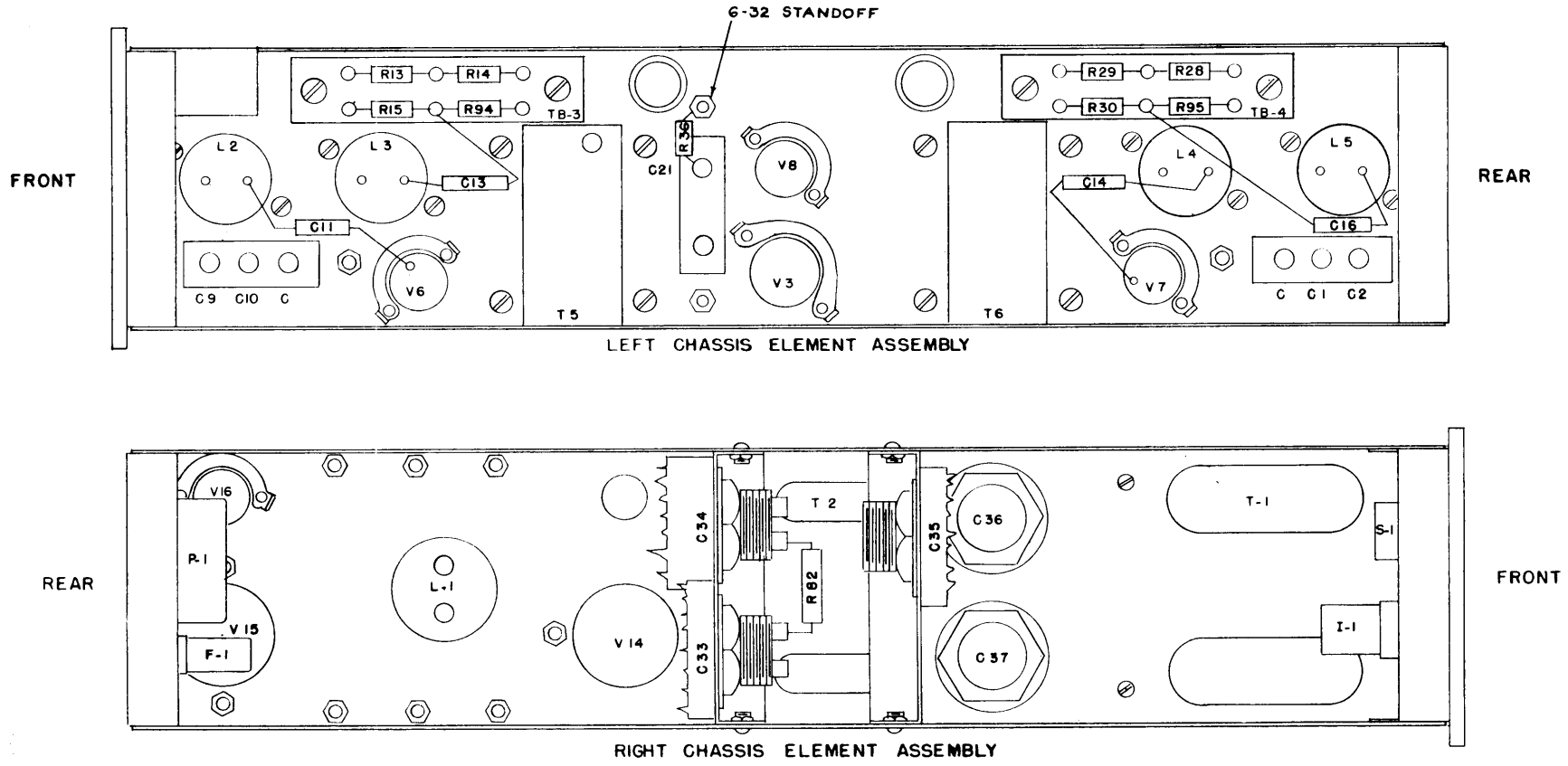


Figure 6-4. Component Layout-Left & Right Views. Model CFA-*.

c. ELECTRICAL PARTS LIST

SYM	DESCRIPTION	FUNCTION	TMC PART NUMBER
C1, C2	CAPACITOR, fixed: paper dielectric; 2 sect; .5 mfd each sect, ±10%; 600 wvdc.	Tone amp. cath. by-pass	CP69B4EF504K
C3	CAPACITOR, fixed: paper; .05 mfd., +40, -20%; 400 wvdc.	Tone amp. screen by-pass	CN-100-3
C4	CAPACITOR, fixed: paper; .05 mfd., +40, -20%; 400 wvdc.	Tone amp. coupling	CN-100-3
C5	CAPACITOR, fixed: paper; .05 mfd., +30, -10%; 600 wvdc.	Tone amp. screen by-pass	CN-100-21
C6	CAPACITOR, fixed: paper; .05 mfd., +40, -20%; 400 wvdc.	Tone amp. coupling	CN-100-3
C7	CAPACITOR, fixed: paper; .05 mfd., +40, - 20%; 400 wvdc.	Line coupling	CN-100-3
C8	CAPACITOR, fixed: paper; .05 mfd., +30, -10%; 600 wvdc.	Line coupling	CN-100-21
C9, C10	CAPACITOR, fixed: paper dielectric; 2 sect; .5 mfd each sect, ±10%; 600 wvdc.	Tone amp. cath. by-pass	CP69B4EF504K
C11	CAPACITOR, fixed: mica; .011 mmfd, ±5%; 300 wvdc; Char. C.	Discriminator condenser	CM-100-4
C12	Not used.		
C13	CAPACITOR, fixed: mica; 2400 mmfd, ±5%; 500 wvdc.	Discriminator condenser	CM30D242J
C14	CAPACITOR, fixed: mica; .011 mfd, ±5%; 300 wvdc, Char. C.	Discriminator condenser	CM-100-4
C15	Not used.		
C16	CAPACITOR, fixed: mica; 2400 mmfd, ±5%; 500 wvdc.	Discriminator condenser	CM30D242J
C17	CAPACITOR, fixed: paper dielectric; .001 mfd., +30, -10%; 600 wvdc.	Discriminator filter	CN-100-9
C18	CAPACITOR, fixed: paper dielectric; .001 mfd., +30, -10%; 600 wvdc.	Discriminator filter	CN-100-9
C19	CAPACITOR, fixed: paper; .002 mfd., +60, -20%; 600 wvdc.	Discriminator filter	CN-100-10
C20	CAPACITOR, fixed: paper; .02 mfd., +30, -10%; 600 wvdc.	Discriminator filter	CN-100-17

SYM	DESCRIPTION	FUNCTION	TMC PART NUMBER
C21	CAPACITOR, fixed: paper dielectric; .1 mfd, ±10%; 600 wvdc.	Clamp coupling	CP69B1EF104K
C23	CAPACITOR, fixed: paper; .05 mfd., +30, -10%; 600 wvdc.	Monitor amp. coupl. cond.	CN-100-21
C24	CAPACITOR, fixed: paper dielectric; .001 mfd., +30, -10%; 600 wvdc.	Integrating cond.	CN-100-9
C25	CAPACITOR, fixed: paper; .005 mfd., +60, -20%; 600 wvdc.	Integrating cond.	CN-100-13
C26	CAPACITOR, fixed: paper dielectric; .001 mfd., +30, -10%; 600 wvdc.	Pulse restorer coupling	CN-100-9
C27	CAPACITOR, fixed: mica; 1000 mmfd., ±20%; 500 wvdc; temp coef letter A.	Pulse restorer coupling	CM20A102K
C28	CAPACITOR, fixed: silvered mica; 500 wvdc; 200 mmfd., ±10%; temp coef letter A.	Osc tank cond.	CM20A201K
C29	CAPACITOR, fixed: silvered mica; 500 wvdc; 200 mmfd., ±10%; temp coef letter A.	Osc coupling	CM20A201K
C30	CAPACITOR, fixed: mica; 1000 mfd, ±10%; 500 wvdc; Char A.	Osc. output filter	CM20A102K
C31	Not used.		
C32	CAPACITOR, fixed: paper; .02 mfd., +60, -20%; 600 wvdc.	Pulse generator by-pass	CN-100-17
C33	CAPACITOR, fixed: paper dielectric; 4 mfd., ±10%; 600 wvdc.	Power supply filter	CP41B1FF405K
C34	CAPACITOR, fixed: paper dielectric; 4 mfd., ±10%; 600 wvdc.	Power supply filter	CP41B1FF405K
C35	CAPACITOR, fixed: paper dielectric; 4 mfd., ±10%; 600 wvdc.	Power supply filter	CP41B1FF405K
C36	CAPACITOR, fixed: paper dielectric; 4 mfd., ±10%; 600 wvdc.	Power supply filter	CP41B1FF405K
C37	CAPACITOR, fixed: paper dielectric; 4 mfd., ±10%; 600 wvdc.	Power supply filter	CP41B1FF405K
C38	CAPACITOR, fixed: paper; .05 mfd., +40, -20%; 400 wvdc.	Monitor amp. coupling	CN-100-3
C39	CAPACITOR, fixed: paper; .005 mfd., +60, -20%; 600 wvdc.	Osc de-coupling cond.	CN-100-13

SYM	DESCRIPTION	FUNCTION	TMC PART NUMBER
C40	CAPACITOR, fixed: paper; .05 mfd., +30, -10%; 600 wvdc.	Monitor coupling	CN-100-21
CR1	Not used.		
CR2	Not used.		
CR3	Not used.		
CR4	Not used.		
E1	BOARD, terminal: general purpose barrier type; nine brass nickel plated 6-32 x 3/16'' binding head screws w/''Y'' type solder lug terminals.	Input-output	TM-100-9
F1	FUSE, cartridge; 2.0 amp; operating in one hour at 135% load and in 25 seconds at 200% load; rated continuous at 110% load; 250 v.; one time.	Line fuse	FU-100-2
I1	LAMP, incandescent: 6-8 volts; 0.250 amp; bulb T-3 1/4 clear.	Power Indicator	BI-100-44
L1	REACTOR, filter choke: 15 henries; 85 ma. DC, 270 ohms DC resistance; 2,500 volts RMS test.	Filter choke	TF-5000
L2	REACTOR, fixed: toroid wound; .75 henries.	Discriminator inductance	TF-5004
L3	REACTOR, fixed: toroid wound; .75 henries.	Discriminator inductance	TF-5004
L4	REACTOR, fixed: toroid wound; .75 henries.	Discriminator inductance	TF-5004
L5	REACTOR, fixed: toroid wound; .75 henries.	Discriminator inductance	TF-5004
L6	REACTOR, fixed: Prim: 300 hys no DC, 50 hys, 3 ma DC; Secdy 6000 ohms.	Discriminator filter choke	TF-5002
P1	CONNECTOR, assembly: male contact; flush motor plug type.	Line chassis connector.	JJ-100
R1	RESISTOR, fixed: composition; 470,000 ohms, ± 10%; 1/2 watt.	Amp. plate load res.	RC20GF474K
R2	RESISTOR, fixed: composition; 1 megohm, ±10%; 1/2 watt.	Tone amp screen drop. res.	RC20GF105K

SYM	DESCRIPTION	FUNCTION	TMC PART NUMBER
R3	RESISTOR, fixed: composition; 470,000 ohms, ±10%; 1/2 watt.	Tone ampl. grid res.	RC20GF474K
R4	RESISTOR, fixed: composition; 2,200 ohms, ±10%; 1/2 watt.	Tone amp cath. bias res.	RC20GF222K
R5	RESISTOR, fixed: composition; 470,000 ohms, ±10%; 1/2 watt.	Line grid res.	RC20GF474K
R6	RESISTOR, fixed: composition; 470,000 ohms, ±10%; 1/2 watt.	Line grid res.	RC20GF474K
R7	RESISTOR, fixed: composition; 100,000 ohms, ±10%; 1/2 watt.	Line plate res.	RC20GF104K
R8	RESISTOR, fixed: composition; 10,000 ohms, ±10%; 1/2 watt.	Line cath. res.	RC20GF103K
R9	RESISTOR, fixed: composition; 220,000 ohms, ±10%; 1/2 watt.	Tone amp. grid res.	RC20GF224K
R10	RESISTOR, fixed: composition; 220,000 ohms, ±10%; 1/2 watt.	Tone amp. grid res.	RC20GF224K
R11	RESISTOR, fixed: composition; 1,000 ohms, ±10%; 1/2 watt.	Tone amp. cath. res.	RC20GF102K
R12	RESISTOR, fixed: composition; 3,900 ohms, ±10%; 1 watt.	Tone amp. cath. res.	RC30GF392K
R13	RESISTOR, fixed: composition; 33,000 ohms, ±5%; 1/2 watt.	Discriminator load res.	RC20GF333J
R14	RESISTOR, fixed: composition; 1,000 ohms, ±5%; 1/2 watt.	Discriminator load res.	RC20GF102J
R15	RESISTOR, fixed: composition; 68,000 ohms, ±5%; 1/2 watt.	Discriminator load res.	RC20GF683J
R16	RESISTOR, fixed: composition; 470,000 ohms, ±10%; 1/2 watt.	Tone ampl. grid res.	RC20GF474K
R17	RESISTOR, fixed: composition; 470,000 ohms, ±10%; 1/2 watt.	Tone ampl. plate res.	RC20GF474K
R18	RESISTOR, fixed: composition; 1 megohm, ±10%; 1/2 watt.	Tone amp screen drop. res.	RC20GF105K
R19	RESISTOR, fixed: composition; 470,000 ohms, ±10%; 1/2 watt.	Tone amp. grid res.	RC20GF474K
R20	RESISTOR, fixed: composition; 2,200 ohms, ±10%; 1/2 watt.	Tone amp. cath. res.	RC20GF222K
R21	RESISTOR, fixed: composition; 470,000 ohms, ±10%; 1/2 watt.	Tone amp. grid res.	RC20GF474K

SYM	DESCRIPTION	FUNCTION	TMC PART NUMBER
R22	RESISTOR, fixed: composition; 10,000 ohms, ±10%; 1/2 watt.	Line cath. res.	RC20GF103K
R23	RESISTOR, fixed: composition; 100,000 ohms, ±10%; 1/2 watt.	Tone amp. cath. res.	RC20GF104K
R24	RESISTOR, fixed: composition; 220,000 ohms, ±10%; 1/2 watt.	Tone amp. grid res.	RC20GF224K
R25	RESISTOR, fixed: composition; 220,000 ohms, ±10%; 1/2 watt.	Tone amp. grid res.	RC20GF224K
R26	RESISTOR, fixed: composition; 1,000 ohms, ±10%; 1/2 watt.	Tone amp. cath. res.	RC20GF102K
R27	RESISTOR, fixed: composition; 3,900 ohms, ±10%; 1 watt.	Tone amp. cath. res.	RC30GF392K
R28	RESISTOR, fixed: composition; 1,000 ohms, ±5%; $\frac{1}{2}$ watt.	Discriminator load res.	RC20GF102J
R29	RESISTOR, fixed: composition; 33,000 ohms, ±5%; $\frac{1}{2}$ watt.	Discriminator load res.	RC20GF333J
R30	RESISTOR, fixed: composition; 68,000 ohms, ±5%; $\frac{1}{2}$ watt.	Discriminator load res.	RC20GF683J
R31	Not used.		
R32	RESISTOR, variable: composition; 100,000 ohms, ±10%; 2 watts; linear taper; 100°C max cont operation; 3 solder lug terms.	Threshold control	RV4ATFH104A
R33	RESISTOR, fixed: composition; 2.2 megohms, ±10%; $\frac{1}{2}$ watt.	Pulse amp. grid res.	RC20GF225K
R34	Not used.		
R35	Not used.		
R36	RESISTOR, fixed: composition; 470,000 ohms, ±10%; $\frac{1}{2}$ watt.	Mon. grid isol. res.	RC20GF474K
R37	Not used.		
R38	RESISTOR, fixed: composition; 10 megohm, ±10%; $\frac{1}{2}$ watt.	Threshold isol. res.	RC20GF106K
R39	Not used.		
R40	RESISTOR, fixed: composition; 10,000 ohms, ±10%; $\frac{1}{2}$ watt.	Threshold drop. res.	RC20GF103K
R41	RESISTOR, fixed: composition; 10 megohm, ±10%; $\frac{1}{2}$ watt.	Mon. amp. grid res.	RC20GF106K

SYM	DESCRIPTION	FUNCTION	TMC PART NUMBER
R42	RESISTOR, fixed: composition 470,000 ohms, ±10%; ½ watt.	Pulse amp. plate res.	RC20GF474K
R43	RESISTOR, fixed: composition; 82,000 ohms, ±10%; 1 watt.	Pulse amp. screen drop.	RC30GF823K
R44	RESISTOR, fixed: composition; 470,000 ohms, ±10%; ½ watt.	Dist. bias drop. res.	RC20GF474K
R45	RESISTOR, variable: composition; potentiometer; 1 megohm, ±10%; 2 watts; linear taper; 100°C max cont oper; 3 solder lug terms.	Dist. pot.	RV4ATSA105B
R46	RESISTOR, fixed: composition; 10,000 ohms, ±10%; ½ watt.	Pulse amp. screen res.	RC20GF103K
R47	RESISTOR, fixed: composition; 2.2 megohm, ±10%; ½ watt.	Pulse amp. grid res.	RC20GF225K
R48	RESISTOR, fixed: composition; 2.7 megohm, ±10%; ½ watt.	Dist. drop. res.	RC20GF275K
R49	RESISTOR, fixed: composition; 470,000 ohms, ±10%; ½ watt.	Pulse amp. plate res.	RC20GF474K
R50	RESISTOR, fixed: composition; 82,000 ohms, ±10%; 1 watt.	Pulse amp. screen drop. res.	RC30GF823K
R51	RESISTOR, fixed: composition; 22,000 ohms, ±10%; ½ watt.	Pulse amp. screen res.	RC20GF223K
R52	RESISTOR, fixed: composition; 1,000 ohms, ±10%; ½ watt.	Pulse amp. cath. res.	RC20GF102K
R53	RESISTOR, fixed: composition; 1 megohm, ±10%; ½ watt.	Pulse rest. grid res. (line condition)	RC20GF105K
R54	Not used.		
R55	RESISTOR, fixed: composition; 56,000 ohms, ±10%; 2 watts.	Pulse rest. plate res.	RC42GF563K
R56	RESISTOR, fixed: composition; 27,000 ohms, ±10%; 2 watts.	Pulse rest. plate res.	RC42GF273K
R57	RESISTOR, fixed: composition; 22,000 ohms, ±10%; 2 watts.	Pulse rest. cath. res.	RC42GF223K
R58	RESISTOR, fixed: composition; 2.2 megohms, ±10%; 1/2 watt.	Pulse rest. grid res.	RC20GF225K

SYM	DESCRIPTION	FUNCTION	TMC PART NUMBER
R59	RESISTOR, variable: composition; potentiometer; 500,000 ohms, ±20%; 2 watts, linear taper; 100°C max. cont. operation; 3 solder lug terminals; w/locking type bushing & lock nut.	Pulse rest. grid bias pot.	RV-100-1
R60	RESISTOR, fixed: composition; 3.9 megohm, ±10%; ½ watt.	Pulse rest. grid leak	RC20GF395K
R61	RESISTOR, fixed: composition; 30,000 ohms, ±10%; ½ watt.	Pulse rest. volt divider	RC20GF303K
R62	RESISTOR, fixed: composition; 470,000 ohms, ±10%; ½ watt.	Pulse rest. volt divider	RC20GF474K
R63	RESISTOR, fixed: composition; 68,000 ohms, ±10%; 1 watt.	Cath. fol. cath. res.	RC30GF683K
R64	RESISTOR, fixed: composition; 220,000 ohms, ±10%; ½ watt.	Osc. grid leak	RC20GF224K
R65	RESISTOR, fixed: composition; 220,000 ohms, ±10%; ½ watt.	Rectifier load	RC20GF224K
R66	RESISTOR, fixed: composition; 2.2 megohm, ±10%; ½ watt.	Monitor voltage divider	RC20GF225K
R67	RESISTOR, fixed: composition; 2.2 megohm, ±10%; ½ watt.	Monitor voltage divider	RC20GF225K
R68	RESISTOR, variable: composition; potentiometer; 1 megohm, ±20%; 2 watt; linear taper; 100°C max cont oper; 3 solder lug terms.	Vertical centering cont.	RV4ATSA105B
R69	RESISTOR, variable: composition; potentiometer; 1 megohm, ±20%; 2 watt; linear taper; 100°C max cont oper; 3 solder lug terms.	Horizontal centering cont.	RV4ATSA105B
R70	RESISTOR, fixed: composition; 2.2 megohms, ±10%; ½ watt.	Monitor plate res.	RC20GF225K
R71	RESISTOR, fixed: composition; 1 megohm, ±10%; ½ watt.	Monitor plate res.	RC20GF105K
R72	RESISTOR, fixed: composition; 1 megohm, ±10%; ½ watt.	Monitor plate res.	RC20GF105K
R73	RESISTOR, fixed: composition; 1 megohm, ±10%; ½ watt.	Monitor voltage divider	RC20GF105K
R74	RESISTOR, variable: composition; potentiometer; 1 megohm, ±20%; 2 watts; linear taper; 100°C max cont oper; 3 solder lug terms.	Monitor focus	RV4ATSA105B
R75	RESISTOR, fixed: composition; 470,000 ohms, ±10%; ½ watt.	Monitor drop. pot.	RC20GF474K

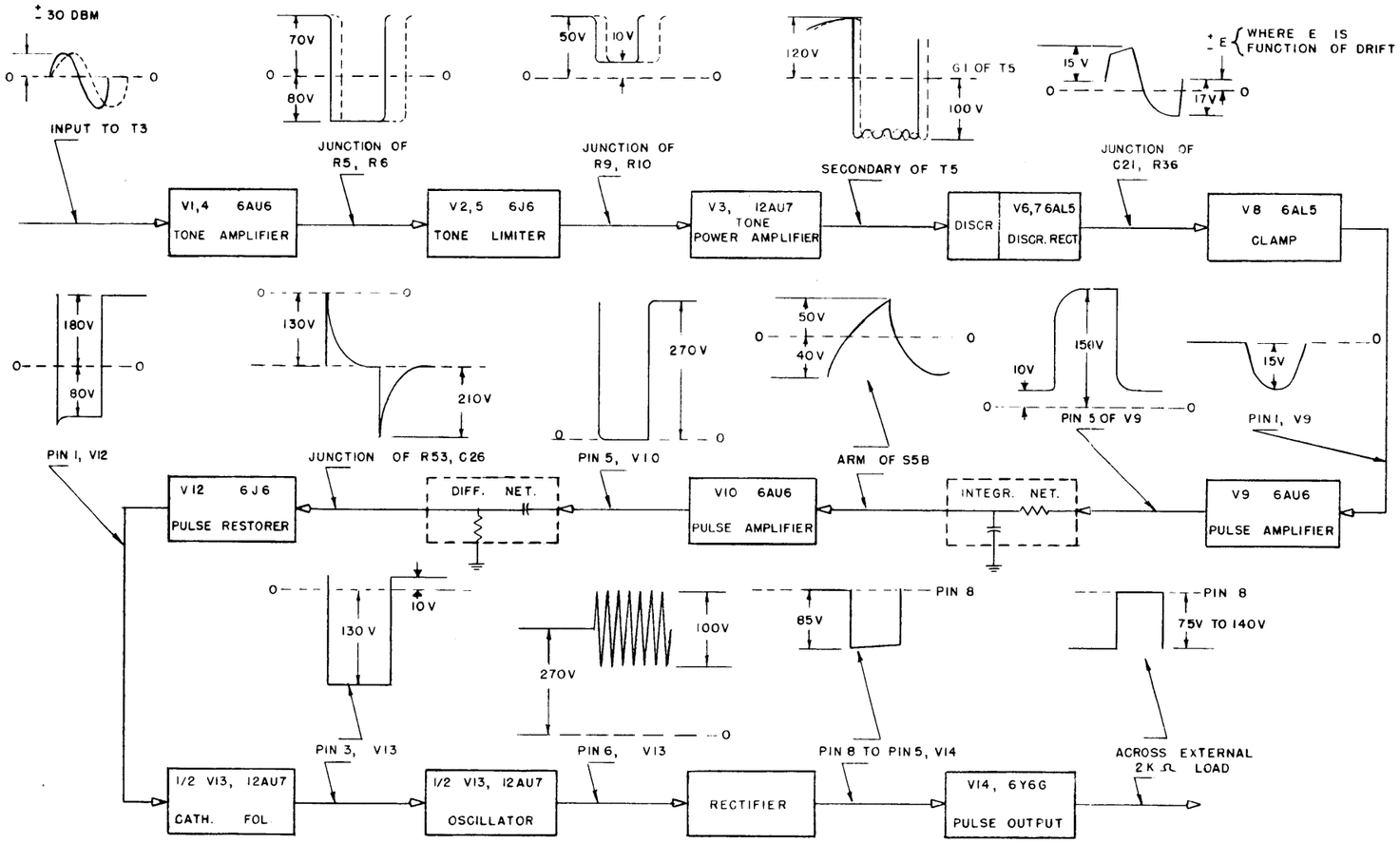
SYM	DESCRIPTION	FUNCTION	TMC PART NUMBER
R76	RESISTOR, variable: composition; potentiometer; 500,000 ohms, ±20%; 2 watts; linear taper; 100°C max cont oper; 3 solder lug terms.	Monitor Intensity pot.	RV4ATSA504B
R77	RESISTOR, variable: wire-wound pot; 2,500 ohms, ±10%; 25 watts.	Line current control	RA251SA252AK
R78	RESISTOR, fixed: composition; 220,000 ohms, ±10%; ½ watt.	Tone amp. grid res.	RC20GF224K
R79	RESISTOR, fixed: composition; 220,000 ohms, ±10%; ½ watt.	Tone amp. grid res.	RC20GF224K
R80	RESISTOR, fixed: composition; 1,000 ohms, ±10%; 2 watts.	Power supply drop. res.	RC42GF102K
R81	RESISTOR, fixed: wire-wound; 3,000 ohms, ±10%; 10 watts.	Power supply drop. res.	RW-109-30
R82	RESISTOR, fixed: wire-wound; 3,000 ohms, ±10%; 10 watts.	Power supply drop. res.	RW-109-30
R83	Not used.		
R84	RESISTOR, fixed: composition; 2.2 megohms, ±10%; ½ watt.	Grid res. pulse rest.	RC20GF225K
R85	RESISTOR, fixed: composition; 100,000 ohms, ±10%; ½ watt.	Monitor amp. plate load	RC20GF104K
R86	RESISTOR, fixed: composition; 39,000 ohms, ±10%; ½ watt.	Monitor amp. plate res.	RC20GF393K
R87	RESISTOR, fixed: composition; 10,000 ohms, ±10%; ½ watt.	Monitor amp. cath. res.	RC20GF103K
R88	RESISTOR, fixed: composition; 5.1 megohms, ±10%; ½ watt.	Monitor amp. grid res.	RC20GF515K
R89	RESISTOR, fixed: composition; 10,000 ohms, ±10%; ½ watt.	Monitor amp. cath. res.	RC20GF103K
R90	RESISTOR, fixed: composition; 47,000 ohms, ±10%; ½ watt.	Monitor amp. plate res.	RC20GF473K
R91	RESISTOR, fixed: composition; 2,200 ohms, ±10%; ½ watt.	Osc decoupling res.	RC20GF222K
R92	RESISTOR, fixed: composition; 220,000 ohms, ±10%; ½ watt.	Discriminator load res.	RC20GF224K
R93	RESISTOR, fixed: composition; 220,000 ohms, ±10%; ½ watt.	Discriminator load res.	RC20GF224K

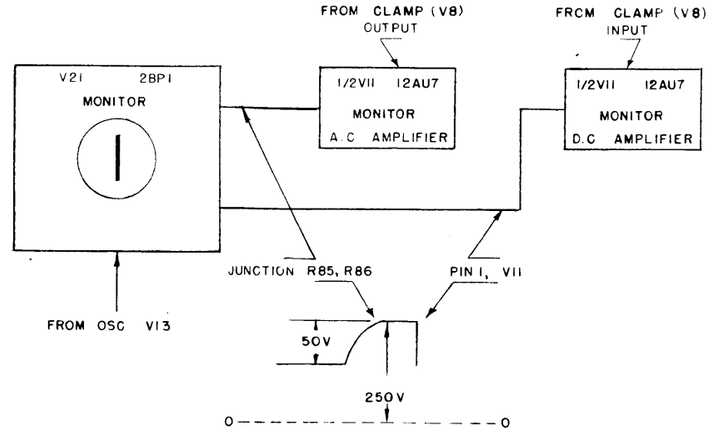
SYM.	DESCRIPTION	FUNCTION	TMC PART NUMBER
R94	RESISTOR, fixed: composition; 1,000 ohms, ±5%; 1/2 watt.	Discriminator load res.	RC20GF102J
R95	RESISTOR, fixed: composition; 1,000 ohms, ±5%; 1/2 watt.	Discriminator load res.	RC20GF102J
S1	SWITCH, toggle: 3 amp; 250 v. phenolic body.	Line switch	ST22K
S2	SWITCH, toggle: DPDT; 3 amp; 250 v. phenolic body.	Channel 1 ON-OFF	ST22N
S3	SWITCH, toggle: DPST; 3 amp; 250 v. phenolic body.	Channel 2 ON-OFF	ST22N
S4	SWITCH, toggle: DPDT; 3 amp; 250 v. phenolic body.	Sense switch	ST22N
S5	SWITCH, toggle: DPDT; 3 amp; 250 v. phenolic body.	Speed switch	ST22N
S6	SWITCH, rotary: 2 pole; 3 positions; single sect; silver plated brass contacts (non-shorting); phenolic body.	Test switch	SW-112
T1	TRANSFORMER, filament and power; input 110/220 v, 50/60 cps; single phase; four output windings; Secdy #1-6.3 v. CT-3 amp; Secdy #2-6.3v, 1.2 amp; Secdy #3-300-0-300 v, 70 ma DC into capacity input filter; Secdy #4-5v, 2 amp; all windings insulated against 1,000 volts; hermetically sealed metal rect case.	Power transformer	TF-106
T2	TRANSFORMER, filament: pri 110/220v. 50/60 cps; Sec. 6.3v. 4.125 amp; CT, hermetically sealed in rectangular steel case.	Filament transformer	TF-104
T3	TRANSFORMER, audio: line to grid; pri. 600 ohms balanced; Sec-80,000 ohms; flat within 3 db 100 to 5000 cps; input level plus 10 dbm max.	Input transformer	TF-112
T4	TRANSFORMER, audio: line to grid; pri 600 ohms balanced; Sec-80,000 ohms; flat within 3 db 100 to 5000 cps; input level plus 10 dbm max.	Input transformer	TF-112
T5	TRANSFORMER, audio: pri 30,000 ohms CT; Secdy-80,000 ohms CT; flat within 3 db from 100 to 5000 cps; 70 volt rms max signal level.	Discriminator coupling transformer	TF-115

SYM.	DESCRIPTION	FUNCTION	TMC PART NUMBER
T6	TRANSFORMER, audio: pri 30,000 ohms CT; Secdy-80,000 ohms CT; flat within 3 db from 100 to 5000 cps; 70 volt rms max signal level.	Discriminator coupling transformer	TF-115
T7	TRANSFORMER, audio: 500 Kcs.	Tone osc.	A-359
V1	TUBE, electron: RMA 6AU6; miniature 7 pin receiving pentode amplifier.	Tone amp.	6AU6
V2	TUBE, electron: RMA 6J6; miniature 7 pin type UHF twin triode.	Limiter	6J6
V3	TUBE, electron: RMA 12AU7; dual-triode, miniature 9 pin.	Tone amp.	12AU7
V4	TUBE, electron: RMA 6AU6; miniature 7 pin receiving pentode amplifier.	Tone amp.	6AU6
V5	TUBE, electron: RMA 6J6; miniature 7 pin type UHF twin triode.	Limiter	6J6
V6	TUBE, electron: RMA 6AL5; receiving miniature 7 pin twin type diode.	Tone rect.	6AL5
V7	TUBE, electron: RMA 6AL5; receiving miniature 7 pin twin type diode.	Tone rect.	6AL5
V8	TUBE, electron: RMA 6AL5; receiving miniature 7 pin twin type diode.	Clamper	6AL5
V9	TUBE, electron: RMA 6AU6; miniature 7 pin receiving pentode amplifier.	Pulse amp.	6AU6
V10	TUBE, electron: RMA 6AU6; miniature 7 pin receiving pentode amplifier.	Pulse amp.	6AU6
V11	TUBE, electron: RMA 12AU7; dual-triode, miniature 9 pin.	Monitor amp.	12AU7
V12	TUBE, electron: RMA 6J6; miniature; 7 pin type UHF twin triode.	Pulse restorer	6J6
V13	TUBE, electron: RMA 12AU7; dual-triode, miniature 9 pin.	Osc cath. foll.	12AU7
V14	TUBE, electron: RMA 6Y6G; beam power amplifier, octal.	Pulse generator	6Y6G
V15	TUBE, electron: RMA 5Y3GT; duo-diode, rectifier, octal.	Power supply rect.	5Y3GT
V16	TUBE, electron: RMA 6X4; dual-diode miniature 7 pin.	Power supply rect.	6X4
V17	TUBE, electron: RMA OB2; miniature 7 pin type voltage regulator.	Volt regulator	OB2

SYM.	DESCRIPTION	FUNCTION	TMC PART NUMBER
V18	TUBE, electron: RMA OA2; miniature 7 pin type voltage regulator.	Volt regulator	OA2
V19	TUBE, electron: RMA OB2; miniature 7 pin type voltage regulator.	Volt regulator	OB2
V20	TUBE, electron: RMA OB2; miniature 7 pin type voltage regulator.	Volt regulator	OB2
V21	TUBE, cathode ray, high vacuum.	Monitor	2BP1
V22	TUBE, electron: RMA 6AL5; min. 7 pin output rectifier.	Output rectifier	6AL5
XV1	SOCKET, tube: 7 pin miniature; one piece saddle mounting.	Socket for V1	TS102P01
XV2	SOCKET, tube: 7 pin miniature; one piece saddle mounting.	Socket for V2	TS102P01
XV3	SOCKET, tube: 9 pin miniature; one piece saddle mounting.	Socket for V3	TS103P01
XV4	SOCKET, tube: 7 pin miniature; one piece saddle mounting.	Socket for V4	TS102P01
XV5	SOCKET, tube: 7 pin miniature; one piece saddle mounting.	Socket for V5	TS102P01
XV6	SOCKET, tube: 7 pin miniature; one piece saddle mounting.	Socket for V6	TS102P01
XV7	SOCKET, tube: 7 pin miniature; one piece saddle mounting.	Socket for V7	TS102P01
XV8	SOCKET, tube: 7 pin miniature; one piece saddle mounting.	Socket for V8	TS102P01
XV9	SOCKET, tube: 7 pin miniature; one piece saddle mounting.	Socket for V9	TS102P01
XV10	SOCKET, tube: 7 pin miniature; one piece saddle mounting.	Socket for V10	TS102P01
XV11	SOCKET, tube: 9 pin miniature; one piece saddle mounting.	Socket for V11	TS103P01
XV12	SOCKET, tube: 7 pin miniature; one piece saddle mounting.	Socket for V12	TS102P01
XV13	SOCKET, tube: 9 pin miniature; one piece saddle mounting.	Socket for V13	TS103P01
XV14	SOCKET, tube: octal; one piece saddle mounting.	Socket for V14	TS101P01

SYM.	DESCRIPTION	FUNCTION	TMC PART NUMBER
XV15	SOCKET, tube: octal; one piece saddle mounting.	Socket for V15	TS101P01
XV16	SOCKET, tube: 7 pin miniature; one piece saddle mounting.	Socket for V16	TS102P01
XV17	SOCKET, tube: 7 pin miniature; one piece saddle mounting.	Socket for V17	TS102P01
XV18	SOCKET, tube: 7 pin miniature; one piece saddle mounting.	Socket for V18	TS102P01
XV19	SOCKET, tube: 7 pin miniature; one piece saddle mounting.	Socket for V19	TS102P01
XV20	SOCKET, tube: 7 pin miniature; one piece saddle mounting.	Socket for V20	TS102P01
XV21	SOCKET, duodecal.	Socket for V21	TS-112
XV22	SOCKET, tube: 7 pin miniature.	Socket for V22	TS102P01
XF1	HOLDER, fuse: extractor post type; for single AGC cartridge fuse.	Fuse holder	FU-100-2
XI1	LIGHT, indicator: with lens; 1/2'' d. red smooth lens; for miniature bayonet base T-3 1/4 bulb.	Pilot light	TS-106-1
W1	CABLE ASSEMBLY: power; consists of molded non-polarized male plug, and six foot 18/2 SJ rubber covered cord and phenolic twist lock female connector with cord grips.	Power cord	CA-103





OPERATING CONDITIONS. UNDER WHICH PATTERNS WERE OBTAINED:

1. LINE SOURCE: 110 V AT 60 CPS.
2. KEYING SPEED: 25 DOT CPS.
3. FREQ. SHIFT: 850 CPS CENTERED ON DISCRIMINATOR
4. R45 SET FOR ZERO DISTORTION.
5. S6 IN LINE POSITION.
6. R32, SET FOR PROPER THRESHOLD FOR 850 CPS SHIFT.
7. S5 SET FOR LOW SPEED OPERATION.
8. S3 IN OFF POSITION.
9. USING HIGH IMPEDANCE SCOPE WITH DC AMPLIFIER (SUCH AS DU MONT 304H WITH 2507 PROBE)

Figure 6-5 Block Diagram

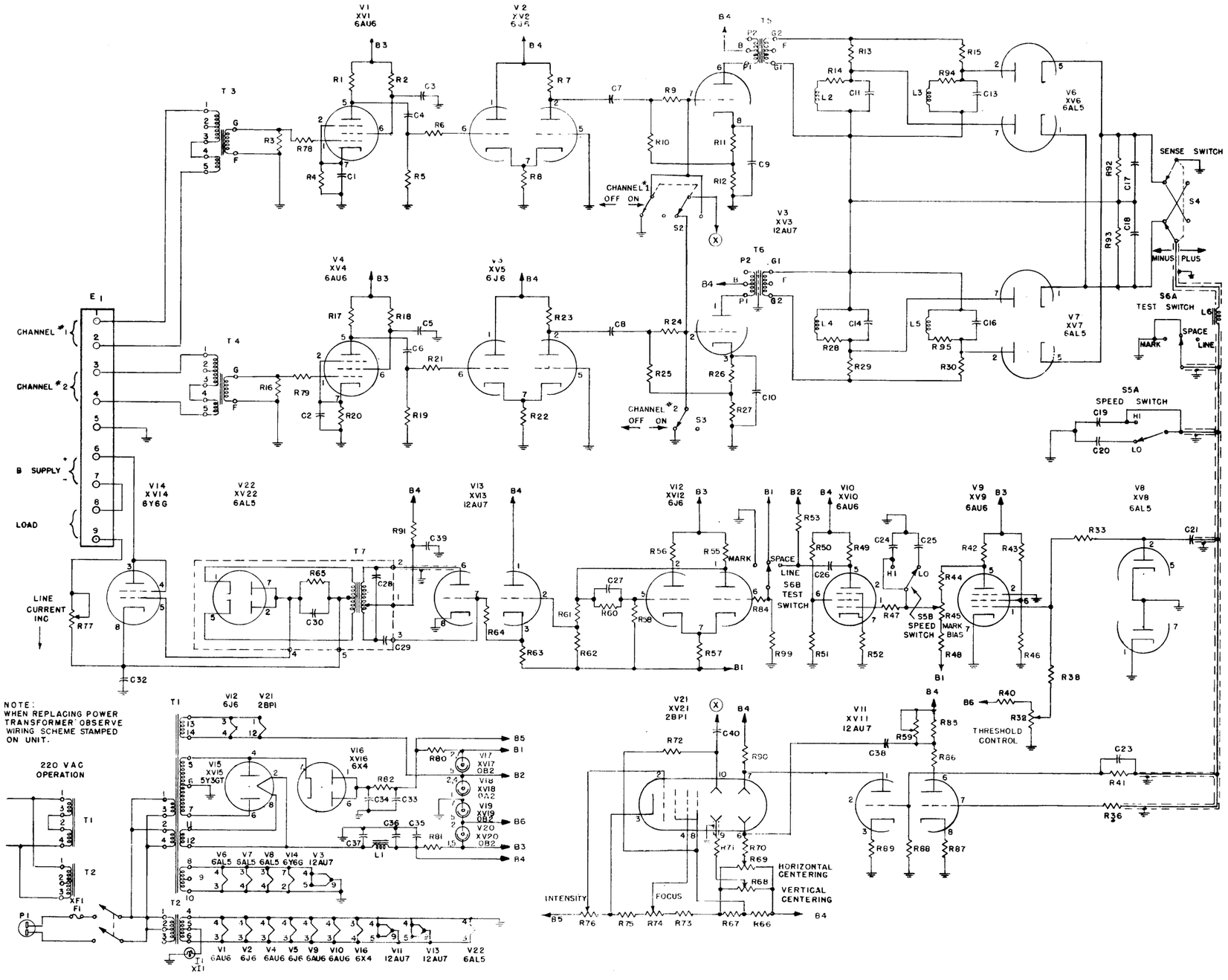


Figure 6-6. CFA-1 Schematic Diagram