NAVSHIPS 92484

INSTRUCTION BOOK

for

TELEGRAPH TERMINAL TH – 20/UG

H. O. BOEHME, INC.
NEW YORK 10, N. Y.

BUREAU OF SHIPS

NAVY DEPARTMENT

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2-1 to 2-10	Original		

DEPARTMENT OF THE NAVY
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IN REPLY REFER TO
Code 993-100
12 April 1955

From: Chief, Bureau of Ships
To: All Activities Concerned with the Installation, Operation and Maintenance of the Subject Equipment

Subj: Instruction Book for Telegraph Terminal TH-20/UG, NAVSHIPS 92484

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RECORD OF CORRECTIONS MADE

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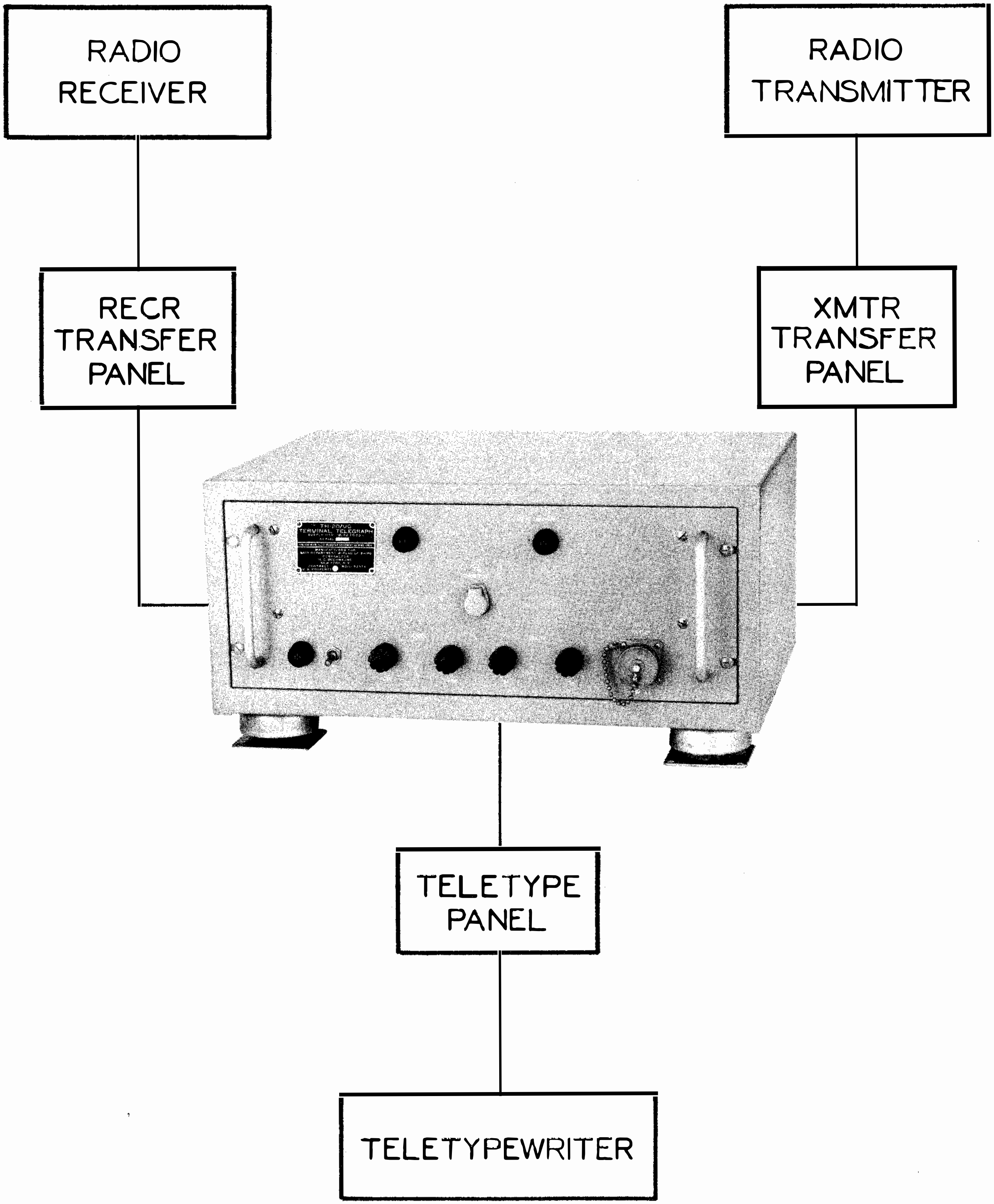


Figure 1—1. Connections to Telegraph Terminal TH-20/UG

SECTION 1
GENERAL DESCRIPTION

1. EQUIPMENT ILLUSTRATIONS.

The drawing on the next page, Fig. 1—1, shows the connections between Telegraph Terminal TH-20/UG, its associated teletypewriter equipment and the radio transmitter and receiver. The teletypewriter shown as generalized block may be any standard Navy unit capable of operating on a 60 milliampere neutral loop. The TH-20/UG consists of the Terminal, repair parts and instruction books.

2. PURPOSE AND BASIC PRINCIPLES.

The purpose of the Telegraph Terminal TH-20/UG is to make possible the transmission and reception of teletypewriter messages by radio communication between stations similarly equipped.

When transmitting messages, typing on the local teletypewriter causes a direct current series loop to intermittently open, thus forming pulses of current. Each letter has its own characteristic pattern of current pulses. These pulses are converted by the local Telegraph Terminal into corresponding audio tones which are sent out over telephone lines. Conversion of the current pulses to audio tones is accomplished by an audio oscillator, which operates at 1325 cps when the teletypewriter loop is in a closed circuit condition, and at 1225 cps when the loop is in an open condition. Hereafter, the closed circuit condition of the loop and its related 1325 cps tone will be known as "Mark".

The open circuit condition and its related 1225 cps tone will be known as "Space". At the instant the operator begins typing a message, a relay places the Terminal in transmit condition. This condition is maintained until after the message has been transmitted.

When receiving messages, the TH-20/UG accepts the incoming Mark and Space tones and converts the intelligence of the tones to a make-and-break contact of a relay connected into the local teletypewriter direct current loop. Thus the local teletypewriter is made to print in unison with the distant teletypewriter.

3. DESCRIPTION OF UNIT.

Fig. 1—1 shows the general appearance of Telegraph Terminal TH-20/UG. There are two indicator lights on the upper portion of the front panel. To the left is a green light which is on in TRANSMIT condition and to the right a red light which is on in RECEIVE condition. Both lights are off when the Terminal is in standby condition. In the center of the panel below the two lights is a jack marked TTY MONITOR. A test or monitoring teletypewriter may be patched into this jack to place it in series with all other equipment in the loop. At the lower left is the POWER indicator light. Next to it is the POWER ON-OFF switch. This switch, when ON causes 115 V AC power to be applied to the Terminal and also causes the adjacent indicator to light. To the right of the power switch are two 1.5 amp POWER fuses protecting against shorts in the Terminal. On the right hand side of the front panel are two 3 amp UTILITY fuses for the 115 V AC UTILITY OUTLET on the extreme right. This outlet is directly connected to the power line and is not controlled by the power switch.

On each side of the cabinet are two retaining bolts. When these are loosened, the front panel and chassis assembly may be pulled out on runners. After reaching the limit of free travel, the chassis may be tilted up to approximately a 90 degree angle for inspection and maintenance. The power and external circuits are connected to the outer cabinet by cables and then via flexible cables to the chassis. The chassis may be tested in an operating condition even when tilted up.

It will be noted that there are no controls located on the front panel. Potentiometers for frequency and bias adjustment are inside the cabinet. Once these controls are set for proper operation, no further attention is usually required for extended periods of time.

TABLE 1—1. EQUIPMENT SUPPLIED

QUAN. PER EQUIP.	NAME OF UNIT	DESIGNATION	OVER-ALL DIMENSIONS			VOLUME	WEIGHT
			HEIGHT	WIDTH	DEPTH		
1	Telegraph Terminal	TH-20/UG	10 11/32	20 5/8	16 1/8	1.6	70.6
1	Set of Equipment Maintenance Parts		6	12	9	0.4	20
2	Instruction Books	NAVSHIPS 92484	11 1/4	8 5/8	3/16	.01	.5

Unless otherwise stated, dimensions are inches, volume cubic feet, weight pounds.

TABLE 1–2. EQUIPMENT AND PUBLICATIONS REQUIRED BUT NOT SUPPLIED

QUANTITY PER EQUIPMENT	NAME OF UNIT	REQUIRED CHARACTERISTICS
1 or more	Teletypewriter	Suitable to operate on 60 ma neutral loop

TABLE 1–3. SHIPPING DATA

SHIP-PING BOX No.	QUAN-TITY	CONTENTS		BOX OVER-ALL DIMENSIONS			VOLUME	WEIGHT
		NAME OF UNIT	DESIGNATION	HEIGHT	WIDTH	DEPTH		
1	1	Telegraph Terminal	TH-20/UG	14	33	20		155.6
1	1	Set of Equipment Maintenance Parts		(Shipped in above box)				
1	2	Instruction Books	NAVSHIPS 92484	(Shipped in above box)				

Unless otherwise stated, dimensions are inches, volume cubic feet, weight pounds.

TABLE 1–4. VACUUM TUBE COMPLEMENT

QUANTITY	TUBE TYPE	DESCRIPTION
2	OA3/VR75	Voltage Regulator
2	5Y3 GT	Full Wave Rectifier
1	6AL5	Duodiode Detector
1	6AU6	Pentode Amplifier
1	6J6	Twin Triode Amplifier
4	12AU7	Twin Triode Amplifier
2	12AX7	Twin Triode Amplifier

REFERENCE DATA

a. NOMENCLATURE: Telegraph Terminal TH-20/UG

b. CONTRACT NUMBER AND DATE: NObsr-63373, 2 April 1953

c. CONTRACTOR: H. O. Boehme, Inc., New York, N. Y.

d. COGNIZANT NAVAL INSPECTOR: Inspector of Naval Material, New York, N. Y.

e. NUMBER OF PACKAGE PER COMPLETE SHIPMENT OF EQUIPMENT: One

f. TOTAL CUBICAL CONTENTS: 5.4 cu. ft., crated; 2.0 cu. ft., uncrated

g. TOTAL WEIGHT: 155.6 lbs. crated; 110.6 lbs. uncrated

(including one spare parts box)

h. FREQUENCY: 1225 and 1325 cycles per second

i. MINIMUM INPUT SIGNAL LEVEL: −40 dbm

j. MAXIMUM OUTPUT POWER: −2 dbm ±2 dbm

k. OUTPUT IMPEDANCE: 600 ohms ±10%

l. INPUT IMPEDANCE: 600 ohms ±10%

m. HEAT DISSIPATION: 84 watts

n. POWER SUPPLY FOR TELEGRAPH TERMINAL: 115 volts ±10%; 50-60 cps AC; .73 amperes

o. POWER SUPPLY FOR TELETYPE LOOP: 110 volts DC: 0.060 amperes

SECTION 2
THEORY OF OPERATION

1. GENERAL.

The block diagram in Fig. 2–1 has the principal circuits and representative oscilloscope patterns of Telegraph Terminal TH-20/UG. At the input of the receive circuit is a 4 db attenuator pad which minimizes the effect of impedance mismatches. A following band pass filter circuit passes audio frequencies between 1110 and 1440 cps and rejects all other frequencies. Then come two amplifier limiter stages with a constant output level. A matching amplifier feeds the signals to a discriminator filter where the 1225 cps and 1325 cps frequencies are passed to a twin diode detector. After the detector and a low pass filter network, the signals are applied to a direct current amplifier which causes the receive keying relay to close its contacts when the incoming signal is 1325 cps and to open its contacts when the incoming signal is 1225 cps. The 1325 cps signal and the related closed circuit condition are known as "MARK". The 1225 cps signal and its related open circuit condition are known as "SPACE".

One set of contacts of the receive relay is in series with the teletypewriter closed series loop consisting of one or more teletypewriters, some series resistance, a "battery" or other 110 V DC source, and one winding of the send relay. Consequently, the receive keying relay is able to open and close the local teletypewriter loop and form current pulse patterns which are identical to those in the transmitting teletypewriter loop.

The teletypewriters to be used with the Terminal must be types that operate on a normally closed line having a current of 60 milliamperes. These teletypewriters have the selector magnet and the keyboard contacts wired in series in the teletypewriter loop. If the loop current remains steady, the teletypewriter will sit idle. But, if the loop current is broken by action external to the teletypewriter machine, the closed keyboard contacts in the machine permit the selector magnet to operate properly and cause the incoming message to be printed on the paper. Messages may be handled only by Half Duplex (H-DX) operation, that is, only one direction at a time.

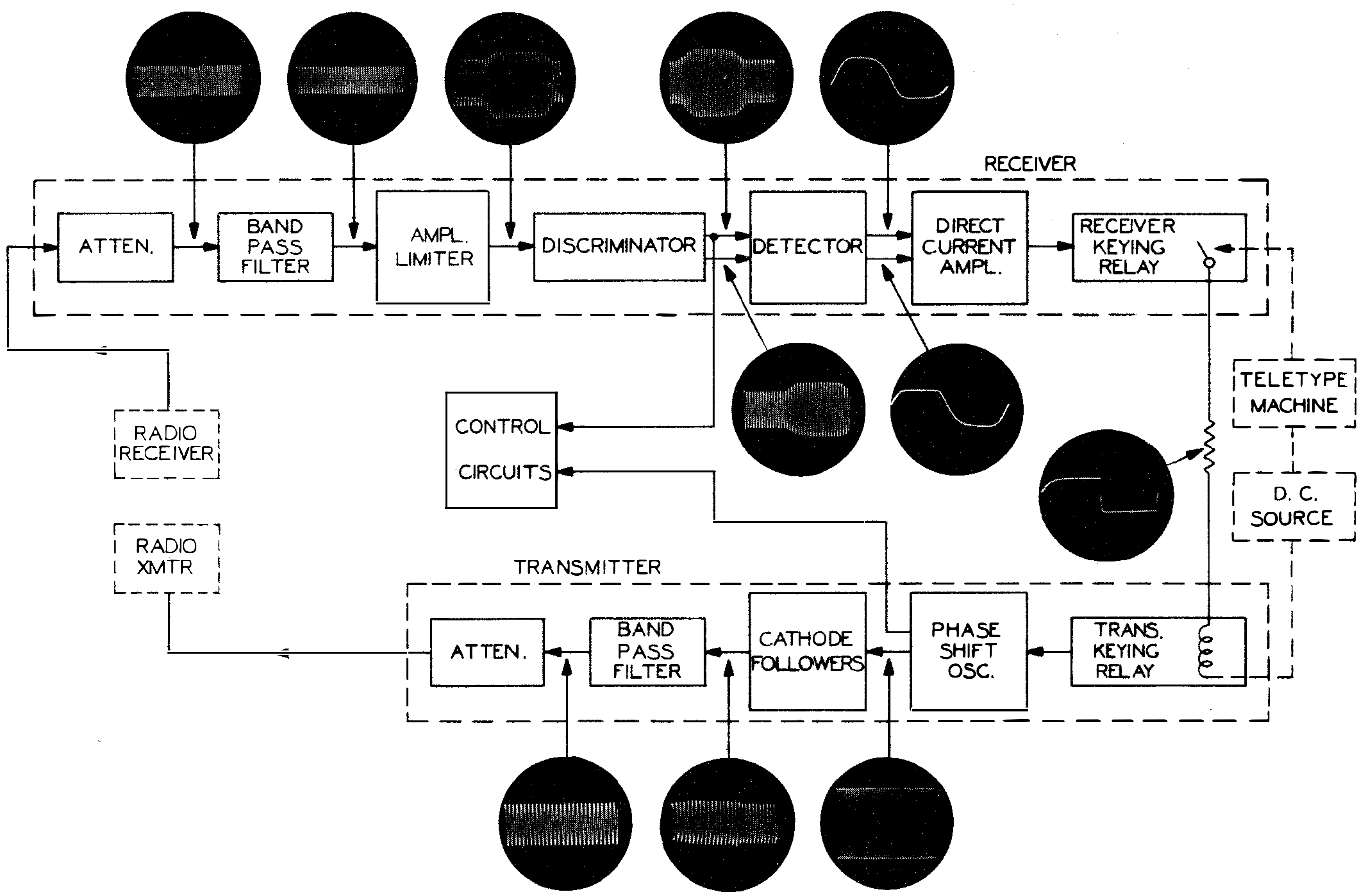


Figure 2–1. System Block Diagram

Since the keyboard contacts and the selector magnet are wired in series, the message is also printed on the paper as it is typed so that the operator may check and correct for errors in his typing. Depressing the keys, intermittently makes and breaks the loop current. The transmit keying relay of the Telegraph Terminal rapidly changes the frequency of the two-tone oscillator and also operates the control circuits. An interlock action of the control circuits prevents operation of the transmit keying relay when the Terminal is in the receive condition.

The two-tone oscillator operates at 1325 cps when the transmit keying relay is in Mark condition and at 1225 cps when the relay is in Space condition. The output of the oscillator passes through two cathode follower stages to a band pass filter, 4 db attenuating pad and an isolating transformer to the output line.

When the terminal is in standby condition the reception of an incoming Mark tone causes the control circuits to change to receiving. Following the end of the incoming message, the circuits shift back to standby. Similarly, when in standby, the operation of the local teletypewriter's keyboard causes the circuits to change to transmit. After the last letter is keyed, there is a time delay of about 3 seconds and then the circuits shift back to standby. The interlocking functions purposely prevent the equipment from shifting directly from transmit to receive or vice versa. Thus, an incoming signal will not interrupt outgoing traffic, nor will keying the local machine when receiving, cause the circuit to shift to transmit.

2. BAND PASS FILTER CIRCUIT.

Fig. 2—2 shows the band pass filter with associated circuit. Signals from the line pass through the 600/600 ohm isolation transformer T101, a 4 db pad and band pass filter Z-101. Resistors R101, R102 and R103 form the 4 db pad which minimizes the effects of any input mismatch. A serious mismatch would alter the frequency response of the band pass filter. The filter passes frequencies from 1110 to 1440 cps with little or no attenuation. Other frequencies are greatly attenuated as can be seen in Fig. 2—3.

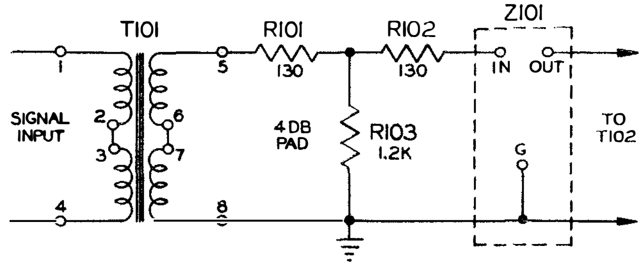


Figure 2—2. Band Pass Filter and Input Circuit

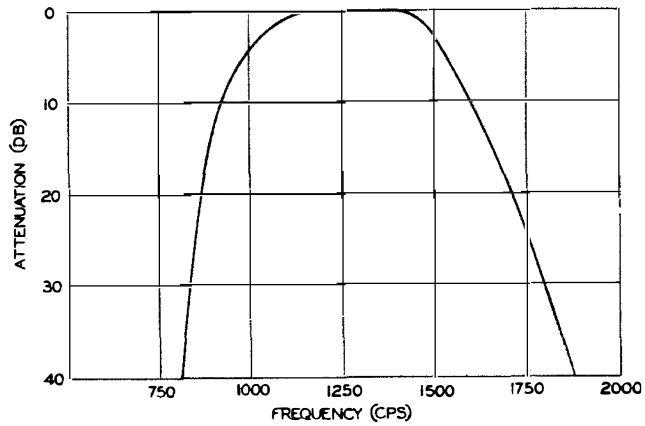


Figure 2—3. Band Pass Filter Attenuation Curve

3. AMPLIFIER-LIMITER.

In the amplifier-limiter shown in Fig. 2—4, transformer T102 couples the 600 ohm impedance of the band pass filter to the high impedance of the amplifier grid. The circuit employs two halves of a tube operating together and is used for its low noise factor. The first half is cathode coupled to the second which acts as a grounded grid amplifier. When the incoming signal goes negative, it drives V101A to cut off. With less current flowing through common resistor R105, the cathode becomes less positive. This decreases the grid bias of Section B and allows more current to flow through the tube dropping the plate voltage of V101B.

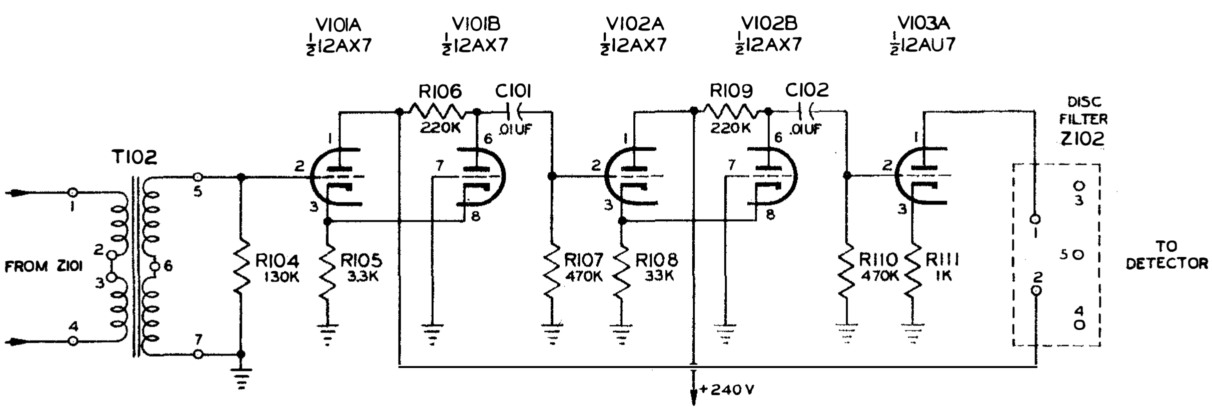


Figure 2—4. Amplifier—Limiter

Limiting action on negative portions occurs in Section A when it reaches cut off. Negative signals of greater amplitude have no further effect. When the signal on the grid of V101A goes positive, this section has an increased current flow causing the tied cathodes to become more positive. This causes plate current of V101B to decrease and plate voltage to increase. Limiting action on the positive cycle occurs in V101B when cut off is reached. Tube V102 is identical to V101 except for the larger cathode resistor which causes limiting at a lower voltage level. Tube V103A further amplifies the signals and feeds them into the discriminator filter Z102.

Throughout the receiver section, it will be noted, unbypassed cathode resistors are employed. While this reduces amplification, it tends to minimize distortion.

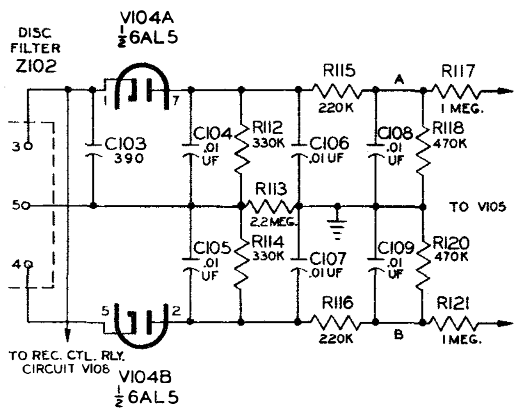


Figure 2—5. Frequency Discriminator Filter Circuit

4. FREQUENCY DISCRIMINATOR FILTER CIRCUIT.

In Fig. 2—5 the frequency discriminator filter Z102 and its associated circuits are shown. The discriminator primary is connected between the 240 volt supply and the plate of amplifier V103A. The center tapped secondary is connected to the two cathodes of detector V104. Each section of the secondary responds to both Mark and Space frequencies but in different proportion. At 1325 cps, a voltage is developed across terminals 3 and 5 as indicated in Fig. 2—6. A smaller voltage of approximately 80% relative amplitude is developed across terminals 4 and 5. This results in opposing negative voltages at the two plates and across local resistors R112 and R114. Only the remaining 20% difference in voltage amplitude is filtered by the two networks consisting of C106, R115, C108 and C107, R116, C109. Grid resistors R118 and R120 act as a divider network and supply a ground reference. Since a higher negative voltage is produced at plate 7 than at plate 2, junction A in Fig. 2—5 is negative with respect to junction B. With divider network R118 and R120 grounded in the center, junction A becomes negative with respect to ground, while junction B becomes positive. These polarities are

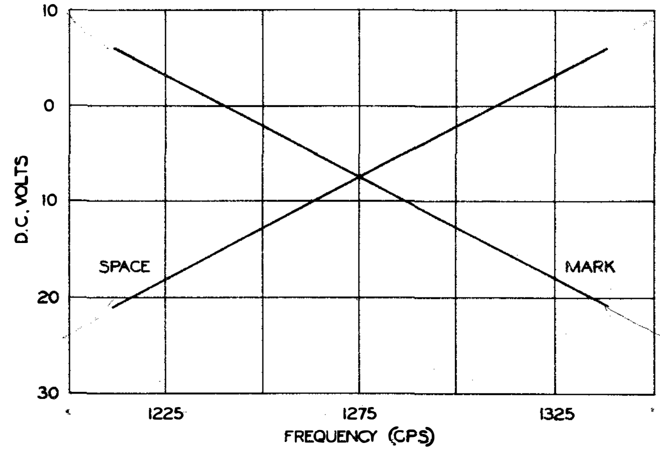


Figure 2—6. Frequency Discriminator Filter Curves

fed through grid limiting resistors R117 and R121 to the grids of V105. When the Space frequency of 1225 cps is received, a higher relative voltage is developed across terminals 4 and 5 of the discriminator filter. Reversed polarities with respect to ground are fed to the grids of V105.

5. DC AMPLIFIER.

The DC amplifier circuit is shown in Fig. 2—7. The cathode of dual triode V105 is tied to ground through resistor R119. The plates of V105A and V105B are connected to the REC KEYING RELAY K101.

Mark pulses applied through R117 to the grid of V105A cause V105A to cut off; Space pulses through R121 to the grid of V105B similarly cause V105B to cut off. Therefore, whenever a frequency shift signal is keying the receiver part of this unit, either V105A or V105B is cut off while the other half is conducting. The plate current from the conducting tube flows through one of the coils of the REC KEYING RELAY K101, operating the relay armature to either Mark or Space contacts.

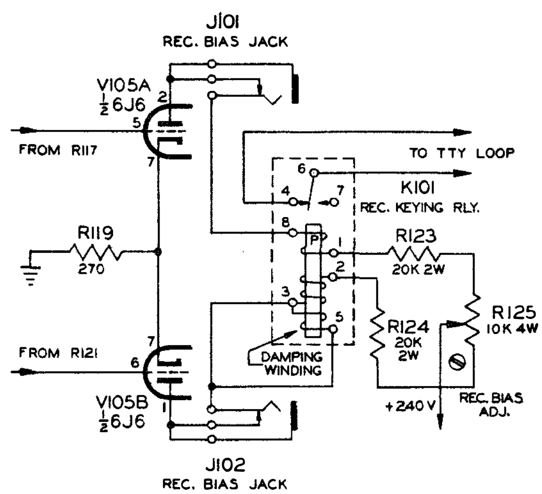


Figure 2—7. D. C. Amplifier

6. RECEIVE KEYING RELAY CIRCUIT.

Fig. 2—8 shows the receive keying relay circuit. The REC KEYING RELAY K101 is polar and, like all polar relays, contains a permanent magnet in addition to two or more coils. If a current flows through one coil only, the polarity of the current through that coil determines whether the armature (pin 6) moves to the Mark contact (pin 4) or to the Space contact (pin 7). If another current flows through the second coil, the polarity of it with respect to the current in the first coil determines whether it will aid or oppose the action of the first coil. Regardless of how the coils are connected, the magnitude and polarity of the resultant magnetic flux is due to the addition of the two currents. If the currents are equal and are so connected that they oppose each other, they cause a magnetic flux of zero magnitude. As soon as the magnetic flux changes polarity with sufficient strength to overcome the inertia of the armature (pin 6), it will move to the other contact. If there is no magnetic flux, the armature will stay on the last contact to which it was operated. The third winding, in this case, consists of only a few turns which are shorted at the relay socket to provide a damping effect. This damping permits high speed keying without contact bounce.

REC KEYING RELAY K101 is connected in the receive keying relay circuit so that plate current flow of V105A and V105B cause opposing flux in the relay. As it has been pointed out in section 2, paragraph 5, Mark pulses applied to the grid of V105A cause this tube half to cut off. V105B is then conducting heavily causing current flow in the Mark winding (pin 2 and 3) of K101. The armature (pin 6) moves to the Mark contact (pin 4) in this condition closing the teletype loop. Likewise, Space pulses applied to the grid of V105B cause V105B to cut off while V105A conducts. During the Space condition, therefore, current flows in the Space winding (pin 1 and 8) of relay K101. The armature then moves to the Space contact and opens the Teletype loop. L101, C110, C111, R122 and R126 collectively form a spark suppression and wave-shaping network. This network is needed to compensate for the inductive reaction peculiar to some models of teletypewriters.

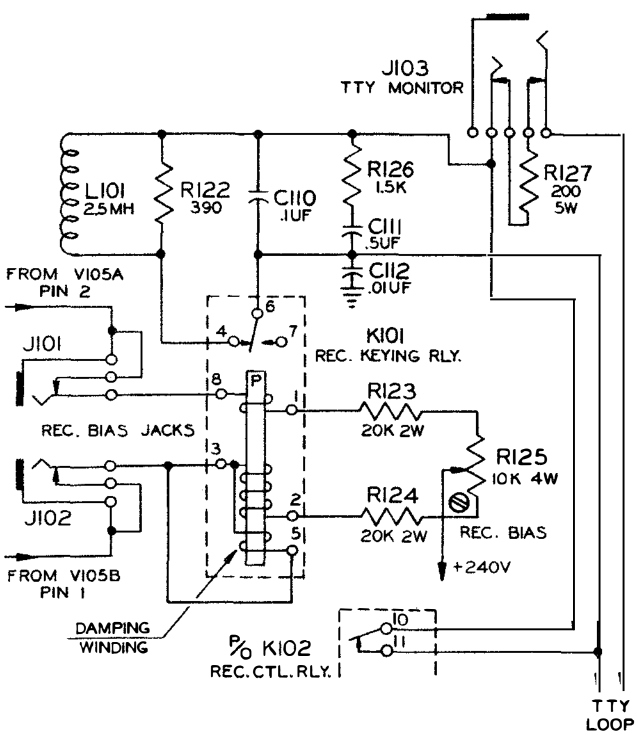


Figure 2—8. Receive Keying Relay Circuit

7. TELETYPEWRITER DISTORTION.

A teletypewriter signal consists of groups of Mark and Space impulses. Each group is caused by the operation of one key or letter on a teletypewriter keyboard. The group formed by each letter always starts with a Space impulse, followed immediately by five selector impulses that may be either Mark or Space depending on the letter of the keyboard, and always terminates with a Mark impulse. All of these impulses, with the exception of the final Mark impulse commonly referred to as Stop impulse, should be the same length. In the majority of cases the teletypewriters are geared to operate at 60 words per minute, known as "60 speed", and the above impulses are each 22 milliseconds long. The Stop impulse is 42% longer than the others and, at 60 speed, is 31 milliseconds long. In various methods of communication involving teletypewriters the signals may be left in the form of current impulses in a series DC loop or the current impulses may be converted to a tone keyed on and off, or to two audio tones (one for Mark and one for Space). In every case the form of intelligence must finally be reconverted to a direct current arranged to operate a teletypewriter. The various methods of transposing intelligence from one form to another and back again usually introduces a distortion known as "bias." This distortion results in the Mark and Space impulses being elongated or shortened with respect to their normal length. The length of time for a teletypewriter letter is fixed by the mechanical gearing of the machine and cannot be altered or distorted. However, the individual Mark impulses can be lengthened, while simultaneously the Space impulses are shortened, or vice versa. If the Marking impulses are longer than normal, the condition is known as Marking Bias or conversely, if the Space impulses are too long, the condition is known as Spacing Bias.

8. RECEIVE BIAS ADJUSTMENT.

A teletypewriter can operate with a considerable amount of bias in its signal. Exactly how much bias it can stand without misprinting is determined by many things such as adjustments of its mechanism or speed of its motor. To compensate for bias, a REC BIAS con-

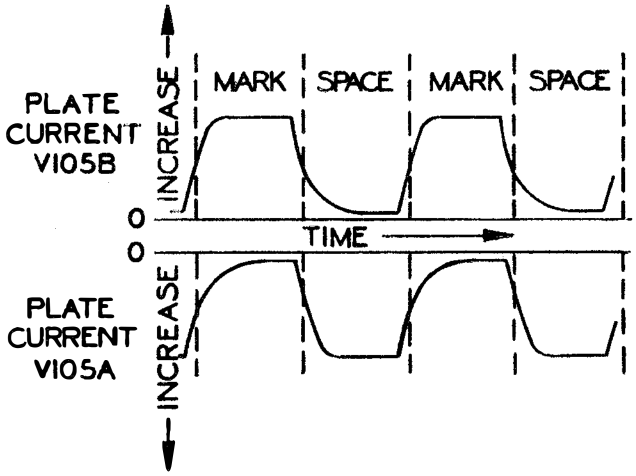


Figure 2—9. Unbiased Impulses

trol R125 is furnished on the Telegraph Terminal. The operation of this control causes the plate currents of V105A and V105B to vary inversely. Fig. 2—9 shows the shape of the Mark and Space plate impulses when the incoming tones are evenly spaced groups of 1225 and 1325 cps signals. For purpose of explanation, the Space impulses are shown upside down to indicate the opposing action of the two plate currents upon the resultant flux in the receive relay, as described in section 2, paragraph 6. It may be noticed that Mark and Space impulses are spaced evenly.

Fig. 2—10 shows the effect when one plate current (V105B) is increased and the other plate current (V105A) is decreased in the operation of the REC BIAS control. The timing of the incoming tones has not changed. The length of time, however, that the relay armature would be operated and held against the Mark contact would be longer than normal and the DC signals to the teletypewriter would have Marking bias. It is evident that rotation of the REC BIAS control in the opposite direction would cause the above conditions to change conversely and the signals to the

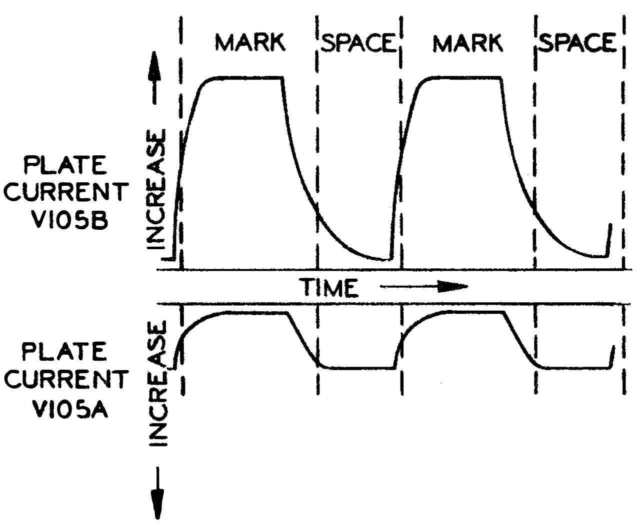


Figure 2—10. Biased Impulses

teletypewriter would have Spacing bias. Under actual conditions, it would be undesirable to deliberately introduce either Marking or Spacing bias, but the above explanations illustrate how the REC BIAS control can compensate for a bias distortion that may be introduced internally or externally. Where the timing of the tone groups is distorted, or the amplitude of the rectified Mark and Space impulses is incorrect the REC BIAS control will usually permit sufficient compensation to correct the trouble.

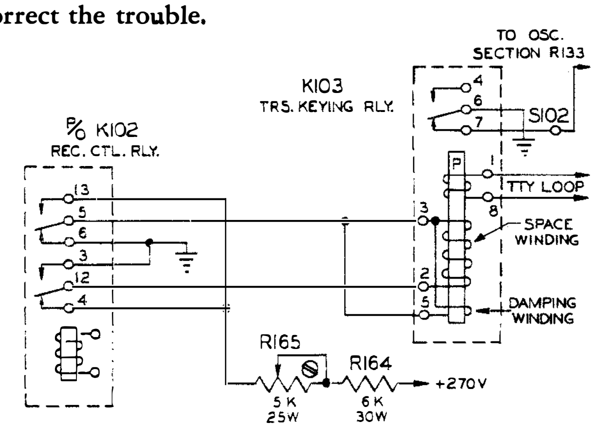


Figure 2—11. Transmit Keying Relay Circuit

9. TRANSMIT KEYING RELAY CIRCUIT.

The TRS KEYING RLY K103 which has three coils, is shown in Fig. 2—11. The current in the winding connected to the teletypewriter loop (pins 1 and 8) is 60 ma when the loop is in the Mark condition and zero ma in the Space condition. In the standby condition this current is reduced to 36 ma. The current in the second winding (pins 2 and 3) is steady at about 30 ma but can be adjusted between 20 and 40 ma by the TRS BIAS control. This second winding is called a Space winding. In the standby condition, the 30 ma current, flowing in the Space winding, produces a magnetic flux that is weaker and opposite to the flux produced by the 36 ma closed teletypewriter loop current flowing in the other winding of the relay. The resultant flux holds the transmit keying relay armature against the Mark contact (pin 7). The third winding, in this case, consists of only a few turns which are shorted at the relay socket to provide damping effects. This damping permits high speed keying without contact bounce.

While transmitting, the conditions are the same in Mark as outlined above, with the exception that the closed loop current increases to 60 ma. For Space, the teletypewriter loop current drops to zero and the unopposed flux produced by the 30 ma current draws the relay armature to the Space contact (pin 4). When a message is typed the loop current is rapidly and repeatedly changed from zero to 60 ma and back to zero again. The resultant flux is continually reversed and, consequently, the relay armature is continually switched from Mark (pin 7) to Space (pin 4) and back again.

In the receive condition, the 30 ma current in the bias winding of relay K103 is reversed by action of the receive control relay (REC CTL RLY) K102. The flux is also reversed so that it now aids the flux produced by the teletypewriter loop current. Therefore, regardless of the loop current, the flux in the transmit keying relay is always in the same direction, and the relay armature is kept on the Mark contact. This interlock feature prevents the transmit keying relay from operating when messages are being received.

Table 2—1 shows the current values in the loop and Space windings of the relay in standby, as well as receive and transmit conditions. An attempt was made to indicate the direction of the current flow in the Space winding by giving it polarity.

TABLE 2—1. TRANSMIT KEYING RELAY WINDING CURRENT.

CONDITION	RELAY CONTACT	LOOP WINDING (ma)	SPACE WINDING (ma)
Standby	Mark	36	−30
Transmit	Mark Space	60 0	−30 −30
Receive	Mark or Space	60 or 0	+30

10. TRANSMIT BIAS ADJUSTMENT.

Under ideal conditions, the waveshape of the loop current impulses is square as shown in Fig. 2—12. But when the teletypewriter loop has more capacity because of a long loop, or when it has more inductance because of several teletypewriters in the loop, the impulses become rounded as in Fig. 2—13 and lose the square shape. It should be understood that the important factor is not the actual change in waveshape, but it is the change of impulse length which is the result of a change in waveshape. This change of impulse length is teletypewriter distortion or bias and is discussed in section 2, paragraph 7.

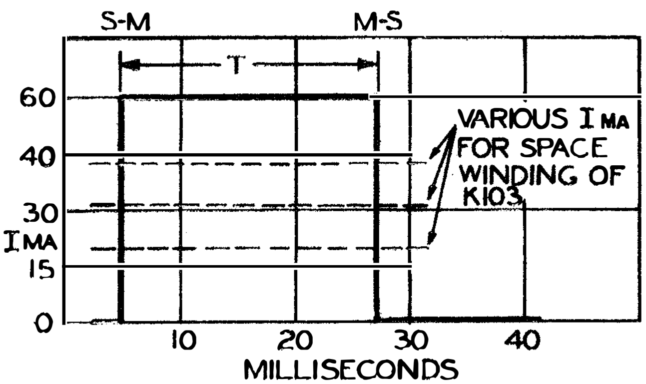


Figure 2—12. Ideal Loop Impulse Waveshape

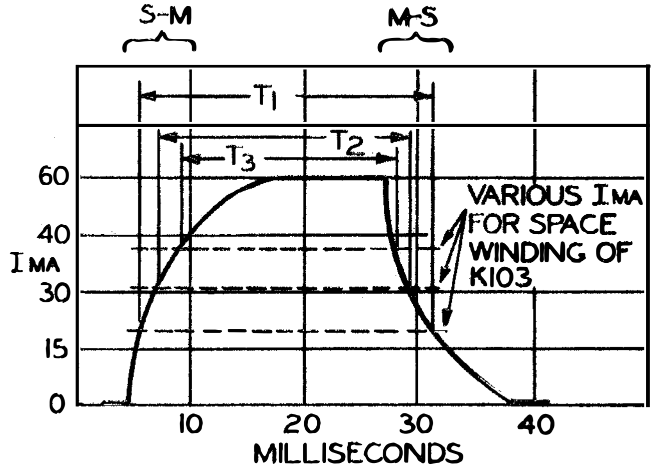


Figure 2—13. Biased Loop Impulse Waveshape

The TRS BIAS control R165 is provided to correct for this change of impulse length. It is a rheostat that is connected in series with the Space winding of the TRS KEYING RLY K103 shown in Fig. 2—11. It was explained in the previous paragraph that the Space windings of the relay K102 has an adjustable but continual current flowing through it. This current, during transmit condition, produces a flux that opposes the flux produced by the loop current. For purposes of explanation, the Space current is shown in the same direction as the loop current in the figures. Because of the opposing action of these currents, the transition of the relay armature takes place when one current exceeds the other current. Therefore, in Fig. 2—12, the transition point is where the impulse current shown by the heavy line crosses the Space current shown by the dotted horizontal line. As the impulse is square, increasing or decreasing the Space current by varying the TRS BIAS control has no effect upon the point of transition. The transition points are indicated on the figure by S-M and M-S. If neither of these transition points is changed, the time T between transitions remains the same.

When the waveshape is not square, as shown in Fig. 2—13, varying the Space current by adjusting the TRS BIAS control causes the points of transition to change. Notice that when the Space current is about 30 ma, the time T2 between transitions is normal. An increase of Space current shortens the time to T3, while a decrease of Space current increases the time to T1. Consequently, the time T between transitions can be varied by the TRS BIAS control to correct for teletypewriter distortion.

If it is necessary to adjust the TRS BIAS control to its extreme counter-clockwise position to fully compensate for Marking bias, it will be necessary to correct the bias condition in the teletypewriter loop. If more than 36 ma flows in the Space winding of the transmit keying relay the equipment cannot remain stable in standby condition.

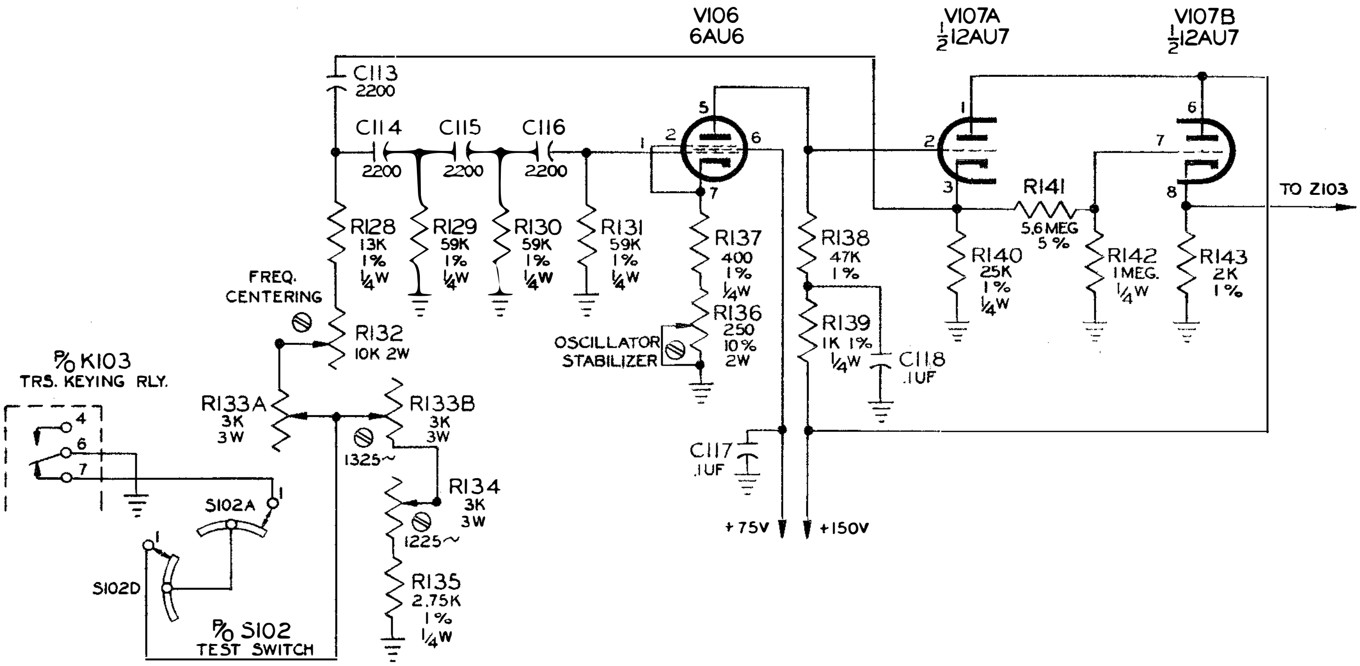


Figure 2—14. Phase Shift Oscillator

11. THE OSCILLATOR SECTION.

In Fig. 2—14 is shown the circuit of the phase shift oscillator which produces the two audio frequencies used in the Terminal. Emphasis was placed on frequency stability and minimum amplitude variation between the two frequencies used. Four resistance capacitance sections (C113 and R128, C114 and R129, C115 and R130 and C116 and R131) are used with each section contributing a phase shift of 45 degrees. The complete circuit provides the necessary 180 degree shift for sustained oscillations. Since the reactance of a capacitor varies with frequency, the required 180 degree shift is present at only one frequency. To increase the frequency, the resistance or capacitance must be decreased. Conversely, to lower the frequency, the resistance or capacitance must be increased. In this circuit, the resistance in the first RC section is varied by connecting or disconnecting the wiper arm of R133 to ground. It will be noted that this point is connected through Test Switch S102 to pin 7 of the TRS KEY RLY. When the Terminal is in transmit condition, the oscillator frequency is varied by the position of the transmit keying relay armature. On contact 4, the entire resistance network (R128, R132, R133, R134 and R135) is in the circuit and it oscillates at the Space frequency of 1225 cps. When the armature is on pin 7, the wiper arm of potentiometer R133 is grounded. This decreases the circuit resistance by shorting out R134 and R135 and raises the oscillator frequency to 1325 cps.

Resistors R128 and R135 limit the frequency adjustment range. FREQ CENT ADJ potentiometer R132 serves as a coarse centering for both frequencies. Potentiometer R133 marked "1325 CYCLES" is the fine control for the Mark frequency. A dual potentiometer rather than an ordinary one is used to allow individual, independent adjustment of the Mark and Space frequencies. Fine Space frequency adjustment is made by potentiometer R134, "1225 CYCLES". Section 3, paragraph 3 contains the proper procedure for adjusting the oscillator frequencies.

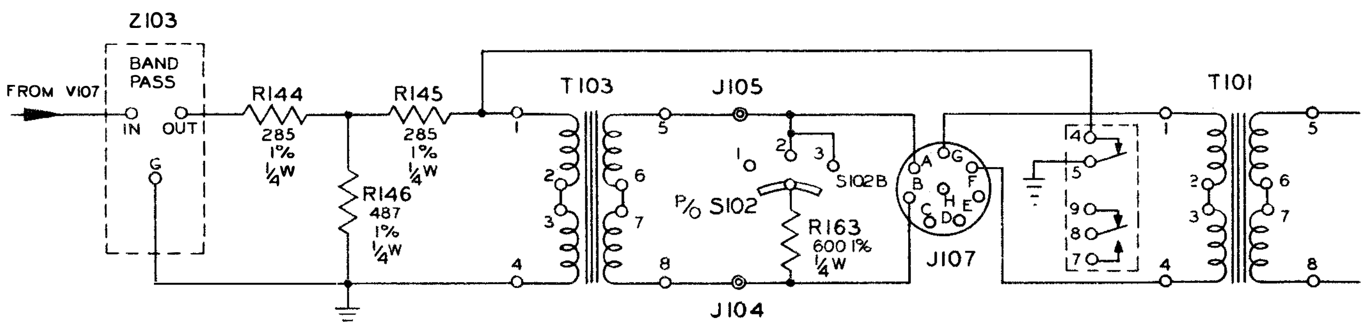


Figure 2—15. Output Circuit

Variations in plate or filament voltage can readily affect oscillator stability. Therefore, a regulated B+ supply is used to minimize plate variations. An OSC STAB potentiometer R136 employed in the cathode circuit helps to reduce the effects of filament voltage variations. The potentiometer is adjusted by depressing the STABILIZER TEST SWITCH S103 which adds resistance in series with the filament and lowers the voltage approximately 10%. An optimum setting can be found for R136 which will result in little oscillator variation when S103 is pressed or released.

Two cathode follower stages are used to isolate the oscillator from the load. The feedback is taken from the cathode of the first cathode follower rather than the plate of the oscillator.

12. OUTPUT CIRCUIT.

The output circuit Fig. 2–15 is composed of a band pass filter, a 5 db pad and an isolation transformer. As stated previously, the output signal of the oscillator contains some distortion. This distortion, due to harmonic content in the signal, is greatly reduced by the band pass filter. Frequencies from 1110 to 1440 cps pass through the filter with little attenuation while other frequencies including harmonic frequencies are greatly attenuated. The 5 db pad is similar to the input pad and fulfills the same purpose. It minimizes the effects of a possible mismatch between the Terminal and the connecting line.

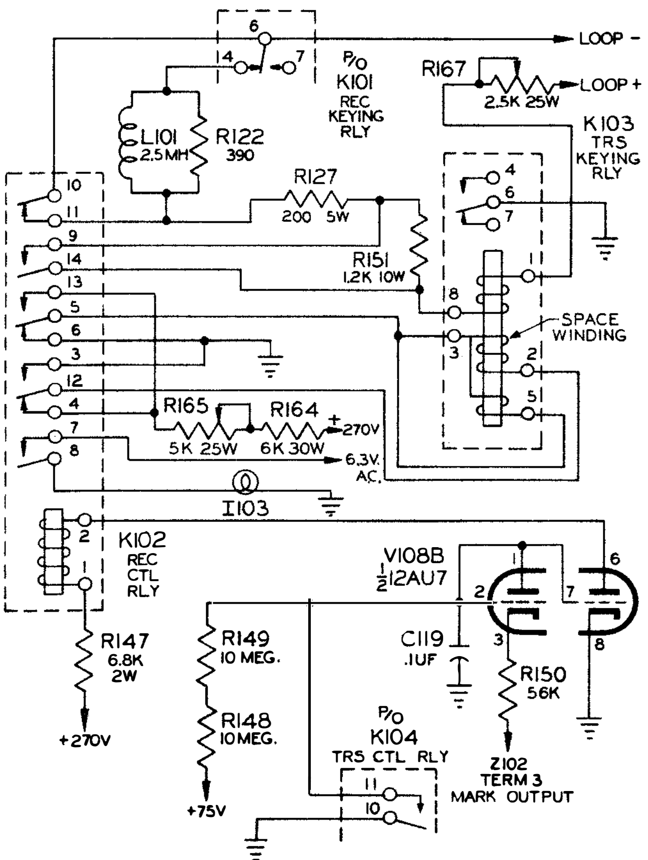


Figure 2–16. Receive Control Relay Circuit

The primary winding of the output isolation transformer is shorted to ground through contacts 4 and 5 in the TRS CTL RLY. Hence in standby or receive condition the TRS CTL RLY is not energized and the oscillator output is shorted out. In transmit condition, the short is removed when the relay is energized. Similarly the secondary of the isolation transformer is connected to J107 and the signal line through a set of contacts in the same relay.

Resistor R163 serves as an output load when TEST SWITCH S102 is in the 1225 or 1325 position used for setting and checking the oscillator circuit.

13. RECEIVE CONTROL RELAY CIRCUIT.

The receive control relay circuit is shown in Fig. 2–16. A 12AU7 twin triode V108, with one triode connected as a diode, operates the REC CTL RLY K102. One end of the relay winding is connected to the 270 V supply through resistor R147 and the other end is connected to the plate (pin 6) of the triode. The relay is energized when plate current flows. Plate current is controlled by the bias voltage on the grid (pin 7). Grid bias is determined by the condition of the transmit control relay and the presence of incoming signals.

In standby condition, the transmit control relay contacts connected to the grid of the triode are open. Also, no signal voltages are applied to the diode (pin 3) from the receive circuit. Under these conditions, the grid is slightly positive because capacitor C119 is charged positive from the 75 V supply. Grid current through R148 and R149 limits this grid voltage to about plus one volt. Thus, plate current flows during standby condition and the REC CTL RLY is energized. Resistor R147 limits plate current to a safe value.

When the receive circuit begins to receive signals, the Mark frequency is applied to the cathode (pin 3) of the diode through R150. When the cathode swings negative during half of each audio cycle the diode rectifies. The diode, the 56,000 ohm resistor R150, and capacitor C119 have a much smaller time constant than the two ten megohm resistors R148, R149 and capacitor C119. Consequently, the higher current in the lower time constant diode circuit determines the polarity of the charge on C119. When the diode rectifies on negative half-cycles, it charges C119 negative thus biasing the triode section to cut off and thereby de-energizing the relay during receive condition. A short time after the last Mark tone is received, the capacitor C119 charges positive and the REC CTL RLY is again energized.

When in transmit condition, the TRS CTL RLY (K104) shorts the grid to ground potential so that the grid and cathode of triode section V108B are at the same potential. This results in plate current flowing and the energizing of the REC CTL RLY. Since the TRS CTL RLY keeps both ends of C119 at ground potential, an incoming signal cannot charge C119 and therefore cannot cause the REC CTL RLY to release to the receive condition. This interlock feature prevents the Terminal from changing directly from transmit condition to receive condition, without first being released to standby condition. It will be noted that the REC CTL RLY is always energized except when the Terminal is in receive condition.

The functions of the REC CTL RLY contacts are as follows:

a. Two sets of SPDT contacts (13, 5 and 6; 3, 12 and 4) control the direction of the current flowing through the TRS KEYING RLY K103 Space coil. Reversing this current when in receive condition prevents relay K103 from functioning, as explained in section 2, paragraph 9.

b. Contacts 10 and 11 close during transmit and standby conditions (as shown). Pins 4 and 6 of the REC KEYING RLY K101 are shorted and the teletypewriter loop is maintained in a closed position, regardless of the position of the relay armature.

c. Contacts 9 and 14 short out resistor R151 in the teletypewriter loop. When this resistor is shorted out during receive condition, the loop current rises from 36 ma to 60 ma.

d. Contacts 7 and 8 apply voltage to the receive indicator light (I103) when in receive condition.

When a teletypewriter is installed out of visible range of the indicator lights of the Terminal, a 100 ma meter may be inserted in series with the teletypewriter loop. When the meter is steady and reads about 36 ma the Terminal is in standby. This is due to the 1200 ohm resistor R151, adding to the resistance of the loop and decreasing the current. When the Terminal is in receive or transmit condition, resistor R151 is shorted out, raising the loop current to 60 ma. During keying the meter fluctuates rapidly as the loop is broken and made.

14. TRANSMIT CONTROL RELAY CIRCUIT.

The transmit control relay circuit is shown in Fig. 2–17. It consists of V109A, V109B and V103B. One end of the TRS CTL RLY winding is connected to the 270 V supply through resistor R161. The other end is connected to the plate of V103B. When plate current flows the relay is energized.

The input at the grid (pin 2) of AC amplifier V109A controls the V103B plate current flow necessary to operate the relay. In standby and receive condition, this V109A grid (pin 2) is tied to ground through S102 and the TRS KEYING RLY which is held on the Mark contact (pin 7). The TRS CTL RLY K104 remains deenergized. When a message is being typed locally, the armature of the TRS KEYING RLY intermittently allows the Mark frequency to be applied to the grid (pin 2) of V109A. The signal is amplified and applied to V109B which is connected as a diode. On positive swings, the tube section conducts charging C121 and driving the grid (pin 7) of V103B positive. This causes plate current to flow and energizes the TRS CTL RLY. The fixed bias on the cathode (pin 8) of V103B insures that the tube will not conduct until C121 has a positive charge overcoming the bias. Capacitor C121 requires approximately three seconds to discharge when the local operator stops typing. Therefore, there is a time delay of approximately three seconds before the transmit control circuit can change to standby condition. This time delay feature holds the Terminal in transmit condition despite short breaks in the outgoing message.

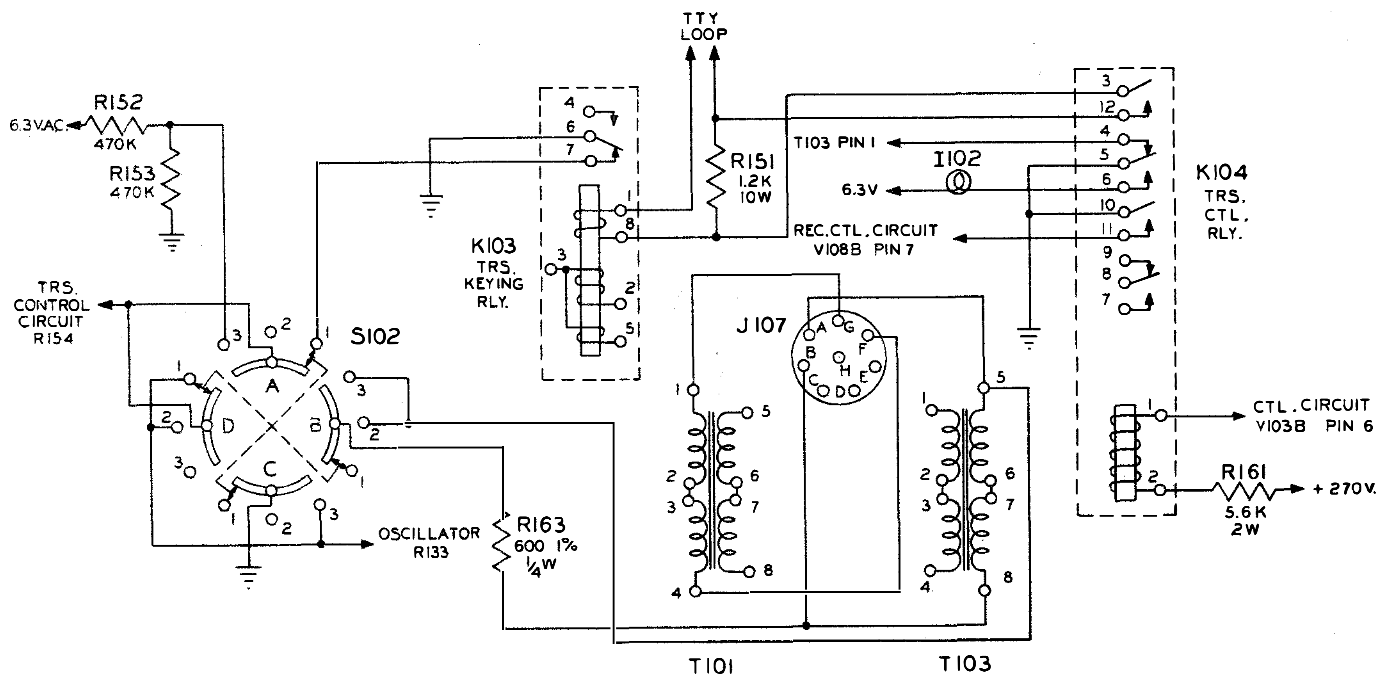


Figure 2–17. Transmit Control Relay Circuit

The functions of the TRS CTL RLY can be readily ascertained by referring to Fig. 2—17. Contacts 3 and 12 short out R151 to raise the loop current to 60 ma. Contacts 4 and 5 place a short across output transformer T103 when the relay is de-energized. Contacts 5 and 6 apply power to transmit indicator light I102. Contacts 10 and 11 ground the grid of the twin triode V108 that operates the REC CTL RLY K102. This action prevents operation of the REC CTL RLY during transmit condition as described in section 2, paragraph 13.

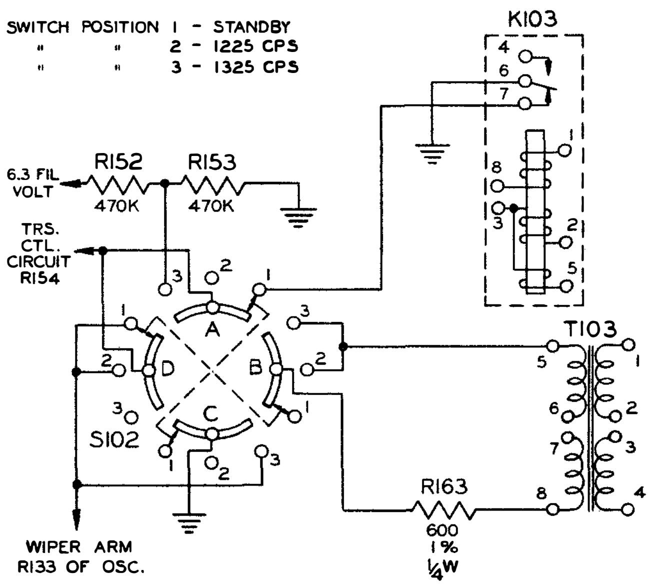


Figure 2—18. Test Switch Circuit

15. TEST SWITCH CIRCUIT.

The test switch circuit is shown in Fig. 2—18. For normal operation, the switch remains at all times in standby position. The "1225" and "1325" positions are used for transmitter testing and calibrating purposes only. In both positions, 600 ohm resistor R163 is placed across the secondary winding of output transformer T103 to provide a working load. This is done through section B of the TEST SWITCH. In the 1225 cps position, oscillator voltage from the wiper arm of dual potentiometer R133 is applied through section D of the switch to the grid (pin 2) of V109A. This will cause the transmit control circuit to operate and energize the relay. As was explained in section 2, paragraph 11, the oscillator will oscillate at 1325 cps when the arm of dual potentiometer R133 is grounded. However, it should be noted that the arm is not grounded in this test switch position. The oscillator will therefore oscillate at 1225 cps and the potentiometer arm will feed a take off voltage to the control circuit to energize the relay. With the TEST SWITCH in "1325 cps" position, the arm of dual potentiometer R133 is grounded through section C. In this switch position a different voltage source is used to operate the transmit control relay circuit. Filament voltage from the divider network R152 and R153 is used for this purpose and applied through switch section A.

16. POWER SUPPLY.

The power supply circuit shown in Fig. 2—19 is a conventional full wave rectifier with two rectifier tubes connected in parallel for longer tube life. Voltage regulator tubes V112 and V113 provide a regulated source of 75 V and 150 V to the oscillator section. The internal jumpers of the regulator tubes prevent possible damage to the equipment if the tubes are removed from the sockets.

There is a stabilizer test switch in the filament circuits of the oscillator section only. This serves to reduce the voltage and simulates reduced AC input to the Terminal. When the OSCILLATOR STABILIZER potentiometer R136 is properly set as explained in section 2, paragraph 11, there will be minimum oscillator drift under normal input voltage variations.

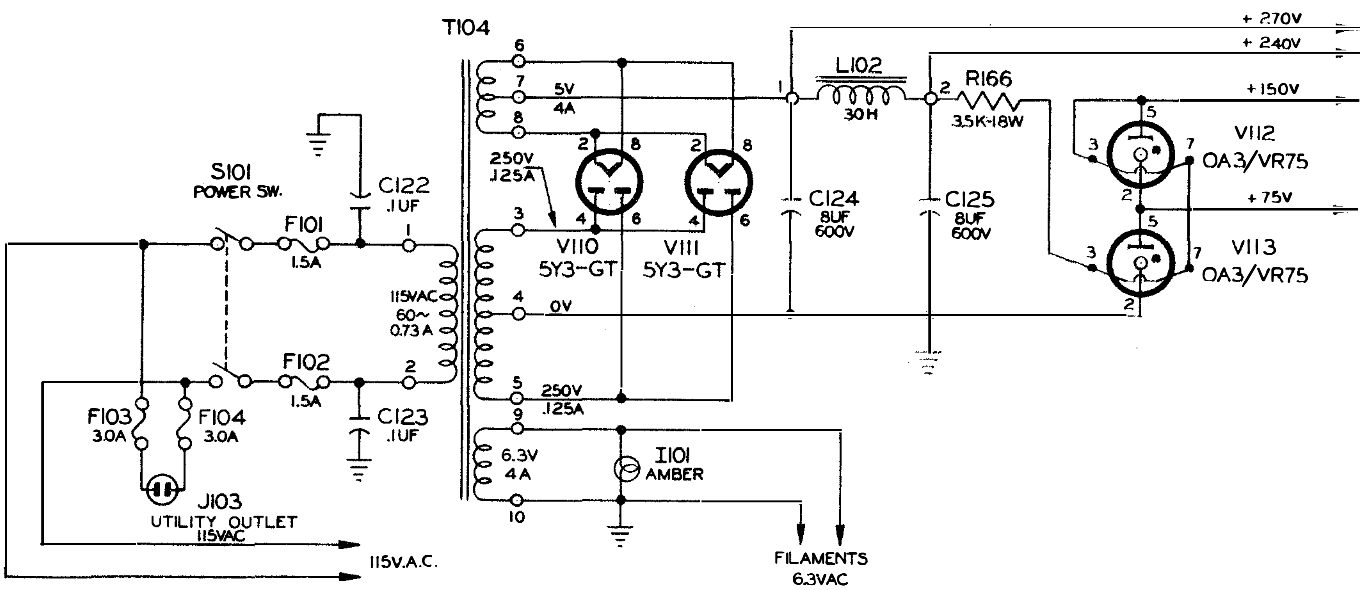


Figure 2—19. Power Supply

SECTION 3
INSTALLATION

1. UNPACKING.

The Telegraph Terminal TH-20/UG, complete with one full complement of vacuum tubes, spare parts and two instruction books is shipped in a single wooden crate. Inside the wooden crate are a waterproof carton, cardboard fillers, vaporproof container and two inner cardboard sections containing the equipment and spare parts box.

Special precautions are necessary only to make certain that the crate is opened from the top and that excessive jars and shocks are not given the equipment during unpacking. Fig. 3—1 shows a cut-away view of the packaged equipment and the procedure for unpacking.

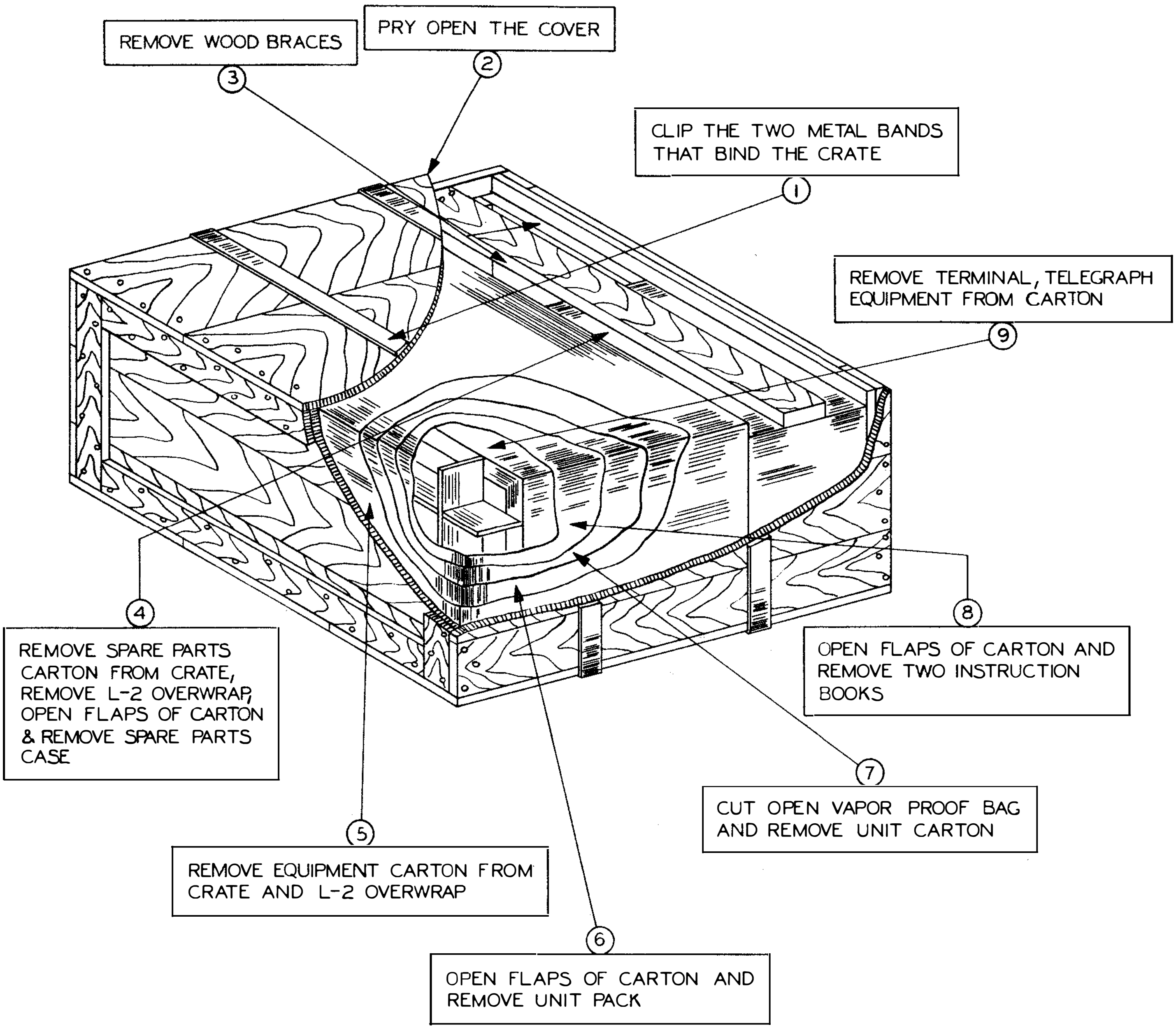


Figure 3—1. Unpacking Procedure for Telegraph Terminal TH-20/UG

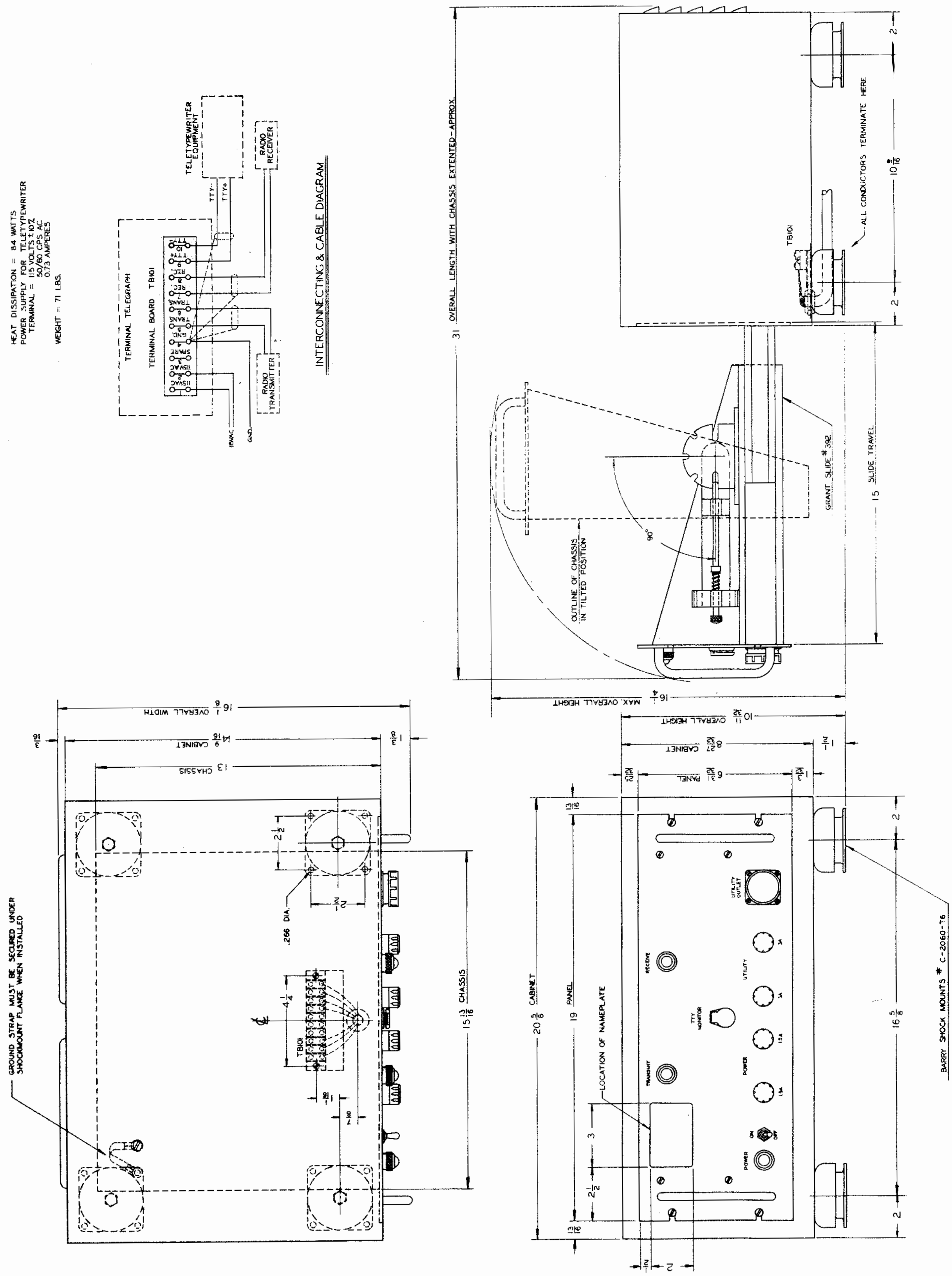


Figure 3–2. Equipment Dimensions, Terminal Strip Connections

2. INSTALLATION.

After unpacking the equipment, it should be inspected for any possible damage that may have resulted from careless handling in transit. Make certain all vacuum tubes are firmly seated in their sockets. Inspection of the chassis and vacuum tubes may be readily effected upon the removal of the chassis from the cabinet. The chassis slides on ball bearings between two aluminum runners connected to the chassis and cabinet. If the four screws on the front panel are removed, the chassis will slide out from the cabinet when it is pulled by the two handles on the front panel.

When the chassis is fully extended horizontally it is automatically locked in position. The release rod knob on each side must either be pressed in to return the chassis to the cabinet or pulled back to tilt the chassis upward for inspection. It may be locked in several tilted positions by releasing the knobs and permitting the rods to engage in a set of slots. The chassis may also be completely removed from the runners and cabinet. The two cables must be disconnected and the chassis tilted 90 degrees. The screw on each side indicated in Fig. 3—2 must be removed and the locking device on each slot removed. The chassis can then be lifted straight up until it is free.

In planning an installation, care should be exercised to provide adequate clearance between the front of the Terminal and the nearest obstruction to enable the withdrawal of the chassis from the cabinet for inspection, servicing or vacuum tube replacement. (See Fig. 3—2 for dimensions). The cabinet should be secured to the mounting surface by sixteen ¼-20 machine screws of appropriate length. The loose end of the ground strap should be secured under the flange of the shock-mount to which it is attached.

Fig. 1—1 shows the Terminal with associated teletypewriter equipment. Fig. 3—2 shows in detail the cable connections to terminal board TB101 located on the bottom of the cabinet. The terminal marked GND should be connected to a good ground. A single phase, 50/60 cycle, AC power source of 115 volts is required and should be attached to the two terminals marked 115 V AC. The external radio receiver and radio transmitter using shielded pairs, are connected to the REC and TRANS terminals respectively. Both shields, of course, should be connected to the GND terminal. The polarity of the wires connected to the teletypewriter should be determined with a voltmeter. Then the positive lead is attached to the terminal marked TTY+ and the negative lead is attached to TTY—.

3. INITIAL ADJUSTMENTS.

Prior to turning on the equipment, all external connections should be checked to make certain they are correctly made, since serious damage may otherwise result.

When the equipment is first put into service in a given location, a systematic adjustment of all variable controls should be made. The controls marked LOOP CURRENT, REC BIAS, FREQ CENTERING, 1325 CYCLES, 1225 CYCLES, OSCILLATOR STABILIZER and TRS BIAS should be rotated fully counter-clockwise and then fully clockwise, after which each control should be set approximately at mid-rotation.

The TEST SWITCH will be used in all three positions during the installation. The POWER switch controls the primary voltage to the chassis. The UTILITY OUTLET is a source of 115 V AC for external use such as for a soldering iron. TTY MONITOR jack is for the use of a monitoring teletypewriter. HEADPHONES MUST NOT BE PLUGGED INTO THIS JACK. The POWER indicator light is illuminated when the equipment is energized. The RECEIVE and TRANSMIT lights indicate when the equipment is in the corresponding condition.

The following operations are essential to ensure proper functioning of the Terminal and must be performed step by step if satisfactory results are to be obtained:

a. See that the teletypewriter is properly connected.

b. Turn the POWER switch ON. The amber POWER light will go on. Each light is equipped with a dimmer. When the knurled ring is turned clockwise, the dimmer is open so that the light is visible.

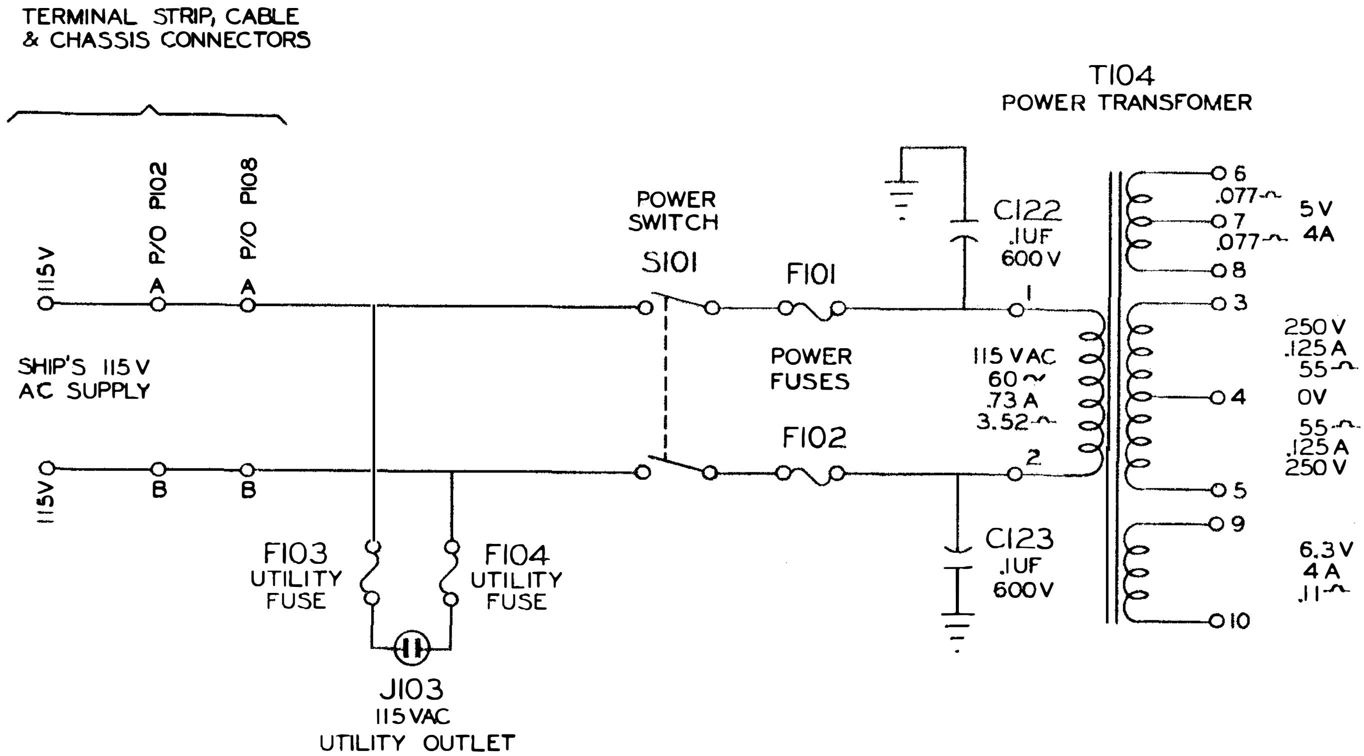
c. Place the TEST SWITCH in 1325 cps position. The green transmit light should go on. Adjust LOOP CURRENT control for 60 milliamperes on DC meter.

d. Return TEST SWITCH to STANDBY position. If the TRS BIAS rheostat R165 is too far clockwise, the Terminal may be slowly cycling between transmit and standby conditions. Turn the control counter-clockwise until this condition stops.

e. Short the input to the receiver section and balance the current flow at jacks J101 and J102 with REC BIAS ADJ R125 on the 10 ma scale.

f. An accurate audio oscillator and an oscilloscope may be used to adjust the Mark and Space frequencies. If these devices are to be used, connect the output of the test oscillator to the horizontal amplifier of the oscilloscope and FREQ TEST JACKS J104 and J105 to the vertical amplifier. With the TEST SWITCH turned to 1325 cps position and the test oscillator calibrated to 1325 cps, the FREQ CENTERING control R132 and the 1325 cycle control R133 can be set for a circle pattern on the oscilloscope screen. R132 is a coarse adjustment and R133 should be used for the fine setting.

g. With the test oscillator calibrated to 1225 cps and the TEST SWITCH in 1225 cps position, the 1225 CYCLES control R134 can be set for a circle pattern.



FUSE	CURRENT	VOLTAGE
F101,102	1.0 A	250 V
F103,104	3.0 A	250 V

Figure 3—3. Primary Power Distribution Diagram

h. With all equipment set as in *g* above, adjust OSCILLATOR STABILIZER R136 for the least frequency deviation when STABILIZER TEST SWITCH is pressed or released.

i. Repeat steps *f* and *g*.

j. TEST SWITCH S102 is then rotated to the standby position. Connect an AC vacuum tube voltmeter between pin 7 of TRS KEYING RLY K103 and chassis ground (pin 6 of K103). Hold down the space bar on the teletypewriter and adjust TRS BIAS ADJ R165 until the meter reads 1.75 V RMS. When there is only one teletypewriter connected in the loop, it may be noticed that there is no appreciable change in the meter reading when the TRS BIAS ADJ control is adjusted. In this case, set the control at a point close to the cycling position of the TRS CONTROL AMP.

k. The last adjustment is the REC BIAS ADJ control R125. The incoming teletypewriter signal from a distant station whose transmit bias was adjusted beforehand is required. Request the distant operator to hold down the space bar. Rotate the REC BIAS ADJ control both ways until the teletype printer ceases to space or starts to print. Note these two positions of the REC BIAS ADJ control and set the control midway between them. In some cases, it will be difficult to adjust the REC BIAS ADJ control because the printer will space accurately throughout the range of the control. The remedy for this condition is to throw off the teletype printer orientation slightly towards both sides, thereby increasing the amount of bias introduced. Then repeat the procedure outlined above.

The equipment is now completely adjusted for operation with its associated teletypewriter for two-way communication with other stations similarly equipped. Fig. 3—3 is the primary power distribution diagram for the TH-20/UG.

SECTION 4
OPERATION

1. GENERAL.

The Telegraph Terminal TH-20/UG is to be used in conjunction with a standard teletypewriter for the transmission and reception of teletypewriter messages by radio communication between stations similarly equipped. The Terminal converts the intelligence of outgoing messages to audio tone signals. Also, it reconverts the intelligence of incoming signals to a form that can cause a teletypewriter to print the message. Under normal operating conditions, little attention is required to maintain communication with other stations.

2. OPERATION.

Refer to Fig. 4—1 for the front panel layout and description. There are three indicator lights which indicate when the power is on and when the Terminal is in receive or transmit condition. Each light has a polaroid dimmer control so that the brilliance of the light may be varied. The light is brightest when the dimmer (the knurled ring) is turned fully clockwise. The 115 V AC outlet is provided for supplying power for external use such as for a soldering iron. This power is not controlled by the POWER switch. The jack is provided for connecting a monitoring teletypewriter into the teletypewriter loop. HEADPHONES MUST NOT BE PLUGGED INTO THIS JACK.

Perform the operations and adjustments outlined in section 3, paragraphs *a* through *k*.

The equipment is now adjusted for operation with its associated teletypewriter and for communication with other stations similarly equipped.

The TEST SWITCH should always be in standby position. It is used in other positions only when tests or adjustments of the oscillator section are being made.

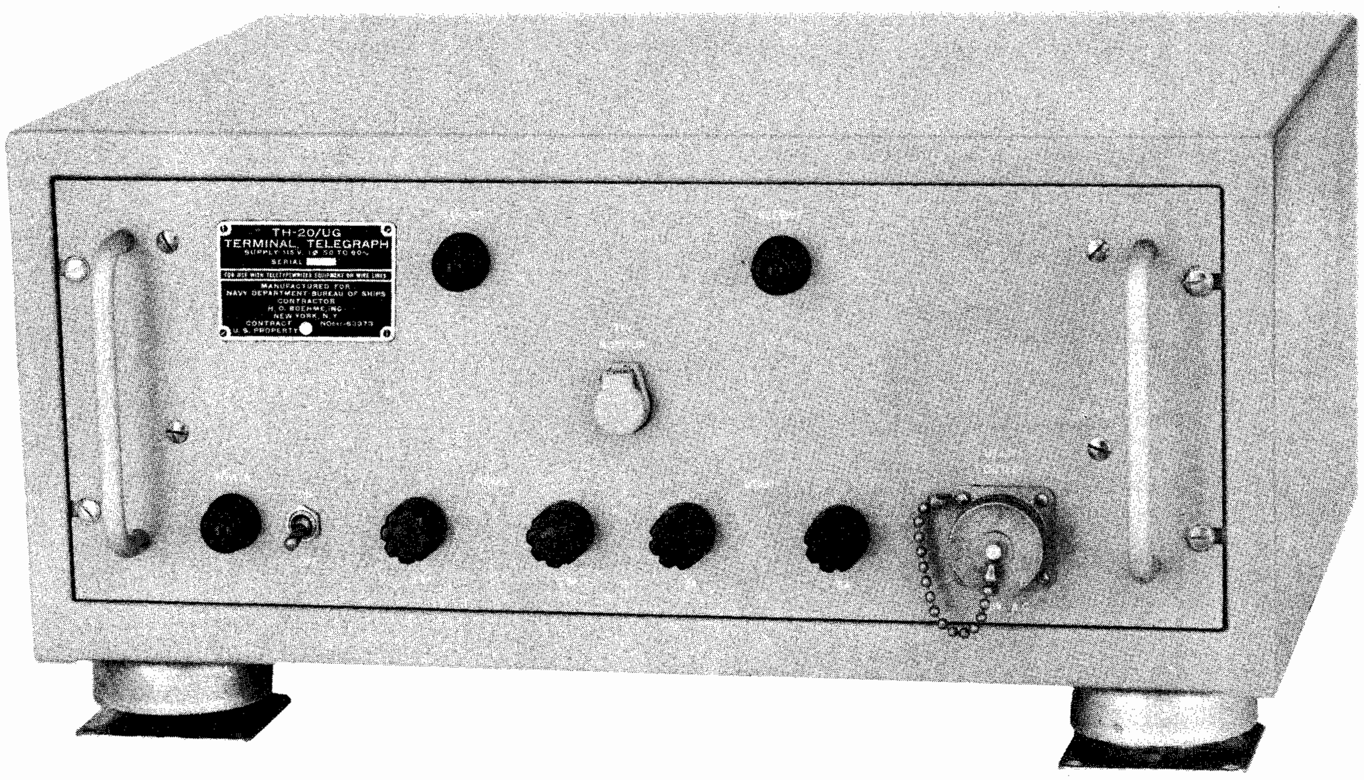


Figure 4—1. Front Panel Layout

SECTION 5
MAINTENANCE

1. GENERAL.

This section of the instruction book contains diagrams, charts and other pertinent data useful in servicing of Telegraph Terminal TH-20/UG. While the equipment does not require periodic checking, it does require the normal adjustments that are made when the equipment is turned on. These normal operation adjustments were described in section 4 titled "Operation". Other adjustments for oscillator frequency and stabilization involve the use of test equipment. These controls remain in correct adjustment over long periods

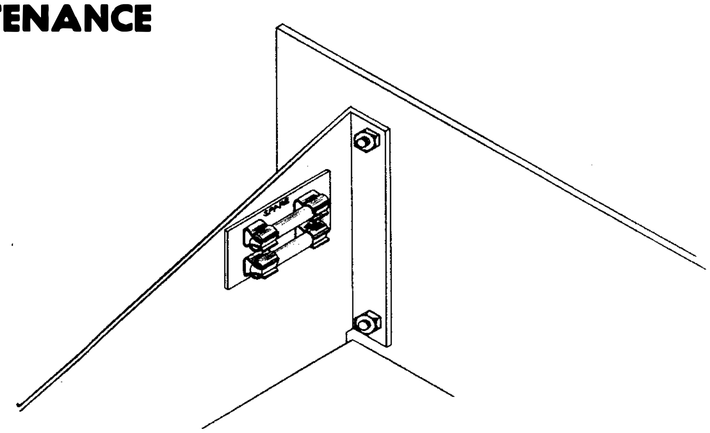


Figure 5—1. Spare Fuse Location

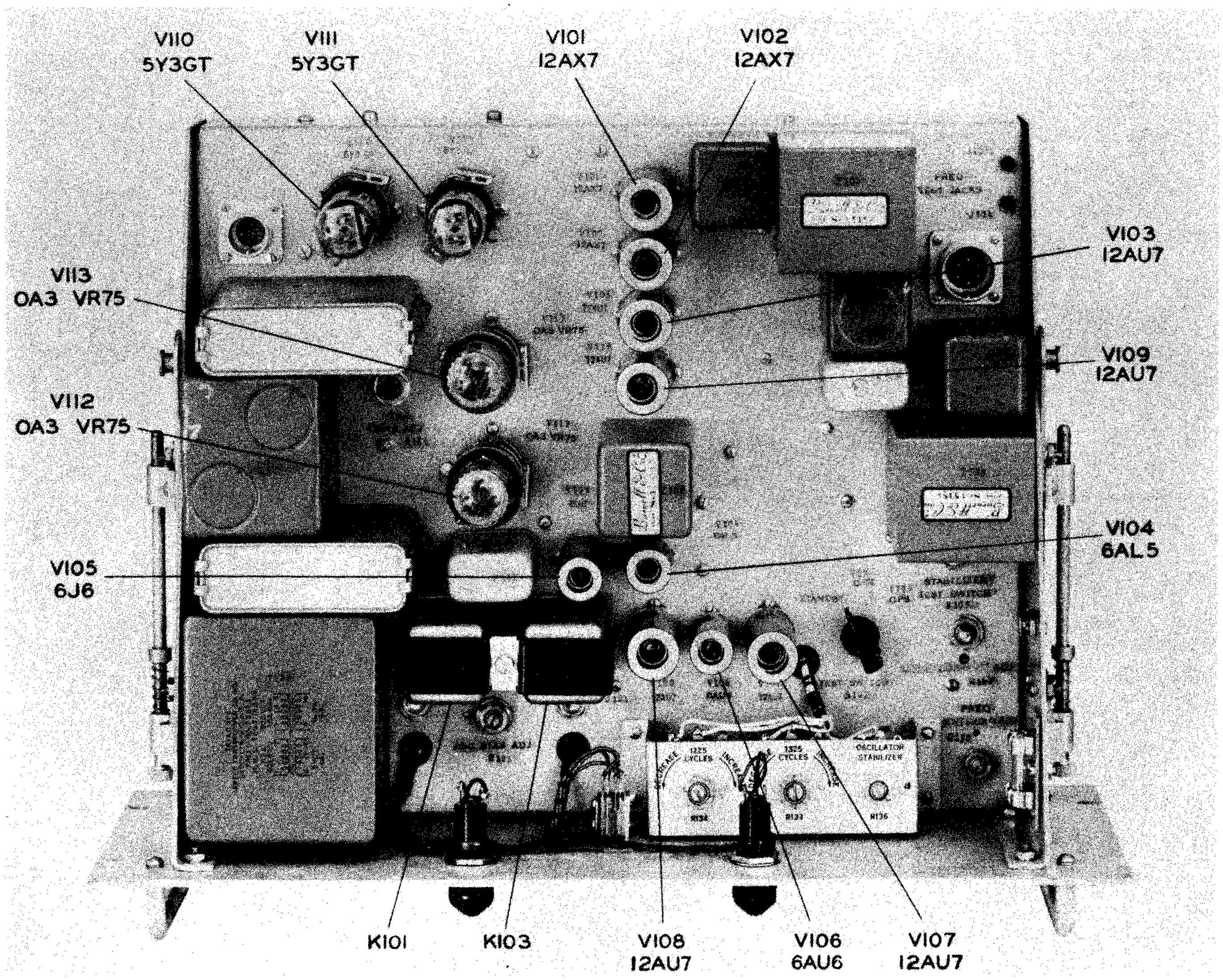


Figure 5—2. Tube and Polar Relay Locations

and usually need attention only after replacing the oscillator or output tubes or after servicing the equipment. Adjustments of this type should be made by technicians to ensure proper operation. However, the operator may be called upon to check these controls and replace fuses or tubes if the equipment becomes faulty during battle conditions. To facilitate inspection and servicing, the four retaining screws on the front panel may be removed and the chassis pulled out from the cabinet. When necessary, it can be tilted up for checking components underneath, as explained in section 3, paragraph 2.

2. EMERGENCY MAINTENANCE.

Fig. 3—2 shows the location of the four fuses on the front panel. The two spare fuses are on the inside right panel support, as shown in Fig. 5—1. Table 5—1 shown below, lists the symptoms of fuse failure and information pertinent to fuse replacement.

Fig. 5—2 shows the location of the tubes and polar relays. If the operation of the Terminal is faulty, visual inspection will determine if the tube filaments are drawing current. If the tube does not have at least a small glow it should be exchanged. The tubes may be checked with a standard tube tester.

Note

ALL TUBES OF A GIVEN TYPE SUPPLIED WITH THE EQUIPMENT SHALL BE CONSUMED PRIOR TO EMPLOYMENT OF TUBES FROM GENERAL STOCK.

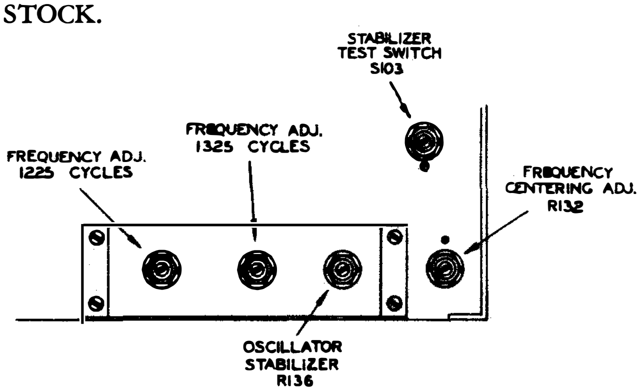


Figure 5—3. Frequency Adjustments Locations

Fig. 5—3 shows the location of the four controls affecting frequency—1225 CYCLES, 1325 CYCLES, FREQ CENTERING and OSCILLATOR STABILIZER. If the oscillator tube V106 or the cathode follower V107 is replaced, the adjustment of the MARK and SPACE frequencies should be checked as outlined below:

a. Connect an accurate audio oscillator which is calibrated to 1325 cps to horizontal amplifier of an oscilloscope. To the vertical oscilloscope amplifier, connect FREQ TEST JACKS J104 and J105. With the TEST SWITCH S102 turned to 1325 cps position, adjust potentiometers R132 (FREQ CENT) and R133 (1325 CYCLES) for a circular pattern on the oscilloscope. R132 is a coarse adjustment; R133 is a fine adjustment.

b. Set the TEST SWITCH in 1225 cps position and calibrate the test oscillator to 1225 cps. Adjust R134 for a circular pattern on the oscilloscope.

c. With the equipment set as in either *a* or *b*, press and release STABILIZER TEST SWITCH S103 and note frequency change. Adjust OSCILLATOR STABILIZER control (R136) for the least frequency deviation when STABILIZER TEST SWITCH is pressed and released.

d. Repeat steps *a* and *b*.

3. CORRECTIVE MAINTENANCE.

The first step in correcting trouble or failure in any electronic device is to isolate the section which is the source of the trouble. The Terminal for analytical purposes can be divided into five basic sections. Several checks or observations in each section can quickly determine whether it is functioning correctly.

POWER. The power circuit supplies the filament, screen and plate voltages. The presence of filament voltage can be determined by observing whether the tubes light up. Plate voltage readings should be taken at 270, 240, 75 and 150 volt points.

RECEIVE CONTROL. This circuit may be checked by observation. When the power is on, relay K102 should always be energized except when the Terminal is in receive condition. Circuit failure would de-energize the relay and the red receive light would go on and stay on in any condition.

TABLE 5—1. FUSE REPLACEMENT

SYMPTOM	BLOWN FUSE	VALUE (amps)	COMMENTS
Equipment inoperative and POWER light does not light.	F-101 and/or F-102	1½	Check power cable connections if utility outlet is also dead.
Utility outlet dead.	F-103 and/or F-104	3	

A double check may be made by feeding a Mark signal of 1325 cps into receiver and observing whether relay de-energizes and light goes on.

RECEIVE. Checks here require 1225 cps and 1325 cps audio signal inputs and current checks at J101 and J102. An audio oscillator and meter leads, terminating in the proper plug, are necessary. With a 1325 cps input, current at J102 should be approximately 6 or 7 ma and the teletype loop should be closed. As mentioned above, the red receive light is on. A 1225 cps signal should open the loop with the current of 6 or 7 ma at J101. The receive light is not on, since only a Mark signal will actuate the control circuit.

TRANSMIT CONTROL. This circuit uses a portion of the filament voltage when TEST SWITCH S102 is in the 1325 cps position. The control circuit is therefore independent of the oscillator in this position, and if the green transmit light goes on, proper functioning is indicated.

TRANSMIT. An oscilloscope connected to jacks J104 and J105 may be used to quickly determine whether the oscillator is functioning properly. Both frequencies should be checked and the patterns compared with those in Fig. 5–7.

These checks are merely a rough means of localizing trouble to a particular section. Additional assistance can be obtained by using the detailed step by step check, which is outlined in trouble shooting chart, Table 5–2.

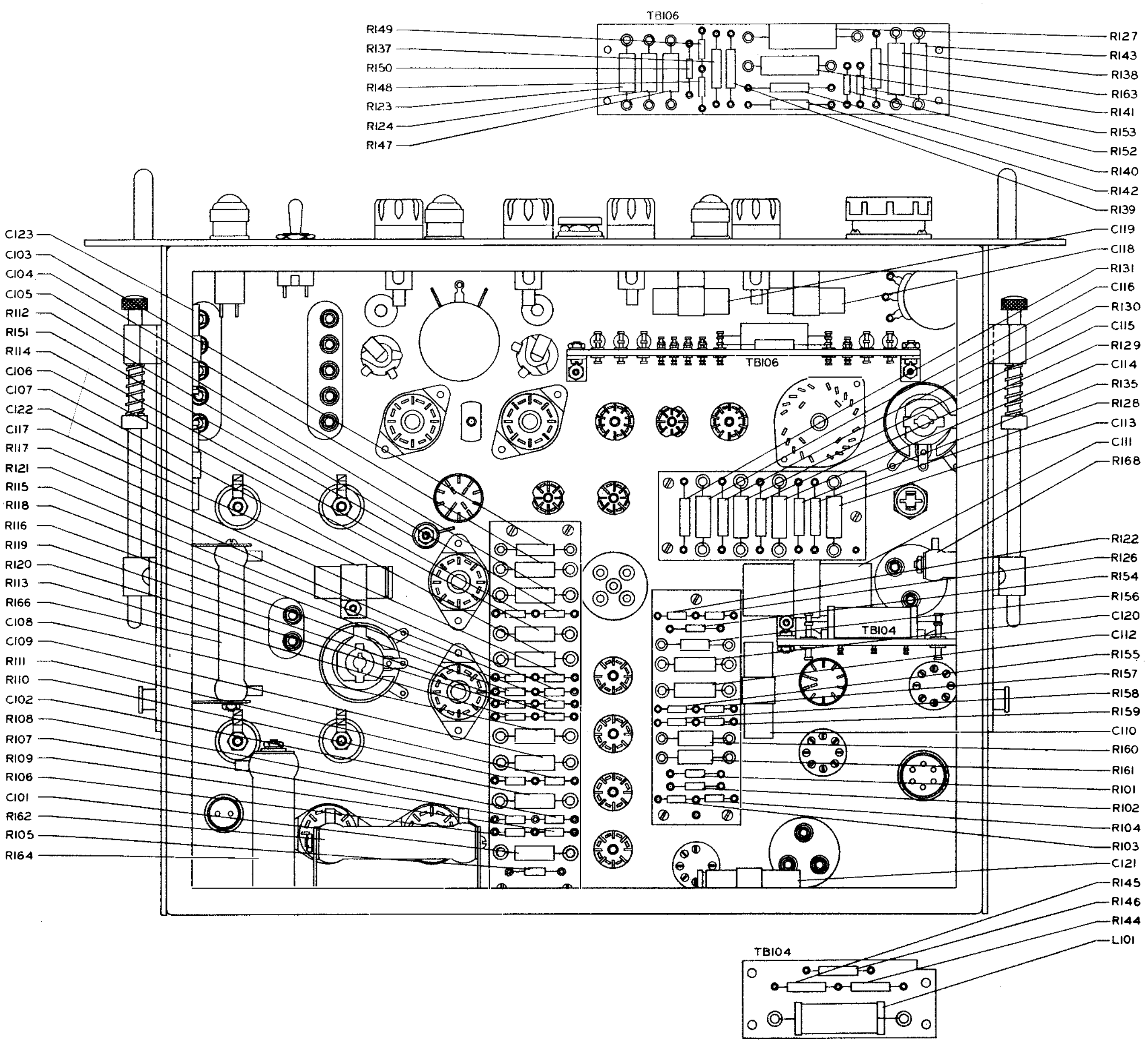


Figure 5–4. Component Locations

Fig. 5—5 is a chart showing the voltages and resistances between each tube socket pin and ground. This chart is provided as a standard so that faulty equipment may be quickly compared with regard to voltages and resistances.

Fig. 5—6 is a diagram showing the voltage and resistance measurements on the terminal strip in the cabinet. This strip has two flexible cables connected between it and the chassis and is the attachment point for the exterior wiring. The flexible cables are attached to the chassis with two AN-connectors shown in this figure. All resistance measurements must be made with the exterior wiring disconnected, as the values shown represent resistances of only the interior components of the Telegraph Terminal TH-20/UG.

An oscilloscope, as indicated previously, may be used to advantage in locating and correcting faulty components. Representative oscilloscope patterns are shown in Fig. 5—7 to enable a comparative visual check of the signal as it passes through the system. These patterns are shown associated with the point in the circuit where they may be observed. The oscilloscope should be connected between ground and the desired point in the circuit, except when the input or output signal pattern is to be observed. To observe these patterns connect the oscilloscope to both sides of the audio line. These lines float with respect to ground so that an oscilloscope connected to ground and one side of the audio line would not produce the pattern present in the line. The pattern at the input of the frequency discriminator filter Z102 and the pattern at the input of the output band pass filter Z103 both show distortion to be present. Although distortion is actually present at these points, it is accentuated by the filters because they pass the undistorted signal voltages and reflect the remaining distorted voltages.

Fig. 5—8 is a schematic of the entire system showing the electrical circuits. Fig. 5—9 is a wiring diagram showing the actual point-to-point connections to enable tracing the cable wires throughout the chassis.

Since corrective maintenance often effects adjustments, the maintenance personnel should check all adjustments properly. The complete adjustment procedures are repeated here. These adjustments must be performed step by step if satisfactory results are to be obtained.

a. See that the teletypewriter is properly connected.

b. Turn the POWER switch ON. The amber POWER light will go on. Each light is equipped with a dimmer. When the knurled ring is turned clockwise, the dimmer is open so that the light is visible.

c. Place the TEST SWITCH in 1325 cps position. The green transmit light should go on. Adjust LOOP CURRENT control for 60 milliamperes on DC meter.

d. Return TEST SWITCH to STANDBY position. If the TRS BIAS rheostat R165 is too far clockwise, the Terminal may be slowly cycling between transmit and standby conditions. Turn the control counter-clockwise until this condition stops.

e. Short the input to the receiver section and balance the current flow at jacks J101 and J102 with REC BIAS R125 on the 10 ma scale.

f. An accurate audio oscillator and an oscilloscope may be used to adjust the Mark and Space frequencies. If these devices are to be used, connect the output of the test oscillator to one amplifier of the oscilloscope and FREQ TEST JACKS J104 and J105 to the other amplifier. With the TEST SWITCH turned to 1325 cps and the test oscillator calibrated to 1325 cps, the FREQ CENTERING control R132 can be set for a circle pattern on the oscilloscope screen. This is a coarse adjustment and 1325 CYCLES should be used for the fine setting.

g. With the test oscillator calibrated to 1225 cps and the TEST SWITCH in 1225 cps position, the 1225 CYCLES control R134 can be set for a circle pattern.

h. With all equipment set as in *g* above, adjust OSCILLATOR STABILIZER R136 for the least frequency deviation when STABILIZER TEST SWITCH is pressed or released.

i. Repeat steps *f* and *g*.

j. TEST SWITCH S102 is then rotated to the standby position. Connect an AC vacuum tube voltmeter between pin 7 of TRS KEYING RLY K103 and chassis ground (pin 6 of K103). Hold down the space bar on the teletypewriter and adjust TRS BIAS ADJ R165 until the meter reads 1.75 V RMS. When there is only one teletypewriter connected in the loop, it may be noticed that there is no appreciable change in the meter reading when the TRS BIAS ADJ control is adjusted. In this case, set the control at a point close to the cycling position of the TRS CONTROL AMP.

k. The last adjustment is the REC BIAS ADJ control R125. The incoming teletypewriter signal from a distant station whose transmit bias was adjusted beforehand is required. Request the distant operator to hold down the space bar. Rotate the REC BIAS ADJ control both ways until the teletype printer ceases to space or starts to print. Note these two positions of the REC BIAS ADJ control and set the control midway between them. In some cases, it will be difficult to adjust the REC BIAS ADJ control because the printer will space accurately throughout the range of the control. The remedy for this condition is to throw off the teletype printer orientation slightly towards both sides, thereby increasing the amount of bias introduced. Then repeat the procedure outlined above.

LUBRICATION. There are no moving parts in this equipment which require lubrication. The slides operate on ball bearings and should require no care.

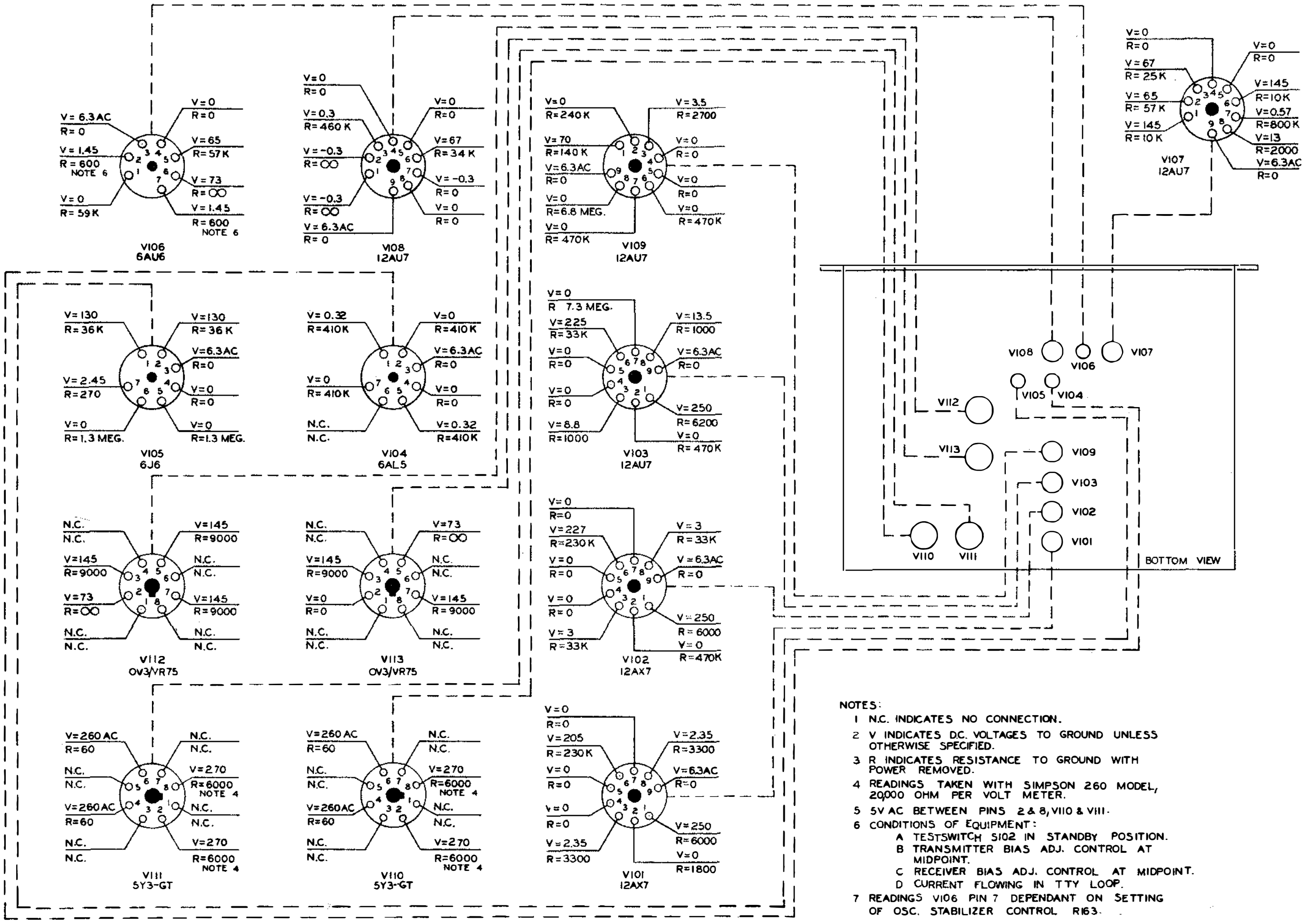
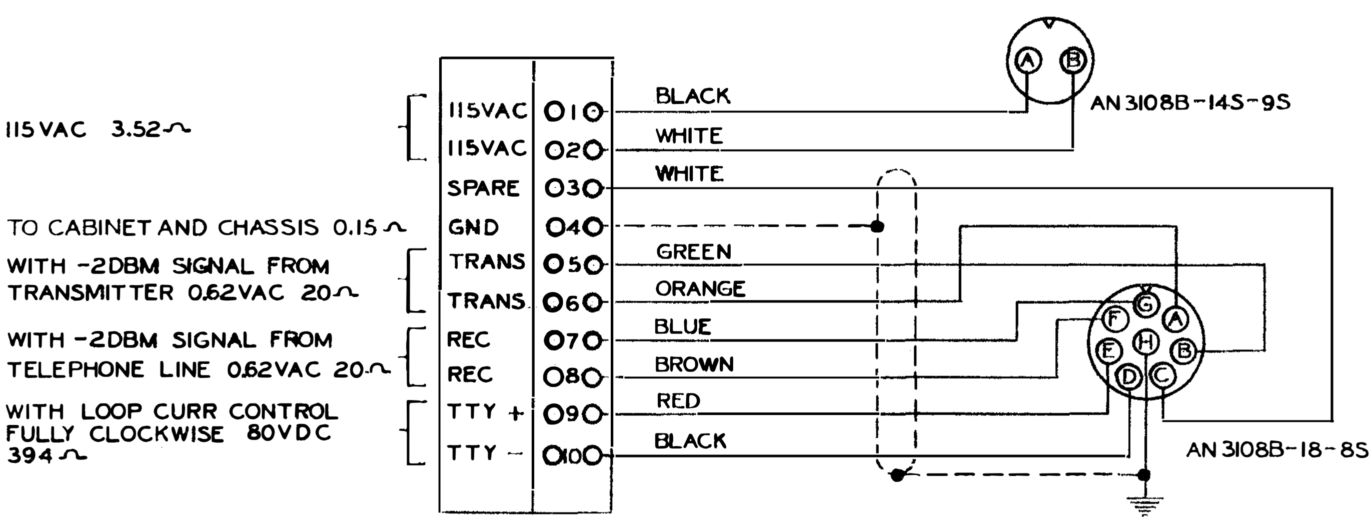


Figure 5—5. Tube Voltage and Resistance Chart



NOTES:

1. EXTERIOR WIRING CONNECTED TO ALL TERMINAL.
2. OPEN CIRCUIT BETWEEN GND. TERMINAL AND ALL OTHER TERMINALS.
3. POWER ON FOR VOLTAGE MEASUREMENTS ONLY.

Figure 5—6. Voltage and Resistance Diagram, Terminal Strip and Cable

TABLE 5—2. TROUBLE SHOOTING CHART

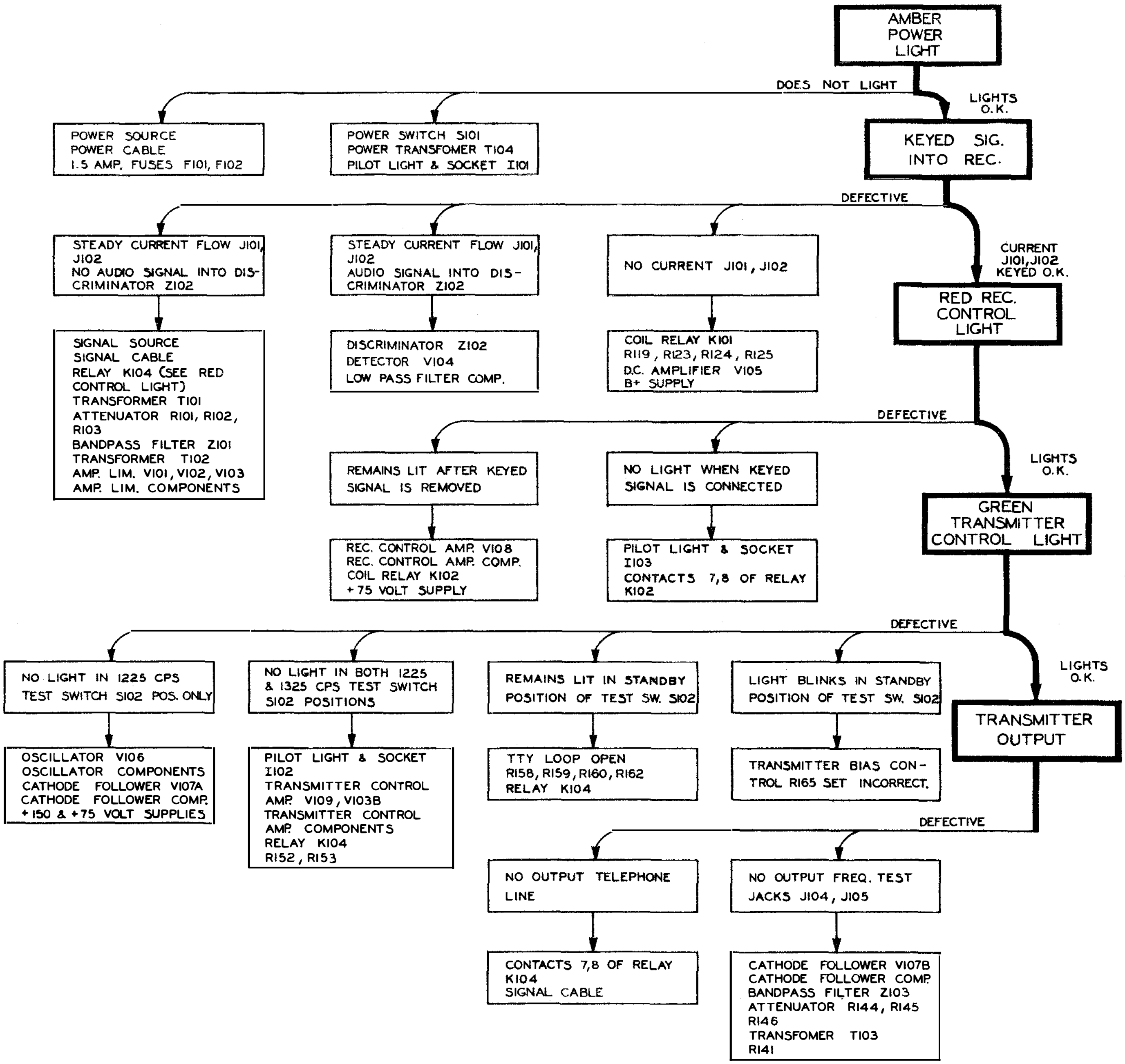


TABLE 5—3. WINDING DATA

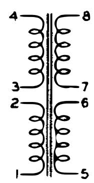
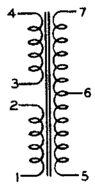
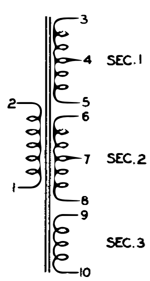
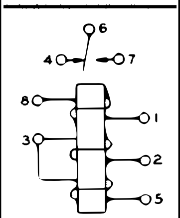
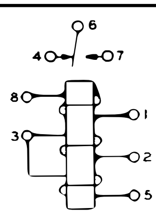
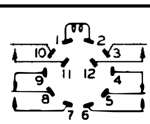
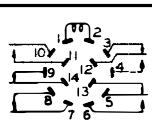
SYMBOL	BOEHME No.	DIAGRAM	WINDING	WIRE SIZE	TURNS	D.C. RES.	IMP. RATIO	HI-V INSUL	REMARKS
L-101	6-C-170		Grouped Single			48			Inductance 2.5 MH Hermetically Sealed.
L-102	6-C-169		Single	#31E	5,040	360		1000V	Inductance 30H at 80 ma. Hermetically Sealed.
T-101 T-103	6-C-166		Split Primary 1-2 3-4 Split Secondary 5-6 7-8	 #33E #33E #33E #33E	 250 250 250 250	 10 10 10 10	1:1	500V	600 ohm line to 600 ohm line. Hermetically Sealed. ± 1DB at 300 — 10,000 cycles.
T-102	6-C-167		Split Primary 1-2 3-4 Center Tapped Secondary	 #31E #31E #42E	 192 192 5,800	 6 6 1,800	1:15	500V	600 ohm line to 135K ohm grid. Hermetically Sealed.
T-104	6-C-168		Primary Sec. 1 Sec. 2 Sec. 3	#22E #31E #16E #16E	346 1,580 16 20	3.52 110 1.54 .11		1600V	Primary 115V 50/60 cycle ± 10%. 500V CT 125 ma. 5V CT 4 amps. 6.3V 4 amps. Hermetically Sealed.
K-101	6-C-161		Differential Winding 1-8 Winding 2-3 Winding 3-5	 #42E #44E #44E	 10,000 10,000 1,500	 3,100 3,100 400		 500V 500V 500V	Hermetically Sealed. Plugs into octal socket.
K-103	6-C-162		Differential Winding 1-8 Winding 2-3 Winding 3-5	 #35E #37E #37E	 2,375 2,575 350	 150 150 20		 500V 500V 500V	Hermetically Sealed. Plugs into octal socket.
K-102	6-C-159		Single	#46E	41,300	20,000		500V	Receive relay contacts 1A 2B 2C. Hermetically Sealed.
K-104	6-C-160		Single	#46E	41,300	20,000		500V	Transmit relay contacts 2A 2C. Hermetically Sealed.

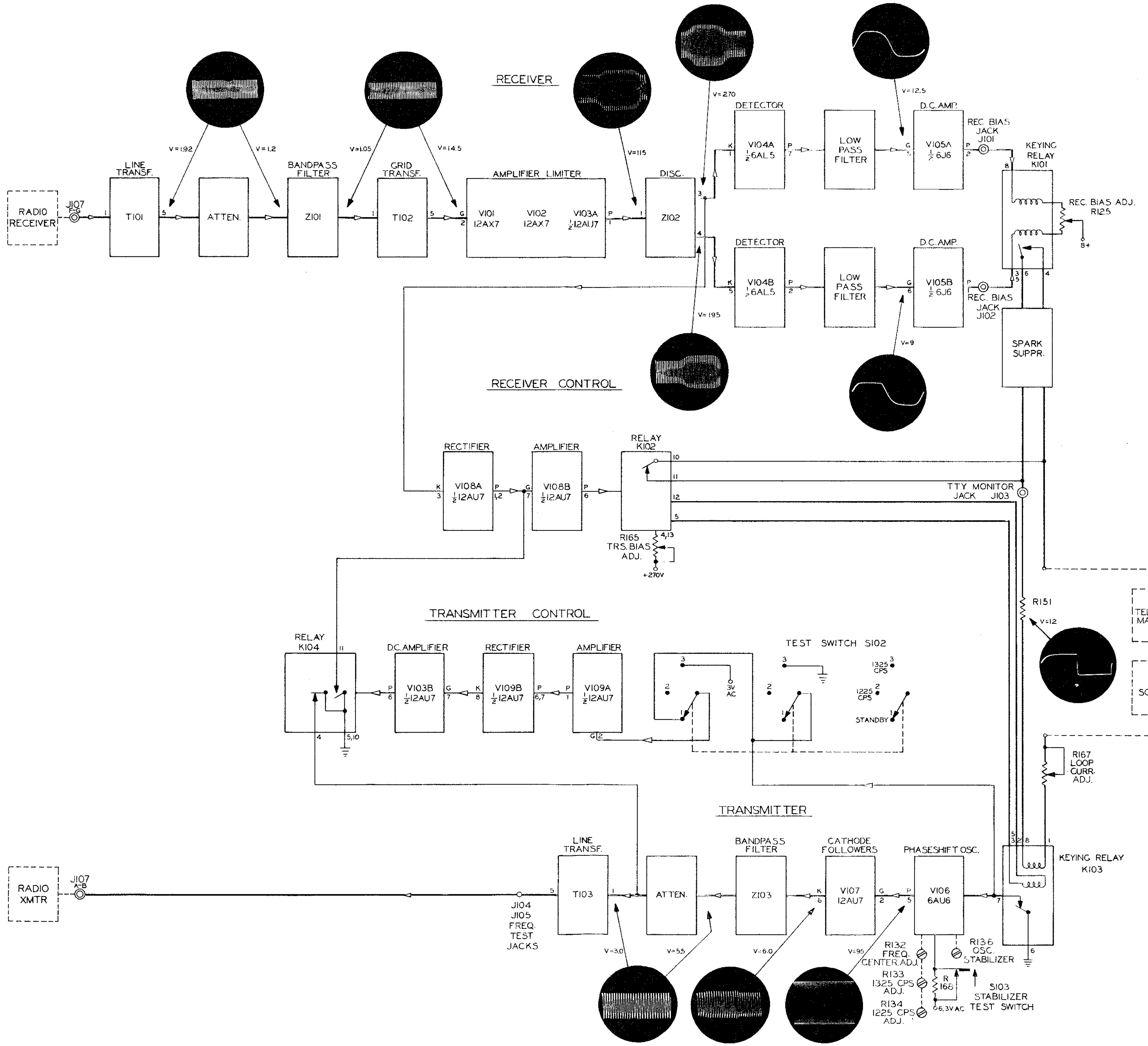
TABLE 5—4. TUBE CHARACTERISTICS

TUBE TYPE	FILA-MENT VOLT. (V)	FILA-MENT CURR. (A)	PLATE VOLT. (V)	GRID BIAS (V)	SCREEN VOLT. (V)	PLATE CURR. (Ma)	SCREEN CURR. (Ma)	AC PLATE RES. (Ohms)	AMP FACT. (Mu)	TRANSCON-DUCTANCE (MICROMHOS) Nor-mal	Mini-mum	EMISSION Is (Ma)	Test Volts
OA3/ VR75			75			5 to 40							
5Y3	5.0	2.0	#1			#1						125 #2	75
6AL5	6.3	.30	150			9.0						40 #2	10
6AU6	6.3	.30	250	1.0	150	10.8	4.3	2 meg.		5200	4150	60	20
12AU7 #3	12.6 6.3	.15 .30	250	−8.5		10.5		7700	17	2200	1750	70	30
12AX7 #3	12.6 6.3	.15 .30	250	2		1.2			100	1650	1250	55	30

#1 For condenser input filter; 350 AC volts (RMS) per plate; 125 ma DC output current.
#2 Each diode.
#3 Each triode.

TABLE 5—5. TUBE OPERATING VOLTAGES AND CURRENTS

TUBE	TYPE	FUNCTION	PLATE (E)	PLATE (Ma)	SCREEN (E)	SCREEN (Ma)	SUPP (E)	CATHODE (E)	GRID (E)	HEATER (E) AC
V-101A	12AX7	AMP-LIM	250	0.5				2.35	0	6.3
V-101B	12AX7	AMP-LIM	205	0.2				2.35	0	6.3
V-102A	12AX7	AMP-LIM	250	0.1				3	0	6.3
V-102B	12AX7	AMP-LIM	227	0.04				3	0	6.3
V-103A	12AU7	AMP	250	8.8				8.8	0	6.3
V-103B	12AU7	Transmit Control Amp.	225	2.3				13.5	0	6.3
V-104A	6AL5	Detector	0					.32		6.3
V-104B	6AL5	Detector	0					.32		6.3
V-105A	6J6	DC AMP	130	4.7				2.45	0	6.3
V-105B	6J6	DC AMP	130	4.7				2.45	0	6.3
V-106	6AU6	Oscillator	65	1.8	73	0.7	1.45	1.45	0	6.3
V-107A	12AU7	Cathode Follower	145	2.7				67	65	6.3
V-107B	12AU7	Cathode Follower	145	6.5				13	.57	6.3
V-108A	12AU7	Receive Control Amp.	−0.3	0				.3	.3	6.3
V-108B	12AU7	Receive Control Amp.	67	7.9				0	.3	6.3
V-109A	12AU7	Transmit Control Amp.	70	1.6				3.5	0	6.3
V-109B	12AU7	Transmit Control Amp.	0	0				0	0	6.3
V-110	5Y3GT	Rectifier	250AC	85						5.0
V-111	5Y3GT	Rectifier	250AC	85						5.0
V-112	OA3/ VR75	Voltage Regulator	75	5 to 40						
V-113	OA3/ VR75	Voltage Regulator	75	5 to 40						



NOTES

1 HEAVY LINES INDICATE MAIN CIRCUIT.
2 LIGHT LINES INDICATE AUXARY CIRCUIT.
3 VARIABLE CONTROLS ARE SHOWN SCHEMATICALLY OR INDICATED BY "SCREW DRIVER ADJ." SYMBOL.
4 LETTERS AND NUMBERS OUTSIDE BLOCKS INDICATE TUBE ELEMENTS AND PIN NUMBERS.
5 WAVE FORMS AS SHOWN ARE FROM PHOTOGRAPHS AS THEY APPEAR ON DUMONT 5" OSCILLOSCOPE TYPE 304-A.
6 ARROWS FROM WAVE FORMS INDICATE CIRCUIT POINT WHERE OSCILLOSCOPE WAS CONNECTED.
7 SYMBOL PLACED NEAR WAVE: V= PEAK TO PEAK VOLT.
8 TEST PATTERN OBSERVED WHEN SQUARE WAVE KEYED EITHER REMOTE TRANSMITTER FEEDING INTO LOCAL RECEIVER OR LOCAL TRANSMITTER DIRECTLY.
9 WAVE FORMS AND VOLTAGES AS SHOWN WHEN:
   KEYING FREQ. = 23 CPS
   INPUT INTO RECEIVER = 0 DBM
10 SWITCHES AND RELAYS SHOWN IN STANDBY CONDITION.

Figure 5–7. Servicing Block Diagram

Figure 5–7. Servicing Block Diagram

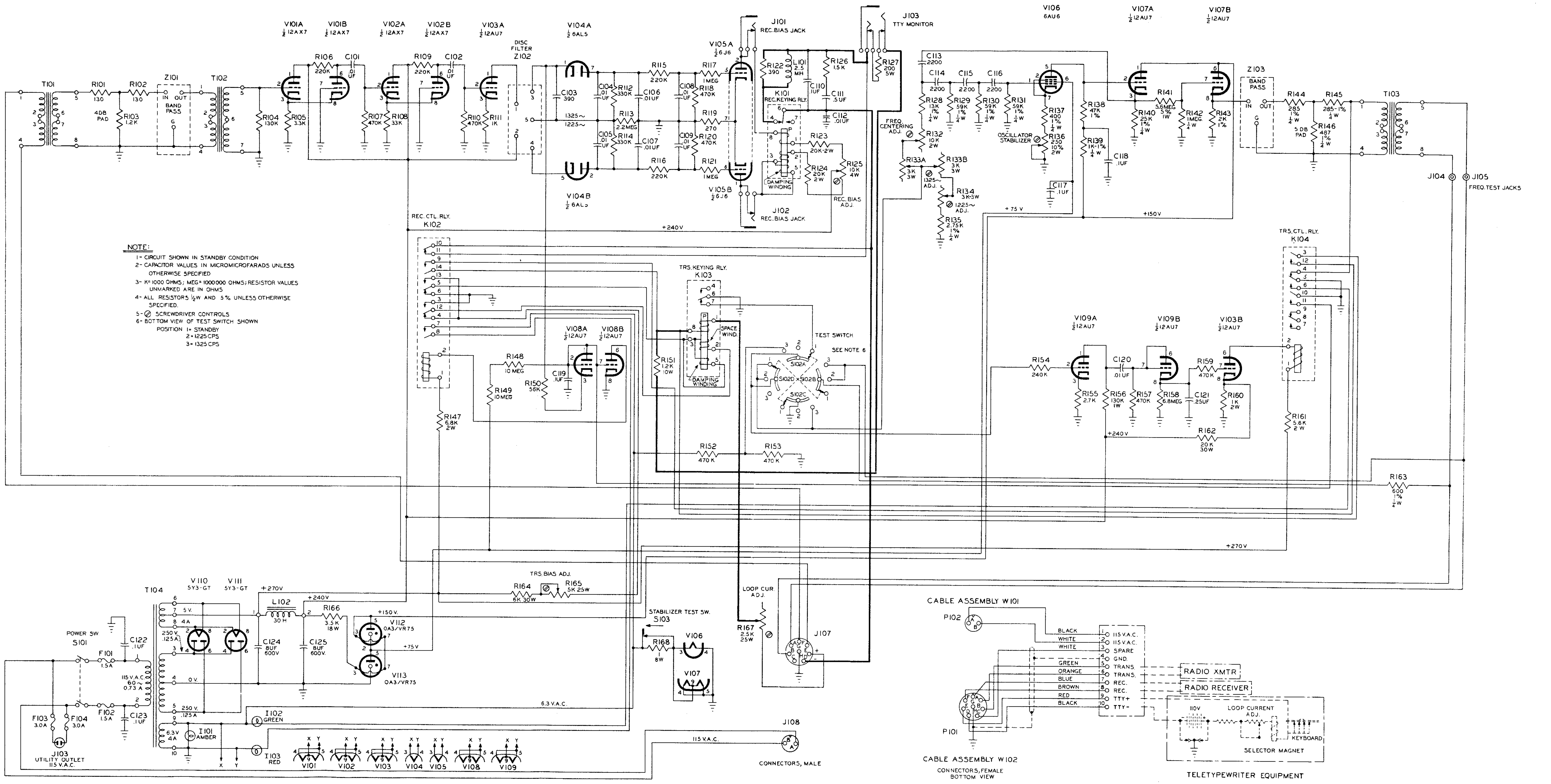


Figure 5–8. System Schematic

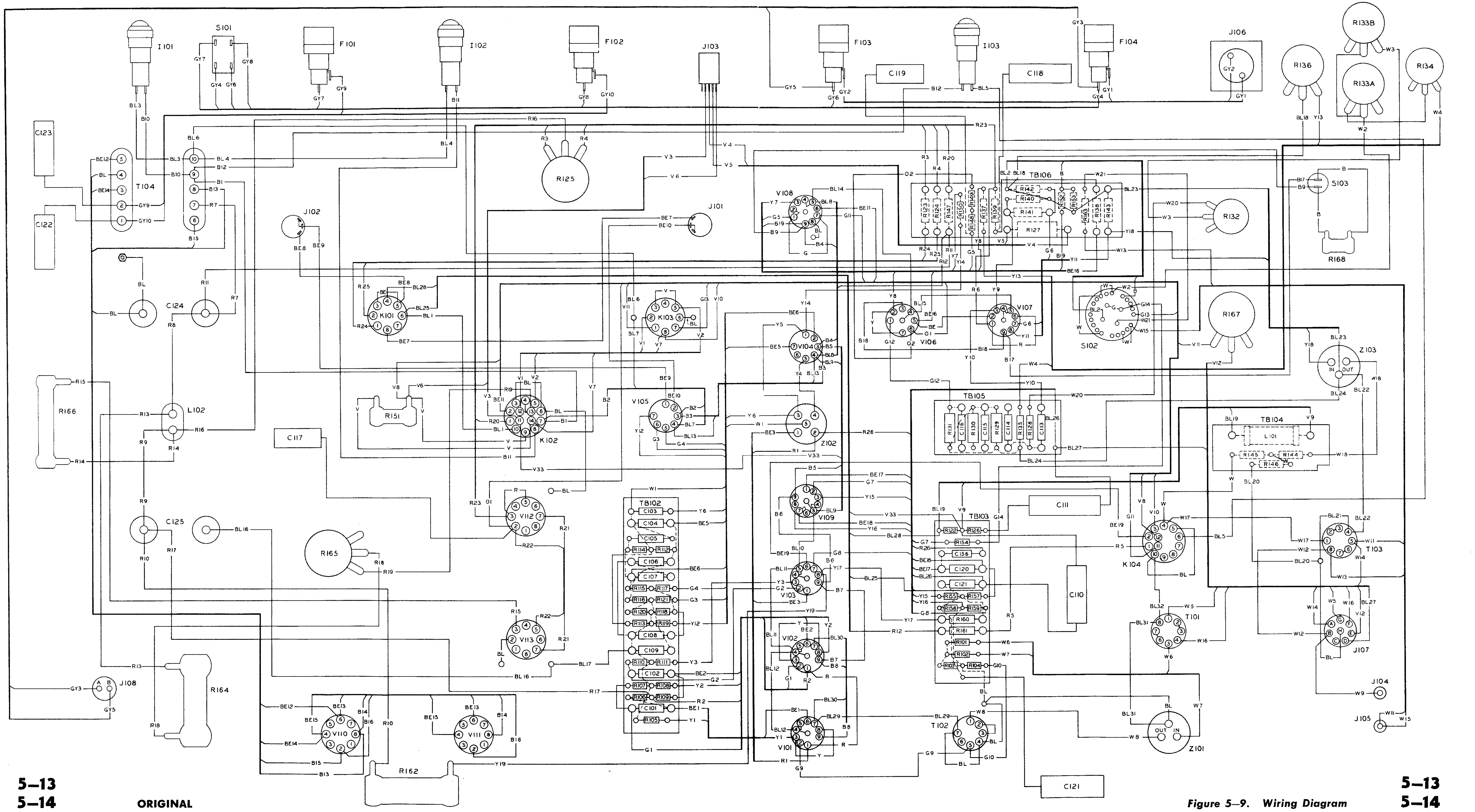


Figure 5–9. Wiring Diagram

Figure 5–9. Wiring Diagram

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SECTION 6
PARTS LISTS

LIST OF TABLES

TABLE 6—1. WEIGHTS AND DIMENSIONS OF EQUIPMENT MAINTENANCE PARTS BOX

EQUIPMENT MAINTENANCE PARTS					
SPARE PARTS BOX	OVERALL DIMENSIONS			VOL-UME	WT.
	HT.	WIDTH	DEPTH		
1	6	12	9	0.4	33

Unless otherwise stated, dimensions are inches, volume cubic feet, weight pounds.

TABLE 6–2. TABLE OF REPLACEABLE PARTS

SYMBOL DESIG.	NAME OF PART AND DESCRIPTION	FUNCTION	MIL/JAN TYPE NO.	NAVY STANDARD STOCK NO.	MFR. AND MFR'S. DESIG.	CON-TRACTOR DWG. AND PART NO.	ALL SYMBOL DESIG. INVOLVED	TOTAL NO. PER EQUIP.
A-101	MOUNT, VIBRATION: rubber cushion plate mounted; sq. mtg. 33-50 lbs; 3" dia. x 1½" high x 3" sq. base; ⅜-16 tapped core; four .266 diam. mtg. holes on 2½" sq. centers.	Isolates cabinet from shock		N17-M-75228-6690	CAYU C2060-T6	6-C-214	A-101 A-102 A-103 A-104	4
A-102	Same as A-101	Isolates cabinet from shock						
A-103	Same as A-101	Isolates cabinet from shock						
A-104	Same as A-101	Isolates cabinet from shock						
C-101	CAPACITOR, fixed, mica: .01 mfd. ±5%; 300 vdcw.	Plate coupling for V-101B	CM35E103J	N16-C-33617-4758	CD	6-C-100	C-101 C-102 C-104 C-105 C-106 C-107 C-108 C-109 C-112 C-120	10
C-102	Same as C-101	Plate coupling for V-102B						
C-103	CAPACITOR, fixed, mica: 390 mmfd. ±1%; 500 vdcw.	Discriminator tuning	For replacement use CM20D391G	For replacement use SNSN N16-C-29893-2126	CMF	6-C-101	C-103	1
C-104	Same as C-101	P/O Low pass filter						
C-105	Same as C-101	P/O Low pass filter						
C-106	Same as C-101	P/O Low pass filter						
C-107	Same as C-101	P/O Low pass filter						
C-108	Same as C-101	P/O Low pass filter						
C-109	Same as C-101	P/O Low pass filter						
C-110	CAPACITOR, fixed, paper tubular, metal encased; .1 mfd. ±20%; 600 vdcw.	P/O Keying filter for K-101	CP29A1EF104M	For replacement use SNSN N16-C-45777-3316	CD	6-C-102	C-110	1
C-111	CAPACITOR, fixed, paper tubular, metal encased; .5 mfd. ±10%; 600 vdcw.	P/O Keying filter for K-101	CP29A1EF504K	N16-C-47297-6465	CD	6-C-103	C-111	1
C-112	Same as C-101	P/O Keying filter for K-101						
C-113	CAPACITOR, fixed, mica; 2200 mmfd. ±1%; 500 vdcw.	P/O Oscillator phase shift network		N16-C-31897-1610	CMF	6-C-104	C-113 C-114 C-115 C-116	4

TABLE 6–2. TABLE OF REPLACEABLE PARTS

SYMBOL DESIG.	NAME OF PART AND DESCRIPTION	FUNCTION	MIL/JAN TYPE NO.	NAVY STANDARD STOCK NO.	MFR. AND MFR'S. DESIG.	CON-TRACTOR DWG. AND PART NO.	ALL SYMBOL DESIG. INVOLVED	TOTAL NO. PER EQUIP.
C-114	Same as C-113	P/O Oscillator phase shift network						
C-115	Same as C-113	P/O Oscillator phase shift network						
C-116	Same as C-113	P/O Oscillator phase shift network						
C-117	CAPACITOR, fixed, paper tubular; metal encased; .1 mfd. ±20%; 200 vdcw.	Screen by-pass for V-106	CP29A2EC104M	N16-C-45803-4128	CD	6-C-105	C-117 C-118	2
C-118	Same as C-117	Plate decoupling for V-106						
C-119	CAPACITOR, fixed, paper tubular; metal encased; .1 mfd. ±10%; 200 vdcw.	Time delay for V-108A	CP29A2EC104K	N16-C-45770-2670	CD	6-C-106	C-119	1
C-120	Same as C-101	Plate coupling for V-109A						
C-121	CAPACITOR, fixed, paper tubular; metal encased; .25 mfd. ±10%; 200 vdcw.	Time delay for V-109B	CP29A2EC254K	For replacement use SNSN N16-C-46340-4626	CD	6-C-107	C-121	1
C-122	CAPACITOR, fixed, paper tubular; metal encased; .1 mfd. +40%, −15%; 600 vdcw.	AC line filter	CP29A2EF104X	For replacement use SNSN N16-C-45777-2866	CD	6-C-108	C-122 C-123	2
C-123	Same as C-122	AC line filter						
C-124	CAPACITOR, fixed, paper, metal encased; 8 mfd. ± 10%; 600 vdcw.	DC filter	CP70E1DF805K	N16-C-51478-2089	CAW 609MSB	6-C-109	C-124 C-125	2
C-125	Same as C-124	DC filter						
E-101	SHIELD, electron tube; 9 pin miniature.	For V-101	TS103U02	N16-S-34576-6514	CHS V24-5056	6-C-183	E-101 E-102 E-103 E-107 E-108 E-109	6
E-102	Same as E-101	For V-102						
E-103	Same as E-101	For V-103						
E-104	SHIELD, electron tube; 7 pin miniature, 1⅜" high.	For V-104	TS102U01	N16-S-34520-3864	CHS V24-5017	6-C-184	E-104	1
E-105	SHIELD, electron tube; 7 pin miniature, 1¾" high.	For V-105	TS102U02	N16-S-34557-8351	CHS V24-5018	6-C-185	E-106 E-105	2
E-106	Same as E-105	For V-106						
E-107	Same as E-101	For V-107						
E-108	Same as E-101	For V-108						

E-109	Same as E-101	For V-109						
E-110	FUSE HOLDER; water tight; for 3AG fuse.	For F-101		N17-F-74266-9084	CLF 342006	6-C-194	E-110 E-111 E-112 E-113	4
E-111	Same as E-110	For F-102						
E-112	Same as E-110	For F-103						
E-113	Same as E-110	For F-104						
E-114	FUSE MOUNTS; for 2 spare size 3AG fuses; XXP material.	Hold spare fuses.		Low Failure item if required requisition from ESO referencing NavShips 900, 180A	CJC S-5169	6-C-193	E-114	1
E-115	KNOB, pointer; double Allen set screw, brass insert.	For rotary switch S-102.		For replacement use SNSN N16-K-700065-701	CAUP S-292-3L-BB-DD	6-C-199	E-115	1
F-101	FUSE, cartridge; 1.5 amp., 3AG size; 1 Time, glass body.	Power fuse	FO 4	G17-F-16302-90	CLF 31201.5	6-C-191	F-101 F-102	3
F-102	Same as F-101	Power fuse						
F-103	FUSE, cartridge; 3 amp., 3AG size, 1 Time, glass body.	Utility outlet fuse	FO 4	G17-F-16302-120	CLF 312003	6-C-192	F-103 F-104	3
F-104	Same as F-103	Utility outlet fuse						
H-101	CLAMP, electrical; SS.; tension lock type; 1¼" dia. x ¾" high.	Clamp for V-110		N16-C-300798-621	CAIS 926B1	6-C-187	H-101 H-102	2
H-102	Same as H-101	Clamp for V-111						
H-103	CLAMP, electrical; SS.; tension lock type; 1$\frac{5}{32}$" dia. x ¾" high.	Clamp for V-112		N16-C-300798-452	CAIS 926A	6-C-186	H-103 H-104	2
H-104	Same as H-103	Clamp for V-113						
H-105	CLAMP, electrical; alum. cad. pl., $\frac{15}{16}$ dia. x 1$\frac{5}{64}$ lg., ¾-20 thread, 2 bolts, ½" max. OD; p/o W-101.	Clamp for W-101	AN3057-6	N17-C-781366-251	CPH	6-C-208	H-105	1
H-106	CLAMP, electrical; alum. cad. pl., 1$\frac{3}{16}$ dia. x 1⅛ lg., 1-20 thread, 2 bolts, ¾" max. OD; p/o W-102.	Clamp for W-102.	AN3057-10	N17-C-781444-634	CPH	6-C-209	H-106	1
H-107	COVER AND CHAIN; cover for convenience outlet.	Cover for utility outlet J-106		Low Failure item if required requisition from ESO referencing NavShips 900,180A	CPH 9760-22	6-C-211	H-107	1
H-108	WRENCH, Allen set screw, "L" shaped; for #8 Allen head set screw; 2" long x $\frac{11}{16}$".	For knob set screws		G41-W-2446-2	CAYT Code 564	6-C-213	H-108	1
I-101	LAMP, incandescent; miniature, 6-8 volt .25 amp., T-3¼ bayonet base.	Power indicator		N17-L-6305-46	CAYZ 44	6-C-200	I-101 I-102 I-103	3
I-102	Same as I-101	Receive indicator						
I-103	Same as I-101	Transmit indicator						
J-101	JACK, telephone.	Receive bias jack for V-105A	JJ089	N17-J-39253-3043	CBIM C-12A	6-C-197	J-101 J-102	2

TABLE 6–2. TABLE OF REPLACEABLE PARTS

SYMBOL DESIG.	NAME OF PART AND DESCRIPTION	FUNCTION	MIL/JAN TYPE NO.	NAVY STANDARD STOCK NO.	MFR. AND MFR'S. DESIG.	CON-TRACTOR DWG. AND PART NO.	ALL SYMBOL DESIG. INVOLVED	TOTAL NO. PER EQUIP.
J-102	Same as J-101	Receive bias jack for V-105B.						
J-103	JACK, telephone.	TTY monitor jack	JJ101	N17-J-39527-8576	CMA	6-C-195	J-103	1
J-104	CONNECTOR, receptacle; green; center contact heat treated; beryllium copper, silver plate; 61/64 long overall; nylon insulator.	Frequency test jack		N17-P-84976-2016	CUF 119052-E	6-C-196	J-104 J-105	2
J-105	Same as J-104	Frequency test jack						
J-106	CONNECTOR, receptacle, convenience outlet; alum. shell, 1⅝″ sq. x 9/16 deep, 125v-15A.	Utility outlet		N17-C-73139-7615	CPH 97-4085	6-C-210	J-106	1
J-107	CONNECTOR, box receptacle; solid shell, chassis mounting, male insert 1 #12, 7 #16 conductors.	Signal circuits receptacle	AN3102A 18-8P	N17-CO72627-3517	CPH	6-C-205	J-107	1
J-108	CONNECTOR, receptacle, box; solid shell, chassis mounting, male insert, 2 #16 conductors.	Power receptacle	AN3102A 14S-9P	N17-C-72596-2880	CPH	6-C-204	J-108	1
K-101	RELAY; high speed, polar, SPDT, hermetically sealed; coil resistance 3100 ohms; trip current one winding .15 to .50 ma DC.	Receiver keying relay		N17-R-64681-3951	CSI 7JOZ3100T	6-C-161	K-101	1
K-102	RELAY; silver contacts; contact arrangement 1A, 2B, 2C; coil resistance 20,000 ohms ± 10%; #46 wire; pull in 5.4 to 6.6 ma DC. drop out 2.25 to 2.75 ma DC.	Receive control relay		N17-R-65591-5221	CARE MH5021-1	6-C-159	K-102	1
K-103	RELAY; high speed, polar, SPDT, hermetically sealed; coil resistance 150 ohms; trip current one winding .63 to 2.1 ma DC.	Transmit Keying relay		N17-R-64646-4091	CSI 7JOZ150T	6-C-162	K-103	1
K-104	RELAY; silver contacts; contact arrangement 2A, and 2C; coil resistance 20,000 ohms ±10%; pull in 5.4 to 6.6 ma DC; drop out 2.25 to 2.75 ma DC.	Transmit control relay		N17-R-65591-6758	CARE MH5022	6-C-160	K-104	1
L-101	COIL, choke; 2.5 mh ±5%; hermetically sealed.	P/O Keying filter for K-101		N16-C-74704-2652	CSM 219	6-C-170	L-101	1
L-102	REACTOR, filter choke; 30 henries, 80 ma, 360 ohms.	DC filter		N16-R-29450-3992	CFX 25624	6-C-169	L-102	1
P-101	CONNECTOR, plug, angle; split shell; female, 2 contacts.	P/O W-101	AN3108B 14S-9S	N17-C-70032-2875	CPH	6-C-206	P-101	1
P-102	CONNECTOR, plug, angle; split shell; female, 8 contacts.	P/O W-102	AN3108B 18-8S	N17-CO70063-3517	CPH	6-C-207	P-102	1
R-101	RESISTOR; fixed, composition; 130 ohms ½ w. ±5%.	P/O Input pad	RC20GF131J	N16-R-49606-438	CBZ	6-C-110	R-101 R-102	2
R-102	Same as R-101	P/O Input pad						
R-103	RESISTOR; fixed, composition; 1200 ohms ½ w. ± 5%.	P/O Input pad	RC20GF122J	N16-R-49939-271	CBZ	6-C-111	R-103	1

R-104	RESISTOR; fixed, composition; 130,000 ohms ½ w. ±5%.	Grid resistor, V-101A	RC20BF134J	N16-R-50659-431	CBZ	6-C-112	R-104	1
R-105	RESISTOR; fixed, composition; 3300 ohms ½ w. ± 5%.	Cathode bias V-101	RC20GF332J	N16-R-50065-438	CBZ	6-C-120	R-105	1
R-106	RESISTOR; fixed, composition; 220,000 ohms ½ w. ±5%.	Plate load V-101B	RC20BF224J	N16-R-50713-431	CBZ	6-C-115	R-106 R-109	2
R-107	RESISTOR; fixed, composition; 470,000 ohms ½ w. ±5%.	Grid resistor V-102A	RC20BF474J	N16-R-50821-431	CBZ	6-C-113	R-107 R-110 R-118 R-120	4
R-108	RESISTOR; fixed, composition; 33,000 ohms ½ w. ±5%.	Cathode bias V-102	RC20GF333J	N16-R-50416-435	CBZ	6-C-121	R-108	1
R-109	Same as R-106	Plate load V-102B						
R-110	Same as R-107	Grid resistor V-103A						
R-111	RESISTOR; fixed, composition; 1000 ohms ½ w. ±5%.	Cathode bias V-103A	RC20BF102J	N16-R-49921-431	CBZ	6-C-117	R-111	1
R-112	RESISTOR; fixed, composition; 330,000 ohms ½ w. ±5%.	P/O Low pass filter	RC20BF334J	N16-R-50758-431	CBZ	6-C-119	R-112 R-114	2
R-113	RESISTOR; fixed, composition; 2.2 megohms ½ w. ±5%.	P/O Low pass filter	RC20GF225J	N16-R-51064-435	CBZ	6-C-122	R-113	1
R-114	Same as R-112	P/O Low pass filter						
R-115	RESISTOR; fixed, composition; 220,000 ohms ½ w. ±5%.	P/O Low pass filter	RC20GF224J	N16-R-50713-380	CBZ	6-C-116	R-115 R-116	2
R-116	Same as R-115	P/O Low pass filter						
R-117	RESISTOR; fixed, composition; 1 megohm ½ w. ±5%.	Grid series limiting for V-105A	RC20GF105J	N16-R-50974-438	CBZ	6-C-123	R-117 R-121	2
R-118	Same as R-107	Grid resistor V-105A						
R-119	RESISTOR; fixed, composition; 270 ohms ½ w. ±5%.	Cathode bias V-105	RC20GF271J	N16-R-49687-321	CBZ	6-C-124	R-119	1
R-120	Same as R-107	Grid resistor V-105B						
R-121	Same as R-117	Grid series limiting V-105B						
R-122	RESISTOR; fixed, composition; 390 ohms ½ w. ±5%.	P/O Keying filter, K-101	RC20GF391J	N16-R-49732-438	CBZ	6-C-125	R-122	1
R-123	RESISTOR; fixed, composition; 20,000 ohms 2 w. ±5%.	Plate current limiting V-105A	RC42GF203J	N16-R-50363-138	CBZ	6-C-131	R-123 R-124	2
R-124	Same as R-123	Plate current limiting V-105B						
R-125	RESISTOR; variable, wire wound; with lock bushing 3/8" -32 P. NEF—2 thd. 10,000 ohms 4 w. ±10%, bushing slots 3/16" deep; 1 57/64" dia. including solder lugs x 11/16" deep.	Receiver bias adjustment		N16-R-91291-7992	CTC Type 25	6-C-151	R-125	1
R-126	RESISTOR; fixed, composition; 1500 ohms ½ w. ±5%.	P/O Keying filter K-101	RC20GF152J	N16-R-49966-433	CBZ	6-C-126	R-126	1

TABLE 6—2. TABLE OF REPLACEABLE PARTS

SYMBOL DESIG.	NAME OF PART AND DESCRIPTION	FUNCTION	MIL/JAN TYPE NO.	NAVY STANDARD STOCK NO.	MFR. AND MFR'S. DESIG.	CON-TRACTOR DWG. AND PART NO.	ALL SYMBOL DESIG. INVOLVED	TOTAL NO. PER EQUIP.
R-127	RESISTOR; fixed, wire wound; 200 ohms 5 w. ±5%.	TTY Monitor resistor	RW55J201	For replacement use SNSN N16-R-68366-5446	COM	6-C-155	R-127	1
R-128	RESISTOR; fixed film, high stability, hermetically sealed, ¾" long x 3/16" dia.; .016 leads 1⅜" lg.; 13,000 ohms ¼ w. ±1%.	P/O Oscillator phase shift network		N16-R-73099-8001	AA DC ¼ HC	6-C-136	R-128	1
R-129	RESISTOR; fixed, wire wound; accurate, hermetically sealed, non-inductive, ⅜" dia. x 1 3/32" lg. #20 leads, 59,000 ohms ¼ w. ± 1%.	P/O Oscillator phase shift network		N16-R-80431-4190	NS6A AP	6-C-137	R-129 R-130 R-131	3
R-130	Same as R-129	P/O Oscillator phase shift network						
R-131	Same as R-129	P/O Oscillator phase shift network						
R-132	RESISTOR; variable, wire wound; 10,000 ohms 2 w. ±10%; with lock bushing ⅜"-32 pitch NEF-2 thread slots 3/16" deep; 1 41/64" dia. including solder lugs x ⅝" deep.	Frequency centering adjustments		N16-R-91291-4916	CTC Type 252	6-C-150	R-132	1
R-133A and R-133B	RESISTOR; variable, wire wound, with ⅜" lock bushing, 2 sections, each 3000 ohms 3 w. ±5%; 3 solder lugs each section; enclosed molded anti-fungus phenolic case with cad. pl. brass end plates; 1⅞" dia. x 1 17/32" deep; ½" shaft with screw driver slot; standard torque, no switch, linear taper.	1325 cycle oscillator frequency adjustment		N16-R-92502-9901	CDJ L402	6-C-148	R-133A R-133B	1
R-134	RESISTOR; variable, wire wound, with ⅜" lock bushing. 3 solder lugs, enclosed phenolic case with brass, cad. pl. end plates, 1⅞" dia. x 29/32" deep; ½" shaft with screwdriver slot: standard torque, no switch, linear taper, standard 300 degree rotation; 3000 ohms 3 w. ±5%.	1225 cycle oscillator frequency adjustment		N16-R-90897-8126	CDJ L400	6-C-149	R-134	1
R-135	RESISTOR; fixed film, high stability; hermetically sealed, ¾" long x 3/16" dia.; .016 leads 1⅜ lg.; 2750 ohms ¼ w. ±1%.	P/O Oscillator phase shift network		N16-R-73021-9135	AA DC ¼ HC	6-C-138	R-135	1
R-136	RESISTOR; variable, wire wound, with ⅜" lock bushing, 32 pitch NEF-2 thd.; 250 ohms 2 w. ±10%.	Oscillator stabilizer		N16-R-90331-4402	CTC 252	6-C-217	R-136	1
R-137	RESISTOR; fixed film, high stability; hermetically sealed, ¾" long x 3/16" dia.; .016 leads 1⅜ lg.; 400 ohms ¼ w. ±1%.	P/O Cathode bias V-106		N16-R-72943-8021	AA DC ¼ HC	6-C-139	R-137	1
R-138	RESISTOR; fixed film, high stability; hermetically sealed, 1" long x 9/32" dia.; .032 leads 1⅜ lg.; 47,000 ohms ½ w. ±1%.	Plate load V-106		N16-R-73328-2788	AA DC ½ HC	6-C-140	R-138	1

R-139	RESISTOR; fixed film, high stability; hermetically sealed, ¾" long x 3/16" dia.; .016 leads 1⅜ lg.; 1000 ohms ¼ w. ±1%.	Plate decoupling V-106		N16-R-72993-3726	AA DC ¼ HC	6-C-141	R-139	1
R-140	RESISTOR; fixed film, high stability; hermetically sealed, ¾" long x 3/16" dia.; .016 leads 1⅜ lg.; 25,000 ohms ¼ w. ±1%.	Cathode resistor V-107A		N16-R-73119-7027	AA DC ¼ HC	6-C-142	R-140	1
R-141	RESISTOR; fixed film, high stability; hermetically sealed; 1⅛" long x ⅜" dia.; .032 leads 1⅜" long; 5.6 megohms 1 w. ±5%.	Grid isolating V-107B		N16-R-51208-851	AA DC 1 HC	6-C-171	R-141	1
R-142	RESISTOR; fixed film, high stability; hermetically sealed; ¾" long x 3/16" dia.; .016 leads 1⅜" long; 1 megohm ¼ w. ±5%.	Grid resistor V-107B		N16-R-50974-166	AA DC ¼ HC	6-C-143	R-142	1
R-143	RESISTOR; fixed film, high stability; hermetically sealed; 1" long x 3/32" dia.; .032 leads 1⅜" long; 2000 ohms ½ w. ±1%.	Cathode resistor V-107B		N16-R-73010-9242	AA DC ½ HC	6-C-144	R-143	1
R-144	RESISTOR; fixed film, high stability; hermetically sealed; ¾" long x 3/16" dia.; .016 leads 1⅜" long; 285 ohms ¼ w. ±1%.	P/O Output pad		N16-R-72926-6231	AA DC ¼ HC	6-C-145	R-144 R-145	2
R-145	Same as R-144	P/O Output pad						
R-146	RESISTOR; fixed film, high stability; hermetically sealed; ¾" long x 3/16" dia.; .016 leads 1⅜" long; 487 ohms ¼ w. ±1%.	P/O Output pad		N16-R-72952-4698	AA DC ¼ HC	6-C-146	R-146	1
R-147	RESISTOR; fixed, composition; 6800 ohms 2 w. ± 5%.	Plate current limiting V-108B	RC42GF682J	N16-R-50201-137	CBZ	6-C-132	R-147	1
R-148	RESISTOR; fixed, composition; 10 megohms ½ w. ±5%.	Grid series V-108A	RC20GF106J	N16-R-51325-438	CBZ	6-C-127	R-148 R-149	2
R-149	Same as R-148	Grid series V-108A						
R-150	RESISTOR; fixed, composition; 56,000 ohms ½ w. ±5%.	Cathode series V-108A	RC20GF563J	N16-R-50515-433	CBZ	6-C-128	R-150	1
R-151	RESISTOR; fixed, wire wound; 1200 ohms 10 w. ±5%.	Standby loop current resistor	RW31G122	For replacement use SNSN N16-R-66048-5006	COM	6-C-154	R-151	1
R-152	RESISTOR; fixed, composition; 470,000 ohms ½ w. ±5%.	Filament voltage divider	RC20GF474J	N16-R-50821-276	CBZ	6-C-114	R-152 R-153 R-157 R-159	4
R-153	Same as R-152	Filament voltage divider						
R-154	RESISTOR; fixed, composition; 240,000 ohms ½ w. ±5%.	Grid series V-109A	RC20BF244J	N16-R-50722-431	CBZ	6-C-118	R-154	1
R-155	RESISTOR; fixed, composition; 2700 ohms ½ w. ±5%.	Cathode bias V-109A	RC20GF272J	N16-R-50038-438	CBZ	6-C-129	R-155	1
R-156	RESISTOR; fixed, composition; 130,000 ohms 1 w. ±5%.	Plate load V-109A	RC32GF134J	N16-R-50659-699	CBZ	6-C-133	R-156	1
R-157	Same as R-152	Load resistor V-109B						
R-158	RESISTOR; fixed, composition; 6.8 megohms ½ w. ±5%.	Time delay V-109B	RC20GF685J	N16-R-51244-438	CBZ	6-C-130	R-158	1

TABLE 6—2. TABLE OF REPLACEABLE PARTS

SYMBOL DESIG.	NAME OF PART AND DESCRIPTION	FUNCTION	MIL/JAN TYPE NO.	NAVY STANDARD STOCK NO.	MFR. AND MFR'S. DESIG.	CON-TRACTOR DWG. AND PART NO.	ALL SYMBOL DESIG. INVOLVED	TOTAL NO. PER EQUIP.
R-159	Same as R-152	Grid series V-103B						
R-160	RESISTOR; fixed, composition; 1000 ohms 2 w. ±5%.	P/O Fixed cathode bias V-103B	RC42GF102J	N16-R-49922-112	CBZ	6-C-134	R-160	1
R-161	RESISTOR; fixed, composition; 5600 ohms 2 w. ±5%.	Plate current limiting V-103B	RC42GF562J	N16-R-50165-131	CBZ	6-C-135	R-161	1
R-162	RESISTOR; fixed, wire wound; 20,000 ohms 30 w. ±5%.	P/O Fixed cathode bias V-103B	For replacement use RW34F203 RW34G203 using .00175 wire	For replacement use SNSN N16-R-66480-4051	CSF	6-C-158	R-162	1
R-163	RESISTOR; fixed film, high stability; hermetically sealed; ¾" long x 5/16" dia.; .016 leads 1⅜" long; 600 ohms ¼ w. ±1%.	Transmitter output load		N16-R-72962-3674	AA DC ¼ HC	6-C-147	R-163	1
R-164	RESISTOR; fixed, wire wound; 6000 ohms 30 w. ±5%.	Send bias current limiting resistor	For replacement use RW34F602 RW34G602	For replacement use SNSN N16-R-61983-5335	CSF	6-C-157	R-164	1
R-165	RESISTOR; variable, wire wound; 5000 ohms 25 w. ±10%.	Send bias adjustment	RP101SA502KK	N16-R-91033-7258	COM	6-C-152	R-165	1
R-166	RESISTOR; fixed, wire wound; 3500 ohms 18 w. ±5%.	Voltage regulator series resistor	RW33G352	For replacement use SNSN N16-R-66187-1746	CSF	6-C-156	R-166	1
R-167	RESISTOR; variable, wire wound; 2500 ohms 25 w. ±10%.	Loop current adjustment	RP101SA252KK	N16-R-90870-9193	COM	6-C-153	R-167	1
R-168	RESISTOR; fixed, wire wound; 1 ohm 8 w. ±5%.	Filament voltage dropping resistor	RW30G1RO	N16-R-64972-8327	CSF	6-C-218	R-168	1
S-101	SWITCH; toggle, DPST.	Power switch	ST22K	N17-S-73082-9028	CHH	6-C-163	S-101	1
S-102	SWITCH; rotary; 1 deck A4N3, 4 circuits, 3 position; material LT 4.	Test switch		N17-S-60200-8508	AC Type 2A	6-C-164	S-102	1
S-103	SWITCH; push button; SPST, normally closed, push to open; solder lugs; metal button 24 V DC 17 amps.	Stabilizer test		N17-S-56997-7531	AS #A402L5	6-C-225	S-103	1
T-101	TRANSFORMER; matching line to line, 600 ohm split primary, 600 ohm split secondary.	Input line isolation	TF1A16AJ	N17-T-62667-3051	CFX MGA-4	6-C-166	T-101 T-103	2
T-102	TRANSFORMER; input, 600 ohm split primary, 135,000 ohm center tapped secondary.	Input grid matching	TF1A10AJ	N17-T-61607-1684	CFX MGA-3	6-C-167	T-102	1
T-103	Same as T-101	Output line isolation						
T-104	TRANSFORMER; power; sec. #1 125 ma at 275v; sec. #2 4a at 5v; sec. #3 4a at 6.3v.; input 115 volts 50-60 cycles.	Power		N17-T-74214-7938	CFX 25623	6-C-168	T-104	1

TB-101	TERMINAL BLOCK; molded barrier type; 2 sided screw terminals, cellulose filled plastic.	Cabinet terminal strip	8TB10C	A17-B-77936-7951	CBZG	6-C-190	TB-101	1
TB-102	TERMINAL BOARD; XXX (PBE) material 7 5/16" x 1¾" x ⅛"; silver pld. brass terminals.	C-101 to C-109 R-105 to R-121		Low Failure item if required requisition from ESO referencing NavShips 900, 180A	CHO	6-C-12	TB-102	1
TB-103	TERMINAL BOARD; XXX (PBE) material, 4 9/16 lg. x 1¾ wide x ⅛ thick; using silver plated brass terminals.	For mounting R-101, R-104, R-122, R-126, R-154, R-161, C-112, C-120		Low Failure item if required requisition from ESO referencing NavShips 900, 180A	CHO	6-C-13	TB-103	1
TB-104	TERMINAL BOARD; XXX (PBE) material, 3¾" long x 1½" wide x ⅛" thick; using silver plated brass terminals.	For mounting L-101, R-144, R-145, R-146		Low Failure item if required requisition from ESO referencing NavShips 900, 180A	CHO	6-C-14	TB-104	1
TB-105	TERMINAL BOARD; XXX (PBE) material, 4 1/16" lg. x 1¾" wide x ⅛"; using silver plated brass terminals.	For mounting C-113, C-116, R-128, R-131 and R-135		Low Failure item if required requisition from ESO referencing NavShips 900, 180A	CHO	6-C-15	TB-105	1
TB-106	TERMINAL BOARD; XXX (PBE) material, 6⅞" x 1¾" x ⅛"; silver plated brass terminals.	For mounting R-137, R-143, R-123, R-124, R-128, R-147, R-150, R-152, R-153, R-163		Low Failure item if required requisition from ESO referencing NavShips 900, 180A	CHO	6-C-16	TB-106	1
	PLATE: identification; XXX (PBE) material, 4⅝" lg. x 1 1/16" wide x 3/32 thick; contains lettered information for cabinet terminal board.	Identifies terminals on TB-101		Shop Manufacture	CHO	6-C-21		1
	PLATE; identification; 3" x 2", #20 GA. (B & S), nickel silver.	Unit nameplate		For reference only	CHO	6-C-11		1
V-101	TUBE, electron; 12AX7.	AMP-LIM		N16-T-58241-60	CRV	6-C-173	V-101 V-102	2
V-102	Same as V-101	AMP-LIM						
V-103	TUBE, electron; 12AU7.	(a) Amplifier (b) Transmit control amp		N16-T-58241	CRV	6-C-174	V-103 V-107 V-108 V-109	4
V-104	TUBE, electron; 6AL5.	Detector		N16-T-56195	CRV	6-C-175	V-104	1
V-105	TUBE, electron; 6J6.	Rec. output		N16-T-56360	CRV	6-C-176	V-105	1
V-106	TUBE, electron; 6AU6.	Oscillator		N16-T-56203-50	CRV	6-C-177	V-106	1
V-107	Same as V-103	Cathode follower						
V-108	Same as V-103	Receive control amplifier						
V-109	Same as V-103	Transmit control amplifier						
V-110	TUBE, electron; 5Y3WGT.	Full wave rectifier		N16-T-55738	CRV	6-C-178	V-110 V-111	2

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V-111	Same as V-110	Full wave rectifier						
V-112	TUBE, electron; OA3/VR75.	Voltage regulator		N16-T-53030	CRV	6-C-179	V-112 V-113	2
V-113	Same as V-112	Voltage regulator						
W-101	CABLE ASSEMBLY, power; uses MIL type DCOP-3 cable, 1⅝ ft. long excluding terminations; AN connector AN 3108B 14S-9S on one end; includes W-101A, P-101.	Power cable		Assemble from component parts	CHO	6-C-K	W-101	1
W-102	CABLE ASSEMBLY, teletype; uses MIL type MCOS-7 cable, 1.7 ft. long excluding terminations; connector AN 3108B 18-8S at one end; includes W-102A, P-102.	Signal circuits		Assemble from component parts	CHO	6-C-L	W-102	1
W-101A	CABLE, power, electrical; 2 single conductors.	P/O W-101	DCOP-3	G15-C-10340-125	CARR	6-C-189	W-101A	1
W-102A	CABLE, special purpose, electrical; 7 cond. shielded.	P/O W-102	MCOS-7	GX15-CO10954-0010	CARR	6-C-188	W-102A	1
XI-101	LIGHT, indicator; with lens; ½" dia. amber clear lens; for miniature bayonet base, T-3¼ bulb; 6-8 volt.	Power lamp socket and lens	LH66DA-2	N17-L-76683-2841	CAYZ 93410-133	6-C-203	XI-101	1
XI-101A	LENS, indicator light; amber, ½" dia. unfrosted lens, $\frac{13}{16}$ OD x 1¼ with 27$\frac{11}{16}$ black nickel plated brass, polaroid dimmer cap assembly, screw on type P/O XI-101.	Power lamp lens		For reference only	CAYZ		XI-101A	1
XI-101B	LAMPHOLDER; without lens, miniature bayonet base T-3¼" bulb, enclosed frame, black nickel plated brass, 1$\frac{11}{16}$ lg. x ⅝ dia. mtg. hole, lamp replaceable from front, any mtg. position, two solder lug terminals located at back end; P/O XI-101.	Power lamp socket		For reference only	CAYZ		XI-101B XI-102B XI-103B	3
XI-102	LIGHT, indicator; with lens; ½" dia. red clear lens; for miniature bayonet base, T-3¼ bulb; 6-8 volt.	Receive lamp lens and socket	LH66DR-2	N17-L-76852-3634	CAYZ 93410-131	6-C-201	XI-102	1
XI-102A	LENS, indicator light; red, ½" dia. unfrosted lens, $\frac{13}{16}$ OD x 1¼ with 27$\frac{11}{16}$ black nickel plated brass, polaroid dimmer cap assembly, screw on type P/O XI-102.	Receive lamp lens		For reference only	CAYZ		XI-102A	1
XI-102B	LAMPHOLDER; without lens, miniature bayonet base T-3¼" bulb, enclosed frame, black nickel plated brass, 1$\frac{11}{16}$ lg. x ⅝ dia. mtg. hole, lamp replaceable from front, any mtg. position, two solder lug terminals located at back end; P/O XI-102.	Receive lamp socket		For reference only	CAYZ		XI-102B	1

XI-103	LIGHT, indicator; with lens; ½" dia. green clear lens; for miniature bayonet base, T-3¼ bulb; 6-8 volt.	Transmit lamp lens and socket		N17-L-76770-4964	CAYZ 93410-132	6-C-202	XI-103	1
XI-103A	LENS, indicator light; green, ½" dia. unfrosted lens, 15/16 OD x 1¼ with 27 11/16 black nickel plated brass, polaroid dimmer cap assembly, screw on type; P/O XI-103.	Transmit lamp lens		For reference only	CAYZ		XI-103A	1
XI-103B	LAMPHOLDER; without lens, miniature bayonet base T-3¼" bulb, enclosed frame, black nickel plated brass, 1 11/16 lg. x ⅝ dia. mtg. hole, lamp replaceable from front, any mtg. position, two solder lug terminals located at back end; P/O XI-103.	Transmit lamp socket		For reference	CAYZ		XI-103B	1
XK-101	SOCKET, electron tube, octal.	Socket for K-101	TS101PO2	N16-S-63515-4158	CHS V24-5080	6-C-182	XK-101 XK-103 XV-110 XV-111 XV-112 XV-113	6
XK-102	Non-existent.							
XK-103	Same as XK-101	Socket for K-103						
XV-101	SOCKET, electron tube; shield base, 9 pin miniature.	Socket for V-101	TS103PO1	N16-S-64063-6713	CHS V24-5052	6-C-180	XV-101 XV-102 XV-103 XV-107 XV-108 XV-109	6
XV-102	Same as XV-101	Socket for V-102						
XV-103	Same as XV-101	Socket for V-103						
XV-104	SOCKET, electron tube; shield base, 7 pin miniature.	Socket for V-104	TS102PO1	N16-S-62603-6702	CHS V24-5042	6-C-181	XV-104 XV-105 XV-106	3
XV-105	Same as XV-104	Socket for V-105						
XV-106	Same as XV-104	Socket for V-106						
XV-107	Same as XV-101	Socket for V-107						
XV-108	Same as XV-101	Socket for V-108						
XV-109	Same as XV-101	Socket for V-109						
XV-110	Same as XK-101	Socket for V-110						
XV-111	Same as XK-101	Socket for V-111						
XV-112	Same as XK-101	Socket for V-112						
XV-113	Same as XK-101	Socket for V-113						
Z-101	FILTER, band pass; 1110-1440 cps, fundamental frequency of 23 cycles, designed so fundamental to 5th harmonic relationship is unchanged; 40 db attenuation below 800 cps and above 1900 cps hermetically sealed.	Input filter		N16-F-32113-4829	CB1S S15154	6-C-172	Z-101 Z-103	2
Z-102	TRANSFORMER, discriminator, center frequency 1275 cps, linear between 1140-1440 50 volt output.	Frequency Discriminator		N17-T-67101-2209	CB1S S-15264	6-C-165	Z-102	1

TABLE 6—2. TABLE OF REPLACEABLE PARTS

SYMBOL DESIG.	NAME OF PART AND DESCRIPTION	FUNCTION	MIL/JAN TYPE NO.	NAVY STANDARD STOCK NO.	MFR. AND MFR'S. DESIG.	CON-TRACTOR DWG. AND PART NO.	ALL SYMBOL DESIG. INVOLVED	TOTAL NO. PER EQUIP.
Z-103	Same as Z-101	Output filter						
	JACK, cover, navy gray.	Cover for Jack J-103			CB1M #520	6-C-198		1
	HOLDER, tool: spring type wire clip; single mounting hole for #8/32 screw.	Allen Wrench holder		N17-C-806531-101	AF #2	6-C-212		1
	SLIDE, aluminum; 3 section telescoping with continuous ball bearing action; can tilt and lock in extended position; 100 lb. load 13" x 3" x 3¼", 15" travel.	For moving and tilting chassis		Low Failure item if required requisition from ESO referencing NavShips 900, 180A	AG 392	6-C-215		2
	GROMMET, rubber: fits 7/16" hole; ¼" ID x ⅝" OD x 3/16" thick x 1/16" thickness of groove.	Cable grommet	AN931-4-7	N16-G-900133-235	AH #S 194	6-C-216		3
	BRACKET, potentiometer support; U shaped, 24SO aluminum .064 thick, 6 3/16" lg. x 1¾" wd. 4 mtg. holes (.1405); 1¼" x 5 11/16" mtg. centers.	Mounting for R-133, R-134 and R-136		Low Failure item if required requisition from ESO referencing NavShips 900, 180A	CHO	6-C-6		1
	CLAMP, relay fastener; steel 1/16" thick, cad. pl.; 3 15/16" lg. x 1" wd.; one hole .196 dia. in center.	Secures K-101 and K-103		Low Failure item if required requisition from ESO referencing NavShips 900, 180A	CHO	6-C-7		1
	NUT; brass, cad. pl., T shaped 10/32 center tapped hole, 2 .120 mtg. holes large section: ¾" dia. x ⅜" wd. x 1/16" thick small section: ¼" dia. x 3/16" lg.	Used with relay		Low Failure item if required requisition from ESO referencing NavShips 900, 180A	CHO	6-C-8		1
	INSULATOR, washer; XXX blk. bakelite fungus proofed; 15/16" dia. x 3/64" thick, ½" center hole.	Insulates J-103		Shop Manufacture	CHO	6-C-9		1
	INSULATOR, bushing; XXX blk. bakelite, T shaped, overall hgt. 7/32" in sections of 1/16 and 5/32" whose respective dia. are 15/16" and 31/64"; center hole 25/64" dia.	Insulates J-103		Low Failure item if required requisition from ESO referencing NavShips 900, 180A	CHO	6-C-10		1
	MOUNTING; brass cad. pl. ½ x ½ x 1/16 thick and 1 5/16" lg; 4 holes .144 dia., 2 on each angle side on 13/16" centers.	For mounting terminal board 6-C-14		Shop Manufacture	CHO	6-C-17		1
	MOUNTING; brass, strip 3/32" thick x ⅜" wide cad. pl. L shaped 1⅞ x ½; 3 holes .144 dia., 1 on ½" leg, 2 on 1" centers on longer leg.	For mounting terminal board 6-C-16		Shop Manufacture	CHO	6-C-18		2

	MOUNTING; brass cad. pl., strip 3/32 thick x 3/8 wide in L shape 1¾ x ½; 3 holes .144 dia., 1 on ½ leg, 2 on 1" centers on longer leg.	For mounting terminal board 6-C-14		Shop Manufacture	CHO	6-C-19		1
	SPACER; brass, cad. pl., 3/8" OD x ¾" long center is #6/32 tapped.	For mounting terminal boards		Shop Manufacture	CHO	6-C-20		10
	BRACKET; with spade lugs #10/32 NF 2A thread; 3.625 long with additional 5/8" threaded portion. Hook fastens over bottom bead of container.	Secures C-124 and C-125 to chassis	CP07SC2	N16-M-60918-1606	CAW 09-MSB	6-C-220		4
	BRACKETS; mounting: through bolt horizontal type mounting includes 2 brackets, 2 metal centering washers and through bolt with nut and lockwasher.	Secures R-166 to chassis		Low Failure item if required requisition from ESO referencing NavShips 900, 180A	CSF 33E	6-C-221		1
	BRACKETS; mounting: through bolt horizontal type mounting includes 2 brackets, 2 metal centering washers and through bolt with nut and lockwasher.	Secures R-162 to chassis		Low Failure item if required requisition from ESO referencing NavShips 900, 180A	CSF 34E	6-C-222		1
	INSULATOR, washer: bakelite 5/8" dia. OD and .380 ID, .020 thick.	Insulates jack J-101and J-102		Shop Manufacture	CB1M S-1028	6-C-223		2
	INSULATOR, bushing: mica filled phenolic, T shaped, 5/8" OD .384 ID; inside collar 3/32" long x .116 thick; outside 1/16" thick.	Insulates jack J-101 and J-102		Low Failure item if required requisition from ESO referencing NavShips 900, 180A	CB1M M-1018	6-C-224		2
	GROMMET, rubber: fits 7/8" hole; 5/8" ID x 1⅛ OD x 7/16" thick x 3/16" thickness of groove.	Input cable grommet	AN931-B10-14	Low Failure item if required requisition from ESO referencing NavShips 900, 180A	AH S-5528	6-C-226		1
	MOUNTING, brass, strip 1/16" thick x ½" wide cad. pl. L shaped 1⅝" x 1 3/16"; 1 hole .177 dia. on 1⅝" leg, 1 hole 7/16" x 3/16" on 1 3/16" leg.	For mounting resistor R-164		Shop Manufacture	CHO	6-C-22		1
	CABLE CLAMP, Alclad aluminum, extruded Neoprene cushion 3/32" thick, for cable diameter 5/16" through 7/16"; .171 dia. mounting hole.	For clamping cable assembly W-101		N17-C-781429-501	AT A3044F-4	6-C-227		1
	CABLE CLAMP, Alclad aluminum, extruded Neoprene cushion 3/32" thick for cable diameter 7/16" through 5/8"; .171 dia. mounting hole.	For clamping cable assembly W-102		N17-C-781609-375	AT A3044F-5	6-C-228		1

TABLE 6—3. MAINTENANCE PARTS KIT

KEY DESIGNATION	QUANTITY	KEY DESIGNATION	QUANTITY
C-113	1	R-138	1
F-101	5	R-139	1
F-103	5	R-140	1
K-101	1	R-141	1
K-102	1	R-142	1
K-103	1	R-143	1
K-104	1	R-144	1
L-102	1	R-146	1
R-125	1	R-163	1
R-128	1	S-102	1
R-129	1	S-103	1
R-132	1	T-101	1
R-133	1	T-102	1
R-134	1	T-104	1
R-135	1	Z-101	1
R-136	1	Z-102	1
R-137	1		

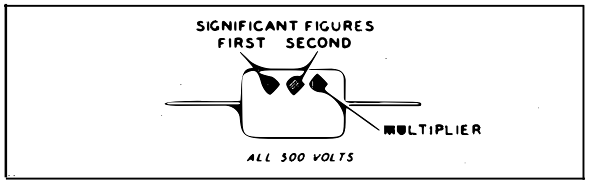
TABLE 6—4. CROSS REFERENCE PARTS LIST

MIL/JAN TYPE NO.	SYMBOL	MIL/JAN TYPE NO.	SYMBOL	MIL/JAN TYPE NO.	SYMBOL
CM20D391G	C-103	RC20GF105J	R-117	RW30G1RO	R-168
CM35E103J	C-101	RC20GF106J	R-148	RW31G122	R-151
CP29A1EF104M	C-110	RC20GF122J	R-103	RW33G352	R-166
CP29A1EF504K	C-111	RC20GF131J	R-101	RW34G203	R-162
CP29A2EC104K	C-119	RC20GF152J	R-126	RW34G602	R-164
CP29A2EC104M	C-117	RC20GF224J	R-115	RW55J201	R-127
CP29A2EC254K	C-121	RC20GF225J	R-113	ST22K	S-101
CP29A2EF104X	C-122	RC20GF271J	R-119	TF1A10AJ	T-102
CP70E1DF805K	C-124	RC20GF272J	R-155	TF1A16AJ	T-101
DCOP-3	W-101A	RC20GF332J	R-105	TS101PO2	XK-101
FO 4	F-101	RC20GF333J	R-108	TS102P01	XV-104
FO 4	F-103	RC20GF391J	R-122	TS102U01	E-104
JJ 089	J-101	RC20GF474J	R-152	TS102U02	E-105
JJ 101	J-103	RC20GF563J	R-150	TS103P01	XV-101
LH66DA-2	XI-101	RC20GF685J	R-158	TS103U02	E-101
LH66DR-2	XI-102	RC32GF134J	R-156	8TB10C	TB-101
RC20BF102J	R-111	RC42GF102J	R-160	AN-3057-6	H-105
RC20BF134J	R-104	RC42GF203J	R-123	AN-3057-10	H-106
RC20BF224J	R-106	RC42GF562J	R-161	AN-3102A-14S-9P	J-108
RC20BF244J	R-154	RC42GF682J	R-147	AN-3102A-18-8P	J-107
RC20BF334J	R-112	RP101SA252KK	R-167	AN-3108B-14S-9S	P-101
RC20BF474J	R-107	RP101SA502KK	R-165	AN-3108B-18-8S	P-102

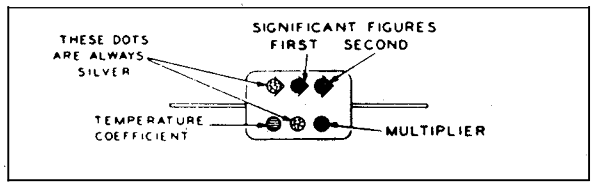
TABLE 6–5. APPLICABLE COLOR CODES AND MISCELLANEOUS DATA

CAPACITOR COLOR CODES

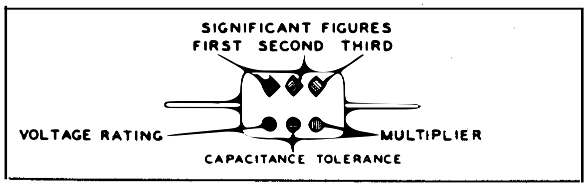
RMA 3-DOT COLOR CODE FOR MICA-DIELECTRIC CAPACITORS



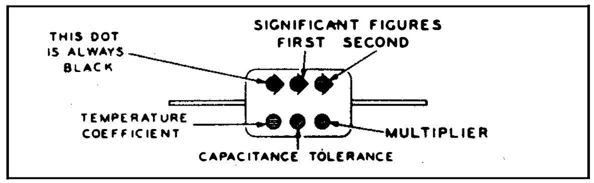
JAN 6-DOT COLOR CODE FOR PAPER-DIELECTRIC CAPACITORS



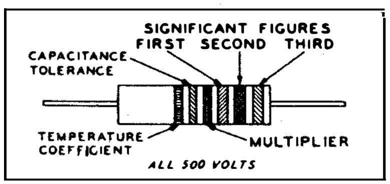
RMA 6-DOT COLOR CODE FOR MICA-DIELECTRIC CAPACITORS



JAN 6-DOT COLOR CODE FOR MICA-DIELECTRIC CAPACITORS

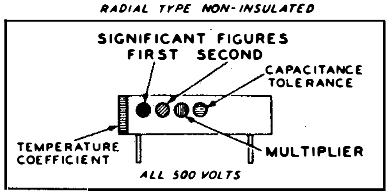


RMA COLOR CODE FOR TUBULAR CERAMIC-DIELECTRIC CAPACITORS

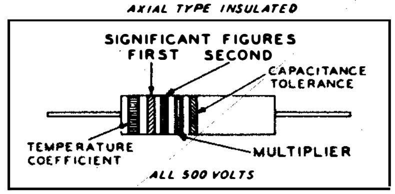


JAN COLOR CODE FOR FIXED CERAMIC-DIELECTRIC CAPACITORS

RADIAL TYPE NON-INSULATED



AXIAL TYPE INSULATED



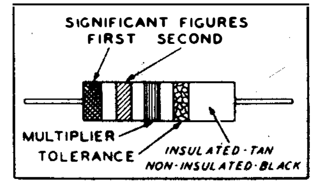
RMA: RADIO MANUFACTURERS ASSOCIATION
JAN: JOINT ARMY-NAVY

RESISTORS		CAPACITORS						
				MULTIPLIER				
TOLERANCE	MULTIPLIER	SIGNIFICANT FIGURE	COLOR	RMA MICA AND CERAMIC-DIELECTRIC	JAN MICA AND PAPER-DIELECTRIC	JAN CERAMIC DIELECTRIC	VOLTAGE RATING	TEMPERATURE COEFFICIENT
	1	0	BLACK	1	1	1		A
	10	1	BROWN	10	10	10	100	B
	100	2	RED	100	100	100	200	C
	1,000	3	ORANGE	1,000	1000	1000	300	D
	10,000	4	YELLOW	10,000			400	E
	100,000	5	GREEN	100,000			500	F
	1,000,000	6	BLUE	1,000,000			600	G
	10,000,000	7	VIOLET	10,000,000			700	
	100,000,000	8	GRAY	100,000,000		0.01	800	
	1,000,000,000	9	WHITE	1,000,000,000		0.1	900	
5	0.1		GOLD	0.1	0.1		1000	
10	0.01		SILVER	0.01	0.01		2000	
20			NO COLOR				500	

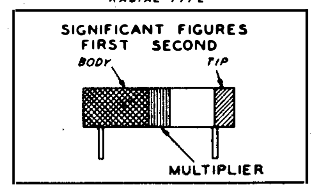
RESISTOR COLOR CODES

RMA COLOR CODE FOR FIXED COMPOSITION RESISTORS

AXIAL TYPE

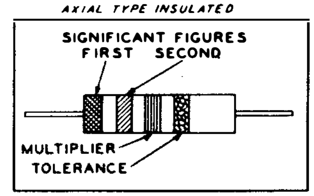


RADIAL TYPE



JAN COLOR CODE FOR FIXED COMPOSITION RESISTORS

AXIAL TYPE INSULATED



RADIAL TYPE NON-INSULATED

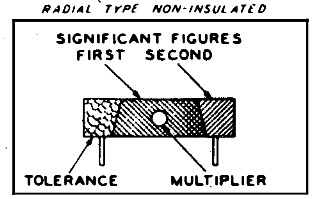


TABLE 6–6. LIST OF MANUFACTURERS

CODE NO.	BUSHIPS DESIG.	NAME	ADDRESS
AA		Electra Manufacturing Company	2537 Madison Avenue, Kansas City, Mo.
AC		Tech Laboratories, Inc.	Bergen Blvd. & E. Edsall, Palisades Park, N. J.
AF		Fahnestock Company	Long Island City 1, N. Y.
AG		Grant Pulley & Hardware Company	Flushing, L. I., N. Y.
AH		Minor Rubber Company, Inc.	Ackerman Street, Bloomfield, N. J.
AP		Eastern Precision Resistor Corp.	130-11 90th Avenue, Richmond Hill 18, N. Y.
AS		Hetherington, Inc.	1200 Elmwood Avenue, Sharon Hill, Pa.
AT		Tinnerman Products, Inc.	Cleveland 1, Ohio
CAIS	CAIS	Birtcher Corporation, The	5087 Huntington Drive, Los Angeles 32, Calif.
CARE	CARE	Potter & Brumfield Mfg. Co., Inc.	Princeton, Indiana
CARR	CARR	Rome Cable Corporation	400 Ridge Street, Rome, N. Y.
CAUP	CAUP	Kurz-Kasch, Inc.	1421 S. Broadway, Dayton, Ohio
CAW	CAW	Aerovox, Corporation	742 Belleville Avenue, New Bedford, Mass.
CAYT	CAYT	Allen Manufacturing Company	100 Sheldon Street, Hartford, Conn.
CAYU	CAYU	Barry Corporation, The	179 Sidney Street, Cambridge, Mass.
CAYZ	CAYZ	Dialight Corporation	60 Stewart Avenue, Brooklyn 37, N. Y.
CBIM	CBIM	Switchcraft Company	1328 N. Halsted Street, Chicago, Ill.
CBIS	CBIS	Burnell & Company	Yonkers 2, N. Y.
CBZ	CBZ	Allen-Bradley Company	118 W. Greenfield Avenue, Milwaukee, Wisc.
CBZG	CBZG	Kulka Electric Mfg. Co., Inc.	30 South Street, Mt. Vernon, N. Y.
CD	CD	Cornell-Dubilier Corporation	1000 Hamilton Blvd., South Plainfield, N. J.
CDJ	CDJ	DeJur-Amsco Corporation	45-01 Northern Blvd., Long Island City 1, N. Y.
CFX	CFX	Freed Transformer Company, Inc.	1718 Weirfield Street, Ridgewood, Brooklyn 27, N. Y.
CHH	CHH	Arrow-Hart & Hegeman Electric Co.	102 Hawthorne Street, Hartford, Conn.
CHO	CHO	Boehme, Incorporated, H. O.	915 Broadway, New York 10, N. Y.
CHS	CHS	Sylvania Electric Products, Inc.	Emporium, Pa.
CJC	CJC	Jones, Howard B.	2300 W. Wabansia Avenue, Chicago, Ill.
CLF	CLF	Littlefuse, Incorporated	1865 Miner Street, Desplaines, Ill.
CMA	CMA	Mallory, P. R., Co., Inc.	1941 Thomas Street, Indianapolis, Ind.
CMF	CMF	Electro Motive Mfg. Co.	Willimantic, Conn.
COM	COM	Ohmite Mfg. Company	4835 W. Flournoy, Chicago, Ill.
CPH	CPH	American Phenolic Corp.	1830 South 54th Avenue, Chicago, Ill.
CRV	CRV	Radio Corporation of America	Camden, New Jersey
CSF	CSF	Sprague Electric Company	N. Adams, Mass.
CSI	CSI	Sigma Instruments, Inc.	70 Ceylon Street, Boston 21, Mass.
CSM	CSM	Shallcross Manufacturing Company	Collingdale, Pa.
CTC	CTC	Chicago Telephone Supply Company	Elkhart, Ind.
CUF	CUF	Ucinite Company Division of United Carr Fastener Company	1 Nevada Street, Newtonville, Mass.