TECHNICAL MANUAL

for

FREQUENCY SHIFT CONVERTER MODEL CFA-1, CFA-IL, CFA-ILB CV-763/URR

THE TECHNICAL MATERIEL CORPORATION

MAMARONECK, N.Y. OTTAWA, CANADA

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NOTICE

THE TECHNICAL MATERIEL CORPORATION
COMMUNICATIONS ENGINEERS
700 FENIMORE ROAD MAMARONECK, N. Y.

Warranty

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

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

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

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

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

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

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

*Electron tubes also include semi-conductor devices.

PROCEDURE FOR RETURN OF MATERIAL OR EQUIPMENT

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

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

PROCEDURE FOR ORDERING REPLACEMENT PARTS

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

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

PROCEDURE IN THE EVENT OF DAMAGE INCURRED IN SHIPMENT

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

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

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

CHANGE NO. 1

INSTRUCTION BOOK CHANGE NOTICE

Date Jan. 20, 1964

Manual affected: Frequency Shift Converter Model CFA-1, IN 4008
CFA-1L, CFA-1LB

Section-8. Schematic Diagrams - Add tie-point in circuit indicated by arrow.

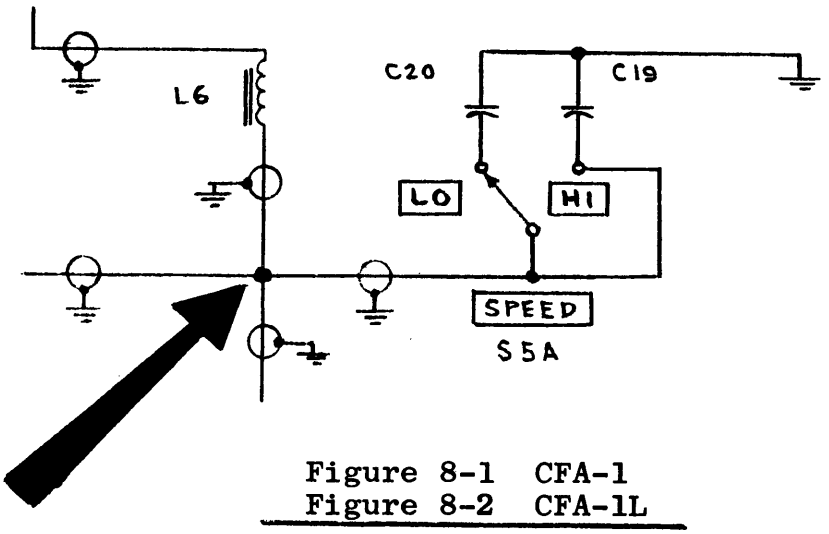

Figure 8-1 CFA-1
Figure 8-2 CFA-1L

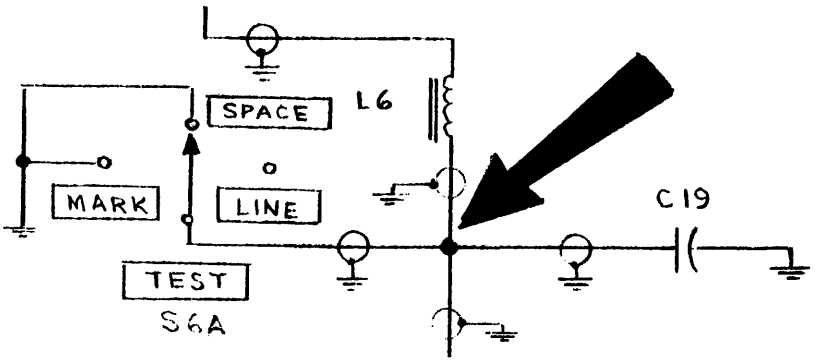

Figure 8-3 CFA-1LB

SHOULD ADDITIONAL COPIES OF THIS CHANGE NOTICE BE REQUIRED, PLEASE CONTACT:
THE TECHNICAL MATERIEL CORP., 700 Fenimore Road, Mamar neck, New Y rk
Attn.: Director of Eng. Services.

RECORD OF CORRECTIONS MADE

Change No.	Date of Change	Date Entered	Entered By

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SECTION 1
GENERAL DESCRIPTION

1-1. PHYSICAL DESCRIPTION.

Frequency Shift Converter, Model CFA, shown in figure 1-1, is a small compact unit designed to be mounted in any standard 19 inch wide equipment rack. Due to its compact construction, only a minimum amount of mounting space is needed. The mounting and outline dimensions are shown in figure 2-2. All operating controls and indicating devices are readily accessible on the front panel. Top and bottom chassis dust covers are also provided.

NOTE

Due to the similarity of construction and operation of Models CFA-1, CFA-1L and CFA-1LB, the following text will refer to all three models as the CFA. The differences in construction and operation of the three units will be indicated as necessary.

1-2. FUNCTIONAL DESCRIPTION, MODEL CFA-1.

Frequency Shift Converter CFA-1 is an audio type dual channel converter designed for use with diversity or single receiver systems. Its function is to convert mark-space signals into dc pulses capable of operating a teleprinter, tape recorder, or any other device requiring make and break signals.

Other functional features of the CFA-1 unit are:

a. Capable of correcting for bias distortion of appreciably more than plus or minus 30%.

b. Contains a drift compensating circuit, that will accommodate total receiver drifts up to 1500 cps without interruptions in service. Specifically, a total drift of 1200 cps will be tolerated when the input signal is being shifted 850 cps.

c. Maximum integration or de-emphasis has been employed to assist in the rejection of noise.

d. Each channel has incorporated within it a series of limiter-amplifiers to effectively eliminate amplitude modulation and noise peaks superimposed on the signal carrier.

e. A CRT type visual monitor is provided to permit simple and rapid tuning. By observing the visual monitor, the operator will know when he is precisely at the discriminator center or how far off center he has drifted.

f. The output is made available for external use through a special all electronic keying stage that functions as a neutral relay. The output terminals may be operated with a floating ground or either terminal may be connected to the ground side of an external battery.

1-3. FUNCTIONAL DESCRIPTION, MODEL CFA-1L.

Frequency Shift Converter, CFA-1L is a low frequency version of Model CFA-1, providing total frequency shifts of known 0 to 400 cps total shifts, optimized at 200 cps. The center frequency of the discriminators in this equipment is 2550 cps (see figure 4-3).

Small frequency shifts are normally used in the lower frequency bands to overcome the large radiation losses encountered. Unfortunately, it is here that noise problems become most pronounced and some of the FM advantages of the frequency shift system are lost. Model CFA-1L enables the user to extract every possible additional margin of advantage out of the frequency shift principle even though he is operating at low frequencies.

When operating in the low frequency bands, care should be taken to insure the stable operation of the receiver HFO and BFO. Crystal oscillators are most desirable. When space diversity is used, the beat frequency should be derived from a common source such as the TMC Variable Frequency Oscillator, Model VOX.

Model CFA-1L incorporates the same circuits as the basic CFA-1, which allows for a drift tolerance of 1-1/2 times the input frequency shift.

When Model CFA-1L is used with a single receiver, the audio output of the receiver should be connected to both input channels. If the converter is to be used on a circuit that requires two operating frequencies, one receiver can be connected to one channel of the convertor and the other receiver to the other channel. In this manner, the operator may quickly transfer the converter from one circuit to the other by simply switching the front panel controls.

1-4. FUNCTIONAL DESCRIPTION, MODEL CFA-1LB.

Model CFA-1LB is a further modification of the basic equipment designed to accommodate the very

narrow shifts being used in specialized VLF and LF applications. This unit may be used to receive total shifts of 20 to 200 cps and has been optimized at 40 cps. The center frequency of the discriminators is 2700 cps. Other center frequencies can be provided on special request. (See figure 4-3.)

1-5. TECHNICAL SPECIFICATIONS.

INPUT IMPEDANCE:	600 ohms
INPUT LEVEL:	Minus 30 to plus 30 dbm
INPUT LIMITING:	50 to 60 db for each channel
INPUT FREQUENCY SHIFT LIMITS:	CFA-1: 100 to 1000 cps, centered at 2550 cps CFA-1L: 0-400 cps, centered at 2550 cps CFA-1LB: 20-200 cps, centered at 2700 cps
INPUT FREQUENCY DRIFT LIMITS:	One and one-half times maximum shift (1500 cps)
KEYING SPEEDS:	100 to 600 words per minute at high speed position. Up to 100 words per minute at low speed.
OUTPUT CIRCUIT:	Neutral, either side grounded or floating. 35 to 75 ma into 2000 ohm load with external battery similar to TMC Power Supply Model PSP. Smaller currents into higher load impedances.
TUNING INDICATOR:	Two inch cathode ray tube.
POWER REQUIREMENTS:	110/220 volts a-c, ±10%, 50/60 cps, approx. 80 watts.
DIMENSIONS:	3-1/2 inches high X 19 inches wide X 16 inches deep, including all rear panel controls.
MOUNTING:	Standard 19 inch relay rack.
SHIPPING WEIGHTS AND DIMENSIONS:	One carton approx. 38 lbs. 23-1/4 inches X 21-1/4 inches X 7-1/2 inches domestic packing. One case approx. 80 lbs. 31-1/4 inches X 29-1/4 inches X 15-1/2 inches export packing.
COMPONENTS AND CONSTRUCTION:	All equipment manufactured in accordance with JAN/MIL specifications wherever practicable.

TABLE 1-1. VACUUM TUBE COMPLEMENT

REFERENCE DESIGNATION	TUBE TYPE	FUNCTION
V1	6AU6	Tone Amplifier
V2	6J6	Limiter
V3	12AU7	Tone Amplifier
V4	6AU6	Tone Amplifier

TABLE 1-1. VACUUM TUBE COMPLEMENT (CONT)

REFERENCE DESIGNATION	TUBE TYPE	FUNCTION
V5	6J6	Limiter
V6	6AL5	Tone Rectifier
V7	6AL5	Tone Rectifier
V8	6AL5	Clamper
V9	6AU6	Pulse Amplifier
V10	6AU6	Pulse Amplifier
V11	12AU7	Monitor Amplifier
V12	6J6	Pulse Restorer
V13	12AU7	Oscillator/Cathode Follower
V14	6Y6C	Pulse Generator
V15	5Y3GT	Rectifier
V16	6X4	Rectifier
V17	OB2	Voltage Regulator
V18	OA2	Voltage Regulator
V19	OB2	Voltage Regulator
V20	OB2	Voltage Regulator
V21	2BP1	Monitor
V22	6AL5	Rectifier

SECTION 2
INSTALLATION

2-1. INITIAL INSPECTION.

Each unit has been thoroughly checked and tested at the factory before shipment. Upon arrival at the operating site, inspect the packing case and its contents immediately for possible damage. Unpack the equipment carefully. Inspect all packing material for parts which may have been shipped as loose items.

With respect to damage to the equipment for which the carrier is liable, The Technical Materiel Corporation will assist in describing methods of repair and the furnishing of replacement parts.

The equipment is shipped with all tubes and other plug-in components installed. Check that all such components are properly seated in their sockets.

2-2. MECHANICAL INSTALLATION.

The CFA units are equipped with standard 19 inch rack panels, designed to be mounted into any suitable equipment rack. The mounting and outline dimensions are shown in figure 2-2.

2-3. ELECTRICAL INSTALLATION.

The units are designed to operate from any suitable power source providing 110 or 220 volts ac, 50/60 cps, single phase power. The units are factory wired for 110 volts ac operation and may be converted for 220 volts ac operation by making the necessary wiring changes shown in figure 2-1.

Referring to figure 2-3 make the following connections on terminal board E1.

a. Connect the channel 1 audio output of a dual diversity receiver (600 ohms) to terminals 1 and 2 and the channel 2 audio output to terminals 3 and 4. For single receiver operation, the audio output should be connected to both sets of terminals simultaneously.

b. Connect a regulated power supply having an output of approximately 200 volts at 70 ma to terminal 6 (+) and terminal 7 (-). Power Supply TMC Model PSP-1 has been expressly designed to fulfill this requirement.

2-4. INITIAL ADJUSTMENTS.

After the equipment has been installed and properly terminated, an initial adjustment must be made to ensure proper operation of the equipment. To perform these initial adjustments, proceed as follows:

a. Turn Line Current control (rear panel) fully counterclockwise.

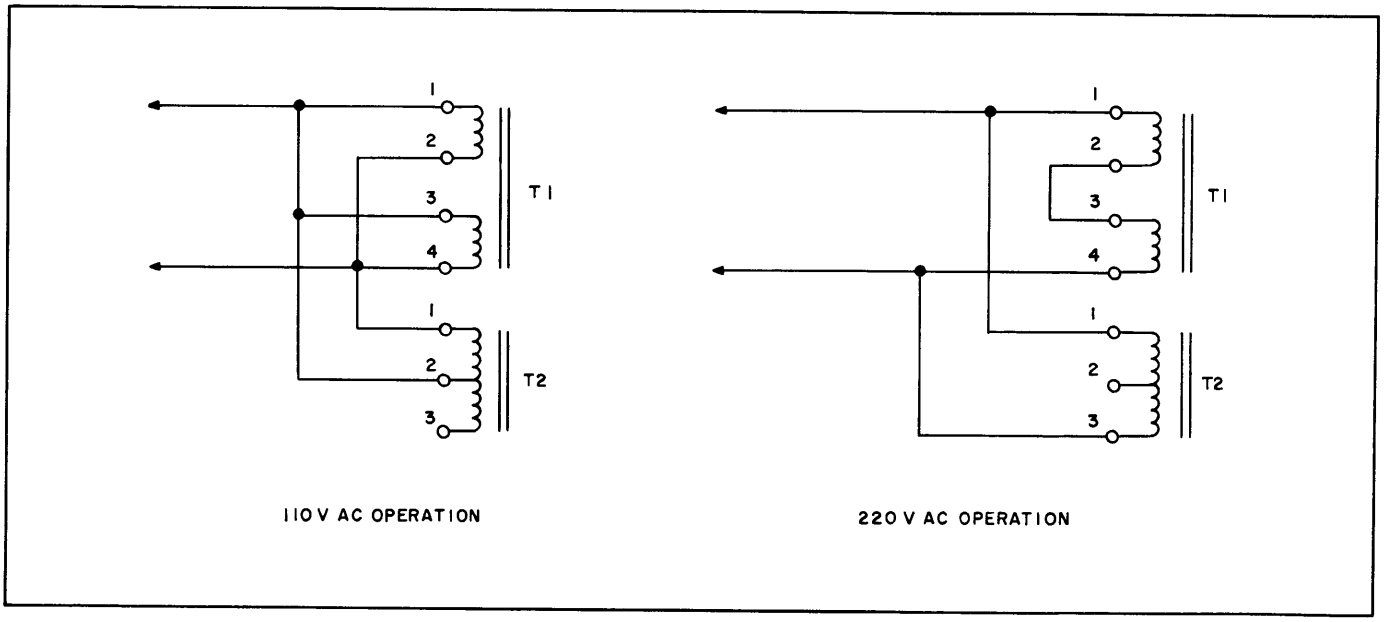


Figure 2-1. Power Supply Interconnections

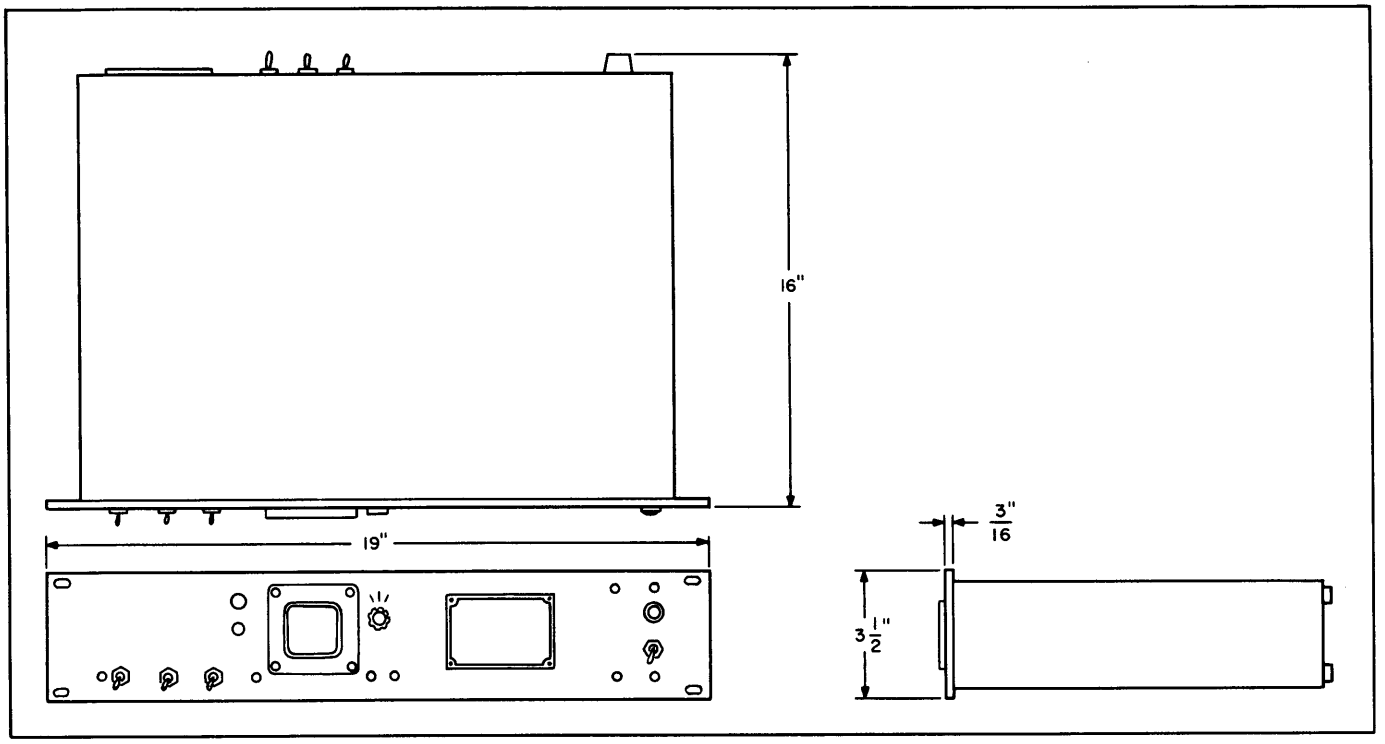


Figure 2-2. Model CFA, Outline Dimensional Drawing

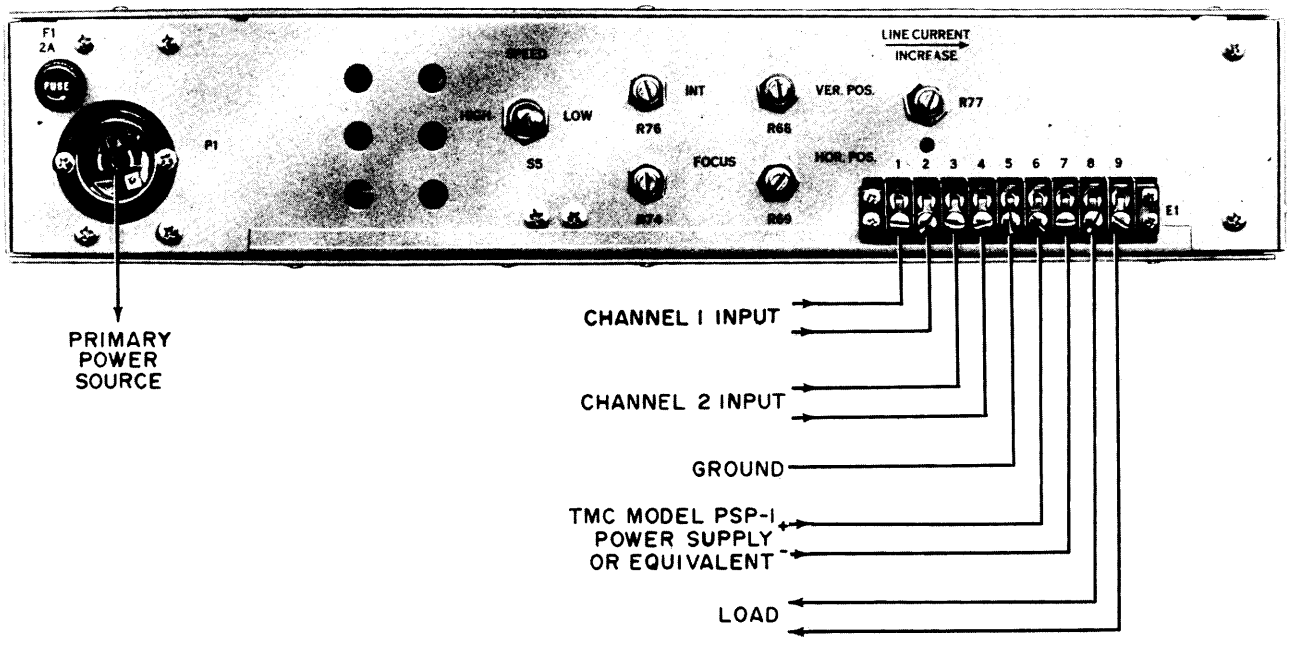


Figure 2-3. Model CFA, Rear Panel Connections

b. Connect a 100 ma meter in series with teleprinter load and connect meter and load to terminals 8 and 9 of terminal block E1.

NOTE

If TMC Model PSP-1 Power Supply is used, the milliammeter may be omitted.

c. Place CFA and teleprinter power supply switches to ON.

NOTE

The pilot lamps should light. Allow a sixty second minimum warm-up period.

d. Turn TEST switch (front panel) to MARK.

e. Adjust LINE CURRENT control (rear panel) for 60 ma reading on milliammeter.

NOTE

If the printer does not revert to standby or mark condition, reverse the printer load connections for proper operation.

f. Turn TEST switch (front panel) to LINE.

NOTE

In dual diversity receivers, it is possible to improperly set one of the BFO controls so that one diversity channel output is in Mark while the other is in Space. For this reason, it is recommended that receivers be used which have common BFO's and high frequency oscillators.

2-5. OPERATIONAL CHECKS AND ADJUSTMENTS.

After the initial adjustments outlined in paragraph 2-4 have been made, an operational check and adjustment should be made as follows:

a. RECEIVER TUNING

(1) Set CH 1 switch (front panel) to ON.

(2) Set CH 2 switch (front panel) to OFF.

(3) Tune channel 1 receiver until its signal is centered on the visual monitor of the CFA.

NOTE

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 tune the receiver so 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 (see figure 2-4).

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

(4) Set channel 1 switch to OFF and channel 2 switch to ON.

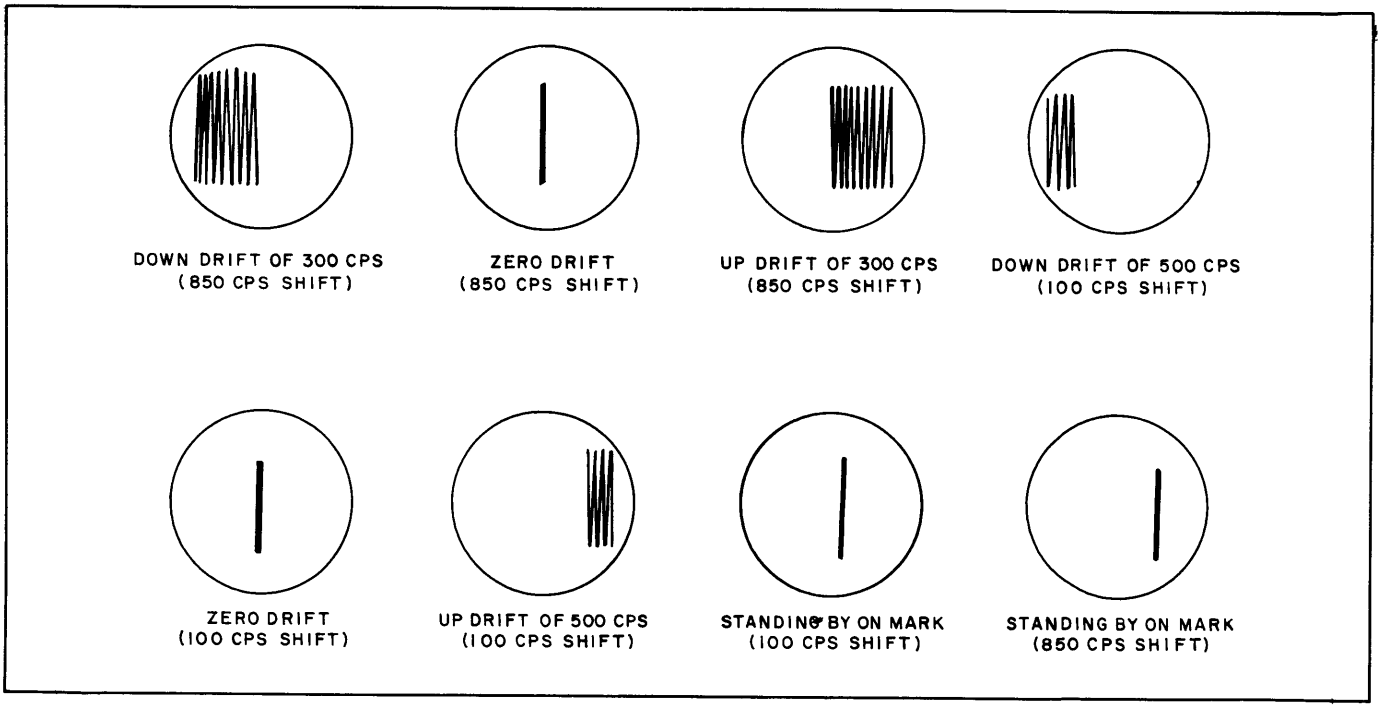


Figure 2-4. Monitor Patterns

Tune output of channel 2 receiver until signal is centered on visual monitor of CFA (see note in step (3)).

NOTE

For single receiver operation, only the channel used should be left in the ON position. For normal teleprinter speeds not exceeding 100 wpm, the SPEED SWITCH S5, rear panel (of Models CFA-1 and CFA-1L only) should be turned to LOW. The position of SENSE switch (front panel) is correctly positioned when the receiving teleprinter functions properly.

b. SHIFT AND BIAS ADJUSTMENT - The unit is set at the factory for optimum operation on a circuit using 850 cps shift signal applied by an undistorted source. The equipment may be adjusted to accommodate other shifts and biased or distorted signals in the following manner:

(1) Shift Adjustment - The THRESHOLD control (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 shifts. (i.e. full rotation is 300 degrees. For 350 cps shift, the THRESHOLD control should 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 equipment has a MARK BIAS control (front panel) 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 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 counterclockwise until the teleprinter commences to print. The MARK BIAS control may then be properly adjusted as has already been described.

(3) C.W. or F.S.K. Operation

(a) Frequency Shift Key - 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.

(b) 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 equipment has been so arranged that dots and dashes will produce spaces in the pulse output tube.

SECTION 3
OPERATOR'S SECTION

3-1. GENERAL.

Operation of the equipment has been designed for a high degree of simplicity and versatility, requiring a minimum of operator effort and skill. The necessary operating controls and indicating devices are all readily accessible on the front panel. All controls requiring only initial settings and the line protective fuse are located on the rear panel.

3-2. OPERATING INSTRUCTIONS.

The operator should have a basic knowledge of the CFA unit function and construction. Therefore, it is suggested that the operator familiarize himself with the contents of this manual, paying particular attention to the General Description and Installation sections of this manual. Referring to paragraphs 2-4 and 2-5, the operator will familiarize himself with the function and settings of the various operating controls and indicators.

Table 3-1 provides equivalent control designations for the operating controls shown in figure 3-1.

Table 3-2 is an operation chart to be used in conjunction with figure 3-1 and table 3-1.

3-3. OPERATOR'S MAINTENANCE.

The operator may, at certain times, be required to perform various aspects of operator's maintenance. This type of maintenance may consist of simply keeping the unit clean and observing for tight interconnecting cable connections.

There are several types of operator's maintenance which can be performed on the CFA unit by the operator when trouble is encountered. If normal operating procedures produce unsatisfactory results, the operator should proceed as follows:

a. Check the POWER indicator lamp to ascertain that power is applied to the unit.

NOTE

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

b. If no power is evident, check input voltage connection to CFA unit. Check fuse on rear panel. Replace blown fuse with fuse of equal value.

c. Check the tubes since the most common cause of operational failure is usually tube failure. Checking the tubes will often save many hours of unnecessary troubleshooting. The location of tubes in the CFA unit is shown in figure 5-2.

d. Check connection and condition of all interconnecting cables and observe that all associated equipments are functioning properly.

TABLE 3-1. OPERATING CONTROLS

ITEM (See figure 3-1)	CONTROL OR INDICATOR
FRONT PANEL	
1	THRESHOLD, control R32
2	MARK BIAS, R45
3	MONITOR, indicator V21
4	POWER, indicator lamp I1
5	power switch S1
6	SENSE switch S4
7	CH. 1 switch S2

TABLE 3-1. OPERATING CONTROLS (CONT)

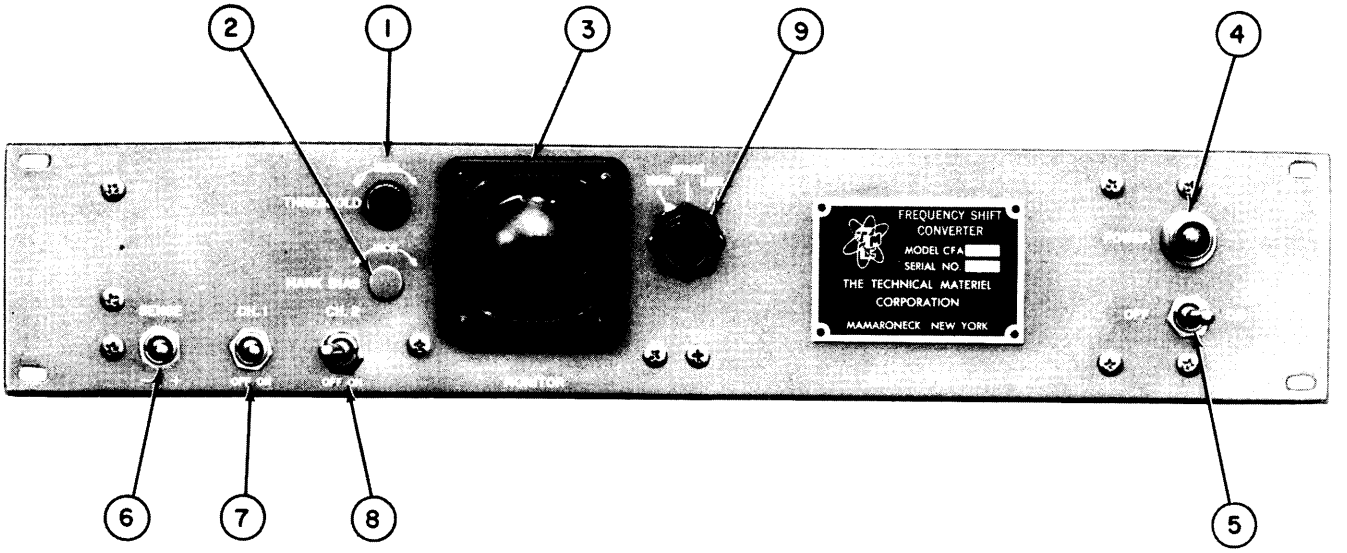
ITEM (See figure 3-1)	CONTROL OR INDICATOR
FRONT PANEL (CONT)	
8	CH. 2 switch S3
9	MARK-SPACE-LINE, switch S6
REAR PANEL	
10	POWER FUSE, F1
11	SPEED switch S5 (Model CFA-1 and CFA-1L only)
11	MONITOR GAIN, R98 (Model CFA-1LB only)
12	INT, control R76, screwdriver adjustment
13	VER POS, control R68, screwdriver adjustment
14	LINE CURRENT, control R77, screwdriver adjustment
15	FOCUS, control R74, screwdriver adjustment
16	HOR POS, control R69, screwdriver adjustment

TABLE 3-2. OPERATING PROCEDURE

STEP	CONTROL	OPERATION	PURPOSE
1	POWER ON-OFF, switch S1	Set to ON. Power indicator lamp should light.	Applies power to all stages.
2	MARK-SPACE-LINE, switch S6	Turn to LINE.	In MARK and SPACE positions, signal is grounded for test purposes.
3	CH. 1 switch S2 and/or CH. 2 switch S3	Set desired channel switch to ON.	For single receiver operation, CH. 1 toggle switch is set to ON position with CH. 2 set to OFF. For dual receiver (diversity) operation, both channel toggle switches are set to the ON position.
4	SENSE switch S4	Set to position which enables receiving teleprinter to function properly.	Selects plus or minus phase from tone rectifier V6 and V7 output.
5	MARK BIAS, control R45	Adjust to correct for fixed mark or space distortion in received signal or in teleprinter. Refer to paragraph 2-5.	Varies input level to pulse amplifier V10 control grid.

TABLE 3-2. OPERATING PROCEDURE (CONT)

STEP	CONTROL	OPERATION	PURPOSE
6	THRESHOLD, potentiometer control (1)	Adjust control for the shift of the received signal. Refer to paragraph 2-5.	Varies input shift to pulse amplifier V9 control grid.



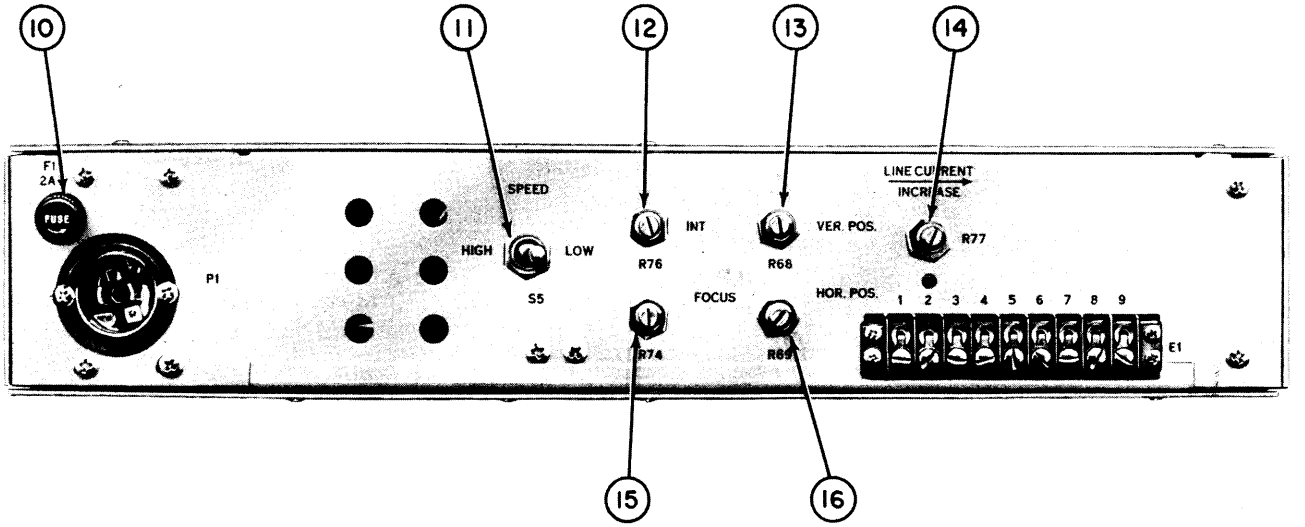


Figure 3-1. Model CFA, Operating Controls

SECTION 4
PRINCIPLES OF OPERATION

4-1. INTRODUCTION.

The following circuit description pertains to the three CFA models covered in this manual.

Models CFA-1 and the CFA-1L are identical in circuitry and operation and CFA-1LB differs only in that the tuned discriminator circuits are moved closer together to increase their Q and develop a 40 cps shift for an input voltage which approximates that formerly obtained at 850 cps shift.

A MONITOR GAIN control (R98) has been incorporated in Model CFA-1LB to make the visual monitor more adaptable to the 20 to 200 cps shift range. This allows for the adjustment of wide variations in discriminator output voltage which result from switching from one extreme to another. Since there is no need for a speed switch, the MONITOR GAIN control occupies the physical position of the SPEED switch on the CFA-1 and CFA-1L units.

4-2. GENERAL DESCRIPTION OF CIRCUITS.

Because the frequency shift principle is not dependent upon amplitude modulation for the conveying of intelligence, it is possible to exploit every advantage inherent in frequency modulation systems. This was done in CFA Models and will become evident in the discussion that follows. Figure 4-1 is an overall block diagram of Model CFA showing the routing of a signal input to output.

a. LIMITER-AMPLIFIERS V1 through V5 - 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. Therefore, a twin set-up is utilized whereby each channel from the dual diversity receiver system passes through a discreet limiter stage. The limiters (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 limiters are preceeded by a limiter-amplifier (V1 or V4) that 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 and V2 or V4 and V5) in tandem is to remain clamped 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 tone and feeds it to the discriminator resonant circuits.

b. 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. (See figure 4-3.)

c. DISCRIMINATOR RECTIFIERS V6 AND V7 - The tone voltage across each resonant circuit is rectified by the discriminator rectifiers and then applied to 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 applied to the clamper. 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 (capacitors C19 and C20).

d. CLAMPER 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 magnitude and polarity of the potential represented by this axis is a function of the degree and direction of drift. (Figure 4-2 A B & C.) The function of the clamper is to treat this drift produced voltage in a 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.

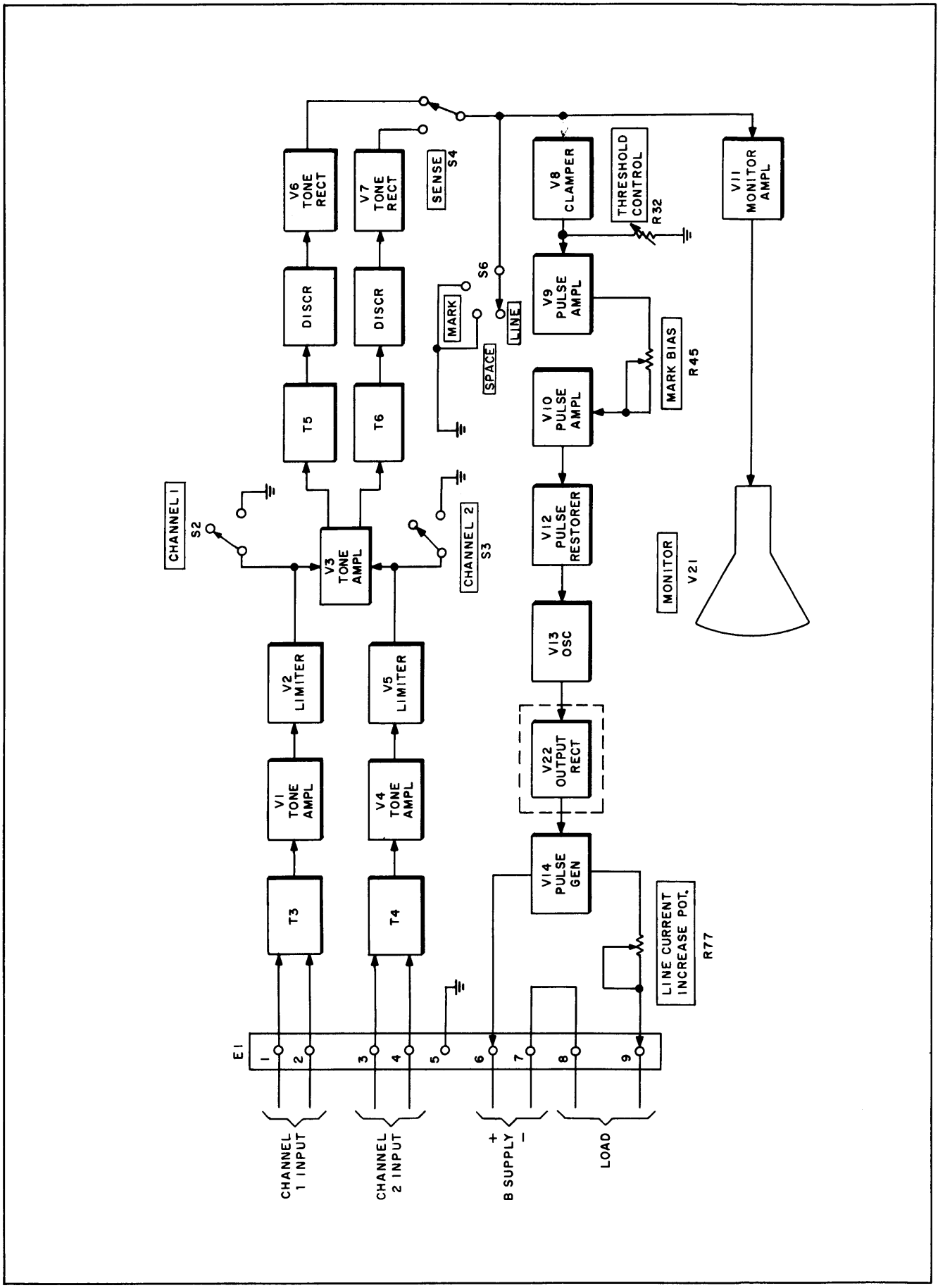


Figure 4-1. Model CFA, Overall Block Diagram

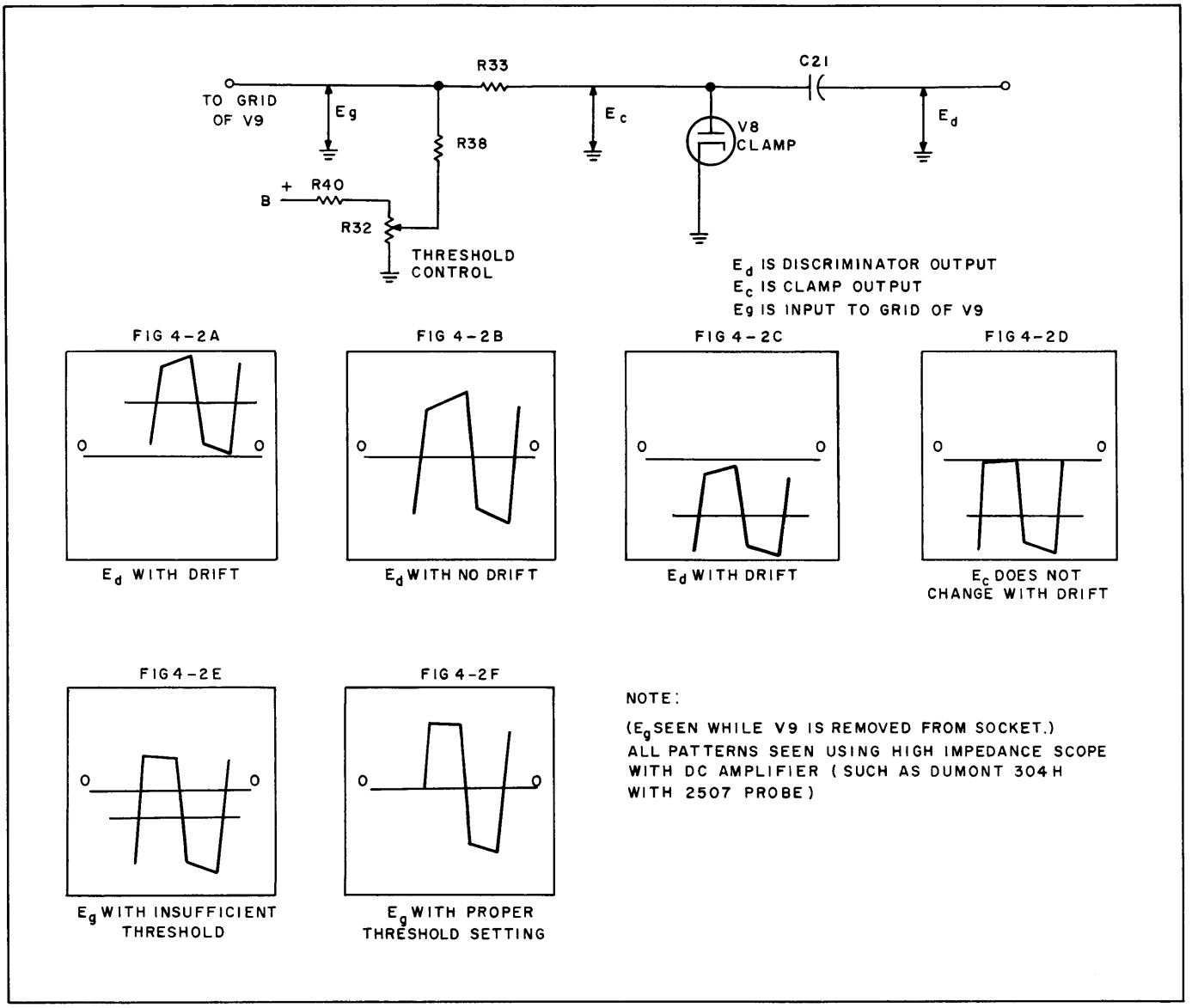


Figure 4-2. Clamp and Threshold Operation

Observation of the schematic diagram will show that the clamper 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 counterclockwise to zero. It can then be seen that, due to the presence of the clamper no positive voltage will ever appear at the grid of V9. Capacitor C21 will prevent the passage of dc and the clamper allows the charging of this capacitor in such a manner that the waveform which is passed will have its uppermost peak at ground potential. (Figure 4-2D.) When the THRESHOLD control is properly adjusted, a fixed positive potential will appear at the grid of V9 and the waveform from the clamp will be symmetrically superimposed on this voltage. Since the clamper 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.

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. PULSE AMPLIFIER V9 - Pulse amplifier V9 is a high gain amplifier which reaches grid saturation and plate current cut-off at very low input voltages and its output normally is essentially square wave. The first pulse amplifier feeds an integrating network that serves to give its output a saw-tooth slope.

f. SECOND PULSE AMPLIFIER V10 - The second pulse amplifier operates essentially like the one that 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 leading and trailing edges of this square wave produce sharp positive and negative voltage pips.

g. PULSE RESTORER V12 - The pulse restorer is a one shot multivibrator that when keyed in a given direction, will remain in one state until an opposite impulse sneds it into another state, where it will again remain. The sharp trigger pulse 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. CATHODE FOLLOWER V13 - The cathode follower simply serves as an isolating stage between the oscillator and the pulse restorer. Its output is precisely like its input except for a slight loss in signal amplitude.

i. OSCILLATOR V13 - Oscillator V13 is a conventional Hartley oscillator 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 dc isolation of the pulse circuit which feeds the teleprinter. This is done through transformer coupling to the oscillator output (T7) which is rectified by V22 and then filtered and coupled to the pulse output stage.

j. 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. MONITOR V11 and V21 - A constant amplitude vertical sweep for the monitor V21 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 that produces a horizontal sweep.

As has already been discussed in paragraph 4-1, d, an average dc potential appears at the discriminator output when drift takes place. Since one of the Monitor amplifiers is a dc amplifier, its output will differ from the other amplifier by an amount proportional to this dc 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 face of monitor V21. 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.

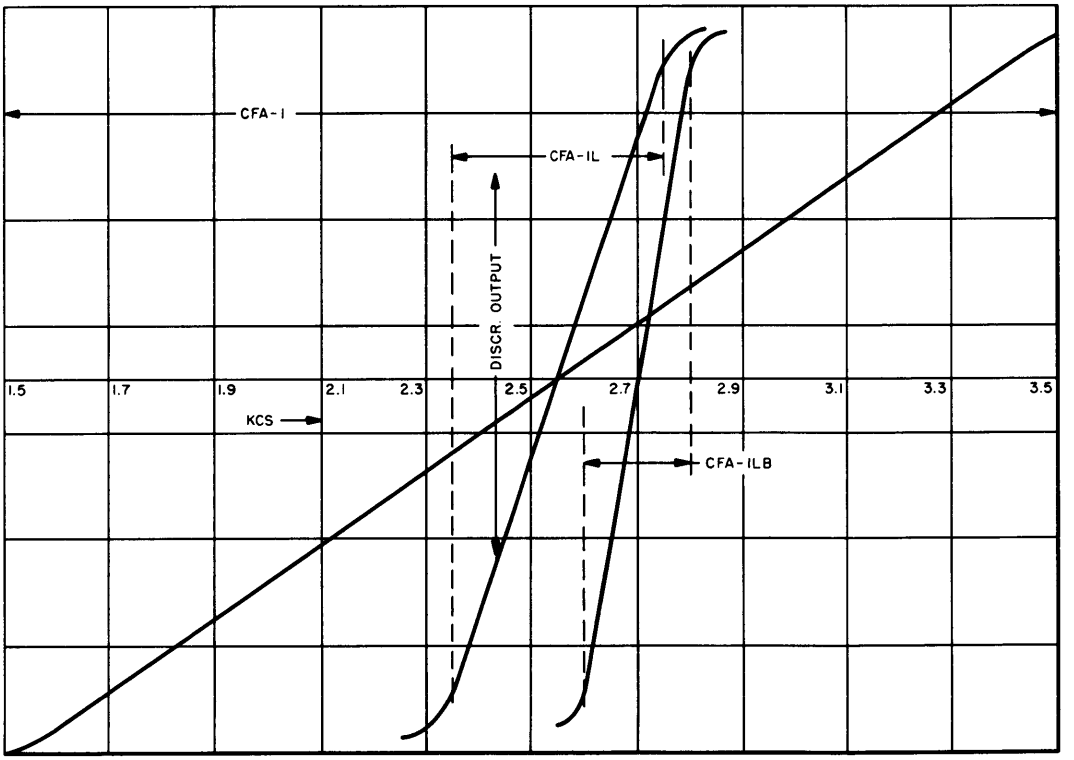


Figure 4-3. Model CFA Discriminator Curves

SECTION 5
TROUBLESHOOTING

5-1. INTRODUCTION.

This section explains how to locate and diagnose equipment troubles and maladjustments. By proper use of the various troubleshooting tables and diagrams shown in this section, the technician can locate and diagnose the particular fault at hand.

The following aids to troubleshooting are provided:

a. Schematic diagrams (figures 8-1, 8-2, 8-3)

b. Voltage Measurements Chart (table 5-1)

c. Test setup (figure 5-1)

d. Tube location data (figure 5-2)

e. Component layout data (figures 5-3 and 5-4)

f. Assembly wiring diagram (figure 5-5)

g. Signal flow diagram (figure 5-6)

5-2. TROUBLESHOOTING TECHNIQUES.

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

A second shortcut in troubleshooting is to ascertain that all tubes and fuses are in proper operating condition and that the proper equipment voltages are present. This may eliminate further investigation.

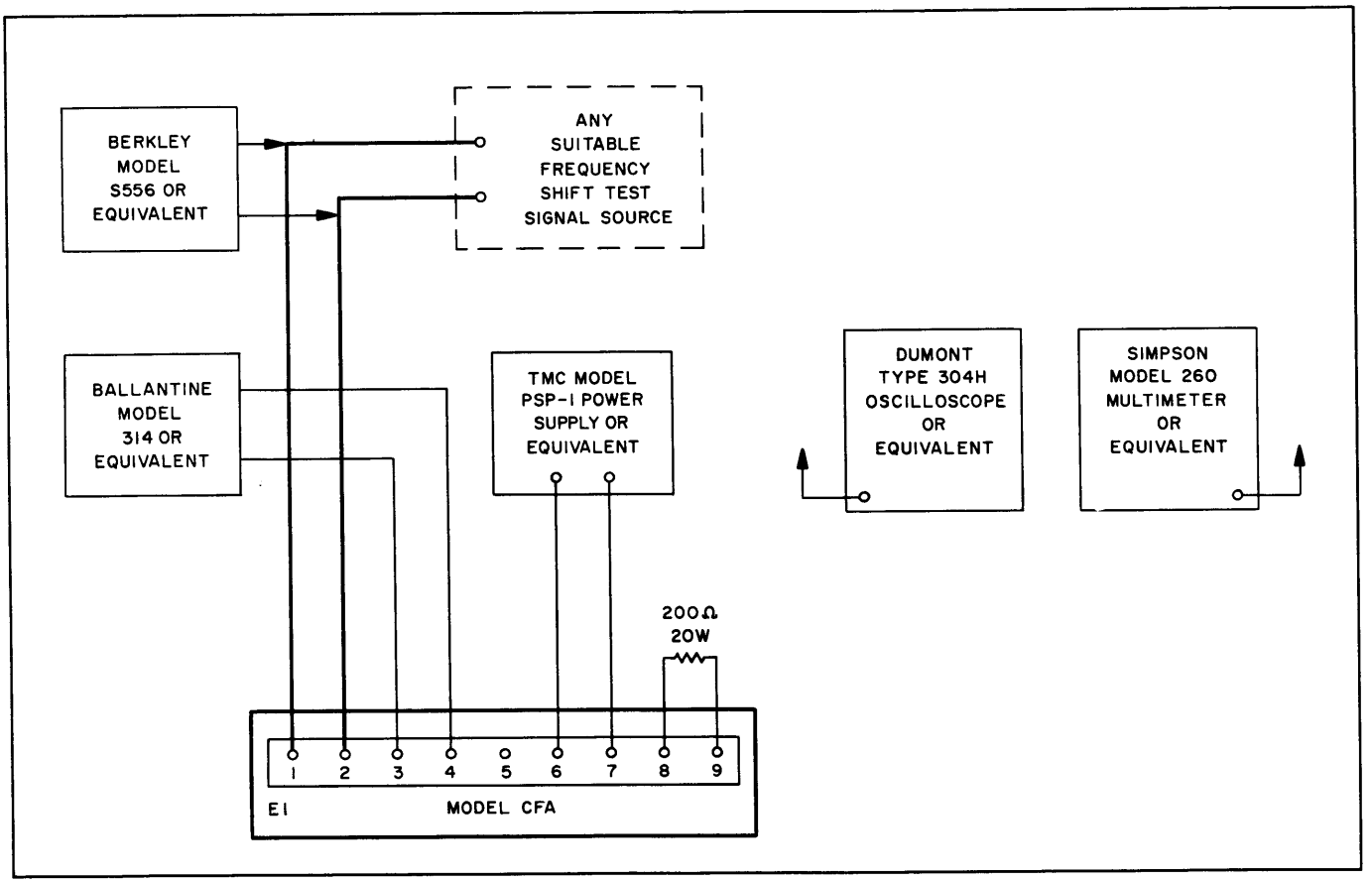


Figure 5-1. Model CFA, Test Setup

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

5-3. SYSTEM TROUBLESHOOTING.

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 oscilloscope or dc meter. If no signal voltage is found here, the converter is defective.

5-4. UNIT TROUBLESHOOTING.

Figure 5-6 illustrates point to point waveforms under actual operating conditions in signal flow order. This diagram, together with the voltage chart table 5-1, will assist in locating troubles.

a. Check SHIFT and MARK BIAS controls to be sure that they have not been tampered with or improperly set.

b. Remove top cover plate and check all tubes.

c. Check power supply voltages against those in table 5-1. If the power supply voltages are correct, a quick check of 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 means that these circuits are operating properly.

d. The equipment may then be connected to the output of a frequency shift oscillator, (providing the necessary frequencies shown in paragraph 1-5) or to a receiver system which is tuned to a suitable frequency shift signal. The operating conditions shown in figure 5-6 should be fulfilled, 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 table 5-1.

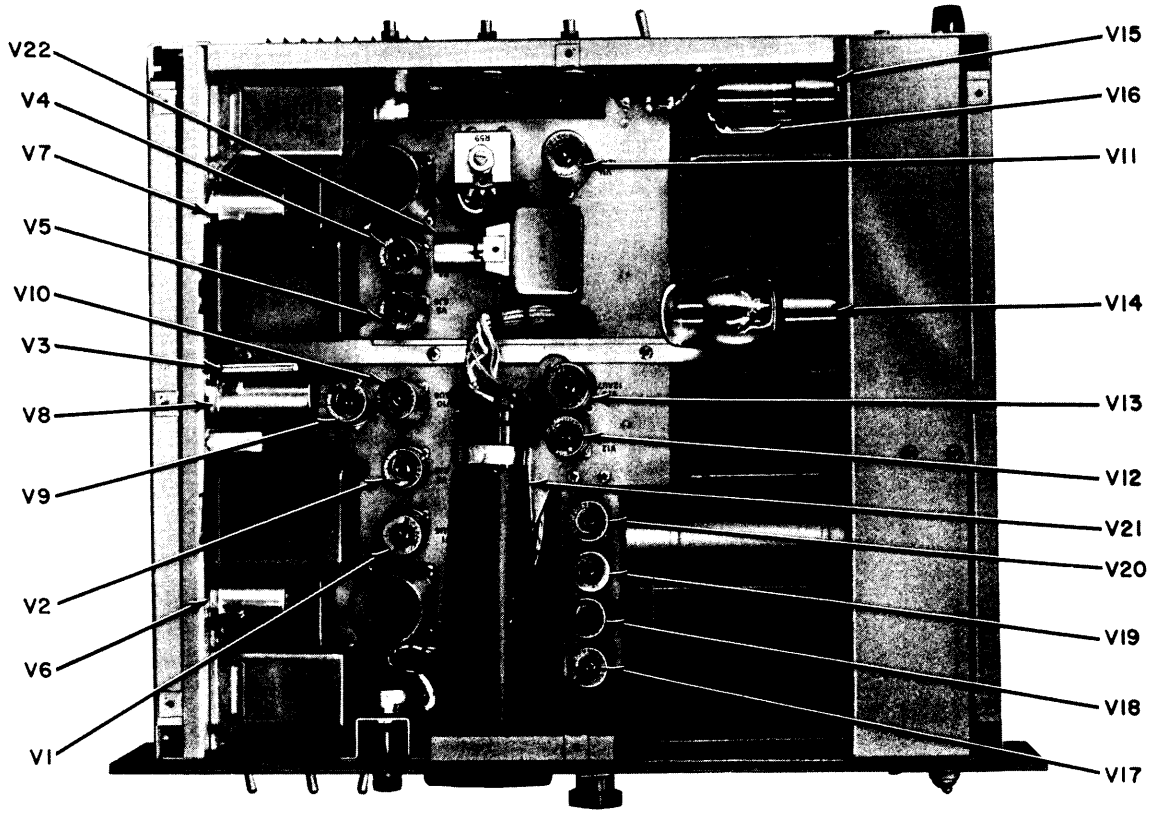


Figure 5-2. Model CFA, Tube Locations

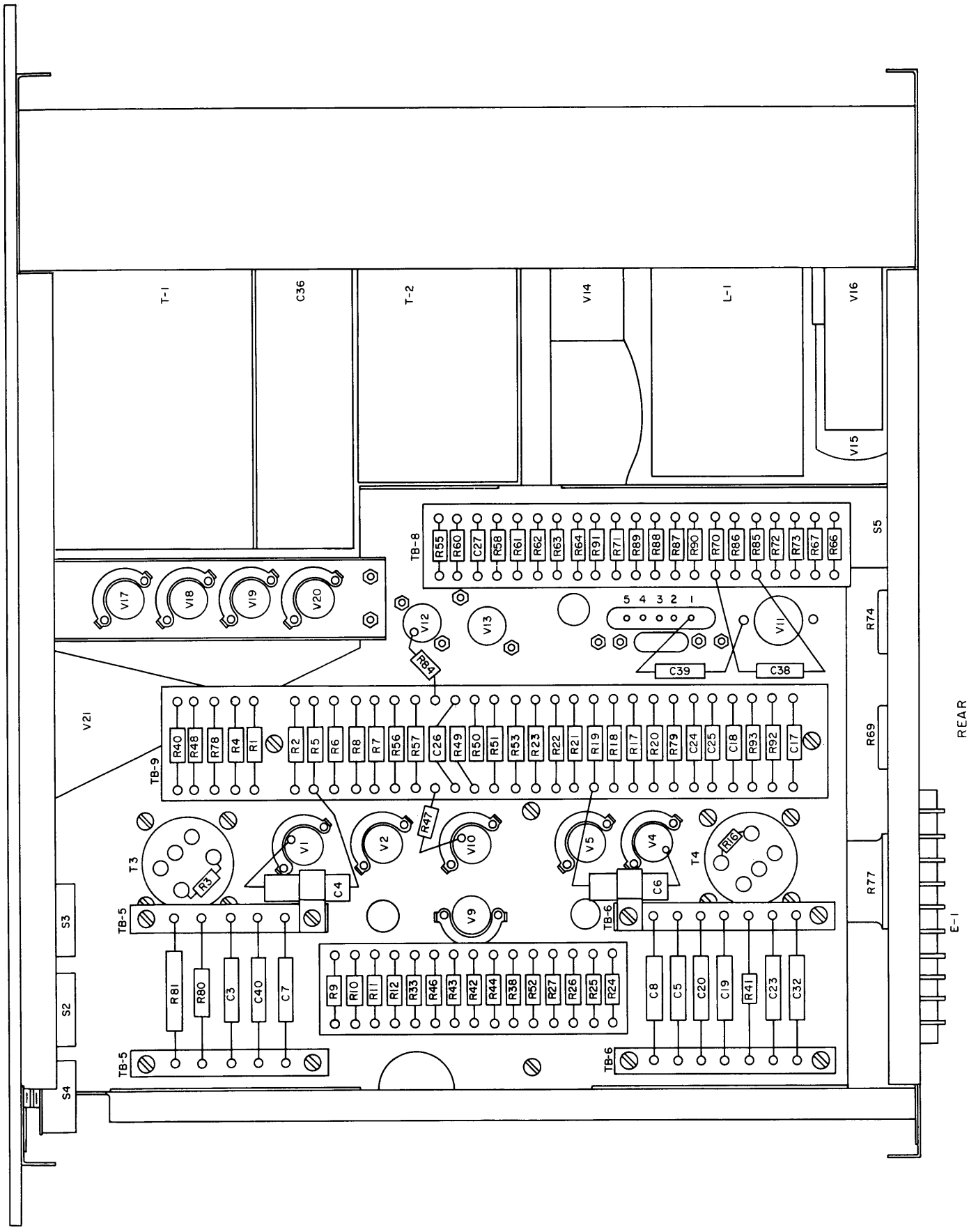


Figure 5-3. Model CFA, Component Layout, Bottom View

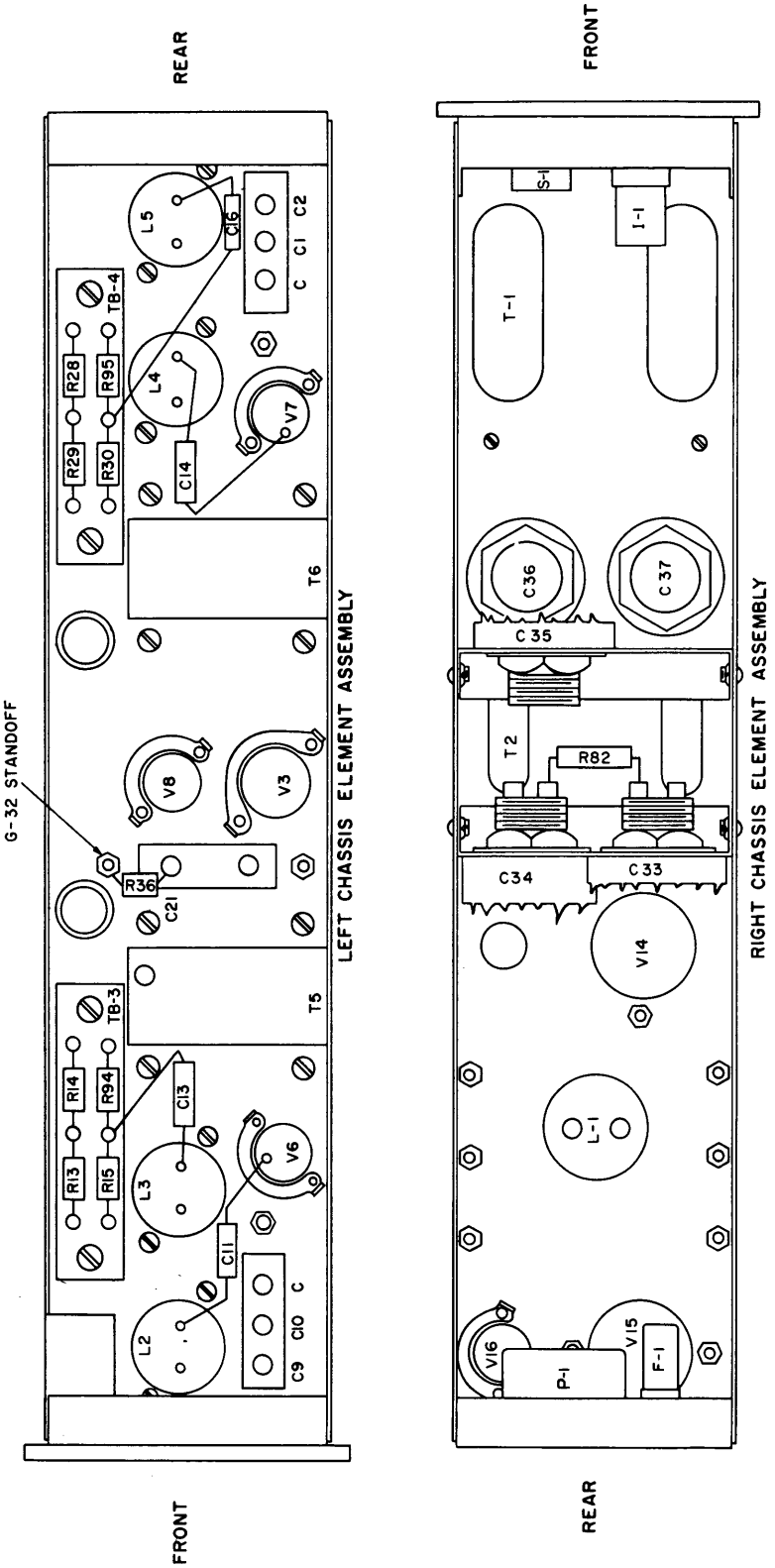


Figure 5-4. Model CFA, Component Layout, Left and Right Views

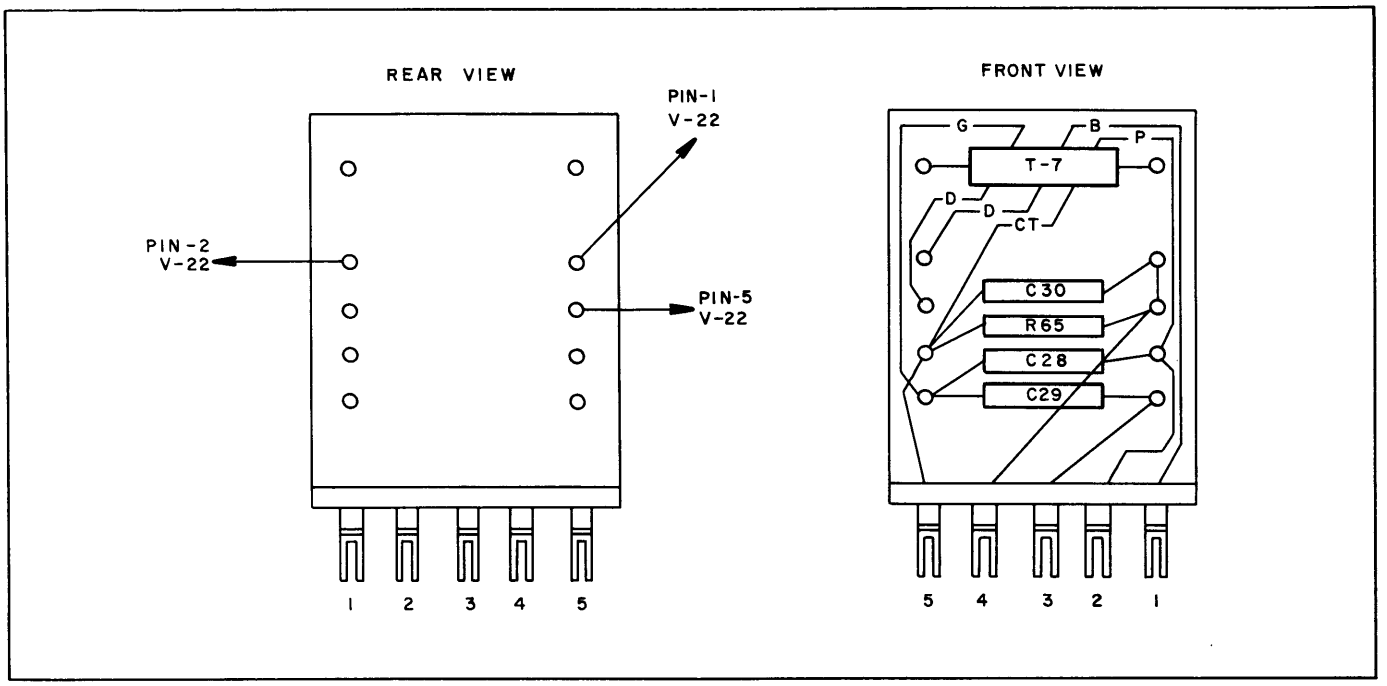


Figure 5-5. Oscillator Assembly Wiring Diagram

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

NOTE

Potentiometer R59 is preset at the factory. If it should become necessary to replace this component, the following steps must be taken:

a. Connect an oscilloscope and a d-c amplifier (or a high impedance d-c voltmeter) from the junction of C21 and R36 to ground.

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

c. Tune the signal until the oscilloscope 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. Tune potentiometer R59 to such a value that the MONITOR will show a thin straight line.

TABLE 5-1. VOLTAGE MEASUREMENTS

Tube Symbol	Function	Type	Pins	Volts	Pins	Volts	Pins	Volts	Pins	Volts	Pins	Volts	Pins	Volts	Pins	Volts
V1	Tone Amplifier	6AU6	1	-6	2	+1	5	+72	6	+10	7	+1	3	6.3 vac		
V2	Limiter	6J6	1	+271	2	+232	5	0	6	0	7	+36	3	6.3 vac		
V3	Tone Amplifier	12AU7	1	+265	2	+43	3	+64	6	+264	7	+40	8	+56	4	6.3 vac
V4	Tone Amplifier	6AU6	1	-6	2	+1.1	5	+70	6	+13	7	+1.1	3	6.3 vac		
V5	Limiter	6J6	1	+275	2	+230	5	0	6	0	7	+35	3	6.3 vac		
V6	Tone Rectifier	6AL5	1	0	2	-24.5	5	+20	7	-24.5	4	6.3 vac				

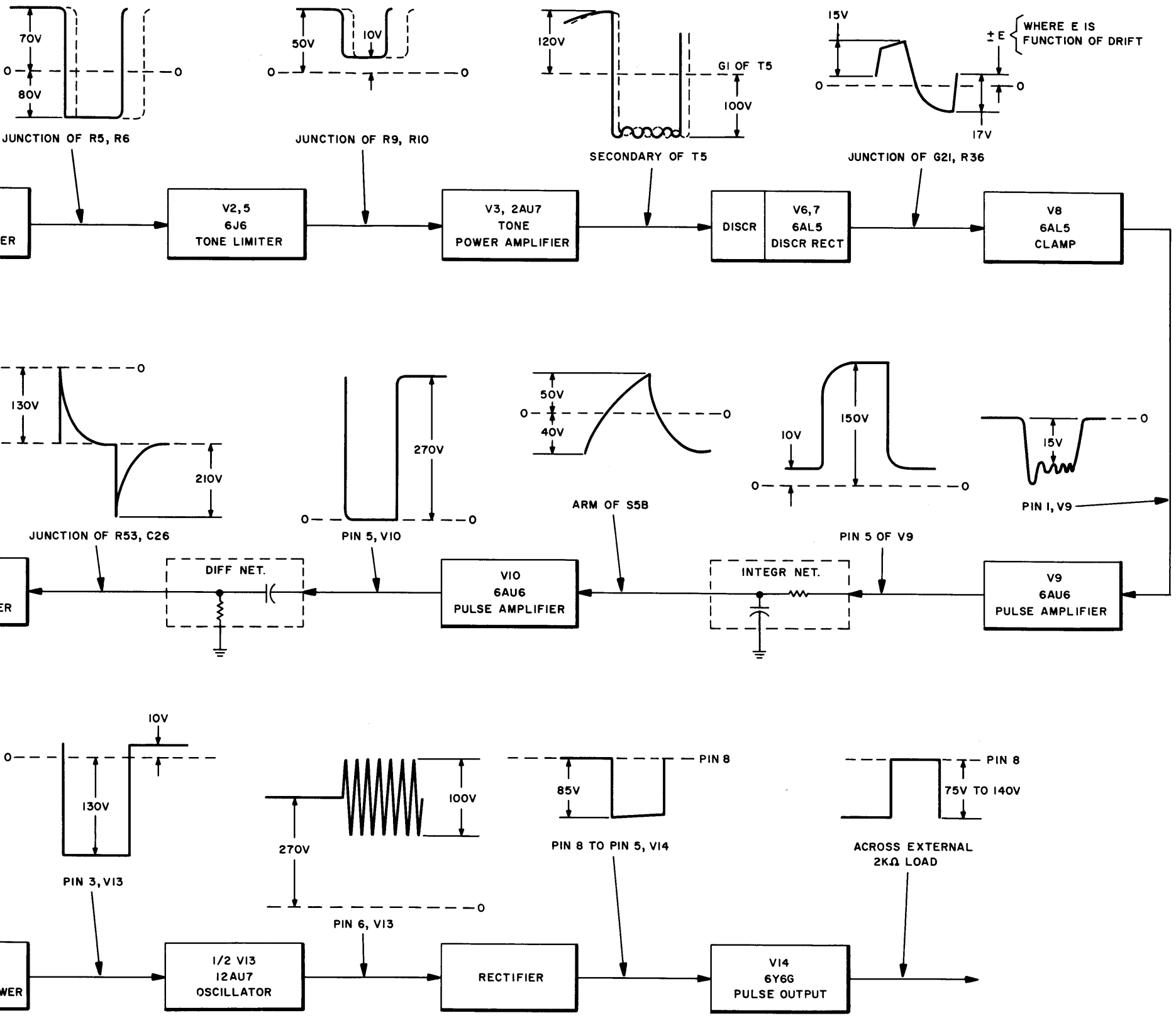
Note: Unless otherwise specified, all voltages are dc.

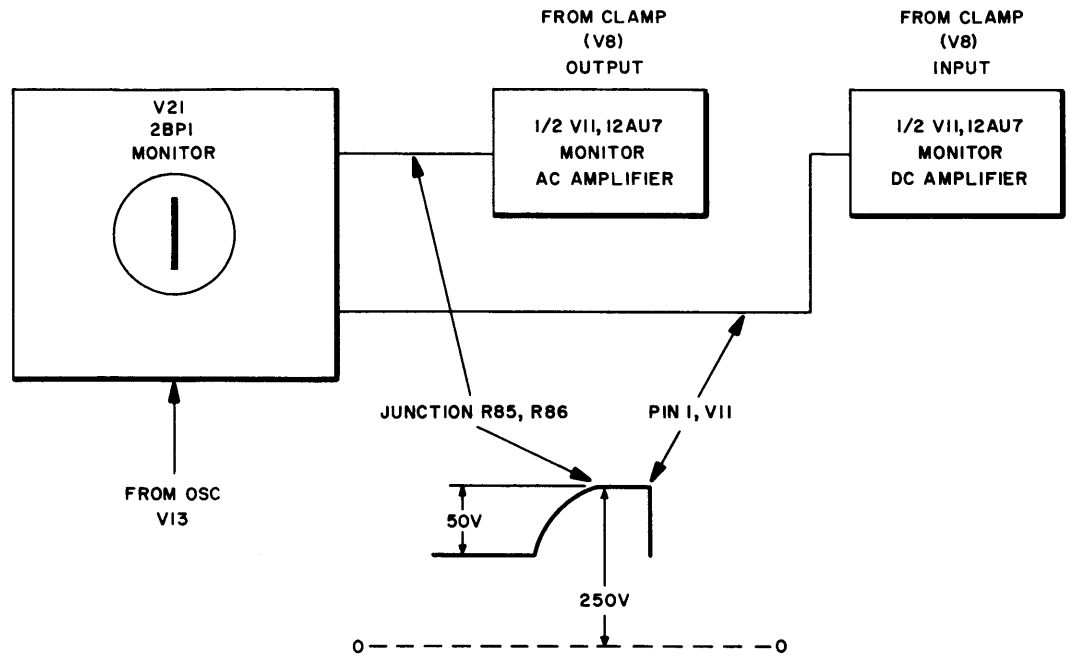
TABLE 5-1. VOLTAGE MEASUREMENTS (CONT)

Tube Symbol	Function	Type	Pins	Volts	Pins	Volts	Pins	Volts	Pins	Volts	Pins	Volts	Pins	Volts	Pins	Volts
V7	Tone Rectifier	6AL5	1	0	2	-24.5	5	+20	7	-24.5	3	6.3 vac				
V8	Clamper	6AL5	2	-.6	1	0	3	6.3 vac								
V9	Pulse Amplifier	6AU6	1	-.25	2	0	5	+1.5	6	+18	7	0	3	6.3 vac		
V10	Pulse Amplifier	6AU6	1	-60	2	0	5	+262	6	+59	7	0	3	6.3 vac		
V11	Monitor Amplifier	12AU7	1	+195	2	6.2	3	+16	6	+78	7	+18	8	+20	9	6.3 vac
V12	Pulse Restorer	6J6	1	-80	2	+190	5	-170	6	-145	7	-130	3	6.3 vac	4	6.3 vac
V13	Oscillator Cathode Follower	12AU7	1	-260	2	-132	3	-110	6	+265	7	-105	8	0	4	6.3 vac
V14	Pulse Generator	6Y6	3-8	+200	4-8	+200	5-8	0	7	6.3 vac						
V15	Rectifier	5Y3	4	260 vac	6	260 vac	2	+285	2-8	4.5 vac						
V16	Rectifier	6X4	7	260 vac	1	-310	6	-310	4	6.3 vac						
V17	Voltage Regulator	OB2	2	-225	5	-130										
V18	Voltage Regulator	OA2	4	-160	1	0										
V19	Voltage Regulator	OB2	7	0	5	+100										
V20	Voltage Regulator	OB2	2	+100	5	+190										
V21	Monitor	2BP1 2BP1	2 10	-185 +220	3 12	-175 6.3 vac	4 1	-83 6.3 vac	6	+215	7	+200	8	+230	9	+210
V22	Output Rectifier	6AL5	1	0	2	-62	3	6.3 vac	7	-42						

CONDITIONS:

1. Line voltage of 110 vac @ 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 (+) condition.
5. TEST switch (S6) in LINE condition.
6. THRESHOLD control set for 850 cps operation.
7. BIAS control set for minimum distortion or near its center point.
8. SPEED switch set to LOW.
9. LINE CURRENT 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.

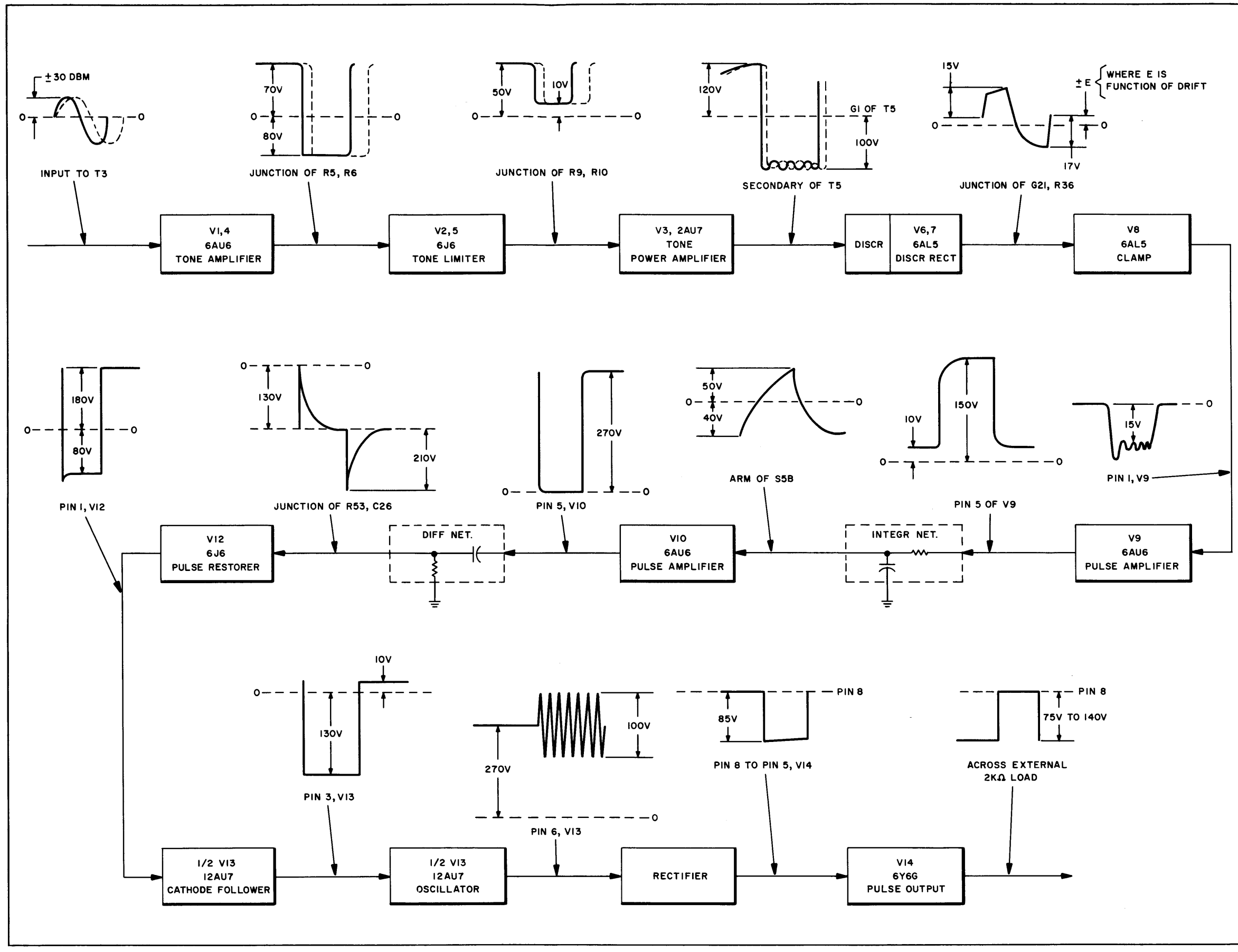




OPERATING CONDITIONS UNDER WHICH PATTERNS WERE OBTAINED:

1. LINE SOURCE: 110V 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 DUMONT 304H WITH 2507 PROBE.)

Figure 5-6. Signal Flow Diagram


±30 DBM
INPUT TO T3
70V
80V
JUNCTION OF R5, R6
50V
10V
JUNCTION OF R9, R10
120V
G1 OF T5
100V
SECONDARY OF T5
15V
±E
WHERE E IS FUNCTION OF DRIFT
17V
JUNCTION OF G2I, R36
V1,4 6AU6 TONE AMPLIFIER
V2,5 6J6 TONE LIMITER
V3, 2AU7 TONE POWER AMPLIFIER
DISCR
V6,7 6AL5 DISCR RECT
V8 6AL5 CLAMP
180V
80V
PIN 1, V12
130V
210V
JUNCTION OF R53, C26
270V
PIN 5, V10
50V
40V
ARM OF S5B
10V
150V
PIN 5 OF V9
15V
PIN 1, V9
V12 6J6 PULSE RESTORER
DIFF NET.
V10 6AU6 PULSE AMPLIFIER
INTEGR NET.
V9 6AU6 PULSE AMPLIFIER
10V
130V
PIN 3, V13
270V
100V
PIN 6, V13
PIN 8
85V
PIN 8 TO PIN 5, V14
PIN 8
75V TO 140V
ACROSS EXTERNAL 2KΩ LOAD
1/2 V13 12AU7 CATHODE FOLLOWER
1/2 V13 12AU7 OSCILLATOR
RECTIFIER
V14 6Y6G PULSE OUTPUT

011634408

SECTION 6
MAINTENANCE

6-1. INTRODUCTION.

Maintenance may be divided into three catagories: operator's maintenance, preventive maintenance, and corrective maintenance.

Corrective maintenance is sometimes considered as consisting of information useful in locating and diagnosing equipment troubles and maladjustments existing and/or pending, and information necessary to remedy the equipment troubles and maladjustments.

All models have been designed to provide long-term, trouble-free operation under continuous duty operation. It is recommended that any necessary maintenance be done by a competent maintenance technician familiar with troubleshooting techniques. If a trouble cannot be corrected, it is recommended that the CFA unit be returned to the Technical Materiel Corporation for servicing.

6-2. PREVENTIVE MAINTENANCE.

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

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

WARNING

When using Carbon Tetrachloride, make certain that adequate ventilation exists. Avoid prolonged exposure.

c. While unit is out of the rack, check the tubes, all of which are accessible on the top of the chassis.

d. Carefully inspect for loose solder connections or screws, especially those on solder lugs. Recommended time interval is every 6 to 12 months, depending on the amount of vibration encountered in service.

e. Test all ac and dc voltages as indicated in the respective tube voltage data sheets and investigate any serious discrepencies.

6-3. CORRECTIVE MAINTENANCE.

Corrective maintenance will consist mainly of replacement of tubes and other electrical components. Calibration procedures may be found in Section 5 of this manual.

It should be noted that when replacing tubes or other components, use exact or equivalent replacements. (Refer to Section 7.) Polarity and positioning of certain components should be observed before removing so that the replacement part will fit and operate properly.

SECTION 7
PARTS LIST

7-1. INTRODUCTION.

Reference designations have been assigned to identify all component parts of the equipment. They are marked on the equipment adjacent to the part they identify and are included on drawings, diagrams, and in the parts list. The letters of a reference designation indicate the kind of part (generic group) such as: resistor, capacitor, electron tube, etc. The number differentiates between parts of the same generic group.

Column 1 lists the reference designations of the various parts in alphabetical and numerical order. Column 2 gives the name and description of the various parts. Column 3 indicates how a part is used within a major component. Column 4 lists each Technical Materiel Corporation drawing or part number.

REF. SYM.	DESCRIPTION	FUNCTION	TMC PART NO.
C1	CAPACITOR, fixed: paper dielectric; 2 sections; 0.5 mfd each; +15%; 600 wvdc.	Cathode Bypass	CP69B4EF504L
C2	Same as C1	Cathode Bypass	
C3	CAPACITOR, fixed: paper; 0.05 mfd, +40, -20%; 400 wvdc.	Screen Bypass	CN-100-3
C4	Same as C3	Coupling	
C5	CAPACITOR, fixed: paper; 0.05 mfd, +30, -10%; 600 wvdc.	Screen Bypass	CN-100-21
C6	Same as C3	Coupling	
C7	Same as C3	Line Coupling	
C8	Same as C3	Line Coupling	
C9	Same as C1	Cathode Bypass	
C10	Same as C1	Cathode Bypass	
C11	CAPACITOR, fixed: mica; 11,000 uuf, ±5%, 300 wvdc. (Model CFA-1 only)	Tank	CM35C113J
C11	CAPACITOR, fixed: mica; 0.0056 uuf, ±5%, 500 wvdc. (Model CFA-1L only)	Tank	CM30C562J
C11	CAPACITOR, fixed: mica; 4,300 uuf, ±2%; 500 wvdc. (Model CFA-1LB only)	Tank	CM30C432G
C12	Not used		
C13	CAPACITOR, fixed: mica; 2,400 uuf, ±5%, 500 wvdc. (Model CFA-1 only)	Tank	CM30D242J
C13	CAPACITOR, fixed: mica; 4,000 uuf, ±5%, 500 wvdc. (Model CFA-1L only)	Tank	CM30C402J
C13	CAPACITOR, fixed: mica; 3,600 uuf, ±2%, 500 wvdc. (Model CFA-1LB only)	Tank	CM30C362G
C14	Same as C11	Tank	
C15	Not used		

REF. SYM.	DESCRIPTION	FUNCTION	TMC PART NO.
C16	Same as C13	Tank	
C17	CAPACITOR, fixed: paper dielectric; 0.001 mfd, +30, -10%; 600 wvdc.	Filter	CN-100-9
C18	Same as C17	Filter	
C19	CAPACITOR, fixed: paper; 0.002 mfd, +60, -20%; 600 wvdc.	Filter	CN-100-10
C20	CAPACITOR, fixed: paper; 0.02 mfd, +30, -10%; 600 wvdc. (Models CFA-1 and CFA-1L only)	Filter	CN-100-17
C21	CAPACITOR, fixed: paper dielectric; .1 mfd, ±10%; 600 wvdc.	Coupling	CP69B1EF104K
C22	Not used		
C23	Same as C5	Coupling	
C24	Same as C17	Integrator	
C25	CAPACITOR, fixed: paper; 0.005 mfd, +60, -20%; 600 wvdc.	Integrator	CN-100-13
C26	Same as C17	Coupling	
C27	CAPACITOR, fixed: mica; 1000 uuf, ±10%; 500 wvdc.	Coupling	CM20B102K
C28	CAPACITOR, fixed: silvered mica; 500 wvdc; 200 uuf, ±10%.	Tank	CM20B201K
C29	Same as C28	Coupling	
C30	Same as C27	Filter	
C31	Not used		
C32	Same as C20 (Models CFA-1 and CFA-1L only)	Bypass	
C32	CAPACITOR, fixed: paper; 0.02 mfd, +30, -10%; 600 wvdc. (Model CFA-1LB only)	Bypass	CN-100-17
C33	CAPACITOR, fixed: paper dielectric; 4 mfd, ±10%; 600 wvdc.	Filter	CP41B1FF405K
C34	Same as C33	Filter	
C35	Same as C33	Filter	
C36	Same as C33	Filter	
C37	Same as C33	Filter	
C38	Same as C3	Coupling	

REF. SYM.	DESCRIPTION	FUNCTION	TMC PART NO.
C39	Same as C25	Decoupling	
C40	Same as C5	Coupling	
E1	BOARD, terminal: general purpose barrier type; nine brass nickel plated 6-32 X 3/16 inch 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;	Tank	TF-5004
L3	Same as L2	Tank	
L4	Same as L2	Tank	
L5	Same as L2	Tank	
L6	REACTOR, fixed: Prim: 300 hys no dc, 50 hys, 3 ma dc; Secdy 6000 ohms.	Filter Choke	TF-5002
P1	CONNECTOR, assembly: male contact; flush motor plug type.	Line Connector	JJ-100
R1	RESISTOR, fixed: composition; 470,000 ohms, ±10%; 1/2 watt.	Plate Load	RC20GF474K
R2	RESISTOR, fixed: composition; 1 megohm, ±10%; 1/2 watt.	Screen Dropping	RC20GF105K
R3	Same as R1	Grid Leak	
R4	RESISTOR, fixed: composition; 2,200 ohms, ±10%; 1/2 watt.	Cathode Bias	RC20GF222K
R5	Same as R1	Grid Leak	
R6	Same as R1	Grid Leak	
R7	RESISTOR, fixed: composition; 100,000 ohms, ±10%; 1/2 watt.	Plate Load	RC20GF104K
R8	RESISTOR, fixed: composition; 10,000 ohms, ±10%; 1/2 watt.	Cathode Bias	RC20GF103K

REF. SYM.	DESCRIPTION	FUNCTION	TMC PART NO.
R9	RESISTOR, fixed: composition; 220,000 ohms, ±10%; 1/2 watt.	Grid Leak	RC20GF224K
R10	Same as R9	Grid Leak	
R11	RESISTOR, fixed: composition; 1,000 ohms, ±10%; 1/2 watt.	Cathode Bias	RC20GF102K
R12	RESISTOR, fixed: composition; 3,900 ohms, ±10%; 1 watt.	Cathode Bias	RC30GF392K
R13	RESISTOR, fixed: composition; 470,000 ohms, ±5%; 1/2 watt. (Model CFA-1L only)	Load	RC20GF474J
R13	RESISTOR, fixed: composition; 470,000 ohms, ±5%; 1 watt. (Model CFA-1LB only)	Load	RC30GF474J
R14	RESISTOR, fixed: composition; 1,000 ohms, ±5%; 1/2 watt. (Model CFA-1 only)	Load	RC20GF102J
R15	RESISTOR, fixed: composition; 68,000 ohms, ±5%; 1/2 watt.	Load	RC20GF683J
R15	Same as R13 (Models CFA-1L and CFA-1LB only)	Load	
R16	Same as R1	Grid Leak	
R17	Same as R1	Plate Load	
R18	Same as R2	Screen Dropping	
R19	Same as R1	Grid Leak	
R20	Same as R4	Cathode Bias	
R21	Same as R1	Grid Leak	
R22	Same as R8	Cathode Bias	
R23	Same as R7	Cathode Bias	
R24	Same as R9	Grid Leak	
R25	Same as R9	Grid Leak	
R26	Same as R11	Cathode Bias	
R27	Same as R12	Cathode Bias	
R28	Same as R14 (Model CFA-1 only)	Load	
R29	Same as R13	Load	
R30	Same as R15 (Model CFA-1 only)	Load	
R30	Same as R13 (Models CFA-1L and CFA-1LB only)	Load	

PARTS LIST (CONT)

REF. SYM.	DESCRIPTION	FUNCTION	TMC PART NO.
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%; 1/2 watt.	Grid Leak	RC20GF225K
R34	Not used		
R35	Not used		
R36	Same as R1	Isolation	
R37	Not used		
R38	RESISTOR, fixed: composition; 10 megohm, ±10%; 1/2 watt.	Isolation	RC20GF106K
R39	Not used		
R40	Same as R8	Dropping	
R41	Same as R38	Grid Leak	
R42	Same as R1	Plate Load	
R43	RESISTOR, fixed: composition; 82,000 ohms, ±10%; 1 watt.	Screen Dropping	RC30GF823K
R44	Same as R1	Dropping	
R45	RESISTOR, variable: composition; potentiometer; 1 megohm, ±10%; 2 watts; linear taper; 100°C max cont operation; 3 solder lug terms.	MARK BIAS Control	RV4ATSA105B
R46	RESISTOR, fixed: composition; 15,000 ohms, ±10%; 1/2 watt. (Model CFA-1 only)	Screen Dropping	RC20GF153K
R46	Same as R8 (Models CFA-1L and CFA-1LB only)	Grid Leak	
R47	Same as R33		
R48	RESISTOR, fixed: composition; 2.7 megohm, ±10%; 1/2 watt. (Models CFA-1 and CFA-1L only)	Dropping	RC20GF275K
R48	Same as R33 (Model CFA-1LB only)	Dropping	
R49	Same as R1	Plate Load	
R50	Same as R43	Screen Dropping	
R51	RESISTOR, fixed: composition; 22,000 ohms, ±10%; 1/2 watt.	Screen Dropping	RC20GF223K

REF. SYM.	DESCRIPTION	FUNCTION	TMC PART NO.
R52	Same as R11	Cathode Bias	
R53	Same as R2	Grid Leak	
R54	Not used		
R55	RESISTOR, fixed: composition; 56,000 ohms, ±10%; 2 watts.	Plate Load	RC42GF563K
R56	RESISTOR, fixed: composition; 27,000 ohms, ±10%; 2 watts.	Plate Load	RC42GF273K
R57	RESISTOR, fixed: composition; 22,000 ohms, ±10%; 2 watts.	Cathode Bias	RC42GF223K
R58	Same as R33	Grid Leak	
R59	RESISTOR, variable: composition; potentiometer; 500,000 ohms, ±20%; 2 watts, linear taper; 100°C max cont operation; 3 solder lug terms.; w/locking type bushing and locknut.	Monitor Adj.	RV4ATXA504B
R59	RESISTOR, variable: locking type; 2.5 megohms, 2 watts. (Model CFA-1LB only)	Monitor Gain	RV4ATXA255B
R60	RESISTOR, fixed: composition; 3.9 megohm, ±10%; 1/2 watt.	Grid Leak	RC20GF395K
R61	Same as R9	Voltage Divider	
R62	Same as R1	Voltage Divider	
R63	RESISTOR, fixed: composition; 220,000 ohms, ±10%; 1 watt.	Cathode Bias	RC30GF224K
R64	Same as R9	Grid Leak	
R65	Same as R9	Load	
R66	Same as R33	Voltage Divider	
R67	Same as R33	Voltage Divider	
R68	Same as R45	Vertical Centering Control	
R69	Same as R45	Horizontal Centering Control	
R70	Same as R33	Plate Load	
R71	Same as R2	Plate Load	
R72	Same as R2	Plate Load	
R73	Same as R2	Voltage Divider	
R74	Same as R45	Focus	

REF. SYM.	DESCRIPTION	FUNCTION	TMC PART NO.
R75	Same as R1	Control Dropping	
R76	RESISTOR, variable: composition; potentiometer; 500,000 ohms, ±20%; 2 watts; linear taper; 100°C max cont operation; 3 solder lug terms.	Intensity Control	RV4ATSA504B
R77	RESISTOR, variable: wirewound pot; 2,500 ohms, ±10%; 25 watts.	Line Current Control	RA75ASA252AK25
R78	Same as R9	Grid Leak	
R79	Same as R9	Grid Leak	
R80	RESISTOR, fixed: composition; 1,000 ohms, ±10%; 2 watts.	Dropping	RC42GF102K
R81	RESISTOR, fixed: wirewound; 3,000 ohms, ±10%; 10 watts.	Dropping	RW-109-30
R82	Same as R81	Dropping	
R83	Same as R38 (Model CFA-1 only)	Grid Leak	
R84	Same as R33	Grid Leak	
R85	Same as R7	Plate Load	
R86	RESISTOR, fixed: composition; 30,000 ohms, ±10%; 1/2 watt.	Plate Load	RC20GF303K
R87	Same as R8	Cathode Bias	
R88	RESISTOR, fixed: composition; 4.7 megohms, ±10%; 1/2 watt. (Model CFA-1 only)	Grid Leak	RC20GF475K
R88	RESISTOR, fixed: composition; 5.1 megohms, ±10%; 1/2 watt. (Models CFA-1L and CFA-1LB only)	Grid Leak	RC20GF515K
R89	Same as R8	Cathode Bias	
R90	RESISTOR, fixed: composition; 47,000 ohms, ±10%; 1/2 watt.	Plate Load	RC20GF473K
R91	Same as R4	Decoupling	
R92	Same as R9 (Models CFA-1 and CFA-1L only)	Load	
R92	Same as R13 (Model CFA-1LB only)	Load	
R93	Same as R9 (Models CFA-1 and CFA-1L only)	Load	
R93	Same as R13 (Model CFA-1LB only)	Load	
R94	Same as R14 (Model CFA-1 only)	Load	

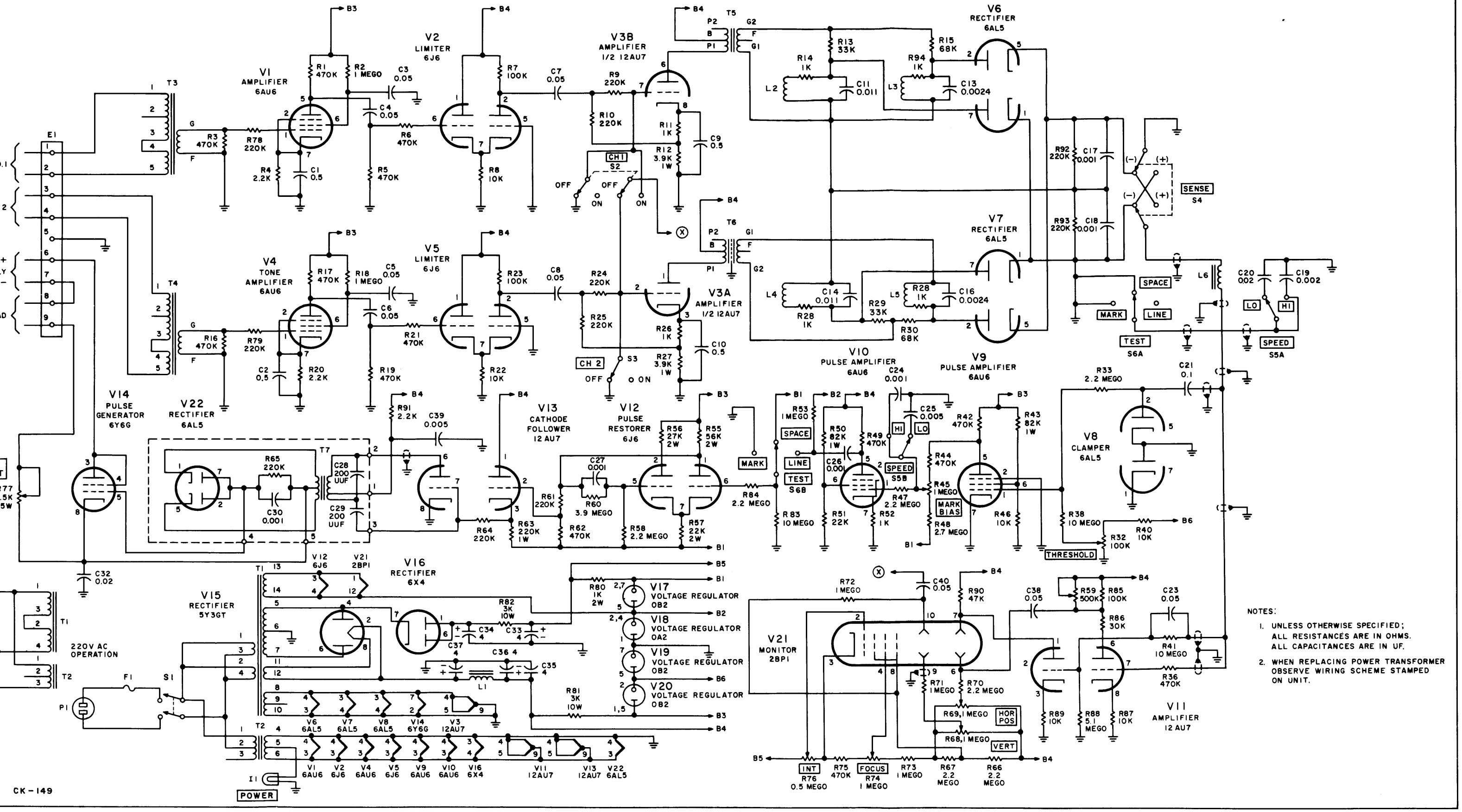
REF. SYM.	DESCRIPTION	FUNCTION	TMC PART NO.
R94	RESISTOR, fixed: composition; 120 ohms, ±5%; 1/2 watt. (Model CFA-1L only)	Load	RC20GF121J
R95	Same as R14 (Model CFA-1 only)	Load	
R95	Same as R94 (Model CFA-1L only)	Load	
R96	RESISTOR, fixed: composition; 390,000 ohms, ±10%; 1/2 watt. (Model CFA-1L only)	Load	RC20GF394K
R97	Same as R96 (Model CFA-1L only)	Load	
R98	RESISTOR, variable: composition; 2.5 megohms, ±10%; 2 watts. (Model CFA-1LB only)	Monitor Gain	RVA4T5A225B
R99	Same as R38 (Models CFA-1L and CFA-1LB only)	Dropping	
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	Same as S1	Channel 2 ON-OFF	
S4	Same as S2	Sense Switch	
S5	Same as S2 (Model CFA-1LB only)	Speed Switch	
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 #2-6.3 v. 1.2 amp; Secdy #3-300-0-300 v, 70 ma dc into capacity input filter; Secdy #4-5 v, 2 amp; all windings insulated against 1,000 volt hermetically sealed metal rect case.	Power Transformer	TF-106
T2	TRANSFORMER, filament; pri 110/220 v. 50/60 cps; Sec. 6.3 v. 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	Same as T3	Input Transformer	
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.	Coupling Transformer	TF-115
T6	Same as T5	Coupling Transformer	

PARTS LIST (CONT)

REF. SYM.	DESCRIPTION	FUNCTION	TMC PART NO.
T7	TRANSFORMER, audio; 500Kcs.	Coupling	A-359
V1	TUBE, electron: RMA 6AU6: miniature 7 pin receiving pentode amplifier.	Tone Amplifier	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 Amplifier	12AU7
V4	Same as V1	Tone Amplifier	
V5	Same as V2	Limiter	
V6	TUBE, electron: RMA 6AL5; receiving miniature 7 pin twin type diode.	Tone Rectifier	6AL5
V7	Same as V6	Tone Rectifier	
V8	Same as V6	Clamper	
V9	Same as V1	Pulse Amplifier	
V10	Same as V1	Pulse Amplifier	
V11	Same as V3	Monitor Amplifier	
V12	Same as V2	Pulse Restorer	
V13	Same as V3	Oscillator/Cathode Follower	
V14	TUBE, electron: RMA 6Y6G; beam power amplifier, octal.	Pulse Generator	6Y6G
V15	TUBE, electron: RMA 5Y3GT; duo-diode, rectifier, octal.	Rectifier	5Y3GT
V16	TUBE, electron: RMA 6X4; dual-diode miniature 7 pin.	Rectifier	6X4
V17	TUBE, electron: RMA OB2; miniature 7 pin type voltage regulator.	Voltage Regulator	OB2
V18	TUBE, electron: RMA 0A2; miniature 7 pin type voltage regulator.	Voltage Regulator	OA2
V19	Same as V17	Voltage Regulator	
V20	Same as V17	Voltage Regulator	
V21	TUBE, cathode ray, high vacuum.	Monitor	2BP1
V22	Same as V6	Output Rectifier	

REF. SYM.	DESCRIPTION	FUNCTION	TMC PART NO.
XV1	SOCKET, tube: 7 pin miniature; one piece saddle mounting.	Socket for V1	TS102P01
XV2	Same as XV1	Socket for V2	
XV3	SOCKET, tube: 9 pin miniature; one piece saddle mounting.	Socket for V3	TS103P01
XV4	Same as XV1	Socket for V4	
XV5	Same as XV1	Socket for V5	
XV6	Same as XV1	Socket for V6	
XV7	Same as XV1	Socket for V7	
XV8	Same as XV1	Socket for V8	
XV9	Same as XV1	Socket for V9	
XV10	Same as XV1	Socket for V10	
XV11	Same as XV3	Socket for V11	
XV12	Same as XV1	Socket for V12	
XV13	Same as XV3	Socket of V13	
XV14	SOCKET, tube: octal; one piece saddle mounting.	Socket for V14	TS101P01
XV15	Same as XV14	Socket for V15	
XV16	Same as XV1	Socket for V16	
XV17	Same as XV1	Socket for V17	
XV18	Same as XV1	Socket for V18	
XV19	Same as XV1	Socket for V19	
XV20	Same as XV1	Socket for V20	
XV21	SOCKET, duodecal.	Socket for V21	TS-112
XV22	Same as XV1	Socket for V22	
XF1	HOLDER, fuse: extractor post type; for single AGC cartridge fuse.	Fuseholder	FU-100-2
XI1	LIGHT, indicator: with lens; 1/2 inch 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

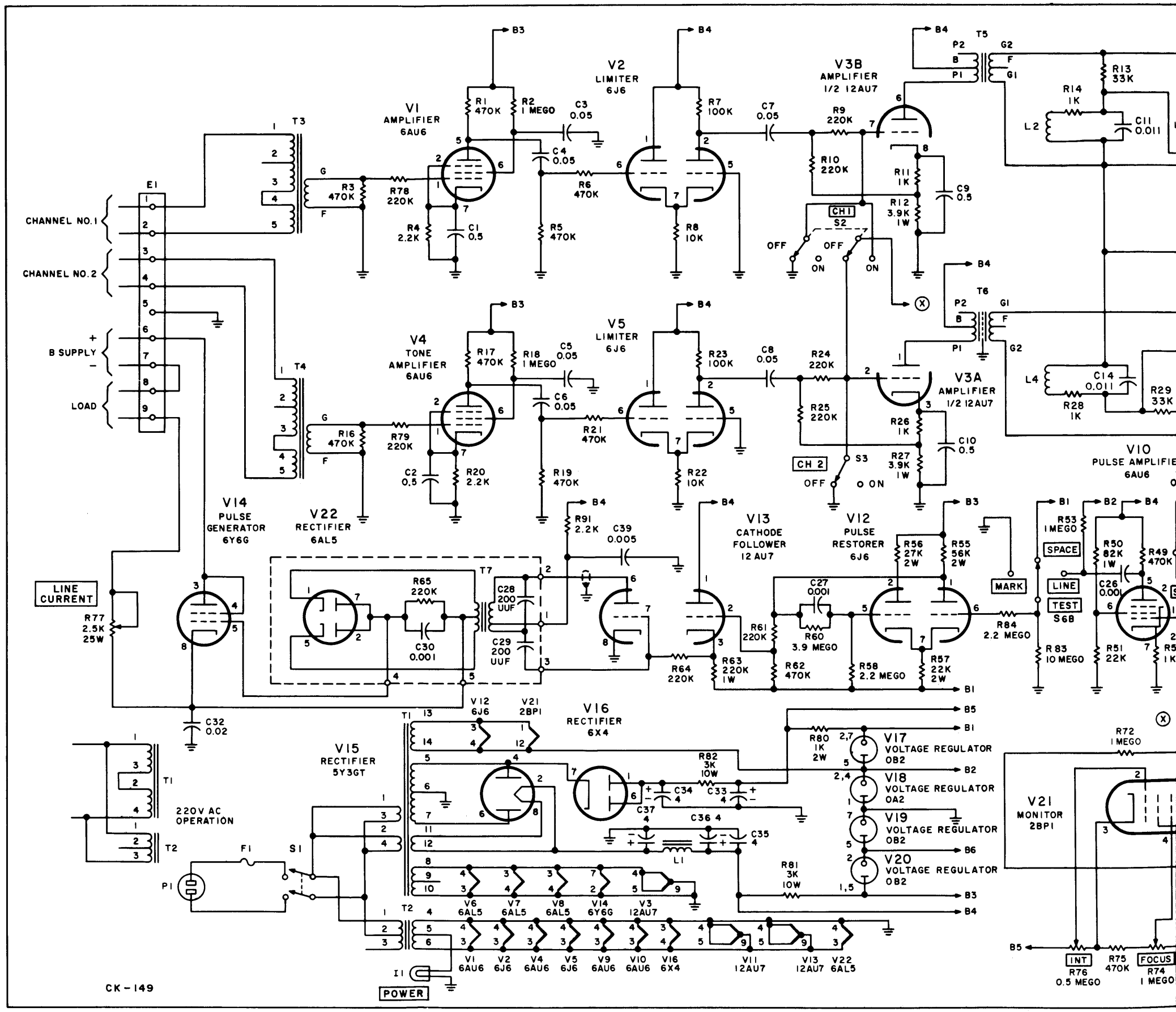
SECTION 8
SCHEMATIC DIAGRAMS

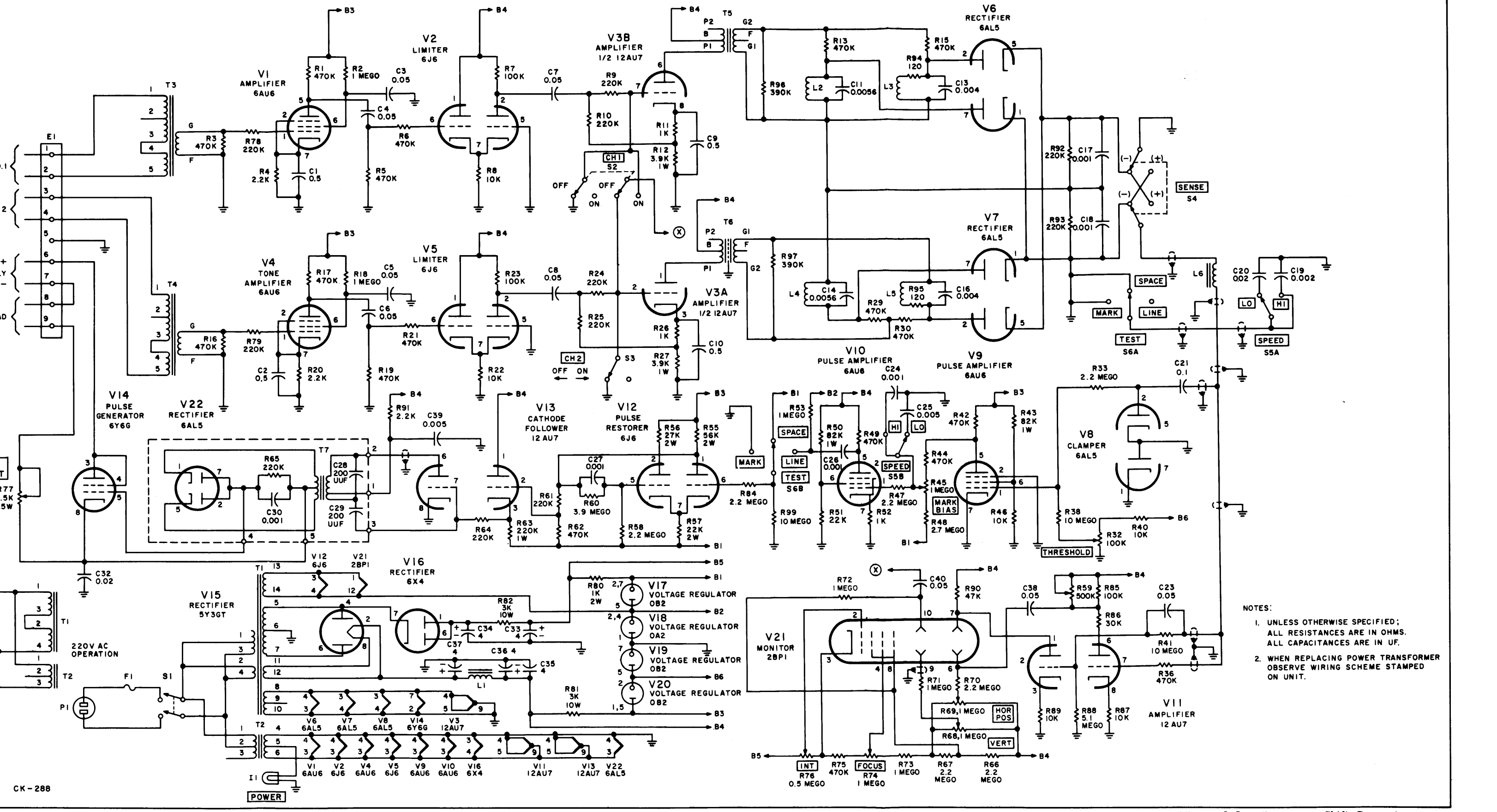


NOTES:

1. UNLESS OTHERWISE SPECIFIED; ALL RESISTANCES ARE IN OHMS. ALL CAPACITANCES ARE IN UF.
2. WHEN REPLACING POWER TRANSFORMER OBSERVE WIRING SCHEME STAMPED ON UNIT.

Figure 8-1. Frequency Shift Converter CFA-1, Schematic Diagram

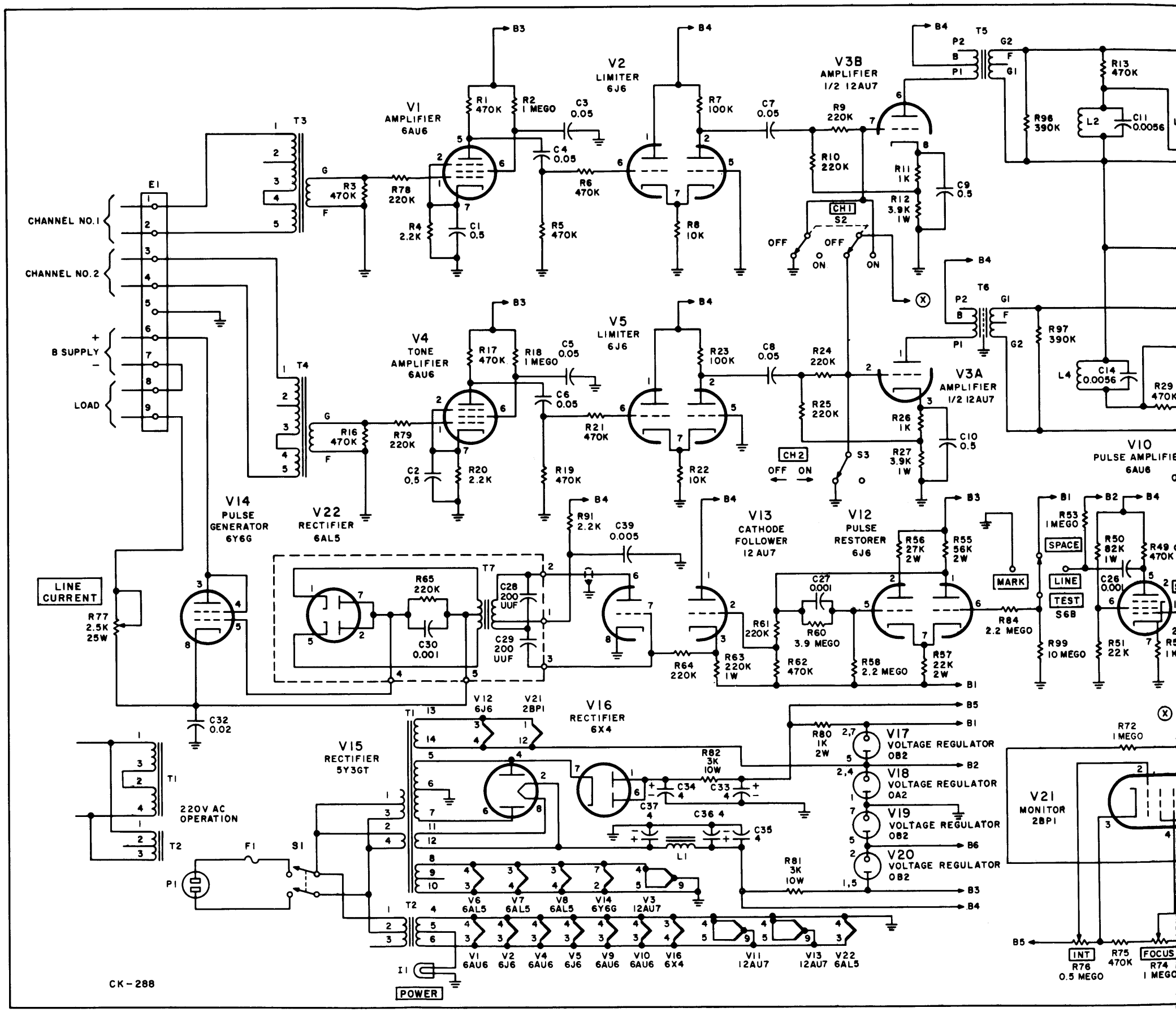

V1 AMPLIFIER 6AU6
V2 LIMITER 6J6
V3B AMPLIFIER 1/2 12AU7
V3A AMPLIFIER 1/2 12AU7
V4 TONE AMPLIFIER 6AU6
V5 LIMITER 6J6
V10 PULSE AMPLIFIE 6AU6
V12 PULSE RESTORER 6J6
V13 CATHODE FOLLOWER 12 AU7
V14 PULSE GENERATOR 6Y6G
V22 RECTIFIER 6AL5
V15 RECTIFIER 5Y3GT
V16 RECTIFIER 6X4
V17 VOLTAGE REGULATOR 0B2
V18 VOLTAGE REGULATOR 0A2
V19 VOLTAGE REGULATOR 0B2
V20 VOLTAGE REGULATOR 0B2
V21 MONITOR 28P1
CHANNEL NO. 1
CHANNEL NO. 2
+ B SUPPLY -
LOAD
LINE CURRENT
220V AC OPERATION
CH 1 S2
CH 2 S3
OFF
ON
SPACE
LINE
TEST S68
MARK
INT R76 0.5 MEGO
FOCUS R74 1 MEGO
POWER
CK-149



NOTES:

1. UNLESS OTHERWISE SPECIFIED; ALL RESISTANCES ARE IN OHMS. ALL CAPACITANCES ARE IN UF.
2. WHEN REPLACING POWER TRANSFORMER OBSERVE WIRING SCHEME STAMPED ON UNIT.

Figure 8-2. Frequency Shift Converter CFA-1L, Schematic Diagram


V1 AMPLIFIER 6AU6
V2 LIMITER 6J6
V3B AMPLIFIER 1/2 12AU7
V4 TONE AMPLIFIER 6AU6
V5 LIMITER 6J6
V3A AMPLIFIER 1/2 12AU7
V10 PULSE AMPLIFIE 6AU6
V14 PULSE GENERATOR 6Y6G
V22 RECTIFIER 6AL5
V13 CATHODE FOLLOWER 12 AU7
V12 PULSE RESTORER 6J6
V15 RECTIFIER 5Y3GT
V16 RECTIFIER 6X4
V17 VOLTAGE REGULATOR 0B2
V18 VOLTAGE REGULATOR 0A2
V19 VOLTAGE REGULATOR 0B2
V20 VOLTAGE REGULATOR 0B2
V21 MONITOR 28P1
CHANNEL NO.1
CHANNEL NO.2
B SUPPLY
LOAD
LINE CURRENT
220V AC OPERATION
CH1
CH2
OFF
ON
SPACE
LINE
TEST
MARK
INT
FOCUS
POWER
CK-288

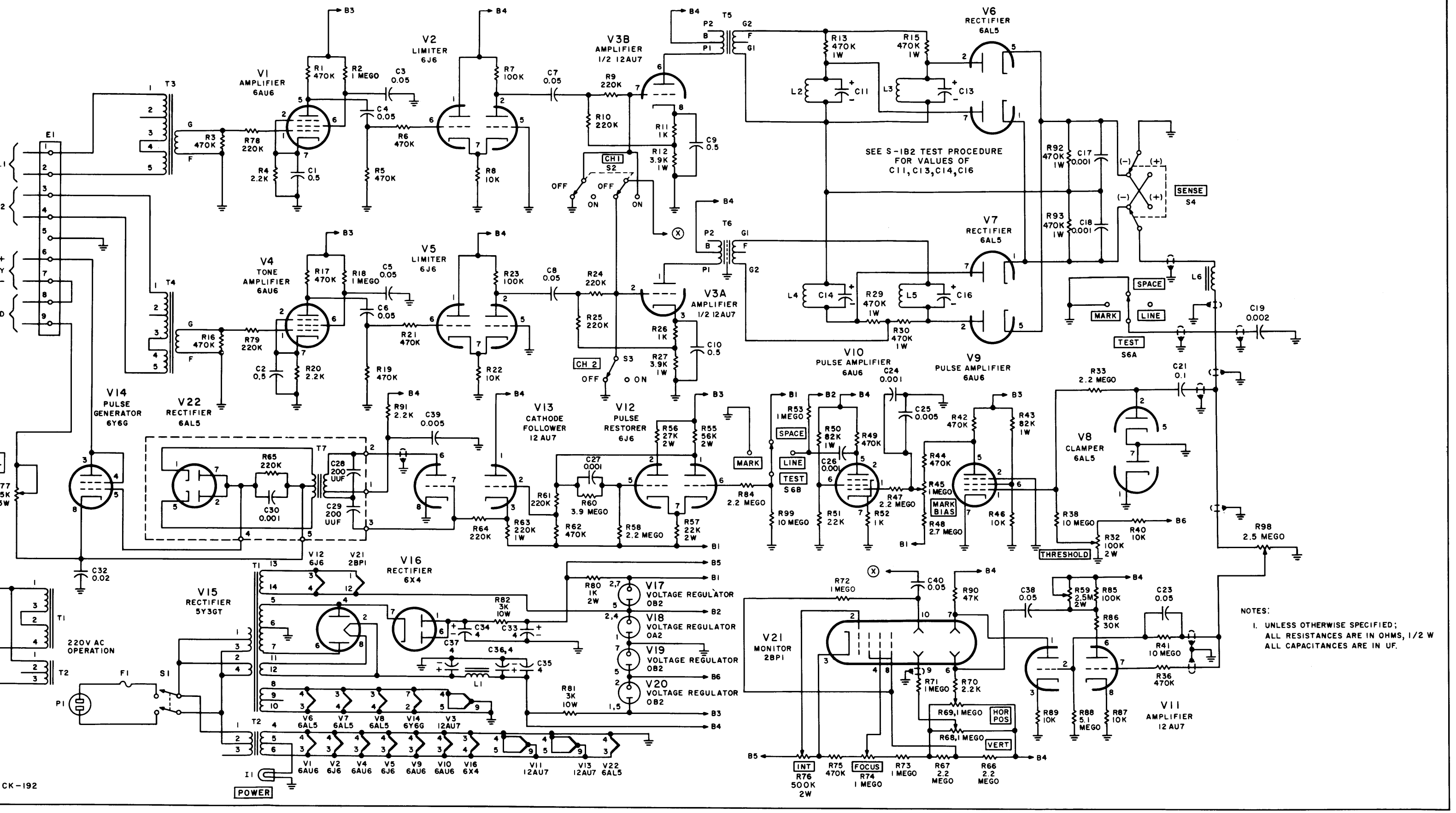
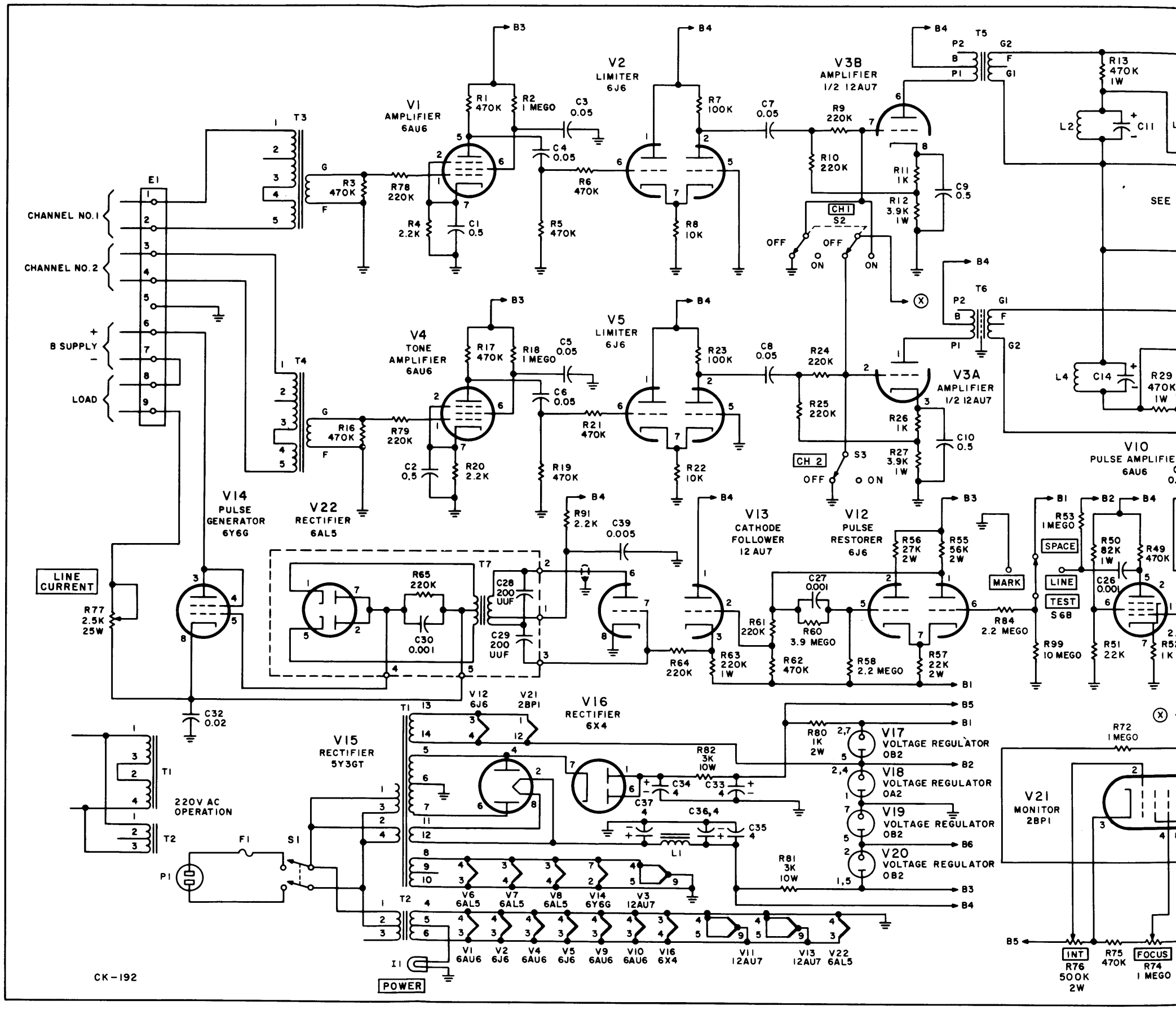


Figure 8-3. Frequency Shift Converter CFA-1LB, Schematic Diagram


V1 AMPLIFIER 6AU6
V2 LIMITER 6J6
V3B AMPLIFIER 1/2 12AU7
V3A AMPLIFIER 1/2 12AU7
V4 TONE AMPLIFIER 6AU6
V5 LIMITER 6J6
V10 PULSE AMPLIFIE 6AU6
V12 PULSE RESTORER 6J6
V13 CATHODE FOLLOWER 12 AU7
V14 PULSE GENERATOR 6Y6G
V22 RECTIFIER 6AL5
V15 RECTIFIER 5Y3GT
V16 RECTIFIER 6X4
V17 VOLTAGE REGULATOR 0B2
V18 VOLTAGE REGULATOR 0A2
V19 VOLTAGE REGULATOR 0B2
V20 VOLTAGE REGULATOR 0B2
V21 MONITOR 2BP1
CHANNEL NO. 1
CHANNEL NO. 2
B SUPPLY
LOAD
LINE CURRENT
220V AC OPERATION
POWER
CH 1 S2
CH 2 S3
MARK
SPACE
LINE
TEST S6B
SEE
CK-192