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377
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TM 11-356

WAR DEPARTMENT

TECHNICAL MANUAL

RADIO TELETYPE TERMINAL EQUIPMENT AN/FGCI OR AN/FGC-IX

5 NOVEMBER 1943

WAR DEPARTMENT
WASHINGTON, 11/5/43

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TECHNICAL MANUAL
NO. TM 11-356

RESTRICTED

RADIO TELETYPE TERMINAL EQUIPMENT AN/FGC1 OR AN/FGC-1X

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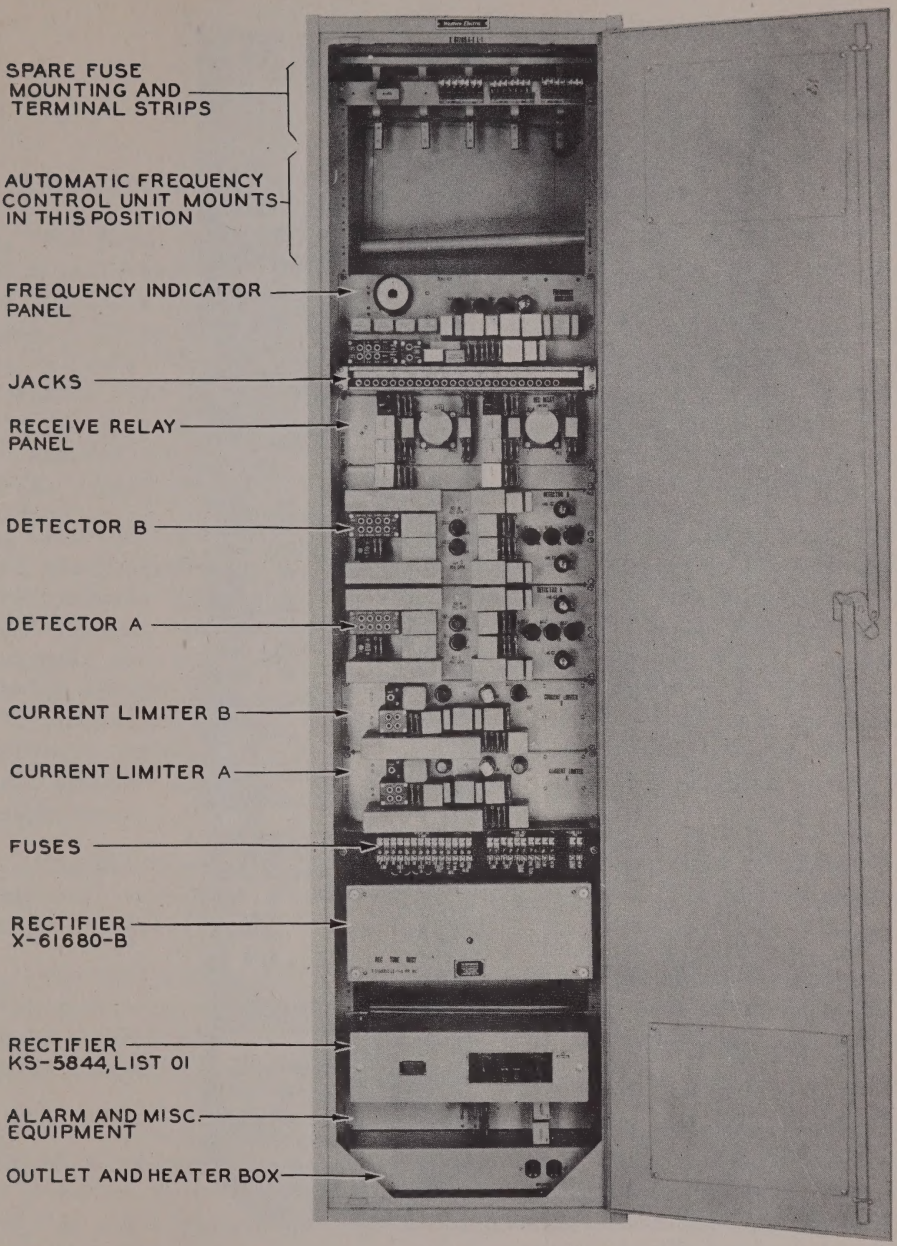


Figure 1 - Radio Teletype Terminal Bay, Front View

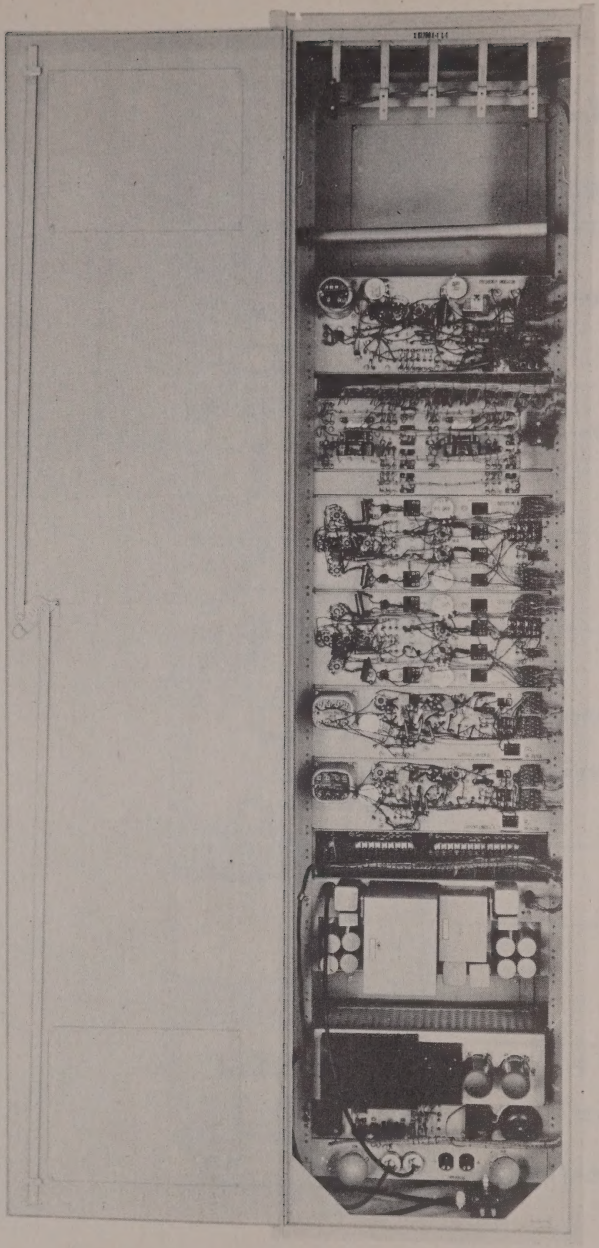


Figure 2 - Radio Teletype Terminal Bay, Rear View

SECTION I
DESCRIPTION

1. INTRODUCTION.

a. The Radio Teletype Terminal Equipment AN/FGC1 or AN/FGC-1X forms part of a radio-telegraph system, the receiving circuit being designed to receive signals alternately from one or two radio transmitters at moderate distances. The radio frequencies employed are in the range of 2 to 26 megacycles. A block diagram of the system is shown in figure 3. AN/FGC1 equipment operates from 50- to 60-cycle a-c power supply and AN/FGC-1X from 25- to 60-cycle supply. The operating and testing procedures are the same for both types. Any reference in this book to AN/FGC1 equipment applies equally to AN/FGC-1X, unless it is stated that the AN/FGC-1X equipment differs.

b. The radio transmitter sends out its normal frequency when the contacts of the telegraph-sending mechanism are closed (marking condition), and when the contacts are opened (spacing condition), the radio frequency is reduced 850 cycles, the amplitude remaining unchanged. At the receiving end these signals are received in superheterodyne receivers, which invert them and finally convert them into frequencies in the voice range of about 2125 and 2975 cycles for the closed and open conditions of the sending contacts, respectively. These voice-frequency signals are rectified in the AN/FGC1 equipment and are passed to the receiving telegraph equipment as d-c telegraph signals.

c. Signals are sent by telegraph printer keyboard or automatically by transmitter-distributor at sixty words per minute. They are received by printer or by typing reperforator.

d. The effect of radio fading is minimized by employing space diversity; the receiving equipment is associated with two receiving antennas which are spaced several wavelengths apart, and thus the reliability of reception is greatly increased.

e. The circuit is arranged so that when the same radio-frequency assignment is being used for transmitting and receiving, the receiving equipment is disabled while the transmitter is in use. When different frequencies are used for transmitting and receiving, however, the circuit may be connected so that these two operations can be carried on simultaneously; in this case, extra printer equipment will ordinarily have to be provided for sending. When messages are not being received, each receiver may be connected to both

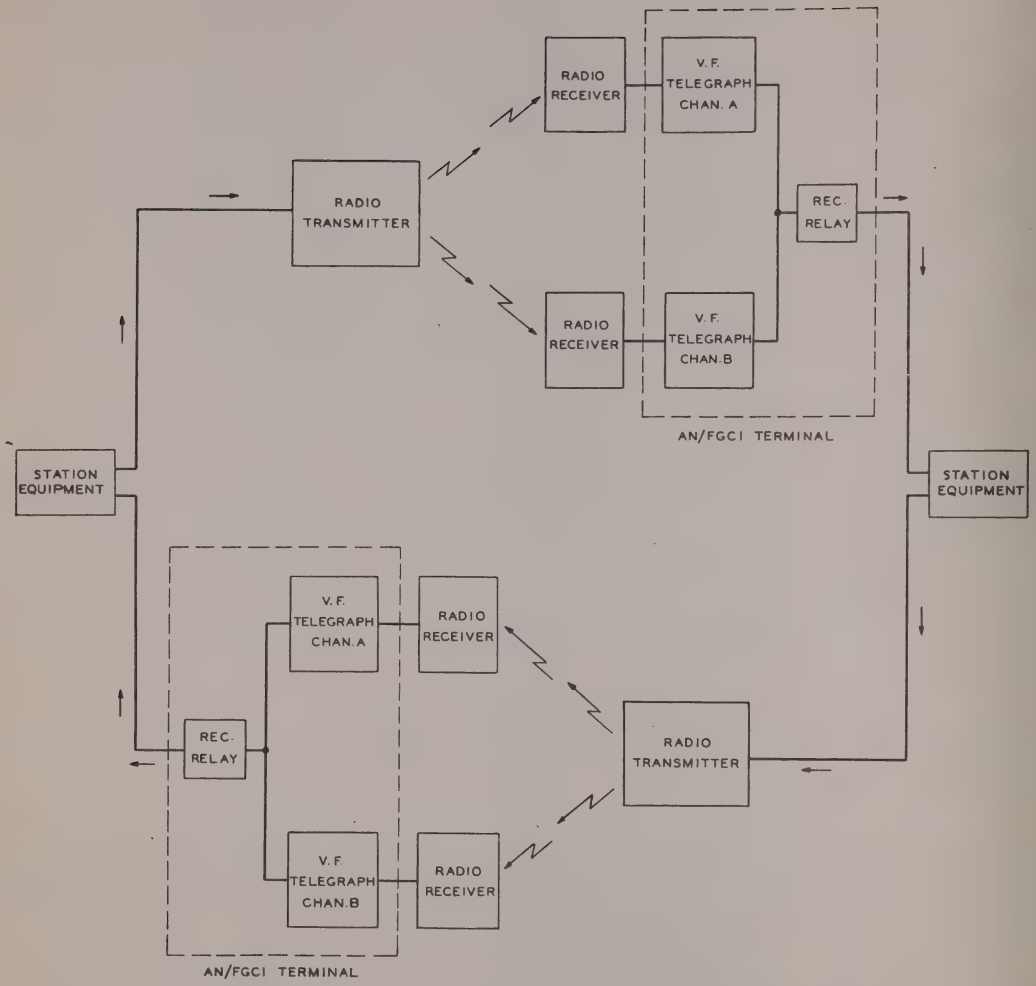


Figure 3 - Block Diagram of System

its pairs of associated antennas in parallel so that signals can be detected from either distant transmitter. A monitoring circuit is provided to prevent operation of teletypewriters by noise during this monitoring period. It is automatically switched out of the circuit when the distant transmitter is energized.

f. For an AN/FGC1 equipment, 50- to 60-cycle, 103- to 127-volt, or 207- to 253-volt a-c power supply is required. AN/FGC-1X equipment uses a-c power of 25 to 60 cycles, 103 to 127 or 207 to 253 volts. The power may be obtained from commercial sources or other equivalent available supply. To protect the equipment from humidity, a heater is provided in each cabinet which is automatically connected to the power supply when the power is switched off from the radio-receiver and voice-frequency terminal equipment.

g. The receiving printer equipment can be connected to the AN/FGC1 bay by means of a metallic pair or by a single wire with ground return from the printer subset. The allowable length of this loop circuit varies greatly, depending on the type of line facility employed. Its resistance should not exceed 3700 ohms, as this value would result in the minimum allowable loop current of 10 milliamperes. In ground-return operation over a composited pair, the workable distance will usually be determined by crossfire to and from the telegraph or signal circuit on the other wire of the pair, and this will depend on the type of circuit used on the other wire. A reasonable distance would be 15 miles of cable or 100 miles of open wire. An ungrounded rectifier (KS-5844) must be added to an AN/FGC1 bay which does not contain one, when a ground-return loop is used. A filter, not covered in these instructions is required in addition to the usual type of composite set to reduce interference from the telegraph to the telephone circuit.

h. A location free from abnormal vibration and protected from outside weather conditions is necessary.

2. EQUIPMENT.

a. A bay of AN/FGC1 equipment consists of the apparatus for two channels of a circuit mounted in a metal cabinet 7 feet high, 1 foot 10-1/4 inches wide, and 1 foot 5 inches deep with doors at front and rear, each 1 foot 7-5/8 inches wide. The total weight is about 425 pounds, not crated. When crated for shipment the weight is about 635 pounds and the over-all dimensions are 7 feet 4 inches x 2 feet 4 inches x 1 foot 9 inches, equivalent to 29.9 cubic feet.

b. Figures 1 and 2 show the front and rear views of the cabinet with the doors open. Both doors are hinged at the right as the observer faces the front, whereas both doors of the radio-receiver cabinet are hinged at the left. The individual panels on which the equipment is mounted are 19 inches

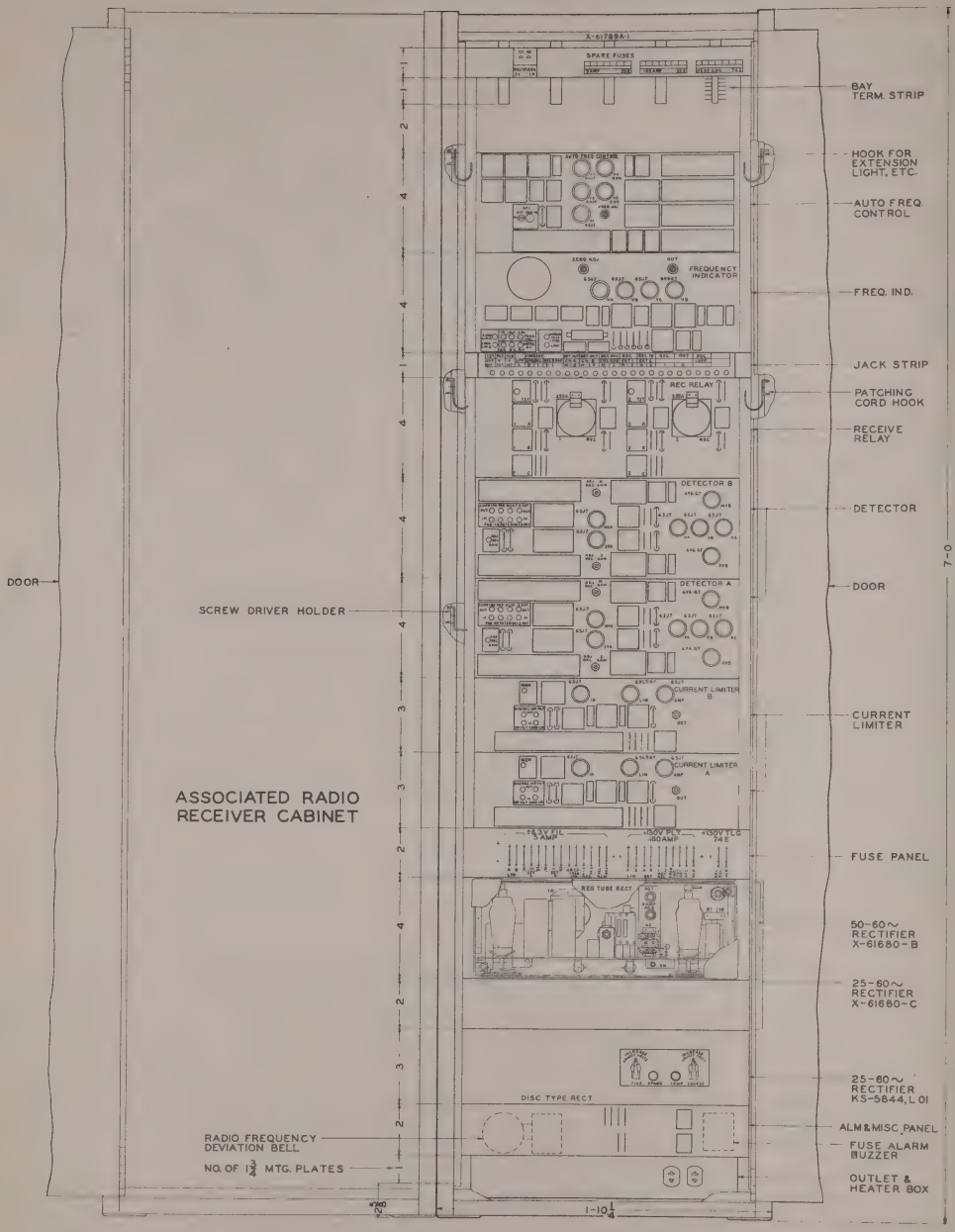


Figure 4 - Cabinet Equipment

wide. Figure 4 shows the arrangement of the equipment on the individual panels and the location within the cabinet.

c. The principal component parts of the equipment mounted in the cabinet are from top to bottom:

Spare fuses
One mounting plate for terminal strips
Frequency-control panel
Panel containing oscillator and frequency indicator (marked FREQUENCY INDICATOR)
Jack strip
Panel containing two receiving-relay circuits (marked REC REL)
Channel B detectors (marked DETECTOR B)
Channel A detectors (marked DETECTOR A)
Channel B limiter (marked CURRENT LIMITER B)
Channel A limiter (marked CURRENT LIMITER A)
Fuse panel
Regulated tube rectifier
Disc-type rectifier
Panel containing frequency alarm bell, fuse alarm buzzer and miscellaneous equipment
Outlet and heater box

d. Unmounted items furnished with each terminal consist of the following:

Quantity	Description	Function
1	Test receiver equipped with headband and cord	For monitoring audio signals
10	165C plug (dummy plug)	For opening jack contacts
3	2-conductor cord, 2 feet long, equipped with two twin plugs (241-type)	Patching
4	2-conductor cord, 4 feet long, equipped with two 2-conductor plugs (347A)	Patching
8	2-conductor cord, 2 feet long, equipped with two 2-conductor plugs (347A)	Patching
2	3-conductor cord, 2 feet long, equipped with two 3-conductor plugs (310)	For patching to meter

Quantity	Description	Function
2	394A vacuum tube	Used in regulated tube rectifier
1	6SA7 vacuum tube	Used in frequency indicator
16	6SJ7 vacuum tube	Used in detector amplifier, frequency indicator, current limiter, and automatic frequency control
5	6V6GT vacuum tube	Used in frequency indicator and detector
2	6SF5 vacuum tube	Used in current limiter
1	6H6 vacuum tube	Used in automatic frequency control
4	3-ampere fuse (1/4-inch x 1-1/4-inch glass tube with fuse enclosed)	Used in regulated tube rectifier
2	50-watt, 115- or 120-volt mazda lamp	Heater lamp
4	50-watt, 230- or 240-volt mazda lamp	Heater lamp

3. POWER SUPPLY.

a. The telegraph terminals are completely a-c operated and are equipped with either of two types of regulated tube rectifiers to supply loop current and plate voltage to the tubes. The first operates from a power supply of 50 to 60 cycles, 103 to 127 volts or 207 to 253 volts, and the second from a supply of 25 to 60 cycles, with the same voltage ranges. A bay may be adapted for use with either of these two voltage ranges by a screwdriver change in the internal connections. The rectifier provides a-c filament and plate voltages. An additional rectifier (disc-type) supplies power to the receiving loop circuit, when the latter employs ground for the return path of the current. It operates from a power supply of 25 to 60 cycles, with the same voltage ranges as the first rectifier. It is connected for 115- or 230-volt power supply, depending on the position of a lever which is accessible through a small hinged door. The output supplies are permanently cabled to the various panels on the bay.

b. Two convenience outlets are provided in the front of the equipment and two in the rear for appliances which have the same voltage rating as the power supply.

c. For typical power consumption conditions, a carrier-telegraph bay requires about 140 watts or 160 volt-amperes of a-c power.

4. FREQUENCY CONTROL.

Most bays of AN/FGC1 equipment contain a circuit for controlling automatically the frequency of the received audio signals. Since the connection to the receiver bay for frequency control is high impedance, the control pair should have high insulation resistance.

5. FREQUENCY SHIFT.

The terminal equipment is designed and these instructions have been written for use with a radio circuit in which there is a frequency change of 850 cycles, normally, between marking and spacing signals. The following table shows recommended values of this frequency shift for various frequency bands, but these recommendations are only tentative and so are subject to change. These instructions do not describe the circuit arrangements or the changes in operating procedures involved, when the frequency shift is other than 850 cycles.

Frequency Band	Carrier Shift
70 - 500 kc	170 cycles
500 - 2000 kc	340 cycles
above 2000 kc	850 cycles

6. CHANGES IN EQUIPMENT.

a. Some bays of earlier manufacture have left the factory with the disc-type rectifier omitted but without the necessary wiring arrangements to permit the use of the regulated tube rectifier for supply of loop current. Instructions for making these wiring changes are given in paragraph 8h.

b. Most bays are equipped at the factory with temporary wiring in accordance with paragraph 8h, for the regulated tube rectifier to furnish loop current.

c. Twenty regulated tube rectifiers were wired according to the color codes which are crossed out on the wiring diagram, figure 46 (see note 15 of fig. 46). The AN/FGC1 bays containing them have twenty of the following twenty-four serial numbers: 2, 3, 4, 7, 10-13, 17, 18, 20-25, 27, 28, 31, 33, 38, 39, 40, and 45. In all other bays, the color codes are normal.

d. Many bays were equipped with monitoring circuits which required a steady closure of the control relay in the radio-receiver bay. Instructions are given in paragraph 8j to modify the wiring so that they will work with only a momentary closure. Bays of later manufacture, will be furnished with this wiring.

SECTION II
INSTALLATION AND OPERATION

7. GENERAL.

a. This section applies specifically to the AN/FGC1 equipment when used with the AN/FRR3 Radio Receiver. If other types of receivers are employed the operating and testing procedure will be the same but controls and terminals to which connections are made may be designated differently. The following table lists the items which possibly may not apply to other receivers and explains the function of each in the AN/FRR3 Receiver so that substitutions can readily be made in the instructions if designations or controls in other receivers used are different.

AN/FRR3 Radio Receiver	Description
AUDIO OUTPUT 600Ω and GND	Audio output terminals of the receiver. In connecting these to the current limiters keep in mind that terminals 2A of the latter are grounded.
AFC1 and AFC2	Terminals to be connected for automatic frequency control. When AFC2 is positive with respect to AFC1 the receiver increases the audio output frequency.
AN/FGC1 DISABLING	Terminals wired to the contacts of a relay. The closure of the relay contacts sets up the monitoring condition in the AN/FGC1 bay.
BFO Control	Manual control for adjusting the frequency of the intermediate frequency oscillator.
AUDIO LEVEL	Manual control for adjusting the level of the audio output.
Control of Power Supply by Dialing	The receiver is equipped with a dial which controls the connection of power in the AN/FGC1 bay. Dialing 01 connects the power and dialing 02 disconnects it.

b. It is presumed that the radio receiver has been installed and is in operating condition and that the power is turned off. In this section, equipment designations written in CAPITALS correspond to designations stamped on the equipment. If any terms used are not clear, refer to the glossary on

page 132. The controls and tubes have identical designations on the two channels. Be careful, therefore, when adjusting one channel, not to operate the controls associated with the other channel.

WARNING: WHEN POWER IS TURNED ON, 250 VOLTS MAY EXIST UNDER THE RECTIFIER COVER. BEFORE REMOVING THE COVER, PULL OUT THE PLUG WHICH CONNECTS THE RECTIFIER TO THE OUTLET BOX. 110 VOLTS ALSO IS DANGEROUS IF GOOD CONTACT IS MADE. WHEN TOUCHING ANY EQUIPMENT WHICH MAY BE ALIVE, DO NOT TOUCH ANY OTHER METAL SIMULTANEOUSLY AND DO NOT STAND ON A DAMP FLOOR.

8. INSTALLATION AND INITIAL PROCEDURE.

a. Remove the AN/FGC1 cabinet from its crate and, unless another location is specified, place it beside the radio-receiver cabinet to the right as you face the fronts of the two cabinets. Allow at least a 2-1/2-foot clearance in front to the nearest wall or other obstruction, 2-1/2 feet at the back, and a 2-foot clearance around one end of the two cabinets for passageway. A clearance of 3 to 4 feet is desirable, both front and rear. The cabinet should be situated in a place reasonably free from vibration on a firm footing, preferably concrete. It should be fastened to the floor, utilizing holes in the bottom corner brackets of the cabinet and lag or expansion screws, and it should be bolted to the receiver bay. Install copper-bonding braids between the two cabinets at top and bottom, scraping off the paint under the braids where they are bolted to the cabinets in order that there may be a good electrical contact.

b. Make the following external connections to the AN/FGC1 bay (refer to the application schematic fig. 36). External connections are brought into the cabinet through cable holes at the top or bottom. Any wires involved which pass from top to bottom inside of the cabinet should be tied to cabinet channel brackets. The bay terminal strip is at the top of the bay. In order to make the shielded pairs short from the limiters to the radio outputs on the adjacent bay (see paragraphs (2) and (3) below), run them through a bottom hole at the left into a facing hole in the radio-receiver bay, unless local conditions dictate otherwise.

(1) Connect an 8-guage wire from waterpipe or other good ground to the ground punching on the cabinet upright (lower left as you face the back).

(2) Shielded pair from terminals 1A and 2A (terminals 1 and 2 of terminal strip A) of the channel A current limiter to the A radio-receiver terminals OUTPUT 600Ω and GND. Connect the shield to terminal 2A.

(3) Shielded pair from terminals 1A and 2A of channel B current limiter to the B radio-receiver terminals OUTPUT 600Ω and GND. Connect the shield to terminal 2A.

(4) Pair or single wire to telegraph station for receiving loop. Connect bay terminal 1 to single-wire loop (ground-return, used only with disc-type rectifier) or to outgoing side of pair (metallic loop). Connect terminal 2 to return side of metallic loop.

(5) Shielded frequency-control pair to radio-receiver cabinet. Connect terminal 5 of terminal strip B on the automatic frequency-control panel to terminal AFC2 of the receiver cabinet and terminal 7B of the frequency-control panel to terminal AFC1 of the receiver cabinet. When terminal 5B is positive with respect to 7B, the audio frequency is too low and so must increase. Connect the shield to terminal 8B. This pair should have high insulation resistance.

(6) Shielded pair from bay terminals 9 and 10 to receiver cabinet terminals AN/FGC1 DISABLING. Connect the shield to bay terminal 11.

(7) First pull out the rectifier power plug or plugs from the RECTIFIER outlets of the outlet box and then plug the main power cord into the 4-contact receptacle provided in the receiver bay.

c. Make sure that the voltage rating of the 50-watt heater lamps corresponds to that of the power supply, 115- or 120-volt lamps for power supply of 103-127 volts and 230- or 240-volt lamps for power supply of 207-253 volts.

d. Disconnect the a-c power by dialing 02 in the radio-receiver bay and check that the heater lamps are lighted. Close the doors and leave until all equipment is thoroughly dry before plugging the rectifier power cords into RECTIFIER outlets.

e. Remove the two pieces of flat sheet steel which close the louvers in each door of the cabinet and store them; also store any cable-hole cover plates which were removed. Replace the louvers during any extended period of nonoperation, except in extremely dry, hot areas, and replace both the louvers and cable-hole cover plates if the cabinet is reshipped.

f. Regulated Tube Rectifier.

(1) Pull out the plug connecting the rectifier to one of the RECTIFIER outlets and remove the can cover. Check for damage in shipment. Check that correct fuses and tubes are in place. Note that the date of manufacture has been stamped on electrolytic capacitors C1 to C8 (C1 to C10 in the rectifier C) and if not, tag with the installation date.

(2) Check that the rectifier is correct for the frequency of the power supply; if marked X-61680B, it operates from 50- to 60-cycles a-c power; if marked X-61680C, it operates from power supplies in the range of 25 to 60 cycles.

(3) Determine whether the input alternating current is nominally 115 (103-127) volts or 230 (207-253) volts and see that connections on the terminal strip AC are correct for that voltage. Refer to the instruction plate below terminal strip AC which describes the connections for each input voltage. Tighten all screws on terminal strip AC with a screwdriver whether connections are changed or not.

(4) Before connecting the a-c power and with the cover off, remove the two tubes and turn rheostat R to maximum counterclockwise position. (To remove a tube, lift off the cap at the top, press down the spring clip near the base, and pull the tube straight up.) See that tube caps do not touch any part of the rectifier. Then plug in the rectifier power cord, and connect a-c power to the AN/FGC1 equipment by dialing 01. Press the plunger of switch SW1.

WARNING: DO NOT TOUCH ANY METAL INSIDE OF THE RECTIFIER WHEN THIS SWITCH IS OPERATED, AS DANGEROUS VOLTAGES EXIST THERE.

Observe the operation time of timer TD as indicated by a slight click in the timer. This time should be 14 to 17 seconds for 60-cycle power or 32 to 42 seconds for 25 cycles. Release the cover switch and disconnect the rectifier power cord. Check that the timer releases and restores to normal in 5 seconds or less. If the timer is operating correctly, replace the tubes with the power still off. If the timer is not operating correctly, refer to paragraph 32a(1). Replace the caps on the tubes. Replace the cover and see that screws holding the cover in place are turned down tight.

(5) Reconnect the power cord.

g. Disc-type Rectifier (KS-5844).

(1) Before using the rectifier, see that a fuse of proper capacity has been provided in the line fuse holder. Where feasible, also have a fuse in the spare fuse holder.

(2) On the rectifier, set the 115V/230V toggle switch in the position corresponding to the voltage of the input power supply being used. For 115-volt a-c power supply, throw this toggle switch to the position designated 115V. If the rectifier is to operate from a 230-volt supply, throw the switch to the position designated 230V.

(3) Check that the electrolytic capacitors are stamped with the date of manufacture, and if not, tag them with the installation date.

Note: A RECTIFIER outlet should not be used for appliances as the relay contacts in the radio-receiver bay which energize this circuit would be overloaded.

h. Wiring Changes, Disc-type Rectifier Not Used.—Some AN/FGC1 equipments were shipped without disc-type rectifiers and without the wiring changes

necessary when the regulated tube rectifier is used to supply loop current. These will be recognized from the fact that the 130V TLG REC REL fuse is not connected to the regulated tube rectifier. In these cases, if the AN/FGC1 bay is to be used with a metallic (2-wire) loop, remove the rectifier cord from the RECTIFIER outlet and make the following wiring changes:

(1) On the terminal strip of the REC RELAY panel, remove the straps between terminals 4 and 11, and between 20 and 27. Do not disturb the black local cable lead between 4 and 20. Strap terminals 4 and 16.

(2) In the REG TUBE RECT, connect a lead between the + (inside) terminal of capacitor C5 and the lower post of the +130V TLG REC REL fuse; do not disturb the existing connections to the capacitor C5. Remove this REC REL fuse, connect power to the rectifier, and measure the voltage in the TLG V TST jack. (See par. 9a on use of meter circuit.) The voltage indication should be 0. Replace the fuse, disconnecting the power while doing so or else being careful not to make personal contact with live equipment. Measure the voltage again. The METER should indicate 65 ±2.

i. Wiring Changes, To Connect Disc-type Rectifier.—To connect the disc-type rectifier to equipment which has been wired according to paragraph h above, make the following wiring changes:

(1) Disconnect and remove the lead between the + (inside) terminal of the capacitor C5 in the REG TUBE RECT and the +130V TLG REC REL fuse; do not disturb existing connections to the capacitor C5.

(2) Disconnect and remove the strap between terminals 4 and 16 of the terminal strip on the REC RELAY panel. Do not disturb the black local-cable lead between terminals 4 and 20.

(3) Connect straps between terminals 4 and 11 and between terminals 20 and 27 of the REC RELAY panel.

(4) Connect the yellow lead of the local cable to the + terminal of the disc-type (KS-5844) rectifier and connect the two blue leads of the local cable to the - terminal of the rectifier.

(5) Follow the initial procedure of paragraph 8g for the disc-type rectifier, and turn the two voltage-adjusting knobs to their extreme low-voltage (counterclockwise) position. Remove the +130V TLG REC REL fuse, connect power to the rectifier, and measure the voltage in the TLG V TST jack. It should be zero.

(6) Replace the fuse, disconnecting the power while doing so or being careful not to make personal contact with live equipment. Test that there is voltage at the TLG V TST jack.

j. Changes, Monitoring Circuits.—The monitoring circuits in many bays were originally wired to operate on a steady closure of the control relay in

the radio-receiver bay. They should be rewired to operate on a momentary closure. These bays can be identified by inspecting the wiring to see if the changes noted below have been made, or noting if relays A, B, and C on the REC RELAY panel remain operated when the control switch at the subset is operated from the SEND or REC positions to the MON position. If they remain operated, the wiring is correct. If not, correct the wiring as follows:

(1) Remove the strap between terminals 1B and 1T of relay C. (See par. 29c for spring designations.)

(2) Remove the R-G wire from terminal 2B of relay B and connect it to 4T (add to existing two S wires).

(3) Connect terminal 2B of relay B to 1B of relay C.

(4) Connect terminal 1T of relay C to the transfer contacts of the TST key (add to existing O-R wire).

k. To Install an Automatic Frequency-control Panel.

(1) Mount the panel in its place near the top of the bay. (See fig. 4.)

(2) Connect the wires which leave the local cable form at this position to the automatic frequency-control panel according to the wiring diagram, figure 44.

9. LINE-UP PROCEDURE AND TESTS.

Before starting service, make all the tests described in this paragraph except those stated to be for trouble location only. Refer to figure 6, for the position in the circuit of the various jacks mentioned. Test all tubes if a tube tester is available.

a. Use of Meter Circuit (See Fig. 5).

(1) The meter circuit can be used for measuring d-c currents and voltages, signal frequencies, and audio-frequency power level. To measure various direct currents in the jacks provided for that purpose, patch the D-C METER jack to the proper jack, according to the following table, and turn the METER knob to D-C. Adjust the meter by turning the screw in the meter face so that the indication is 0 when there is no current in the meter.

Current or Voltage to be Measured	Jack	Approximate Value for Full Scale
Detector output or REC relay	REC REL CURRENT	50 milliamperes
Receiving loop	LOOP CURRENT	50 milliamperes
Suppressor current	SPR A or B CURRENT	20 milliamperes
Plate voltage	PLT V TST	200 volts
Telegraph voltage	TLG V TST	200 volts

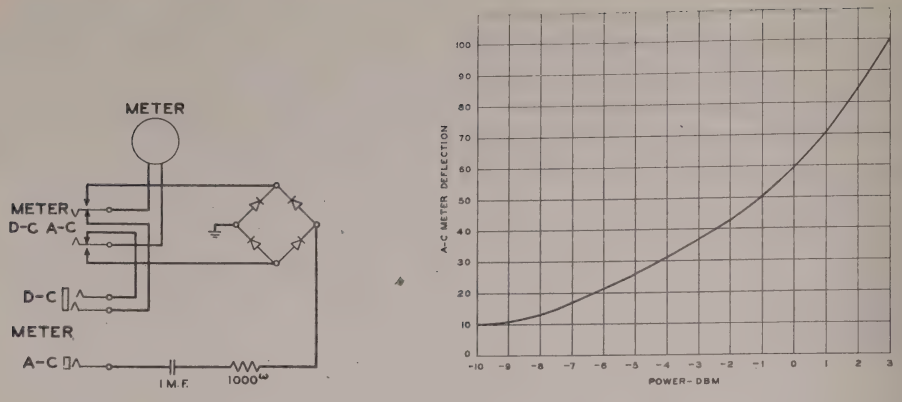


Figure 5 - Meter Circuit and A-c Meter Calibration

(2) To measure alternating voice-frequency power level, patch the A-C METER jack to the jack which carries the level to be measured and turn the METER knob to A-C. The approximate dbm corresponding to various deflections when the meter terminates a 600-ohm circuit are shown in figure 5, but these values will vary ±2 dbm, depending on the varistor, its age and temperature.

b. Use of Cords.

(1) A cord equipped with 241A plugs is used to patch from DET OUT CH A (or CH B) or DET OUT CHS A & B to REC REL IN CKT 1 (or CKT 2) jacks or from REL OUT 1 (or 2) to REC LOOP jacks; these are twin plugs, making tip and sleeve connections, the two sleeves being electrically connected, but the sleeve contacts are not used in this equipment. Always insert these plugs with the knurled edge to the left.

(2) A cord equipped with 310-type plugs is used to patch the D-C METER jack to any of the jacks provided for measuring d-c voltage or current; these are 3-conductor plugs, making tip, ring, and sleeve connections, but the sleeve is not used in these applications.

(3) For all other patches, unless otherwise specified, use cords equipped with 347A plugs; these are 2-conductor plugs, making tip and sleeve connections. Two of these may be used in place of a single cord equipped with 241A plugs. When the loop is single wire (ground-return) one of these cords may be used to patch the loop, connecting the left-hand REL OUT to the left-hand REC LOOP jacks.

(4) Under no condition shall any patches be made other than those herein specified, as damage to equipment may result.

c. Operating Voltage of Regulated Tube Rectifier.—Turn the METER knob to D-C and patch the D-C METER jack to PLT V TST jack. Connect power to the AN/FGC1 bay (dial 01) and after the timer has operated, slowly turn the slotted shaft R of the REG TUBE RECT until the meter indicates 65, which corresponds to 130 volts. If the meter continues to indicate zero, refer to the suggestions for clearing trouble in paragraph 27. Readjust R, 20 minutes after the initial adjustment.

d. Operating Voltage of Disc-type Rectifier.

(1) To avoid damage to the rectifying discs by a high a-c voltage, turn the two voltage-adjusting knobs to their extreme low-voltage positions (extreme counterclockwise), before power is turned on.

(2) Plug the power cord into a RECTIFIER outlet. The rectifier should now operate. Patch the D-C METER jack to TLG V TST and turn the METER knob to D-C. Adjust the voltage-adjusting knobs to obtain a meter indication of 65 ±2.

e. Test of Detector and Noise-suppression Circuit (See figs. 12 and 16).

(1) Full Output Current Test.

(a) Turn the 1 TST knob to TST.

Note: This knob should be turned to TST (to disable the monitoring circuit) in all local tests involving the operation of the receiving relay or measurement in a REC REL CURRENT jack. Always have the TST knob of the relay circuit which is not in use turned to TST.

(b) Turn the ADJ M REC GAIN and ADJ S REC GAIN potentiometers in both channels to their extreme clockwise positions (maximum gain).

(c) Patch detectors OUT CH A jacks to REC REL IN CKT 1 jacks.

(d) Insert open-circuit plugs in both CURR LIM OUT jacks.

(e) Patch NORMAL TEST LEVEL jack to M DET IN jack of channel A.

(f) Measure the d-c current in the REC REL 1 CURRENT jack. Requirement: +50 to +80.

Note: If this or any other requirement in this test are not met, it probably indicates that a tube should be replaced.

(g) Patch NORMAL TEST LEVEL to S DET IN jack of channel A and measure the current in the REC REL 1 CURRENT jack. Requirement: -50 to -80.

(h) Patch DET OUT CH B jacks to REC REL IN CKT 1 jacks and repeat paragraphs (e) and (f) in channel B. Requirements: Same as in paragraphs (e) and (f).

(i) Remove the patch cords and measure the currents in the SPR A and SPR B CURRENT jacks. Requirement: +30 to +50 each.

(2) Test of Noise-suppression Circuits.—These circuits are on the detector panels. To test the operation of a noise-suppression circuit, steady tone is inpressed on one detector of a channel, and a tone of gradually increasing magnitude on the other detector, simultaneously. This roughly simulates the effect of noise or other interference in a channel.

(a) With circuit conditions unchanged from paragraph (1), set the ADJ S REC GAIN potentiometer of channel A in its extreme counterclockwise position (minimum gain).

(b) Patch NORMAL TEST LEVEL to M DET IN jack of channel A.

(c) Patch LOW TEST LEVEL to the CURR LIM IN jack of channel A and CURR LIM OUT jack to the S DET IN jack of channel A (removing the open-circuit plug).

(d) Measure and record the currents in the SPR A and SPR B CURRENT jacks. Requirement: +30 to +55 each.

(e) Connect the D-C METER jack to SPR A CURRENT jack and slowly turn the ADJ S REC GAIN potentiometer of channel A clockwise until the METER indication has increased by 20. Leaving the potentiometer at this setting, measure the current in the SPR B CURRENT jack. Requirement: It shall be 15 to 30 less than the value recorded in paragraph (d) for the SPR B CURRENT jack.

(f) Repeat paragraph (e) on channel B as follows: Restore the open-circuit plug to the CURR LIM OUT jack of channel A. With the ADJ M REC GAIN potentiometer of channel B still set for maximum gain, set the ADJ S REC GAIN potentiometer at minimum (extreme counterclockwise). Patch NORMAL TEST LEVEL to the M DET IN jack of channel B. Patch LOW TEST LEVEL to CURR LIM IN jack of channel B and the CURR LIM OUT jack to S DET IN jack (removing the open-circuit plug). Measure and record the currents in SPR A and SPR B CURRENT jacks. Requirement: +30 to +55 each.

(g) While measuring the current in the SPR B CURRENT jack, slowly turn the channel B ADJ S REC GAIN potentiometer until the METER indication has increased 20. With this gain setting, measure the current in the SPR A CURRENT jack. Requirement: 15 to 30 less than that recorded for the SPR A CURRENT jack in paragraph (f).

(h) When locating trouble, it may be desirable to repeat the above tests interchanging the marking and spacing detectors, i.e. substituting M for S and S for M in the procedure.

(i) Remove all open-circuit plugs and patch cords.

f. Adjustment of Sensitivity of Detectors.

(1) General.—Tests with noise have indicated that the best operating level for the detectors is about 7 db above the level which makes the detector output current one-half its maximun value. The following procedure results in this optimum level; the pad controlled by the ADJ REC GAIN button is 9 db instead of 7 db because the channel filter is not in the circuit during the adjustment, as it will not pass the test frequency, 2550 cycles.

(2) Procedure.

(a) Insert open-circuit plugs into both CURR LIM OUT jacks, operate the 1 TST knob to TST, and in channel A patch the NORMAL TEST LEVEL jack to PAD IN and PAD OUT to M DET IN.

(b) Turn the ADJ M REC GAIN potentioneter of channel A to the maximum clockwise position and measure the current in the REC REL 1 CURRENT jack. Requirement: +20 to +40.

(c) Hold the ADJ REC GAIN button of channel A depressed, and turn ADJ M REC GAIN potentiometer counterclockwise until the meter indication of REC REL CURRENT is one-half the value found in paragraph (b) above.

(d) Repeat paragraphs (a), (b), and (c) on each of the other three detectors in turn. The meter indications for spacing detectors are negative. The detectors now have their correct operating gain.

(e) Remove all patches and open-circuit plugs and restore the 1 TST knob to horizontal.

(f) When the circuit is to be used for high-speed signals, it is desirable to relocate the two MVB and two SVB tubes in the detectors so that the detector output current (measured as in paragraph (b) above) from an MVB tube is nearly the same in magnitude (though of opposite sign) as the current from the SVB tube in the same channel. This need not be done for 60 words per minute, since the resulting decrease in bias would be small.

g. Use of Detector to Measure Levels.—Normal test level, 2550 cycles at -6 dbm, is connected to the detector input through a pad of 9 db, thus making the input level -15 dbm. The detector output current is noted and used as a reference point for determining whether an unknown level is greater or less than -6 dbm when impressed through the 9-db pad. The lining-up procedure for detectors ensures that this current will be about 12 to 20 milliamperes (meter indication 25 to 40); its value changes rapidly with changes in input level, and the changes are not directly proportional to changes in level.

(1) Operate 1 TST knob to TST and patch NORMAL TEST LEVEL jack to PAD IN jack.

(2) Patch PAD OUT jack to M DET IN jack of the channel under test (or to DET IN jack of any other detector being used).

(3) Patch D-C METER jack to REC REL 1 jack and operate the METER knob to D-C.

(4) Patch DET OUT CH A (or B) jacks of the channel under test to REC REL IN CKT 1 jacks (or insert open-circuit plugs in the DET OUT CH B (or A) jacks of the other channel). This disables the noise-suppression circuits.

(5) Depress the ADJ REC GAIN button and note the METER indication; it should be +25 to +40 (negative if a spacing detector). The meter indication may now be used to measure the level of any tone connected to the PAD IN jack with the ADJ REC GAIN button depressed. If the indication is greater than the above noted value, the level is higher than that from the NORMAL TEST LEVEL jack (about -6 dbm); if the indication is lower, the level is lower than this nominal -6 dbm level. Levels are not directly proportional to the meter indications, however.

h. Adjustment and Testing of Current Limiter.—Test both limiters as follows:

(1) Connect a detector for measuring levels according to paragraph 9g, and patch its DET IN jack to PAD OUT jack of the channel under test, removing any plug that may be in CURR LIM OUT jack.

(2) Patch the NORMAL TEST LEVEL jack to CURR LIM IN jack of the limiter under test.

(3) Hold the ADJ REC GAIN button of the channel under test depressed and turn the OUT potentiometer of the limiter by means of a screwdriver until the METER indication is the same as that read in paragraph 9g(5) above. Restore the screwdriver to the holder provided on the equipment bay. Cultivate the habit of always restoring the screwdriver to its holder.

(4) Patch the A-C METER jack to the LIM OUT jack of the channel under test and operate the METER knob to A-C.

(5) Note the meter indication and the number of dbm it corresponds to in figure 5.

(6) Patch the LOW TEST LEVEL jack (about -50 dbm) to the CURR LIM IN jack and note the meter indication, and the corresponding dbm in the table. It should be 0 to 2 dbm less than the value found in paragraph (5) above.

(7) Remove all open-circuit plugs and patch cords not required for service.

i. Adjustment of Audio-frequencies.

(1) Method Using Steady Mark, AFC Provided.—This is the preferred method.

(a) Patch the D-C METER jack to the FREQ IND OUT jack and turn the METER knob to D-C. Calibrate the frequency indicator, if it has not been done within one week (see par. 9j).

(b) Turn the AFC knob to OFF and press the AFC DISCHG button momentarily. Wait a few seconds to allow the frequency to stabilize.

(c) Adjust the BFO frequency of the radio receivers to make the frequency indication 0. This adjustment may be made with the DISCHG button depressed, if preferred. The calibration of the automatic frequency control circuit below, will compensate for any frequency drift which might occur when the button is released.

(d) Patch the RAD REC OUT jack to CH FILTS IN. Measure the A-C output in the M CH F OUT jack. If the average meter indication exceeds +10, the frequency is correct. This assumes that the radio-receiver output has been correctly adjusted (see par. 9k). Remove the patch cords.

(e) Calibration of the Automatic Frequency-control Circuit.—After adjusting the frequency with the AFC knob turned to OFF, according to paragraph (a) to (d) above, turn the AFC knob to ON. Set the FREQ ADJ potentiometer to make the frequency indication 0. If the DISCHG button is depressed momentarily to speed this adjustment, wait a few seconds for the frequency to stabilize after releasing the button.

(f) When traffic starts on the circuit, note the indication of the frequency meter. If it is abnormally unsteady (see par. 10c), turn the AFC knob to OFF and adjust the BFO frequency to make it steady. If the steady indication exceeds ±15, notify the transmitting station that the frequency shift is too large if the indication is positive, too small if negative. If the indication is within the limits +15 to -15, repeat the frequency adjustment. The frequency control holds the marking frequency close to 2125 cycles and so the frequency meter will kick somewhat if the frequency shift is different from 850 cycles but is within the allowable limits. The receiver should not be tuned to remove this normal unsteadiness.

(2) Method Using Miscellaneous Signals, AFC Provided.

(a) Turn the AFC knob to OFF, press the DISCHG button momentarily, and wait a few seconds for the frequency to stabilize.

(b) Patch the D-C METER jack to the FREQ IND OUT jack and turn the METER knob to D-C.

(c) Adjust the BFO frequency of the radio receivers to make the frequency-indicator meter steady. If the steady indication exceeds ±15, notify the transmitting station that the frequency shift is wrong. This adjustment may be made with the DISCHG button depressed, if preferred.

(d) Turn the AFC knob to ON.

(e) If the circuit can be interrupted, patch a RAD REC OUT jack to CH FILTS IN jack and listen with the 716C head receiver in M CH F OUT and S CH F OUT jacks. If the marking and spacing signals have normal volume, the frequencies are correct. Remove the patch cords.

(3) Method, AFC Not Provided.

(a) Proceed as in paragraph (1) or (2), omitting the procedures involving the automatic frequency control.

(b) Adjust the frequency, finally, to make the frequency meter indication steady. If it exceeds ±15, check the frequency adjustment, and if it is correct, notify the transmitting station that the frequency shift is outside the limits.

(c) The BFO must be readjusted often enough so that the frequency indication does not exceed the limits ±80.

CAUTION: When changing the frequency adjustment on a working circuit, turn the BFO control slowly and be careful not to turn it too far, as errors would be caused in the received copy.

j. Calibration of Frequency Indicator.

(1) Turn the AFC knob (if provided) to OFF and press the DISCHG button momentarily.

(2) Obtain a steady marking signal and adjust the BFO frequency until the meter indicates 0. Check the correctness of the frequency by patching the RAD REC OUT jack to CH FILTS IN jack and measure the A-C level in M CH F OUT jack (should be 2 dbm less than the normal radio-receiver output, see par. 9k); remove the patch cords.

(3) Hold the FREQ IND CAL button depressed and turn the ZERO ADJ potenitometer to make the meter indicate 0.

(4) Release the button and readjust the BFO to make the meter indicate 0.

(5) Hold the FREQ IND CAL button depressed and again turn the ZERO ADJ potentiometer to make the meter indication 0.

k. Adjustment of Radio-receiver Output.

(1) Obtain a steady marking signal from the distant transmitter.

(2) Adjust the BFO control of the radio receiver to make the marking frequency 2125 cycles as indicated by a zero indication of the frequency indicator METER.

(3) To adjust channel A, turn the METER knob to A-C and patch the A-C METER jack to the NORMAL TEST LEVEL jack. Note the meter indication.

(4) Patch the A-C METER jack to RAD REC OUT jack of channel A.

(5) Adjust the radio-receiver output by turning the AUDIO control on the channel A radio receiver until the average meter indication is the same

as that noted in paragraph (3). The above procedure will result in a nominal signal level at the RAD REC OUT jack of about -6 dbm. This adjustment should be checked on several different days at the start of service in order to obtain an adjustment for average radio conditions. Once this average adjustment has been made, do not change it as radio conditions change from day to day; the limiter should compensate for these. Change it only if tests indicate that the adjustment is far from the correct value, or if the two channels do not have the same average output.

(6) To adjust channel B, follow the procedure in paragraph (5) above, substituting channel B for channel A. Make the outputs of the two receivers as nearly the same as is practical, in accordance with the instruction book for the receivers.

(7) Remove all patch cords not required for service.

l. Measuring Received Bias.—Reversals or repeater printer signals similar to reversals are sent from the local or distant radio transmitter. The meter indication of receiving loop current is used as a measure of bias.

(1) Turn the 1 TST knob to TST. Patch the NORMAL TEST LEVEL jack to the M DET IN jack of channel A in order to operate the receiving relay steadily to its marking contact, and measure the LOOP CURRENT. The meter indication should vary from 67 ±3 when the resistance of the line to the printer equipment is negligible to 21 ±1 when this line has its maximum allowable resistance of 3700 ohms. If noise in channel B causes the receiving relay to operate, disconnect it by inserting open-circuit plugs in DET OUT CH B jacks.

(2) Patch the NORMAL TEST LEVEL jack to the S DET IN jack of channel A and neasure the LOOP CURRENT. It should be negative and the same numerical value as that measured in paragraph (1) above. Remove the patch cords and the open-circuit plugs. (With a ground-return loop, the marking and spacing loop currents will differ if there is a difference in ground potential between the two ends of the loop.)

(3) Local Test.—If the signals from the local transmitter can be received locally (only when operated simplex), send reversals from it, or if a source is not available, send repeated RYRY---- signals automatically (not by keyboard). If local signals cannot be received, have them sent from the distant transmitter. If both the transmitting and receiving circuits are unbiased, the average meter indication will be 0 in the case of reversals, and +5 per cent of the loop current measured in paragraph (1) above in the case of repeated RY signals. If the indication exceeds the limits ±3 per cent for reversals or +2 to +8 per cent for RY signals (i.e., for a steady loop current of 58, if the meter indication with reversals exceeds ±2 or with RY signals +1 to +5), check the adjustment of the receiving relay and of the transmitter relay, using the portable relay test set. The measurement cannot

be so precise with RY signals as with reversals, because of the vibration of the meter needle. The observer will have to use his judgment as to what is the average indication of the meter. (If the steady marking and spacing currents measured in paragraphs (1) and (2) differ, one-half the algebraic sum of the two is the meter indication for no bias and it shall be added to the above limits. For instance, if the two values are +60 for mark, and -66 for space, the no-bias indication is (60-66) ÷ 2 = -3; the limits for reversals are -5 to -1; for RY signals -2 to +2).

(4) To test the second receiving relay circuit, patch DET OUT CHS A and B jacks to REC REL IN CKT 2 jacks and REL OUT 2 jacks to REC LOOP jacks. If the loop is ground return, a single cord equipped with 347A plugs may be used for this latter patch, connecting the left-hand REL OUT 2 jack to the left-hand REC LOOP jack.

(5) Obtain reversals or repeated automatic RY signals from the distant transmitter. If the average bias measurement exceeds the limits given in paragraph (3) above, have the adjustment of the distant transmitter relay checked. Remove all patch cords not required for service, and restore the TST knob to horizontal.

m. Adjustment of Alarm Sensitivity.

(1) Turn the AFC knob (if provided) to OFF, and tune the radio receiver to give the correct audio frequencies, according to paragraph 9i(3), (Method, AFC Not Provided). If the steady frequency-meter indication with miscellaneous signals exceeds ±15, have the frequency separation between marking and spacing signals readjusted at the transmitter to bring it within these limits.

(2) Obtain a steady marking signal.

(3) Adjust the BFO control of the radio receiver to make the frequency indication -80 (250 to 300 cycles above the correct frequency), unless another value is specified. When a frequency-control circuit is provided, make the indication -50.

(4) Obtain printer signals from the transmitter.

(5) Turn potentiometer OUT counterclockwise to its minimum position and then turn it clockwise, slowly, until the alarm bell just rings, and leave it at this setting. If with automatic frequency-control the bell does not ring for the above -50 indication when the potentiometer is at its maximum clockwise position, set the frequency to obtain a -80 indication, and check that the bell rings. Leave the potentiometer at maximum.

(6) Restore the radio receivers to their correct tuning and turn the AFC knob to ON. The bell should stop ringing.

(7) If the bell does not ring when the frequency is set for a -80 indication in paragraph 9m(5), make the following slight readjustments of the bell in an attempt to make it ring.

(a) Place long-nose pliers on the armature tension spring (vertical spring to the left of the left-hand coil) near the bend. Turn the pliers slightly counterclockwise to reduce the tension of the spring against its stop.

(b) Apply pressure at the end of the armature sufficient to cause the armature stop pin to touch the pole piece of the right-hand coil. There should be a very slight clearance between the clapper and the gong. To adjust for the proper clearance, loosen the gong-supporting screw and reposition the gong while tightening the screw. If necessary, bend the clapper arm with the long-nose pliers. Make further slight adjustment of the armature tension, if necessary, to make the bell ring.

(c) If the bell still fails to ring, refer to paragraph 31b.

n. Test of Frequency Tolerance.—The frequency tolerance of the receiving equipment is tested by varying the frequency of the received signals by means of the manual tuning adjustments in the radio receiver. This test is used for trouble location only.

(1) To test channel A, patch REC REL IN CKT 1 jacks to DET OUT CH A jacks and turn the AFC knob to OFF (if provided).

(2) Obtain printer signals from the transmitter, preferably a test line repeated continuously, and check the frequency (see par. 9i). If the steady meter indication with miscellaneous signals is greater than ±15, have the frequency shift of the transmitter changed to meet these limits, provided this can be done, and record the final indication. Turn the TST knob to TST. Take a record of a few lines on the printer or typing reperforator. (If the printer is at a different location, this test will require co-operation from the printer operator.)

(3) Obtain a steady mark in the radio receiver.

(4) Calibrate the frequency meter and adjust the BFO control in the receiver bay to cause the meter indication to be as follows:

If Steady Frequency Indication in Par. (2) Was:	Adjust BFO to Make Frequency Indication
0 to ±5	+80
±5 to ±10	+75
±10 to ±15	+70

(5) Record a few lines on the printer or reperforator with the BFO control at the setting found in paragraph (4) above.

(6) With a steady mark, adjust the BFO control to make the frequency indication the negative of the value adjusted to in paragraph (4); i.e. -80, -75, or -70.

(7) Record a few lines with the BFO control at the setting found in paragraph (6).

(8) To test channel B, patch REC REL IN CKT 1 jacks to DET OUT CH B jacks and repeat the above procedure.

(9) If considerably more errors are found in either channel when the frequencies are at either extreme setting than when they are properly centered, a filter may be in trouble. Filters, however, are rarely in trouble and so a careful check of the tests should be made before replacing a filter. Interchange filters between the good and bad channel one at a time and repeat the above tests: if the poorer results are obtained on the channel which was good in the tests of paragraphs (1) to (7) when a filter is patched into that channel from the other, it is to be presumed that that filter is in trouble. The filters are interchanged by means of the following patches:

From Jack of One Channel	To Jack of Other Channel
RAD REC OUT	INP FILT IN
CURR LIM IN	INP FILT OUT
M CH F OUT	M DET IN
S CH F OUT	S DET IN
PAD OUT	CH FILTS IN

If considerably more errors are found on both channels when the frequencies are at their extreme settings, than when they are properly centered, suspect that the indication of the frequency indicator is wrong. This may be checked by asking the distant station to obtain a frequency check.

(10) Retune the radio receivers, remove all patch cords not required for service, turn the TST knob to make the indicator horizontal, and restore the AFC knob to ON.

o. Test of Frequency Control.

(1) Obtain a steady marking signal and calibrate the automatic frequency control [see par. 9i(1)(e)].

(2) Turn the AFC knob to OFF, press the DISCHG button momentarily, and wait a few seconds.

(3) Adjust the BFO control to make the frequency indication +100.

(4) Turn the AFC knob to ON. The frequency indication should stabilize in a few seconds between 0 and +10.

(5) Turn the AFC knob to OFF, and press the DISCHG button momentarily.

(6) After a few seconds, adjust the BFO control to make the frequency indication -100.

(7) Turn the AFC knob to ON. The frequency indication should stabilize between 0 and -10.

(8) Readjust the BFO control for correct audio frequencies.

p. Check of Normal Test Level.—If a db meter which measures levels of -8.5 dbm is available, it may be used to check the Normal Test Level, which should be within the limits -3.5 to -8.5 dbm if meter is 600 ohms, or between the limits of -2.5 to +2.5 dbm if the meter is high impedance. If the Normal Test Level is low, check tube VA and its associated circuit elements. The settings of the ADJ REC GAIN potentiometers in the four detector circuits offer a rough check of the correctness of the test level. Their normal position, when adjusted according to paragraph 9f, is about 0.4 of their total range clockwise from their minimum gain position. If the average setting of the four detectors, therefore, corresponds to this position, it may be assumed that the test level is correct. If the normal setting of one ADJ REC GAIN potentiometer exceeds 0.5 of its range from minimum, it may indicate that a tube has low gain. If all tubes pass their tests and the detector fulfills all test requirements, it will be satisfactory for service.

10. OPERATION.

a. Summary of Indicators for Normal Operation.

(1) When signals are being received, no patch cords or plugs should be in any jacks except:

(a) When REC RELAY CKT 2 is used, REC REL IN CKT 2 jacks are patched to DETS OUT CHS A & B, and REL OUT 2 to REC LOOP.

(b) The METER may be patched to any CURRENT jack and the 716C head receiver to a MON jack at any time.

(c) The following knobs should be as indicated:

Knob	Position
AFC (when provided)	ON
TST (working REC RELAY circuit)	Horizontal
TST (spare REC RELAY circuit)	TST

(2) If the frequency meter remains within the limits +80 and -80, the frequencies are within the working range. Readjust the tuning of the radio receivers often enough, when there is no automatic frequency-control circuit, so that the meter does not kick beyond these limits.

(3) If the ALM bell rings, the receiver tuning should be readjusted.

(4) If, after retuning, the steady meter indication exceeds ±15, check the tuning and, if it is correct, notify the transmitter station that the frequency separation between marking and spacing frequencies is wrong.

(5) Check the voltage of the plate supply by patching the D-C METER to PLT V TST jack. Measure this voltage frequently for a few days after service is first started and occasionally after that. If the voltage is within the limits 63 to 67 (130 ±4 volts) as indicated by the meter, do not readjust. If the voltage exceeds the limits 63 to 67 on the meter, readjust to 65.

(6) Check the voltage of the telegraph supply when a KS-5844 rectifier is provided, by patching the D-C METER to TLG V TST jack. The indication should be about 65 ±2. The indication varies approximately the same percentage from 65 as the percentage departure of the power-supply voltage from its normal voltage. If the meter indication exceeds 67, turn the ADJ VOLTS knobs to make the indication approximately 67; if it is less than 63, turn the knobs to make it approximately 63.

(7) A buzzer indicates that a fuse has blown.

b. Listen to signals frequently with the 716C receiver at the MON jack in order to become familiar with how signals sound under different radio conditions. This knowledge will be valuable in diagnosing trouble. The sound will be different in the MON jack from that in the monitoring jack of the radio receiver, because the INPUT FILTER precedes the MON jack in the circuit.

c. The automatic frequency control holds the marking frequency close to 2125 cycles. If the transmitter-frequency shift is not 850 cycles, therefore, the frequency indication will be somewhat unsteady. Become familiar with the meter indication, when the frequency shift is known to be within the limits, in order to be able to judge when the limits are exceeded. To gain this experience, measure the frequency shift at the time the frequency is being adjusted. (Turn the AFC knob to OFF and adjust the BFO control to make the frequency indication steady for miscellaneous signals.) Restore the AFC knob to ON, and watch the meter indication.

d. Summary of Procedure for Adjusting Audio Frequencies, AFC Provided (See Par. 9i).

(1) Method Using Steady Mark.

(a) Turn the AFC knob to OFF. Press the DISCHG button momentarily and wait a few seconds.

(b) Adjust the BFO to make the frequency indication 0.

(c) Patch RAD REC OUT to CH FILTS IN and measure A-C volume in M CH F OUT jack. Remove the patch cords.

(d) Turn the AFC knob to ON and calibrate the AFC.

(e) Check that the indication of the frequency meter with miscellaneous signals is not abnormally unsteady.

(2) Method Using Miscellaneous Signals.

(a) Turn AFC knob to OFF. Press the DISCHG button momentarily and wait a few seconds.

(b) Adjust the BFO to make the frequency indication steady. Limits +15 to -15. (DISCHG button may be held depressed if desired.)

(c) Turn the AFC knob to ON and check that the frequency indication is not abnormally unsteady.

(d) If allowable, patch RAD REC OUT to CH FILTS IN and listen with the 716C head receiver in M CH F OUT and S CH F OUT. Remove the patch cord and receiver.

e. Routine Tests.

(1) Schedule.—Make tests periodically according to the table below. In the column headed "Test Period", M and W indicate monthly and weekly, respectively. Under "Paragraph" is given the number of the paragraph in which the test is described.

Test	Test Period	Paragraph
Local and over-all bias test	W	9ℓ
Normal test level	W*	9p
Regulated tube rectifier voltage	W*	10a
Disc-type rectifier voltage	W	10a
Frequency-indicator calibration	W*	9j
Automatic frequency-control calibration	W*	9i(1)(e)
Detector sensitivity	W*	9f
Radio-receiver output	W	9k
Vacuum tubes	M	10e(2)
Limiter	M*	9h
Noise-suppression circuit	M*	9e
Polar relays including spares	M	10e(4)
Test of frequency control	M	9o
Adjustment of alarm sensitivity	M	9m

*Perform all tests described for an item of equipment whenever a tube is changed in that item.

(2) Vacuum Tube Tests.—Test all vacuum tubes including spares once a month using Test Set I-171 (Hickok Model 560), I-56-C or the equivalent. Follow the instructions for testing and rejecting tubes which accompany the test set.

(3) Plug Cleaning.—Polish all plugs often enough to keep them bright, wiping polish off carefully with clean cloth.

(4) Polar Telegraph Relay.

(a) Test polar relays with a portable polar relay test set (Signal Corps Test Set I-193-A or Western Electric Company Polar Relay Test Set X-61809A). Insert the plug of the test set cord into the TST SET BAT jack in the telegraph terminal bay to provide testing power for the test set. Follow the instructions accompanying the test set for testing the relay and for readjusting it if it fails to pass the electrical test.

(b) In the table in paragraph e(1) it is specified that all polar relays be tested once a month. Relays in some locations and services may require testing less frequently. This can be determined from the results of the tests and from whatever service irregularities are attributed to the relays for the first 6 months of operation. Once every 6 months readjust each working relay regardless of whether it meets the electrical test with the relay test set. Following the test set Instruction Book procedures, back off the contact screws, file them, and then readjust the relay.

f. Emergency Operation with One Channel.—If one channel is in trouble, the good channel can be used temporarily. Service will be inferior, however, and so 2-channel operation should be restored as soon as possible. To operate on one channel:

(1) Place open-circuit plugs in CURR LIM OUT and DET OUT M and S jacks of the channel in trouble.

(2) Adjust the AUDIO control of the receiver in the defective channel for minimum output, to prevent interference with the operation of the automatic-frequency control. If this receiver must be used to locate the trouble, disconnect the frequency-control circuit from it by disconnecting the shielded pair from lug 1B or 2B of the frequency-control panel.

SECTION III
FUNCTIONING OF PARTS

11. OVER-ALL CURRENT.

a. Figure 6 is a schematic drawing of one terminal of the over-all circuit. A complete circuit includes another similar terminal at a distant place.

b. In the radio transmitter circuit, signals from the telegraph-sending circuit control the frequency of the radio signals. During marks the transmitter puts out its normal frequency as determined by the transmitter exciter. During spaces the frequency of the radio signal is reduced 850 cycles. Different radio frequencies are used in the band from 2.4 to 26 megacycles and any one transmitter may use one of several frequencies in this range, the particular frequency chosen depending upon the length of path, the time of day, and the season.

c. At the receiving station, radio signals are received in two different antennas spaced several wavelengths apart. Radio waves at the frequencies used in this system are subject to fading. The signal arrives at either antenna over two or more changing paths of different lengths and the waves over these paths may neutralize or reinforce each other depending upon their respective phase relations. When the phase relations are such that they neutralize in one antenna, however, the phase relations are different in the other antenna spaced a few wavelengths away and so will not usually neutralize each other in the second antenna. Thus by using two antennas in a space-diversity receiving arrangement, there will usually be a good signal in one or the other.

d. Each antenna is connected to a superheterodyne radio receiver in which the signals are demodulated. The marking signal becomes 2125 cycles at the output of the radio receiver and the spacing signal, 2975 cycles. These frequency values are nominal, and the receiving equipment is designed to tolerate a total variation of ±300 cycles for the transmitted frequencies and the beat frequencies of the receivers combined. The two channels of the receiving diversity circuit are designated channel A and channel B. The signals in channel A pass from the radio receiver through a 7-db pad and an input filter to a LIMITER. The filter passes all frequencies within both the marking and spacing bands but excludes noise frequencies outside of these bands. In the limiter, the signals are amplified and the action of the limiter is such that it delivers a substantially constant output for wide

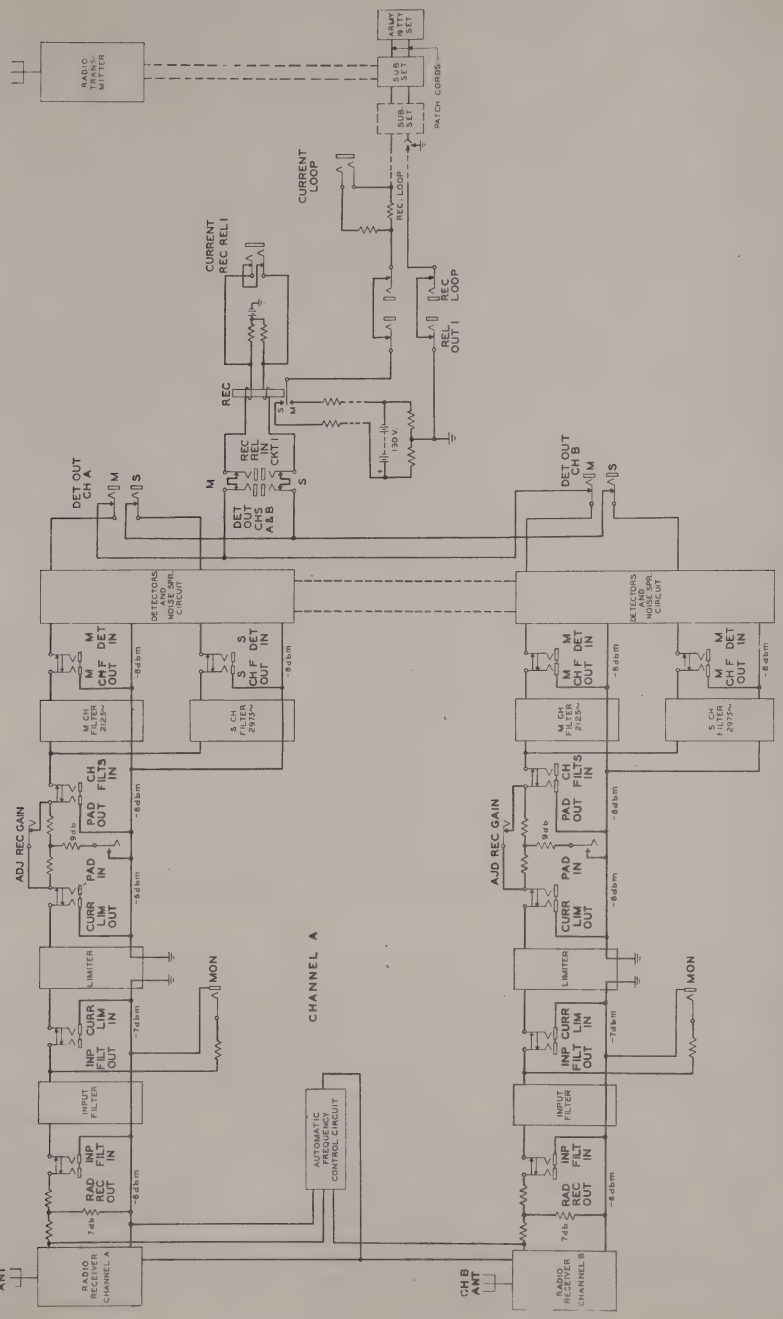


Figure 6 - Schematic of One Terminal

variations of the input level. The marking and spacing frequencies are separated at the limiter output by the M CH FILTER and S CH FILTER and are separately amplified and rectified in the DETECTORS. The rectified marking signal passes through the marking winding of the receiving relay, operating it to its marking contact and the rectified spacing signal passes through the spacing winding, operating it to its spacing contact. The circuit of channel B is the same as that of channel A. The rectified marking signal from channel B passes through the marking winding of the receiving relay, which is common to the two channels, in parallel with the rectified marking current of channel A; and likewise the rectified spacing signal of channel B actuates the spacing winding of the receiving relay. Most bays are equipped with an automatic frequency-control circuit, which regulates the intermediate beat frequency of the radio receiver to keep the marking audio frequency within narrow limits.

e. Two sets of antennas may be provided to communicate with two different distant points; in this case, a control circuit enables the operator at the telegraph station to connect the radio transmitter and receivers to either or both sets of these. This latter connection is used, normally, only to monitor circuits in which the distant transmitters are not energized. A monitoring circuit, in this case, keeps the teletype equipment from responding to noise and is automatically restored to normal when a steady marking signal is received longer than about 1/4 second.

f. The receiving relay sends polar d-c signals over the loop circuit to the printer station.

g. A noise-suppression circuit is provided which decreases the magnitude of the relay current from channel A or channel B, if the signal-to-noise ratio in one is lower than in the other; it does not depress both channels simultaneously.

h. In figure 6, signal levels are indicated in dbm at various points in the circuit. These are the nominal levels for either a steady marking or spacing signal and are expressed in db below a milliwatt. Levels at the limiter output and beyond are constant except at the bottom of a very deep fade. Preceding the limiter, however, the levels fluctuate widely from about 10 db greater than their nominal values to many db less.

12. RADIO TRANSMITTER.

a. The sending equipment at the printer station sends polar d-c signals through a loop circuit to the radio-transmitter station, current being sent in one direction for marking signals and an equal and opposite current for spacing. The magnitude of these currents depends on the resistance in the loop, the minimum being 10 milliamperes for the maximum allowable re-

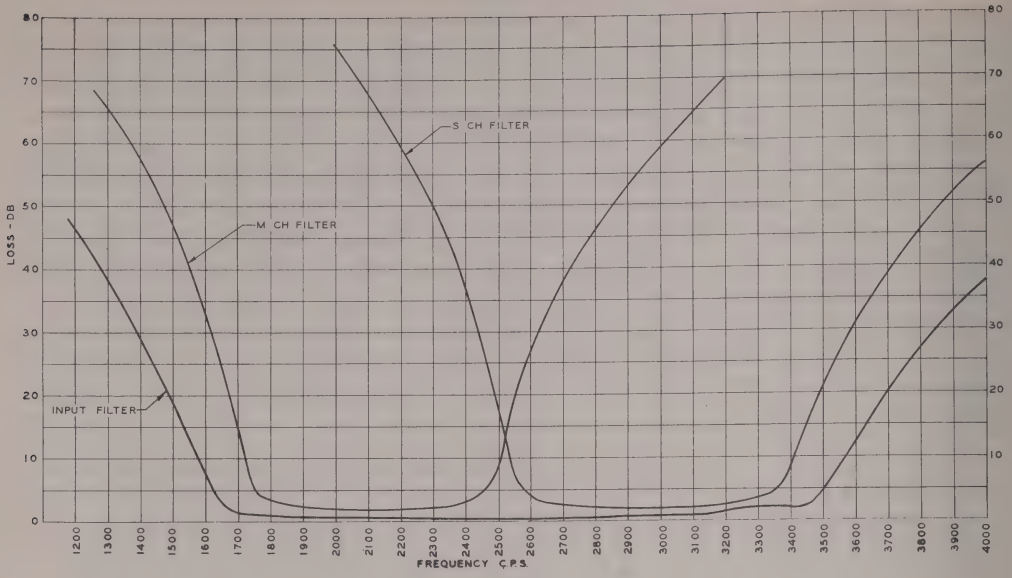


Figure 7 - Filter Losses



Figure 8 - Limiter Characteristics

sistance, 4150 ohms, and 35 milliamperes for zero loop. At the transmitter, one winding of a 255A relay is inserted in this loop circuit. When this relay is in the spacing condition, it causes the frequency of the radio signal at the output of the radio transmitter to be reduced approximately 850 cycles.

13. RADIO RECEIVER.

Each radio receiver is of the superheterodyne type, employing oscillators which are common to the two receivers. In the first stage, the output of a high-frequency oscillator modulates the incoming signal, reducing it to a frequency of about 465 kilocycles. This intermediate frequency is again modulated by means of a second oscillator, which is adjusted so that beat frequencies of about 2125 and 2975 cycles result in the audio output for marking and spacing frequencies respectively. This second oscillator may be either crystal or manually controlled. In receiving terminals equipped with automatic-frequency control, either the automatic-frequency or crystal control may be employed. The automatic-frequency control should usually keep the audio frequencies within ±50 cycles of their nominal values. When this control is not used, the frequencies should not be allowed to depart more than ±300 cycles from their nominal values.

14. FILTERS.

a. The INPUT FILTER passes a frequency band of about 1600 to 3600 cycles. A typical loss characteristic plotted against frequency is given in figure 7. The pass band of this filter is made wide enough to pass both the marking and spacing signals when the frequencies of these signals vary over the range of ±300 cycles.

b. The M CH FILTER passes a band of about 1700 to 2500 cycles. A typical loss characteristic of this and of the spacing filter is shown in figure 7.

c. The S CH FILTER passes a band of about 2600 to 3400 cycles.

15. LIMITER.

a. The strength of signals received over a short-wave radio circuit varies many db due to fading. To compensate for this, a limiter is inserted in the circuit, which has the property of delivering a substantially constant output for wide variations in the input level. A typical input-output characteristic is given in figure 8.

b. A front view of the current limiter panel is shown in figure 9 and a schematic drawing of the circuit is shown in figure 10, on the following page. The signals are amplified by the first tube which is designated IN.

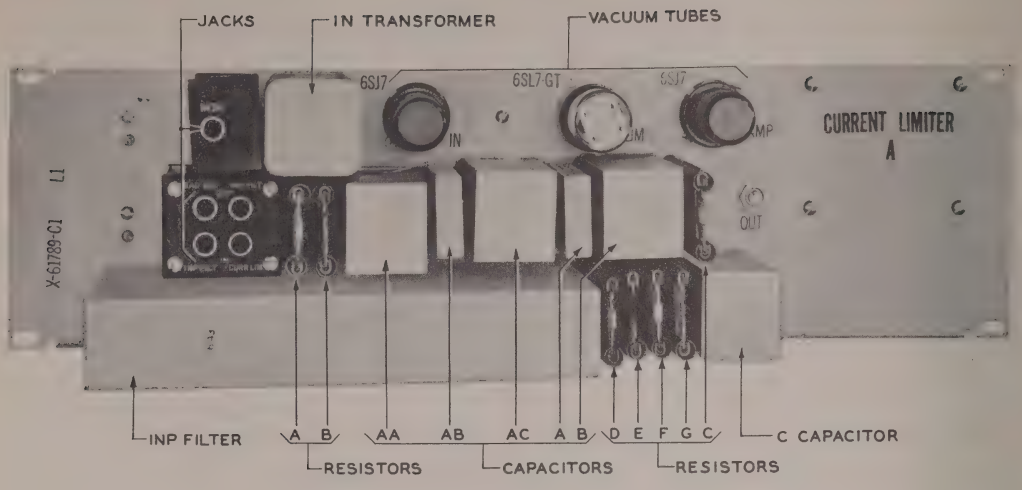


Figure 9 - Current-limiter Panel, Front View

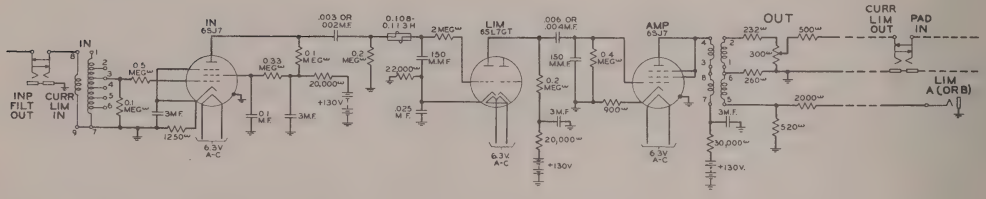


Figure 10 - Current Limiter Circuit

A 0.5-megohm resistor is in series with the control grid of this tube. If signals are strong enough to cause this grid to become positive, grid current will flow, producing a voltage drop in this resistor. Therefore, though this tube for ordinary signals acts solely as an amplifying tube, it has some limiting action for strong signals. The output of this tube is connected to the second tube, designated LIM, through a single-section low-pass filter which excludes high frequencies. A 2-megohm resistor is in series with the control grid of the LIM tube and it is this tube that acts as a limiter for weaker signals. When the grid becomes positive, the voltage drop through this resistor will be sufficient to limit the grid potential to a value only slightly positive with respect to the cathode. Thus a definite upper limit

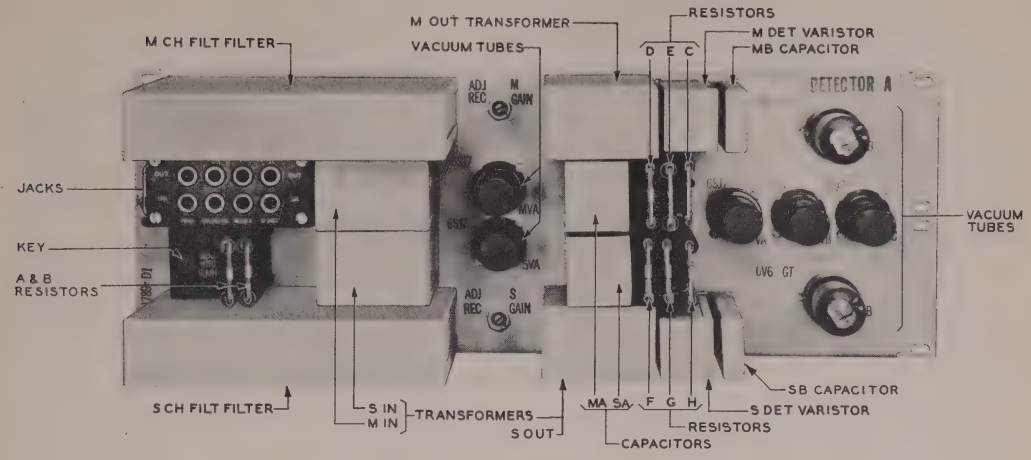


Figure 11 - Detector Panel, Front View

is imposed on the positive portion of the a-c wave. A definite limit is imposed on the negative portion by the cutoff of the tube characteristic. Therefore, the output will have a substantially constant value if the input exceeds -40 dbm. The third tube, designated AMP, amplifies the output from the second tube. The output coil of this tube has two secondary windings, one of which is connected to the detector circuit and the other to the frequency indicator. A potentiometer in the first of these outputs is used to adjust the signal level to a value of about -6 dbm.

16. PAD.

Between the limiter and the detector a 9-db pad is inserted in the circuit by means of the ADJ REC GAIN button. This is used for adjusting the gain of the detector circuit and is not in the circuit during operation.

17. DETECTOR.

A front view of the detector panel is shown in figure 11 and a schematic drawing of the circuit in figure 12, on the following page. This circuit contains two similar branches, one for marking signals and the other for spacing. The marking and spacing signals are separated from each other by the M CH and S CH FILTERS and the signal levels at the outputs of these filters are each approximately -8 dbm. From the output of the M CH FILTER, the marking signals pass through an input coil which is designed to operate most efficiently between impedances of 600 and 25,000 ohms, as indicated in the figure. Following the coil is a potentiometer and amplifier tube MVA. The

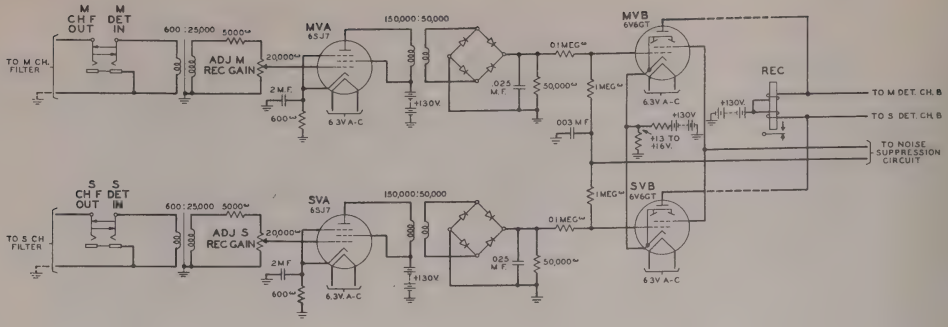


Figure 12 - Detector Circuit

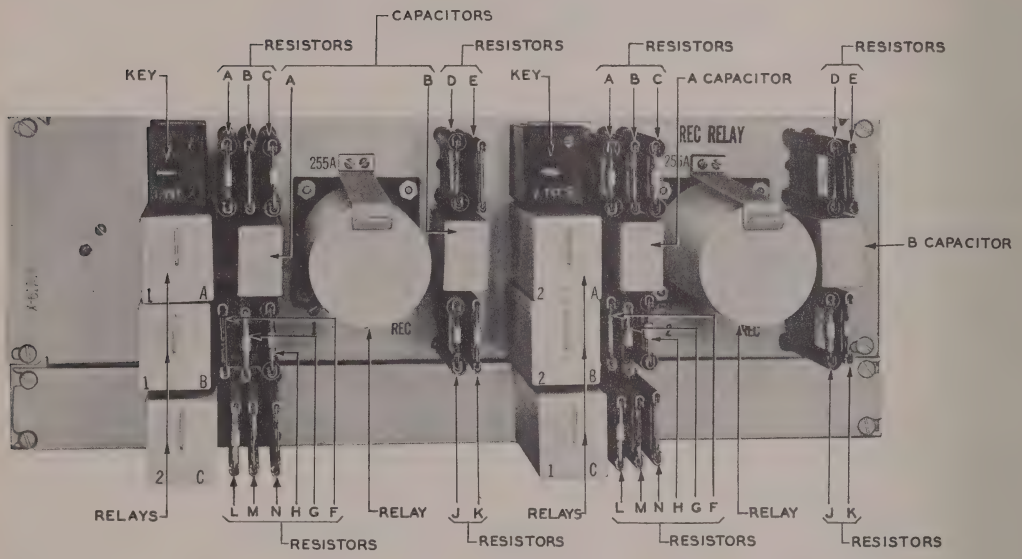


Figure 13 - Receive Relay Panel, Front View

output of this tube is rectified in a full-wave copper-oxide rectifier, most of the high-frequency components of the wave passing through a .025-microfarad capacitor across this rectifier. The rectifier current, which has a wave shape similar to the envelope of the a-c wave, is impressed on the control grid of tube MVB in which it is amplified. The amplified envelope from the plate of tube MVB passes through the marking winding of receiving re-

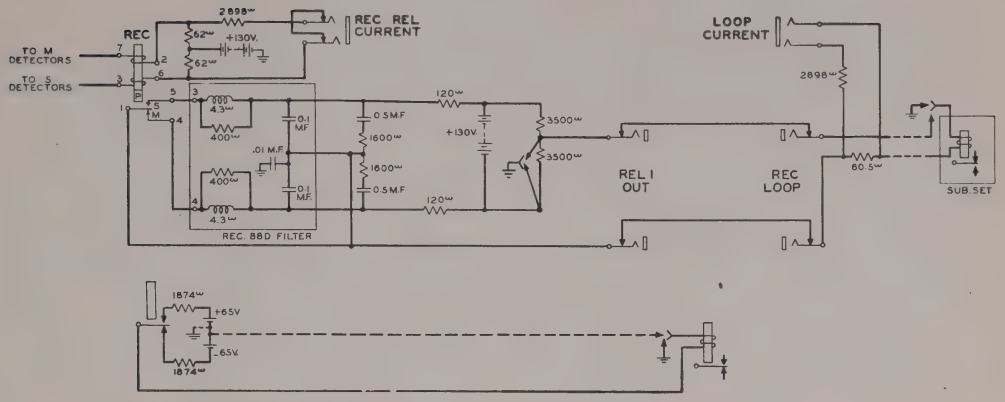


Figure 14 - Receive Relay and Loop Circuit

lay REC. Spacing signals are amplified and rectified similarly in the spacing detector and the rectified spacing signals pass from the plate circuit of tube SVB to the spacing winding of the receiving relay. With a steady marking signal, the normal current in the marking winding of the relay is 15 milliamperes from each channel and in the spacing winding zero milliamperes; with a steady spacing signal these currents are interchanged. When only one channel is connected to the relay, for some tests, the above currents are 30 and zero milliamperes, respectively, since in this case the noise-suppression circuit is disconnected, as explained in paragraph 20.

18. RECEIVE RELAY CIRCUIT.

a. A front view of the receive relay panel is shown in figure 13 and the relay and loop circuits are shown in the upper part of figure 14. When the receiving relay is operated to its marking contact by a marking signal from the detector circuit, it connects the negative pole of the regulated tube or disc-type rectifier through 124 ohms to the loop, which leads to the receiving telegraph equipment; when operated to its spacing contact it connects the positive pole of this 130-volt supply through 124 ohms to the same loop. The loop current returns to the midpoint of a potentiometer which is across the same voltage either metallically or through ground. This arrangement is electrically equivalent to that shown in the lower part of figure 14. The 130-volt power and 7000-ohm potentiometer produce the same loop currents as would two 65-volt batteries acting through 1750 ohms. It is evident that marking signals will cause current to flow through the receiving loop in one direction and that spacing signals will cause an equal current to flow in

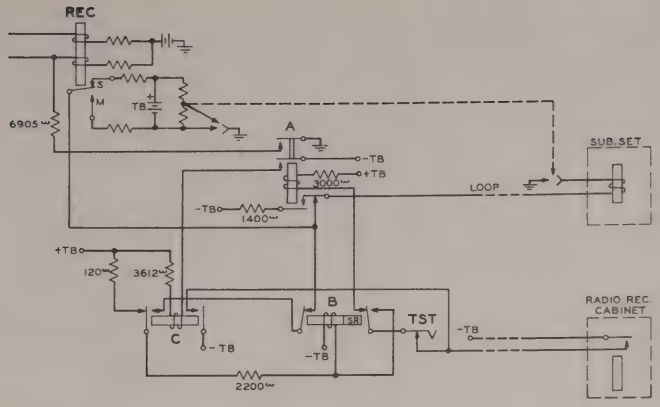


Figure 15 - Monitoring Circuit

the opposite direction. Thus the transmission to the subset will be polar, and practically independent of ordinary variations in rectifier voltage or loop current.

b. An 88D filter REC is connected in the contact circuits to prevent interference in neighboring circuits, and spark-killers are provided to protect the contacts. The marking and spacing relay currents can be measured by connecting a meter to the REC REL CURR jack. The current in the receiving loop can be measured by connecting a meter to the CURRENT LOOP jack. Jacks associated with the circuit of REL 1 or REL 2 are designated 1 or 2, respectively.

c. The marking and spacing relay windings are also connected to the plate circuits of the MVB and SVB tubes of channel B. Thus if signals are being received over both channels, the rectified currents from each will add in the receiving relay windings. The noise-suppression circuit, described below, reduces the rectified current from a channel when the noise becomes excessive.

d. The spare relay circuit, REL 2, may be patched in place of the regular circuit. When plugs are inserted in the REC REL IN CKT 2 jacks, contacts transfer the 130-volt power connection from circuit 1 to circuit 2; thus only one circuit is energized at a time.

e. Monitoring Circuit.

(1) The purpose of the monitoring circuit is to prevent the operation of the receiving printer equipment by noise when the radio receivers are connected to one or two radio circuits on which the distant transmitters are

not energized or when the receiving circuit is disabled because the local transmitter is sending the frequencies to which the receivers are tuned. When the distant transmitter sends a marking signal for more than about 1/4 second, the monitoring circuit automatically restores the loop circuit to its normal receiving condition and the monitoring circuit itself is restored to its nonmonitoring condition. If two radio circuits have been monitored simultaneously, the receivers must be disconnected from the idle circuit before messages are received. To set up the monitoring condition, relay contacts are closed in the radio-receiver cabinet for at least 0.1 second. These relay contacts are closed for more than 0.1 second during the switching operations which change from the receiving to the sending condition or which connect two antennas in parallel for monitoring. They are permanently closed while signals are being sent in simplex operation. Note that the monitoring condition cannot be set up while the distant transmitter is sending a steady mark.

(2) Figure 15 shows a monitoring circuit in schematic form. When the relay contacts in the radio-receiver cabinet are closed, they connect the negative terminal of the telegraph rectifier -TB to the winding of relay A, operating it. Relay B is normally operated. The top upper contacts (fourth and third) of relay A ground the spacing winding of the receiving relay through 6905 ohms, thus tending to hold it on the spacing contact. Noise may cause it to leave this contact momentarily but this will have no effect as long as it does not touch the marking contact for more than about 1/4 second. The first and second top contacts of relay A operate relay C. The bottom contacts of A connect -TB through 1400 ohms to the loop, thus holding the loop relay in the subset steadily on its marking contact and so preventing the operation of the printer equipment due to noise. The operation of the left hand contacts of relay C disconnect the winding of relay B from the positive terminal of the telegraph rectifier +TB, which has held it operated, and connect it to the armature of the REC relay. As noted above, this armature is held on the spacing contact which also is connected to +TB and so relay B, which is slow releasing, remains operated. The right-hand contacts of relay C connect -TB to the winding of relay A, through contacts of B, holding A operated.

(3) When a distant transmitter is energized for over 1/4 second with the frequency which corresponds to a marking signal, the REC relay operates to its marking contact, causing relay B to release. The release of relay B releases relay A which in turn releases relay C. Relay B thereupon operates again.

(4) Connections from the telegraph rectifier to either REC relay circuit pass through contacts of the REC REL IN CKT 2 jacks. When no plugs are in these jacks, the circuit of REL 1 is energized; when plugs are in, circuit 2 is energized.

19. NOISE-SUPPRESSION CIRCUIT.

a. If a signal in one of the channels is decreased in amplitude due to fading, that channel may receive considerably more noise or static energy than the other. The noise-suppression circuit reduces the strength of signals into the receiving relay windings from a channel when it is noisier than the other and at the same time increases the strength of signal from the quieter channel. This circuit is mounted on the detector panel.

b. When a steady marking signal is being received, the rectified voltage on the control grid of tube MVB is about +15 or +16 volts with respect to ground; it will be assumed to be +16 volts for the purpose of description. At the same time the voltage on the control grid of tube SVB will be zero volts if the circuit is not noisy. When a steady spacing signal is received, the above voltages are interchanged. A point which is electrically one-half way between these two grids, therefore, will normally be at a potential of +8 volts with respect to ground. Such a half-way point is the junction between the two one-megohm resistors ME and SE, designated P in figure 16. This junction point is connected to the control grids of tubes VC and VB in the noise-suppression circuit. Point P is not stamped on the equipment.

c. When a channel is noisy, some of the noise currents will be rectified in the spacing detector while marking current is being rectified in the marking detector and vice versa. Thus the potential at the control grids of the tube MVB or SVB which is not carrying signal is raised above zero and so P has a potential greater than +8 volts. This potential on the grids of tubes VC and VB causes the plate currents in these tubes to increase above their normal values of about 1 and 0.5 milliamperes respectively. This increased current in tube VC, flowing through the 6000-ohm resistor H, causes the voltage on the screen grids of tubes MVB and SVB to decrease and so the current from the plate of MVB or SVB into the receiving relay winding decreases.

d. The increased plate current in tube VB, flowing through the 30,000-ohm resistor N, causes the plate voltage to decrease. A potentiometer consisting of resistors P and R maintains the potential on the control grid of tube VA at one-third of that on the plate of tube VB, and so when the plate voltage of VB decreases due to noise, the grid of tube VA becomes less positive and its plate current decreases. The sum of the plate currents in tubes VC and VA remains practically constant at 9 milliamperes. The plate current of tube VA in channel A passes through the resistor H of channel B. Consequently, when its current decreases, the voltage on the screen grids of tubes MVB and SVB in channel B increases and so the plate current increases. The relay current is thus maintained at a nearly constant value of 30 milliamperes, but the portion of it contributed by the noisy channel is reduced,

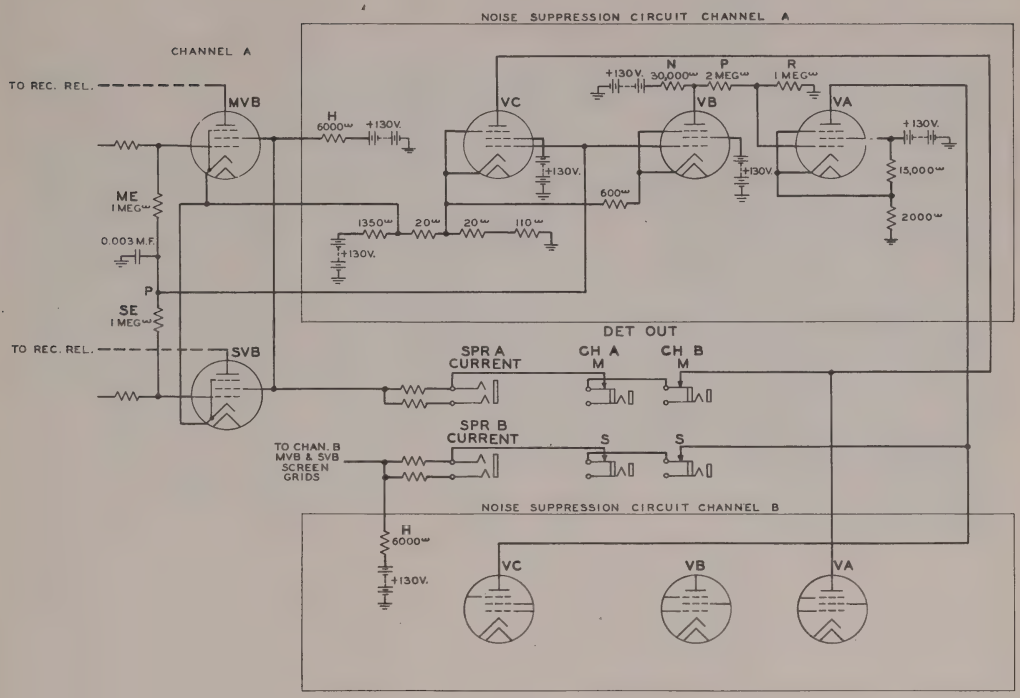


Figure 16 - Noise-suppression Circuit

and that contributed by the quiet channel increased. In extreme cases the current from the noisy channel may be as low as 5 milliamperes.

e. When both channels are equally noisy, the potentials of point P in both channels A and B are raised equal amounts above 8 volts and, though the plate currents in VC and VA depart from their normal values, the two channels change symmetrically. Thus the sum of the VC plate current in one channel plus the VA plate current in the other remains constant at 9 milliamperes and no voltage change will occur on the screen grids of MVB and SVB tubes in either channel.

f. If the noise-suppression circuits are disabled, for instance, by plugging open-circuit plugs into DET OUT CH A M & S jacks, the drain through the 6000-ohm resistors H due to tubes VC and VA is removed and so the potential of the screen grids of tubes MVB and SVB rises. This causes the cur-

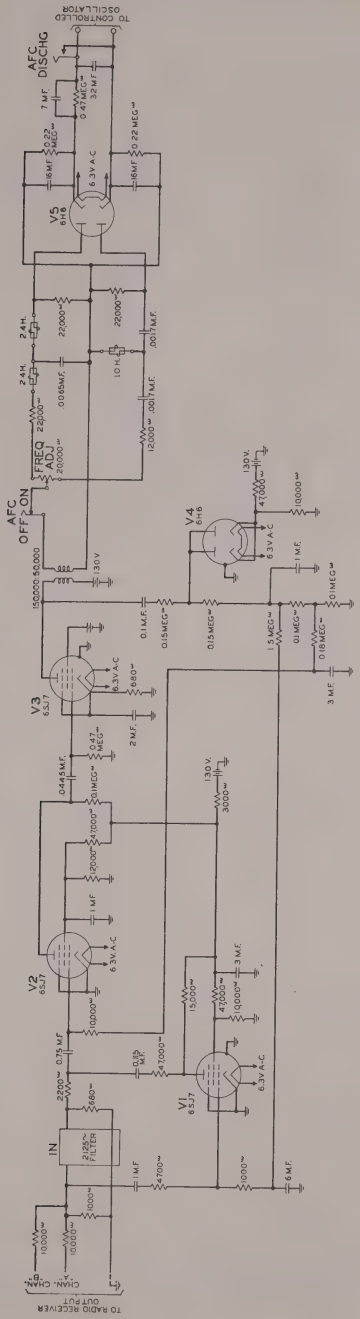


Figure 17 - Frequency-control Circuit

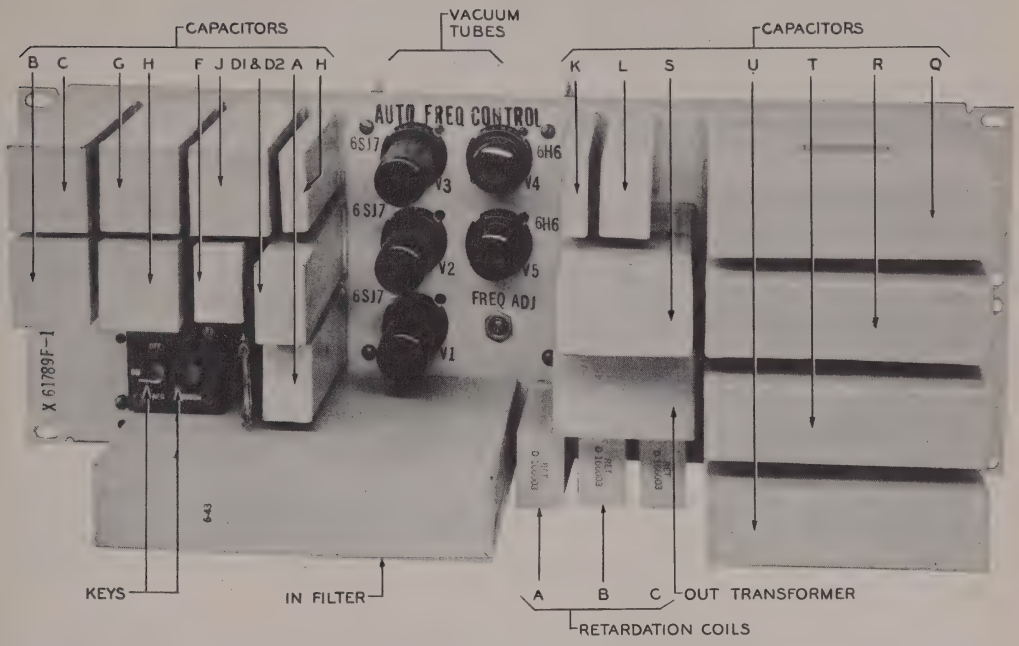


Figure 18 - Frequency Control Panel, Front View

rent from channel B through the marking or spacing winding of the REC relay to increase. If the CH B mark and space jacks had been opened instead, the current from channel A would have increased. Thus the relay current is substantially constant at about 30 milliamperes, regardless of whether one or two channels are connected.

20. FREQUENCY-CONTROL CIRCUIT.

a. A view of the frequency-control panel is shown in figure 18 and the circuit in figure 17. This circuit is designed to keep the marking audio frequency delivered to the AN/FGC1 equipment by the radio receivers within ±50 cycles of 2125 cycles. If the frequency deviates from 2125 cycles, a d-c voltage appears in the output of this circuit which causes a compensating change in the frequency of the radio-receiver output. The marking frequency passes through the IN filter to the control grid of tube V2 which amplifies it and it is further amplified in tube V3. The output of V3 contains two branches. In one branch a portion of the output passes through a 0.1-microfarad capacitor and a potentiometer which impresses one-half of the output voltage on the plates of double diode V4. The cathode of V4 is biased about +23 volts

by means of the 130-volt supply acting through a potentiometer. If the peak voltage of the a-c output of tube V3 exceeds about 46 volts, therefore, pulses of current will pass to ground through V4, increasing the charge of the 0.1-microfarad capacitor. As in other similar AVC circuits, the resulting current through the resistor-capacitor network which is connected between the plates of V4 and ground impresses a negative potential on the grid of tube V2. This is a variable gain tube, and so its gain is reduced. Thus tube V4 and its associated circuit acts as an automatic volume control and maintains the output of V3 substantially constant with a peak voltage somewhat greater than 46 volts. A negative potential is impressed on the control grid of tube V1 by the AVC circuit, which is twice the value impressed on V2. When V3 has its above normal output, this potential is sufficient to disable V1.

b. If the radio receivers are so far out of tune that the received frequency will not pass through the IN filter, i.e., if it is outside the limits of about 1600-2600 cycles, tube V1 will be active. This tube acts as a by-pass of the IN filter and the circuit constants are such that the loss through this by-pass is greater than the loss in the pass band of the filter. The automatic-frequency control, responding to this frequency, will bring the received frequency within the pass band of the filter and V1 will then be disabled, as explained above.

c. The second output of V3 is impressed on a high-pass and a low-pass filter in parallel, which act as a discriminator. These filters are adjusted to have the same losses at 2125 cycles by the FREQ ADJ knob. The outputs of the two filters are rectified in V5, which is a double diode connected to form two half-wave rectifiers. When the frequency is 2125 cycles, equal currents pass through the two diodes and so no voltage exists across the output terminals. If the frequency is lower than 2125 cycles, it passes freely through the upper filter to the upper diode whereas the lower filter allows little or no current in the lower diode. Thus the upper output terminal has a positive potential with respect to the lower terminal. Similarly, if the frequency is higher than 2125 cycles, the lower terminal is positive with respect to the upper. Since the latter is grounded, the upper in this case will be negative with respect to ground.

d. The output delivered to the controlled oscillator is ±1 volt for a frequency departure of about ±60 cycles from 2125 cycles. This control voltage acts upon the tuning of the intermediate frequency oscillator of the radio receivers to keep the marking frequency approximately 2125 cycles and it is expected that the maximum deviation from this value will be approximately 50 cycles. If one volt in the control pair causes a change in frequency of 1000 cycles in the radio receivers, and if the uncontrolled frequency is 2125 + 1060 cycles the control voltage tends to increase to a value much greater than -1 volt. But as it increases, the intermediate oscillator changes

frequency in the direction to decrease the output frequency. When the control voltage reaches -1 volt, the output frequency will have decreased 1000 cycles, establishing equilibrium, and so the controlled frequency will remain 2185 cycles (2125 cycles plus the 60 cycles necessary to make a 1000-cycle correction). The circuit controls the marking frequency in the range 2000 cycles below to several thousand cycles above 2125 cycles. The maximum voltage in the control pair is about 8 volts.

e. The automatic-frequency-control circuit will tune the receiver in 1 or 2 seconds if the transmitter is energized after being "off the air" for over 10 seconds. If under operating conditions, however, the frequency should suddenly be changed several hundred cycles, it would take about 10 seconds for the receiver to be retuned, because the delay circuit associated with the control grid of tube V1 must discharge before this tube can become active. A steady spacing signal lasting about 5 seconds can be sent without causing the received frequencies to depart excessively from the correct value. If this signal is prolonged about 10 seconds, the receiver tuning will be changed so that this space becomes approximately 2125 cycles. It will then require a steady mark of 10 seconds for the correct tuning to be re-established. A steady spacing signal lasting over 5 seconds, therefore, should be avoided.

f. The circuit is connected to both Channels A and B at the radio receiver outputs. The circuit can be made inoperative by turning the AFC knob to OFF. The DISCHG button is provided to short-circuit the output momentarily when testing, in order to save the time which would otherwise be required for the 32-microfarad capacitance to be discharged.

21. REGULATED TUBE RECTIFIER.

a. General.

(1) All a-c heater current for tubes and all 130-volt d-c power, except that used in the circuits associated with the contacts of the receiving relay, are furnished by either the X-61680B or X-61680C Rectifiers. They are identical except as pointed out herein and will be referred to as the B and C rectifiers. A front view of the rectifier B is shown in figure 19. For this application, these rectifiers will operate satisfactorily on input voltages of 103 to 127 or 207 to 253 volts alternating current in temperatures from -20F to +120F. The rectifier B is for 50-60 cycles and the rectifier C is for 25-60 cycles.

(2) These rectifiers should not be used to float a storage battery unless means are provided externally to prevent the output current from exceeding the rated value when the rectifier is started while battery voltage is low.

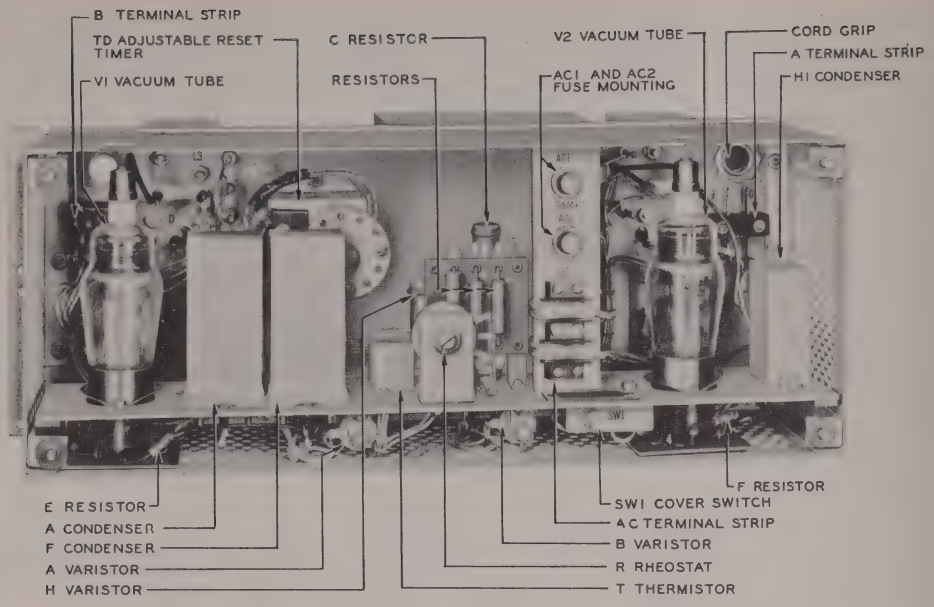


Figure 19 - Rectifier B Panel, Front View

(3) The wiring, tubes, terminal strips, etc., are on the front of the rectifier panel and are protected by a cover with a cover switch to kill high d-c voltages when the cover is removed.

(4) Output d-c voltage is regulated and may be adjusted with a screwdriver or coin applied to a slotted shaft which extends through the cover or can be reached through a hole in the cover. The a-c outputs of all rectifiers are unregulated.

(5) The transformer coils are cross-connected at terminal strip AC for 115- or 230-volt input as per the instruction plate located below the terminal strip. (The instruction plate designations are respectively 120 and 240 volts.)

(6) Input fuses are located on the subpanel with terminal strip AC and the rating of the fuses (3 amperes) is stamped on the subpanel. The fuses are removed by unscrewing the fuse mounting cap. Spare fuses are mounted in fuse holders at the top of the bay.

b. Rectification.

(1) A functional diagram of the rectifier circuit is shown in figure 20. In AN/FGC1 equipment, the cutout relay, shown connected to lugs 4 and 6, is omitted and therefore negative potential must not be connected to

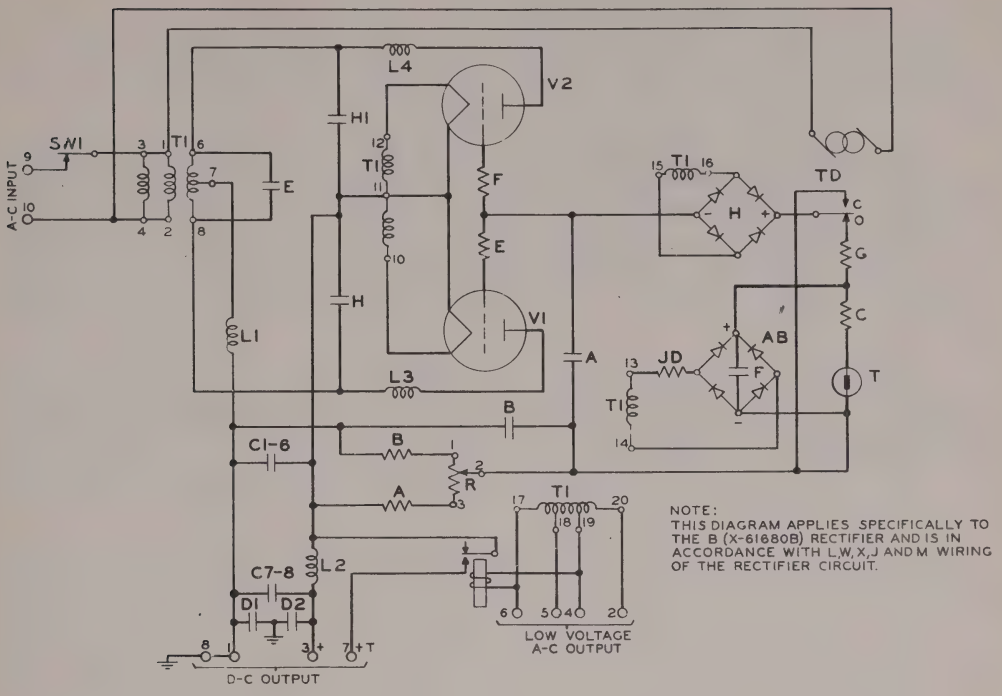


Figure 20 - Regulated Tube Rectifier Circuit

the output of the rectifier (or to the loop circuits of the AN/FGC1 equipment), as the electrolytic capacitors would be damaged when the rectifier power was shut off.

(2) The rectifier circuit uses two gas-filled, 3-element rectifier tubes, one of which conducts during the positive half cycle and the other during the negative half cycle to give full-wave output. The filaments are directly heated by secondary windings 11-12 and 10-11 of transformer T1. Plate voltage is supplied from secondary windings 6-7 and 7-8 for d-c output of 120 to 130 volts.

c. Regulation.

(1) The regulator for the d-c output is composed of three parts: The potentiometer consisting of fixed resistors A and B, and rheostat R, the reference voltage circuit described in paragraph d below, and varistor H which furnishes line voltage compensation.

(2) Resistors A and B, and rheostat R are connected across the d-c output so that the current in them is proportional to the output voltage.

Resistor A, the 2-3 section of rheostat R, the reference voltage across capacitor F, and the output of varistor H are connected in series between the filaments and the grids of the tubes, resulting in a grid bias of about -3 volts.

(3) Rheostat R can be adjusted by trial so that the grid voltage is just enough negative to cause the tubes to fire over enough of each a-c cycle to maintain the desired voltage. When output voltage increases, the current in resistor A and rheostat R also increases to make the grid bias more negative, which decreases the firing time and the output voltage to bring it back to the regulated value. A decrease in output voltage has the opposite effect.

(4) As mentioned above, the output of varistor H is in the grid-control circuit. Its input is connected to the 15-16 secondary coil of transformer T1 so that its supply voltage varies with changes in the applied a-c power. Its output variation is just sufficient to change the grid bias voltage as required to compensate for the change in plate voltage due to line voltage variations.

(5) There is a common grid circuit for the two tubes, and resistors E and F isolate one grid from the other and limit the grid currents.

(6) A time-delay timer TD, is provided to delay firing of the tubes until the filaments of the tubes have heated to operating temperature. When power is first connected to the rectifier, the tube plates are energized but the timer is closed through contact C, thereby omitting the reference voltage circuit and connecting the grids through varistor H direct to rheostat R, to leave the grid too negative for the tube to fire. When power is connected to the rectifier, a small motor in the timer starts to rotate and, after the delay interval, operates the timer contacts to open C and close O. This switches in the reference-voltage circuit and normal operation begins, as evidenced by a glow from the tubes and output from the rectifier.

d. Reference Voltage.

(1) A reference voltage of constant value is required. In these rectifiers, the reference voltage is furnished by an auxiliary regulated rectifier supplied as part of the main rectifier and connected in the grid-control circuit so that its voltage opposes the voltage from the potentiometer and varistor H. The auxiliary rectifier consists of secondary 13-14 of transformer T1, varistors A and B connected as a full-wave rectifier, resistors D and J in series with the varistor input and a constant voltage shunt (thermistor T in series with resistor C) across the d-c output of the auxiliary rectifier.

(2) An increase in current through thermistor T causes a decrease in the voltage drop across its terminals and the same current flowing through

resistor C causes an increase in the voltage drop across its terminals. A decrease in current would have the opposite effect. T and C have been selected so that the increase in drop across one compensates for the decrease across the other, and the total voltage drop across the two in series as well as the output voltage of the auxiliary rectifier remains practically constant.

(3) As the current in T and C changes with line voltage variations, there is a corresponding change in the current through the input resistors D and J. The resulting voltage drops across the input resistors assist in compensating in the auxiliary rectifier for line voltage changes and maintaining a constant reference voltage.

e. Filters.

(1) Retardation coils L3 and L4 with capacitors H and H1 suppress radio-frequency noise generated in the tubes. Capacitors D1, D2, and E, together with the electrostatic shield in transformer T1, keep carrier and radio-frequency noise originating within the rectifier from being carried out of the rectifier case over either the a-c or d-c leads.

(2) The ripple in the d-c output is suppressed by a 2-stage filter. The first stage consists of retardation coil L1 and a set of capacitors. On the rectifier B this set consists of six capacitors C1 to C6 with a combined capacitance of 750 microfarads. On the rectifier C this set consists of seven capacitors C1 to C7 with a combined capacitance of 1400 microfarads. The second stage consists of retardation coil L2 and two capacitors C7 and C8 on the rectifier B with a combined capacitance of 250 microfarads and three capacitors C8 to C10 on the rectifier C having a combined capacitance of 600 microfarads. The coil L2 is omitted when only telegraph is supplied but, when used, it is in the ungrounded output lead. On combined plate and telegraph, the telegraph output is taken off between the filter stages so that noise from the telegraph will not be applied to the plate output.

(3) Capacitor B effectively by-passes the potentiometer for sudden changes in output voltage, thereby making the grid-control circuit more responsive to rapid changes in load.

(4) Capacitors A and F with resistor G filter the ripple introduced by varistors A, B, and H, thus preventing it from being applied to the grids of the tubes.

f. Tube Operation.

(1) The tubes are of the 3-element, gas-filled type and the point in the a-c cycle at which they start firing (conducting current) is controlled by the negative grid bias or difference between the voltage of the grid and the filament. In general, the greater the negative grid bias the higher the plate voltage must be before the current starts to flow, but for

any tube there is a critical grid negative bias beyond which the tube will not fire. After starting to fire, a tube continues to conduct current for the rest of the a-c half-cycle and the output current, and therefore the maintained voltage, depends on how much of each half-cycle each tube is firing. V1 fires during one half-cycle and V2 during the other, which gives full-wave rectification. Changes in output voltage are reflected through the grid-control circuit to change the output and return the voltage to the regulated value.

(2) At light loads it is not necessary for the tubes to fire every cycle as the electrolytic capacitors carry the load for a few cycles during which time the grid bias is enough to prevent firing of the tubes. When the output voltage decreases below the regulated value, the tubes fire again for a few cycles to recharge the capacitors. This type of operation is evidenced by a flicker in the glow within the tubes and vibration of the needle of the voltmeter. At extremely light loads, firing of one tube only is sufficient to maintain the output voltage at regulated value. Even at heavy load, and with the tubes loaded approximately equally, the glow from the tubes will not necessarily be uniform, due to variations in temperature and physical characteristics of the tubes.

(3) Cathode trouble usually consists of open filament or low emission. With low emission the tube will glow and appear normal but still be unsatisfactory. Grid trouble may be high firing point or grid emission. High firing point is the condition where too high plate voltage is necessary to fire the tube. While this can be compensated to some extent by changes in the setting of rheostat R, the tube is inclined to be unstable at light loads and high line voltages. It should be replaced if causing erratic operation. Grid emission sometimes occurs due to cathode material which has been carried over to the grid. The effect of this is negligible until the temperature of the tube becomes high enough to cause this active material on the grid to give off electrons which causes the grid to lose control, resulting in high output voltage. This effect disappears as the tube cools so that satisfactory operation may be possible at light loads when it is not possible at full load.

g. Auxiliary Filament Supply.

(1) Alternating current is also supplied, as follows, to heat filaments and heaters of tubes in the associated equipment:

T1 Secondary Coil	Terminals on 8-point Strip	Volts	*Amperes
20-17	2 & 6	10.2	5
19-17	4 & 6	6.6	10
18-17	5 & 6	6.4	10

*Note that full ampere rating can be taken from only one a-c output at a time.

h. Cover Switch.

(1) When the rectifier cover is removed, a cover switch SW1 opens one side of the line to protect operating personnel from the relatively high plate voltages within the rectifier. The cover switch does not remove power-supply voltage from the 2-point input terminal strip A and if the a-c line lead connected to terminal 10 of this terminal strip is ungrounded, the fuses, terminal strip AC, transformer T1 primary terminals, and a-c wiring to timer TD will be alive even when the cover switch is operated. To avoid shocks and also destructive short circuits, disconnect the a-c supply before working on the rectifier unless a live circuit is necessary, as when taking point-to-point voltages.

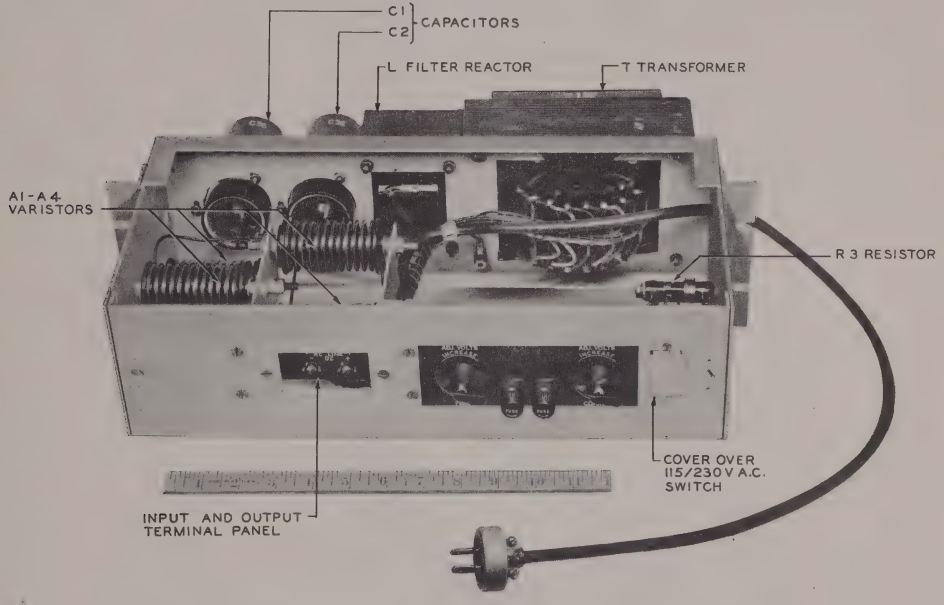


Figure 21 - Disc-type Rectifier Panel, Front View, Cover Removed

22. DISC-TYPE RECTIFIER.

a. The KS-5844 Power Unit which supplies 130-volt d-c power to the contacts of the receiving relay and to the receiving loop, is a full-wave, selenium-disc rectifier for changing nominal 115- or 230-volt, 25-60-cycle, a-c supply into 130±3 volt direct current, with maximum output 0.24 ampere. Figure 21 shows a front view of the disc-type rectifier panel.

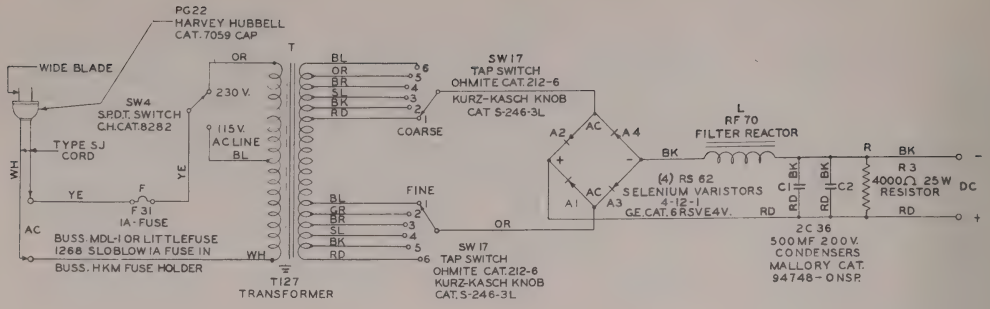


Figure 22 - Disc-type Rectifier Circuit

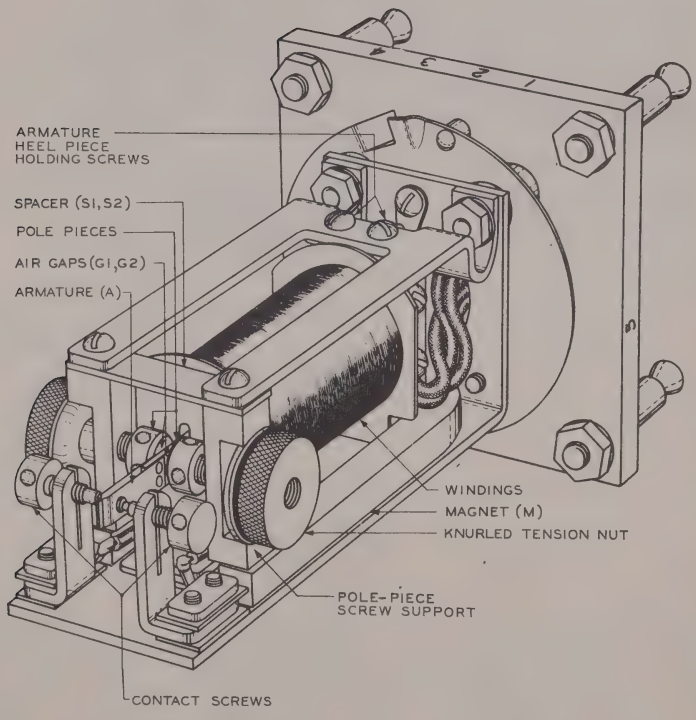


Figure 23 - Receiving Relay

b. A simplified schematic circuit is shown in figure 22. A single-pole, double-throw lever, accessible through a small hinged door at the control panel, permits the rectifier to be operated from either a 115- or a 230-volt a-c power supply. The rectified output voltage can be adjusted manually by turning the two knobs designated ADJ VOLTS located on the control panel, one controlling coarse and the other fine voltage adjustments by means of taps in the secondary winding of transformer T.

c. The line-supply fuse, mounted on the control panel, can be readily replaced by removal of the cap over the fuse holder. A spare fuse is located in a holder adjacent to the working fuse.

d. The rectifier is provided with a 24-inch 2-conductor, a-c input cord, equipped with a polarized cap. A 4-point terminal plate for the above input leads and for the two d-c output leads is accessible at the front and left side of the rectifier when the cover is removed.

e. The selenium varistor A1-A4, having four stacks wired as a bridge, acts as a full-wave rectifier. Its output is filtered by a retardation coil L and two electrolytic capacitors C1 and C2. Resistor R3, bridged across the output terminals, serves as an artificial load for the rectifier to reduce the light-load voltage.

23. RECEIVING RELAY.

a. The receiving relay, shown in figure 23, is polar-type, i.e., it operates to one contact for one polarity of current through a winding and to the other contact for current in the other direction. The windings surround a permalloy armature, to one end of which contacts are fastened. The armature projects between two pole pieces, one of which is made a north pole, and the other a south pole by means of a permanent magnet. A rough explanation of the operation of the relay is as follows: Current through a winding in one direction magnetizes the armature, causing the end which passes between the pole pieces to become a north pole and the other end a south. The north pole is attracted toward the south pole piece. Current in the opposite direction magnetizes the armature in the opposite direction, causing it to be attracted toward the north pole piece. In the telegraph terminal, marking current flows through one winding to cause the relay to operate to the marking contact, whereas spacing current flows through an equal and opposite winding to operate the relay to its spacing contact.

b. If the permanent magnet is removed from the relay and replaced, its magnetic strength is weakened. Though the relay can usually be given an operating adjustment after that, the gaps between the armature and pole pieces will have to be made considerably smaller and more trouble will be experienced from magnetic particles in the gaps. Therefore do not remove the mag-

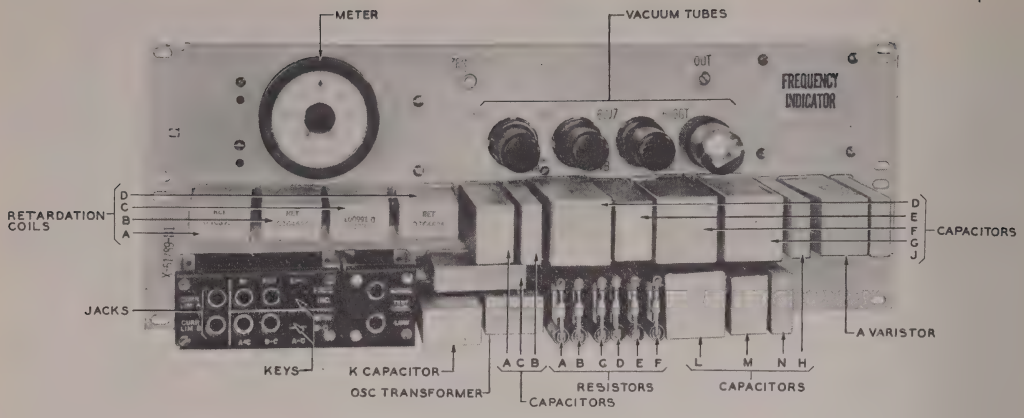


Figure 24 - Frequency-indicator Panel, Front View

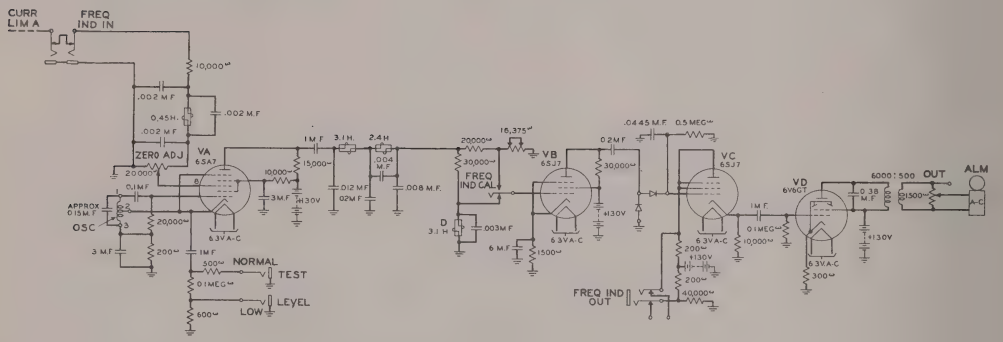


Figure 25 - Frequency-indicator Circuit

net unless necessary. Also do not place any magnetic metal across the magnet, as it may permanently alter its magnetization; this caution applies only to the magnet proper, not to other parts of the magnetic circuit.

c. The contact screws are set sufficiently close together, relative to the pole pieces, so that the armature does not normally strike the latter. A flexible spring structure of the armature contacts tends to prevent chattering when it strikes the contact screws. There are two windings, each having 3200 turns and a resistance of approximately 135 ohms. An insulated

shell or cover clamps over the base to protect the operating parts of the relay. Its use is essential to prevent magnetic dust and other particles from upsetting the relay adjustment.

d. The pole-piece screws project to either side of the armature through iron brackets and their distance from the armature is adjustable. A brass knob assembly (the brass may be replaced by some other material in later models) fits over these pole-piece screws and exerts a longitudinal tension on them which may be regulated in amount by turning the knurled heads. The clamping device consists of a spring disc with a conical rim which rests against a conical seat in the bracket. Its deformation ensures enough friction with the pole-piece screw so that the latter will retain whatever adjustment is made in turning it by means of a no. 340 tool. It further serves to keep the pole-piece screw in axial adjustment at all times. Use the fingers only in tightening the brass knob. If tightened with a tool, the seat may be damaged. If this seat should become damaged, as indicated by the failure of the relay to hold its adjustment, and no replacement part is available, thereafter tighten the knob firmly with pliers. Relay operation will be satisfactory but readjustment somewhat more difficult. The contact screws are also adjusted by means of the 340 tool.

24. FREQUENCY-INDICATOR CIRCUIT.

a. A front view of the frequency-indicator panel is shown in figure 24, and a schematic drawing in figure 25. In this circuit, the marking and spacing carrier frequencies from an output branch of the limiter in channel A are modulated by a frequency of 2550 cycles. These are normally 2125 and 2975 cycles, respectively, and the difference product, normally 425 cycles, is separated from other products by a filter and passed through an inductance, the voltage drop across which is proportional to the frequency. This voltage is amplified and rectified, resulting in a direct current which is proportional to the frequency, and the indication of a d-c meter in the path of this current is a measure of the frequency. If the marking and spacing frequencies are normal, the center-zero meter will indicate zero. If they are symmetrically located about 2550 cycles and do not differ by 850 cycles, the meter deflection will be steady but will be negative (to the left of zero) if the frequency separation is less than 850 cycles, positive if greater. If the frequencies are not symmetrically located, the meter indications will be unsteady. The radio receiver is tuned to make the meter indication steady; if it then indicates more than ±15, the transmitter station should be notified that the frequency separation is wrong. The frequencies of channel B can be measured by patching its CURR LIM B jack to the FREQ IND IN jack, but this is not necessary, since the oscillators are common to the two receivers and ensure that the audio frequencies will be identical.

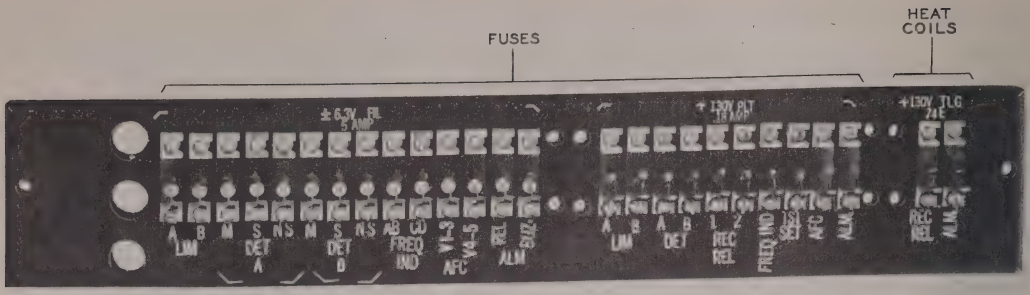


Figure 26 - Fuse Panel, Front View

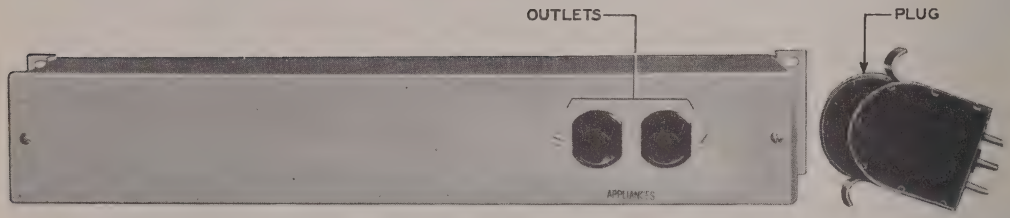


Figure 27 - Outlet and Heater Box, Front View

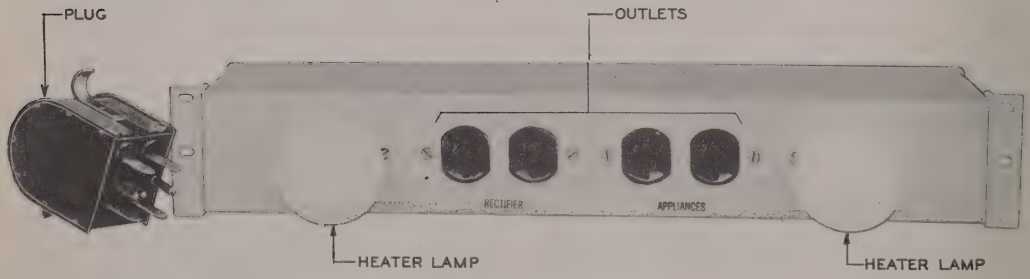


Figure 28 - Outlet and Heater Box, Rear View

b. Oscillator.—Referring to figure 25, the cathode of tube VA is connected to terminal 2 of the winding of an autotransformer OSC, and the full winding 1-3 is connected from the grid of the tube to ground. An alternating voltage existing in the cathode circuit, therefore, will cause an emf between terminals 1 and 3 of the transformer. Since this is impressed upon the control grid of the tube, this circuit forms an oscillator. The frequency is adjusted to be 2550 cycles at the factory by a capacitance of approximately 0.15 microfarad connected to the coil terminals.

c. Modulator.—The marking and spacing currents of about 2125 and 2975 cycles respectively pass from the CURR LIM A jack through a filter which attenuates frequencies above about 4000 cycles and a ZERO ADJ potentiometer to grid 8 of the tube VA. The modulation resulting from the interaction of these frequencies with the 2550-cycle oscillator frequency produces in the output:

2550-2125 = 425 cycles

2975-2550 = 425 cycles

A filter consisting of two coils with associated capacitors passes any frequency below about 1000 cycles and attenuates higher frequencies.

d. Discriminator.—From the output of the filter mentioned above, the 425-cycle current is connected to coil D through 30,000 ohms. The 30,000-ohm impedance is large compared to that of the 3.1 henrys in coil D and so the current will be substantially independent of frequency. Coil D acts as a discriminator, since the voltage drop across it will be directly proportional to the frequency; this proportionality is made more constant by a small bridged capacitance. It will be recalled that the output of the limiter is constant except during deep fades and is independent of frequency; the output of the oscillator too is substantially constant; and so the resulting modulation product will be substantially constant in amplitude. Therefore, the voltage drop across the discriminator is directly proportional to frequency and may be used to measure it. This voltage is applied to the control grid of tube VB.

e. Calibration.—When the CAL button is depressed, the grid of tube VB is connected to a potentiometer which is in parallel with the discriminator; the voltage then does not vary with frequency. This potentiometer is adjusted at the factory so that the voltage applied to the grid is the same as that across the discriminator coil for 425 cycles, and so causes the frequency indicator meter to indicate zero. The process of calibration, then, consists in depressing the CAL button and adjusting the ZERO ADJ potentiometer until the meter indicates zero.

f. Meter Circuit.—The 425-cycle current in the output of amplifier tube VB is rectified in a half-wave copper-oxide rectifier and the resulting

d-c voltage amplified by tube VC. The plate circuit forms one arm of a Wheatstone bridge, the other arms consisting of resistances of 40,000, 200, and 200 ohms respectively, and the meter is connected across one diagonal. In the calibration process, the circuit has been adjusted to balance this bridge at 425 cycles; if the frequency is lower, the bridge will be unbalanced and the meter indication will be negative (to the left); for higher frequencies it will be positive. The deflections will be nearly proportional to the departure from 425 cycles and will be full scale for a departure of about 300 cycles. The frequency-indicator meter is sometimes located in the bay with the radio receivers to aid in tuning them. Frequencies may be measured at the telegraph bay by patching the D-C METER jack to FREQ IND OUT and turning the METER knob to D-C.

g. Alarm Circuit.—The cathode of tube VC is connected to the control grid of tube VD through a one-microfarad capacitor. So long as the voltages from the discriminator due to marking and spacing signals are alike, they do not affect tube VD. When they differ, an impulse will pass through the capacitor to the control grid of VD at each transition between mark and space. Tube VD amplifies these impulses and they cause the ALM bell to sound if the frequency difference exceeds the allowable limit. The output potentiometer OUT can be adjusted so that the bell will respond at any desired departure from the correct frequency.

h. Fuse Panel.—Figure 26 shows a front view of the fuse panel.

i. Outlet and Heater Box.—Figure 27 shows a front view of this box and figure 28 a rear view.

SECTION IV
MAINTENANCE

25. GENERAL.

Service failures will be kept to a minimum by careful handling of the equipment during installation and operation and by exercising care in making field repairs and adjustments on the apparatus. Do not disturb the wiring any more than is necessary in testing or inspecting for troubles and, if a soldering iron is used, take care to prevent dropping splashes of solder on apparatus parts or wiring terminals. Keep the parts as free from dirt as possible by keeping the can covers on apparatus except when it is necessary to remove them for maintenance purposes. Also, do not keep open the doors of the cabinet unnecessarily.

26. TROUBLE ANALYSIS.

a. When trouble develops, and from a preliminary analysis of the condition, it appears that a particular item of equipment may be at fault, make the tests in paragraph 9 for that item in an attempt to find the cause of trouble.

b. In determining what item of equipment is at fault, it will be helpful to keep in mind the symmetry of this telegraph system. It contains two receiving channels which have identical electric circuits. Furthermore, each of these channels has marking and spacing branches which are similar except that they pass different frequencies. A convenient method for determining what item of equipment is causing the trouble is to "frog" the two channels at the various jacks, in turn, where this is practicable. For example, if there is reason to suspect that the trouble is in a detector, patch it into the good channel and patch the detector from the latter into the bad channel. If the trouble changes to the other channel, it is an indication that the suspected detector is in trouble.

c. A suggested procedure in locating trouble follows. It need not be adhered to rigidly if experience or some clue as to the location of the trouble suggests a short cut. Before following this procedure, test the receiving relay or replace it by a spare, and make any simple tests which the nature of the trouble suggests.

(1) If practicable, obtain printer signals or reversals, depending on the nature of the trouble, from the local transmitter and observe them in a printer, typing reperforator, or on the meter which measures loop current,

respectively. If the trouble is not present, it was probably at the transmitting end or due to unusual radio conditions. There is a possibility however, that it is in the radio receivers, since they will usually be receiving local signals at a much higher level than signals from the distant transmitter.

(2) Patch DET OUT CH A jacks to REC REL IN CKT 1 jacks and repeat the tests. Repeat with DET OUT CH B jacks patched to REC REL IN CKT 1 jacks. This will determine whether the trouble is in channel A or B. If the trouble has disappeared, it is probably in the noise-suppression circuits or the wiring associated with these jacks. These patches disable the noise-suppression circuits. If the trouble is in both channels, it is presumably in the receiving relay circuit, the loop, or the substation equipment. To see if it is in the receiving relay circuit, patch in the no. 2 circuit by patching DET OUT CH A to REC REL IN CKT 2 and REL OUT 2 to REC LOOP jacks. Record the results of tests.

(3) Frog the circuit by patching from PAD OUT of CHANNEL A to CH FILTS IN of channel B and PAD OUT of channel B to CH FILTS IN of channel A. Repeat the tests in paragraph (2) and record the results. If the trouble is in the same channel as it was before, it is behind the frogging point; if the trouble has changed channels, it is ahead of the frogging point. Remove all patches.

(4) If the results obtained in paragraph (3) indicate that the trouble is ahead or behind the frogging point, frog at other points in turn which precede or follow, respectively, the PAD OUT jacks in the circuit, and repeat the tests in paragraph (2) recording the results, until the trouble is located. The patches required to frog at various jacks are given in the table below. Keep in mind that if the trouble changes from one channel to the other when the channels are frogged, as compared with the channel in which the trouble was located in paragraph (2), the trouble is ahead of the frogging point.

Frogging Point	Patch From Jacks Channels A & B	To Jacks Channels B & A
Limiter input	INP FILT OUT	CURR LIM IN
Limiter output	CURR LIM OUT	PAD IN
Receiver output	RAD REC OUT	INP FILT IN
Marking filter output	M CH F OUT	M DET IN
Spacing filter output	S CH F OUT	S DET IN

(5) When the trouble has been located in an item of equipment, make a check test by patching that item into the good channel and replacing it by the corresponding item from the good channel, if jacks are available. For instance, if the trouble located in a limiter, interchange the two limiters

by frogging at both input and output of the limiters according to the table in paragraph (4). If the trouble has now changed channels, it is in the equipment patched.

27. TROUBLE LOCATION.

a. When it has been determined that there is trouble in a particular item of equipment, either by the nature of the trouble indication or by the procedures in paragraph 26, the next step is to determine the actual cause of the trouble such as a defective tube, wiring trouble, etc. To do this, make check tests, such as measuring the voltage from each vacuum tube terminal to ground or as specified otherwise, according to the table in paragraph 34. Test the vacuum tubes. Inspect the wiring and make continuity tests with an ohmmeter.

b. A Western Electric Co. KS-8295 volt-ohmmeter or its equivalent, for voltage and resistance measurements, will probably be sufficient for most trouble location tests. This volt-ohmmeter may be used for measuring either a-c or d-c voltages or resistances and for checking capacitors for short circuits or grounds any other available volt-ohmmeter having an internal resistance of at least 1000-ohms per volt may be used.

CAUTION: Do not use a buzzer or other insensitive device for continuity tests as it may harm a coil. Safe direct current through any coil winding is the amount passed by 6 volts in series with 1000 ohms, connected to the winding. Do not send direct current through the 716C Receiver.

To check the loss in a pad, measure each component resistance and compare with values in the list of parts.

c. If a cathode-ray oscilloscope is available, it will be a useful testing tool for locating trouble. When similar items of equipment are available, for instance, those of channels A and B, the indications on the oscilloscope screen when connection is made to various parts of the good and defective equipment, in turn, and they are energized by steady signals or reversals, will usually show whether an item of equipment is in trouble.

d. Trouble in Power-supply Units.

CAUTION: To avoid shocks and also destructive short circuits, disconnect the rectifier cords from the RECTIFIER outlets before working on the rectifiers, unless a live circuit is necessary, as when making point-to-point voltage measurements.

(1) Tables in paragraph 33 give a list of indications of trouble in the power-supply units and the possible cause and remedy. When a-c supply to the rectifier is available but there is no d-c output, the fuses and tubes

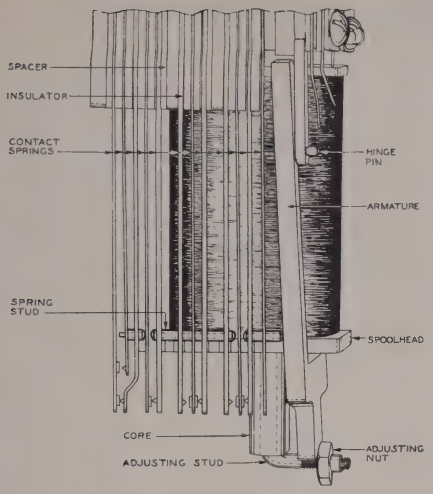
are the first items to check. If the line fuse in the disc-type rectifier (KS-5844) is blown, attempt to find the cause of the failure before inserting a new fuse. If the input supply is 230 volts, see whether the toggle switch is in the right position. If the trouble is not found by inspecting the items given in the trouble location and remedy tables, check the point-to-point voltages in accordance with paragraph 33a or b.

(2) When trouble is present and its cause has not been located by other checks, it may be desirable to make circuit continuity checks and check the resistance of the transformer, resistors, and retardation coils. D-c resistance values and in some cases tolerances are given in the list of parts (see par. 35). Tubes should be removed and a-c power disconnected before making resistance measurements. In some cases where parallel paths are present, it may be necessary to disconnect a lead before making resistance measurements.

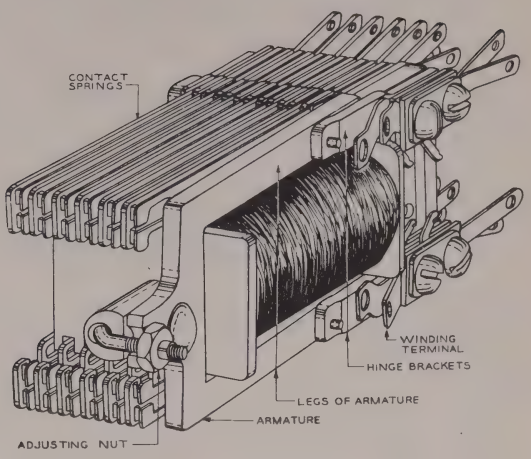
e. Wiring Diagrams.—In locating trouble it may be necessary to refer to the wiring diagrams. In these diagrams (see List of Illustrations for fig. numbers) each piece of apparatus has the same designation as that stamped on the equipment, and the wiring terminals on each piece of apparatus are shown in their proper relative location as viewed from the wiring side. Some wiring diagrams employ the "airline" system of showing connections. With this system, each piece of apparatus is arbitrarily numbered and lines, called feed lines, representing the individual wires are carried a short distance and terminated at a common or base line running at right angles to the feed lines. These feed lines are marked with the color of the wire and have a number near the base line which is the same as the number of the piece of apparatus to which the other end of the wire connects. If two figure numbers appear on a feed line, it means that there are two wires one from each of the indicated figures. If the number "2" precedes the color code, both wires are of the same color. It is not necessary to trace a connection through the common or base line and no provision is made for doing so. By observing the color and identification number, it is possible to move directly to the other end of the wire. In addition to obvious color abbreviations, the following are used: BL for blue, BK for black, G for green, and S for slate or gray.

28. FUSE ALARMS.

When a fuse on the fuse-alarm panel blows, the buzzer sounds. The blown fuse is indicated by its glass bead being out of line with the beads of the other fuses. When the fuse is removed, the buzzer stops. In replacing a fuse, make sure that it is put in place right side up, otherwise the buzzer will not sound when the fuse blows. The color of the glass bead indicates the current rating of the fuse. This rating is also stamped on one terminal. The fuses in the rectifiers are not of the alarm type and the buzzer will not sound when one of these fuses blows.



U-type Relay, Top View



Y-type Relay, General View

Figure 29 - U- and Y-type Relays

29. RELAYS A, B, AND C.

a. General.

(1) These relays are in the receive relay circuit, figure 33. Relays A and C are U-type and relay B is a Y-type. U- and Y-type relays are of the same general type and the same class of mechanical requirements and methods of adjustment apply to both. Figure 29 shows typical relays of this type.

(2) For field maintenance, no tests or inspection of these relays is recommended and the procedures and requirements covered in this paragraph need be used only if a relay fails to function properly in the circuit.

(3) Relay maintenance involves cleaning of the relay parts and contacts, adjustment to meet mechanical requirements, and the further refinement of some of the adjustments if necessary to meet the electrical requirements. The electrical requirements are shown on the circuit requirement table in figure 34. An explanation of the information shown on the circuit requirement table is covered in paragraph b on the following page. In most cases, the electrical and mechanical requirements are specified under two headings, test and readjust. If a relay meets its test requirements, it is satisfactory for service. If, however, on investigation it is found that certain of the test requirements which may affect the performance of the relay in the circuit

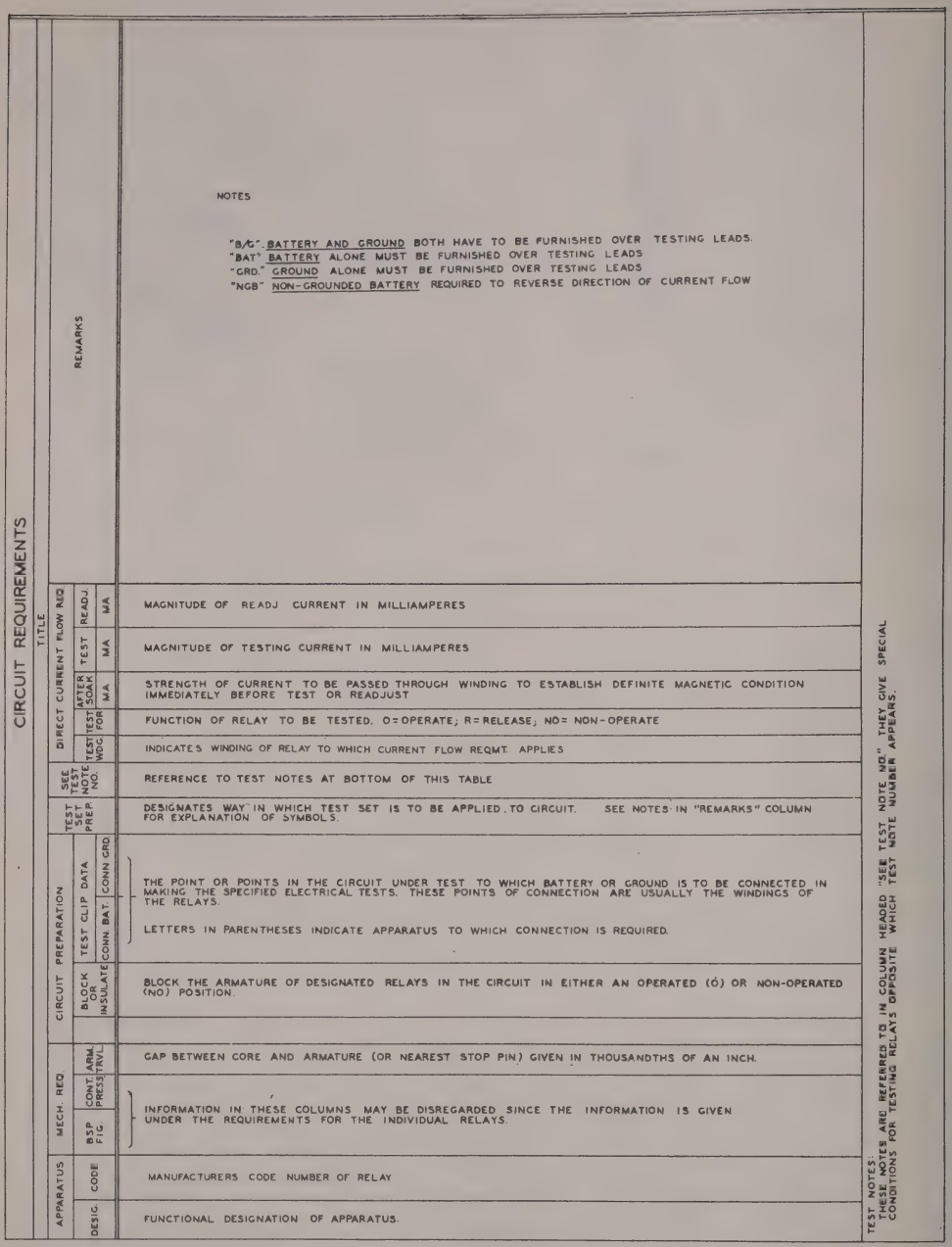


Figure 30 - Explanation of Circuit Requirement Tables

are not met, then the relay should be readjusted to meet the readjust requirements. The readjust requirements are more severe than the test requirements.

b. Explanation of Circuit Requirement Table.—Figure 30 illustrates the headings of the circuit requirement table and explains the meaning of the usual entries in each column. The winding and spring numbers which appear in the "circuit preparation" columns in figure 34 correspond to the numbering of the terminals shown on the circuit and wiring drawings and an explanation of this numbering is described in paragraph c below.

c. Winding and Spring Designations of U- and Y-type Relays (See Fig. 31).

(1) The contact springs and winding terminals are numbered consecutively from right to left facing the terminal side of the relay. The spring assembly of the top and bottom sides of the relays are each numbered in this sequence. On the schematic and wiring drawings, the top and bottom relay spring pileups are shown in this relative position with respect to the relay winding. The relay winding terminals on the drawings are followed by the letter T or B to indicate whether these terminals are aligned with the top or bottom spring terminal pileups.

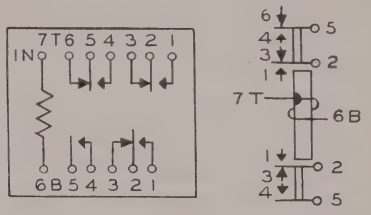
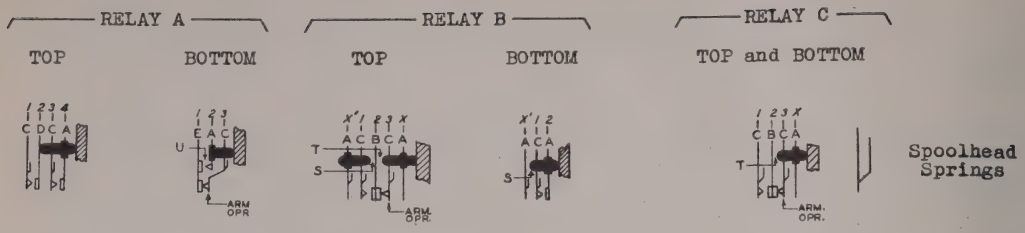


Figure 31 - Winding and Spring Terminal Arrangement as Viewed From the Rear (Terminal Side), U- and Y-type Relays

d. Cleaning Relays and Contacts.

(1) It is essential that relay parts and contacts be kept clean, since failure of the circuit is often traced to particles of dirt or lint between the contacts or to dirty parts. Covers are provided to reduce as far as possible the entry and accumulation of foreign materials to the working parts of relays. It is important that relay covers be kept in place except when necessary to remove them for maintenance purposes. When covers are replaced on relays they should be replaced right side up, as determined by the designations on the covers, in order to avoid depositing dirt and lint from the bottom of the cover on the relay contacts and parts. When relays are cleaned, the inside of the cover should be wiped clean, using a lint-free cloth.

(2) If there is evidence that a relay contact is not properly closed, this condition may be checked by bridging a test receiver (such as the 67B test set) across the springs of the contact through which current should be flowing. Absence of clicks or fluttering in the test receiver is evidence of a satisfactory contact. If the contact is unsatisfactory and on inspec-



Spring Tension Requirements	Tension, Grams Test	Readjust
All springs shall be tensioned toward the armature. Apply the gauge so that its tip engages both prongs of forked springs. On solid springs apply the tip of the gauge just in front of contact. Use the 70J gauge.		
Tension of springs marked ARM OPR is measured with the armature in the operated position; tension of all other springs is measured with the armature in the nonoperated position.		
The minimum armature back tension measured as the armature leaves its back stop.	18	22
The springs designated A have no definite tension requirement, other than that the combined pressures of the top and bottom A springs which produce pressure against the armature (together with the D spring of relay A) shall be sufficient to meet the armature back tension requirement above.		
Minimum tension of D springs measured as the spring leaves the stud.	5	6
Minimum tension of B springs measured as the contacts break.	18	20
Minimum tension of C springs measured as the spring tang leaves the spoolhead.	25	30
Minimum tension of E springs measured as the contacts break.	28	30

Figure 32 - Spring Arrangements and Spring Tension Requirements

tion it is found to be in mechanical adjustment, it should be burnished in accordance with paragraphs (3) and (4) below.

(3) Contact Burnishing.—When necessary to clean the contacts, burnish them using a clean no. 266 blade of the no. 265C contact burnisher. It is very important to keep clean the blades of the contact burnishers and any thickness gauges which are used on the contacts. These should be wiped off with a clean dry cloth before being placed against each contact and frequently wiped with a clean cloth dampened with carbon tetrachloride.

(4) In burnishing normally-open contacts, place the blade of the burnisher between the contacts, and operate the relay manually giving a slight pressure against the blade of the burnisher, at the same time moving the blade back and forth. The desired result is usually obtained by rubbing the burnisher between the contacts two or three times. In the case of normally-closed contacts, the tension of the springs themselves will usually furnish sufficient pressure against the burnisher. On springs having heavy tension, lift one of the springs away to insert the burnisher.

e. Mechanical Requirement.

(1) Tools and gauges referred to in the requirements for U- and Y-type relays in this paragraph are tabulated below. All codes are Western Electric Co. codes unless otherwise specified.

Tools	Description
474A	3/16" x 1/4" hexagonal closed-end off-set wrench
505A	Spring adjuster for thin (.013") springs
507A (two required)	Spring adjuster for springs other than .013"
265C	Contact burnisher [see paragraph 29d(3)]
Gauges	
70J	0-150 gram gauge
131A	Thickness gauge nest (consists of a nest of 132-type gauges)
Test Sets	
D-162269 Test Set (Signal Corps Test Set I-181) or 35D Test Set	Current flow test set for testing and adjusting relays.

(2) The spring arrangements and spring tension requirements are shown in figure 32.

(3) Armature Travel.—To adjust the armature travel, insert the proper 132-type gauge between the armature and core with the long axis of the gauge parallel to the axis of the core. Turn the adjusting nut with the 474A wrench until friction is felt against the gauge.

(4) Stud Gaps.—Stud gaps labeled T shall be a minimum of .006 inch. Stud gaps labeled S shall be a slight clearance when the armature is in the electrically-operated position [see par. 29f(5)].

(5) Contact Separation.—The minimum separation between each pair of contacts normally open or between each pair of contacts that are opened when the relay is electrically operated shall be .005 inch, except for the contact labeled U (see fig. 32) which shall be minimum .010 inch.

(6) Contact Make.—All normally-open contacts shall make when the relay armature is electrically operated against a gauge of .008-inch thickness (132A gauge) placed between the armature and the core. All normally-closed contacts shall close before the relay armature has completed its backward travel toward the adjusting nut.

f. Adjustment of Springs.

(1) Use the 505A spring adjuster for thin springs and the 507A spring adjuster for the thick springs.

(2) To adjust the position of springs to meet the contact separation, stud gap, and contact make requirements, adjust the spring tang resting against the spoolhead. To do this, hold the spring with one 507A spring adjuster placed above the spring tang and adjust the tang to the right or left as required with another 507A adjuster.

(3) Spring Tension.

(a) Spring tensions are specified in figure 32 on a minimum basis. They have, however, in the case of moving springs (springs which do not rest against the spoolhead) a direct bearing on the electrical performance of the relay and if they are greatly in excess of the specified minimum, the relay may fail to meet its electrical requirements, in which case the tension will have to be reduced. In readjusting, it is desirable to have as much tension in the moving springs as is consistent with meeting the other requirements. Attempt to distribute the tension of the moving springs proportionately between the top and bottom spring combinations.

(b) If a spring is excessively bowed or bent or if there is not a noticeable clearance between springs, straighten the spring before adjusting to meet the spring tension requirement. To straighten a spring, span it with the slotted end of the proper spring adjuster just back of the bow or bend and while exerting pressure to the right or left, as required, draw the spring adjuster forward the length of the bow. Repeat this operation as

required until the spring is approximately straight. Take care when making this adjustment to avoid tilting the spring.

(c) To adjust a spring for tension, span it with the slotted end of the proper spring adjuster just back of the stud and slide the adjuster to the base of the spring. Adjust the spring by applying at the handle end of the tool, slight sidewise pressure to the right or left as required, thus tending to bend the spring at its base. Exercise care not to disturb adjacent springs and avoid twisting the spring.

(d) If the desired tension cannot be obtained by adjusting as outlined in paragraph (c) above, without bowing the spring too much, apply the proper spring adjuster to the spring just back of the stud and slide it back to the base of the spring. Then, draw the adjuster forward the length of the spring, meanwhile applying pressure as required so that the spring is formed into a slight gradual bow with its concave surface facing the armature. Then move the adjuster to the base of the spring and adjust as covered in paragraph (c). The magnitude of the bow to be formed in the spring must be learned by experience and should be such that when the final tension adjustment is made at the base the spring will be approximately straight.

(4) Adjustment For Pressure of Armature Against Adjusting Nut.—If the armature is not held against the adjusting nut with the pressure specified in figure 32, increase the tension of the D and A springs which are tensioned against the armature as outlined in paragraph (3)(c) above. In making this adjustment, increase the tension of the spring farthest from the armature first and if the desired pressure cannot be obtained by adjusting this spring alone, adjust the other springs which hold the armature against the adjusting nut as required. It is not necessary to distribute the tension of all A and D springs in any particular combination equally. However, take care in making the adjustment that the combined pressure of the A and D springs of the top combination is approximately equal to that of the bottom combination. To check this, block the armature unoperated and place the tip of the 70J gauge against the spring nearest the armature. Read the tension when a clearance is noticeable between the stud and the armature.

(5) Buffer Springs.—The buffer springs labeled X on relay B perform no useful function for this application. The spring tang of each of these springs should be so adjusted that there is a slight clearance between the stud and the spring when the relay armature is electrically operated.

g. Electrical Requirements.—When a relay has been adjusted mechanically, it should be checked with a current flow test set to make sure that it meets the electrical requirements. To do this, connect a current flow test set as indicated in the circuit requirement table and apply the current flow values. If the relay fails to meet the electrical check, adjust as

follows: To meet the operate requirement, decrease the tension of moving springs toward the minimum. If the requirement cannot be met in this manner, increase the stud gaps. To meet the release requirement, increase the tension of the moving springs. In all cases, however, keep the tensions within the requirements specified in figure 32.

30. RELAYS T AND P.

a. These relays are in the alarm circuit which is shown on the application schematic, figure 36. They are R-type relays of the same code and have a single make contact on the top and bottom. They should require little maintenance and need not be tested or readjusted unless trouble is suspected. If it becomes necessary to clean the contacts, follow the procedures outlined in paragraph 29d.

b. The following are the requirements to be used if it is necessary to adjust these relays.

(1) The armature travel is shown on the circuit requirement table. To adjust the armature travel, insert the 67A gauge between the armature and core and turn the adjusting nut with the 474A wrench until the gauge fits snugly.

(2) Adjust the tension of the top and bottom springs resting against the armature stud with a 507A spring adjuster so that the pressure of the armature against the adjusting stud is about 10 grams.

(3) The separation between the contacts when the armature is in the normal (unoperated) position should be a minimum of .005 inch.

(4) The contact follow (the further movement of the springs after the contacts have closed) should be about .004 inch.

(5) Adjust the tension of the springs resting against the spoolhead with a 507A spring adjuster so that the tension measured with a 50J gauge is not less than 20 grams just as the spring tang leaves the spoolhead.

(6) Check that the relay meets the electrical requirements, using a current flow test set.

31. RECEIVE RELAY.

a. Polar Receive Relay (255A Relay) and Bell ALM.—The necessary information for adjusting this relay is given in the instruction book accompanying the polar relay test set referred to in paragraph 10c(3). The tools required are included in the test set.

b. Requirements and Adjusting Procedures for Bell ALM.

(1) The following procedures assume that the bell is in the position it normally occupies on the panel, that is, gong to the right and clapper

uppermost and that the cover has been removed. If the bell is removed from the panel for convenience in adjusting, spring tensions in paragraphs (5) and (6) below shall be measured with the bell in its normal position.

(2) Tighten the flathead screws in the terminal strip and temporarily remove the terminal connection screw D.

(3) Examine the armature assembly for looseness of rivets which hold the armature spring to the armature proper. If these appear to be loose, remove the armature and tighten these rivets so that the springs are firmly held to the armature. The armature contact spring should be approximately parallel to the surface of the armature.

(4) Replace the armature if it has been removed. With two roundhead armature mounting screws loosened, and with a .005-inch thickness gauge between the armature and the left pole face, hold the armature fully operated by applying pressure to the armature on a line midway between the two pole faces and tighten the armature mounting screws. Replace terminal screw D.

(5) Adjust the armature tension spring with long-nose pliers until the pressure at the end of the spring is 150 ±25 grams.

(6) Adjust the tension of the spring which holds the armature in place by means of the long-nose pliers applied at the bend of the spring, so that the armature is tensioned away from the coils with a pressure of 20 to 50 grams measured at a point opposite the center of the right pole face.

(7) Adjust the armature back stop bracket (opposite right pole face) until there is a .010-inch (±.001 inch) clearance between the armature stop pin and the right pole face with no current flowing in the coils.

(8) Adjust the position of the gong and bend the armature extension if necessary, until the following requirement is met: With the armature fully operated and the gong screw tightened, the clapper should just clear the gong at a point about 1/16 inch from the open side of the gong.

(9) Repeat the test in paragraph 9m and make slight adjustment of the gong position and armature spring tension to obtain the most satisfactory sound of the bell.

32. POWER RECTIFIERS.

a. Regulated Tube Rectifier.

(1) Timer.—The reset timer in the X-61680B rectifier is arranged for adjustment of the time of operation but this adjustment should not be changed. The timer requires no lubrication or contact maintenance. It should be replaced if its switch does not operate in normal operation time [see par. 8e(4)] after connecting the power and restore within 5 seconds after power is disconnected. Release time is 0.2 to 0.5 second. Operation and

release are indicated by a slight click in the contact box. Restore time is the time required for the rotating disc to return to normal after power is disconnected. The amount of travel of the spring arm after operation of the switch, and measured at the end of the switch box, should be approximately 1/8 inch. This travel controls the release time and permits instantaneous operation of the rectifier after power failures of such short duration that filaments have not cooled. It need not be checked if the rectifier seems to be operating satisfactorily. Travel can be adjusted by loosening the lock nut on the stop screw on the spring arm and turning the screw, as required. The above also applies to the reset timers used on X-61680C rectifiers except that neither the operation time nor the travel of the spring arm after operation of the switch are adjustable.

(2) Varistor Replacement.—Failure of a varistor may be caused by high voltage or a prolonged overload. Replace if the voltage readings are less than 8 volts for varistor H, less than 42 volts for varistors A and B, or less than 4.5 volts for varistor C used in rectifiers C.

(3) Thermistor and Associated Resistor.—When thermistor T or resistor C is replaced, select the C resistor tap that agrees with the resistance value stamped on the thermistor being used.

b. Disc-type Rectifier (KS-5844).

(1) When the rectifier is connected to either a 115- or 230-volt a-c input power supply and there is no d-c output as indicated by the equipment meter, check for a blown line fuse. Should the fuse be blown, ascertain the cause of its failure before inserting a new one. If the input power supply is 230 volts, check the position of the toggle lever. If fuse and lever are satisfactory, check point-to-point voltage readings given in paragraph 33 to locate part of circuit not functioning. Check circuit continuity to locate a defective piece of equipment for replacement.

(2) When making a continuity test, disconnect the input power from the rectifier, and where parallel paths are present in the rectifier circuit it may be necessary to disconnect one of the leads.

(3) Replacement of Varistor.—Failure of the varistor may be caused by a high input voltage or by a prolonged overload on the rectifier. The varistor should be replaced when the d-c output voltage approaches the low voltage limit with the two adjusting switches turned to the extreme right or high-voltage position.

c. Electrolytic Capacitors.—Replace electrolytic capacitors in the power-supply units with new ones about 3-1/2 years after the date on the capacitor. If the rectifiers are not in use, operate them temporarily for 1/2 hour every 18 months to restore the film on the electrolytic capacitor

plates. These capacitors are marked C1 to C8, C1 to C10, and C1 and C2, respectively, in rectifiers X-61680B, X-61680C, and KS-5844. Connect spare electrolytic capacitors to the positive 130-volt supply for 1/2 hour every 18 months. To do this, disconnect the power from the AN/FGC1 equipment (dial 02 and check that the heater lamps light); connect the + terminal of the capacitor to the output of the regulated tube rectifier (not the KS-5844) through one of the 35R or 35S fuses or 74E heat coils, and a mounting lug (negative terminal) to ground; connect power to the bay (dial 01) and leave for 1/2 hour; then disconnect the power again and wait a few seconds for the capacitor to discharge before removing the connections to the capacitor.

SECTION V
SUPPLEMENTARY DATA

33. POWER-SUPPLY UNITS.

a. Regulated Tube Rectifiers (X-61680B and X-61680C).

(1) Trouble Location and Remedy.—If any of the following troubles are indicated it is suggested that the possible causes be checked in the order listed below: If trouble is not found, check point-to-point voltages. (See paragraph (2) on the following page.)

Trouble	Possible Cause
No output voltage	A-c supply may be interrupted (no power supply or fuse blown).
	Cover switch open, possibly because can cover screws are not tight.
	Grid cap of tube open.
	Failure of a main filter capacitor C1 to C8 or C1 to C10 by shorting.
	Failure of tube, possibly filament lighted but no emission from tube. Replace tube.
	Relay, if any, in telegraph leg not operated.
	Timer TD not operated.
Low output voltage	A-c supply voltage may be low.
	Load current may be too high. [See par. 21a(1)].
	Low emission in tube though still lighted. Replace.
	Regulating circuit may be in trouble. Try to raise and lower voltage with rheostat R.
	Low reference voltage. [See par. 21d and 32a(2)].
High output voltage	A-c supply voltage high.
	Grid emission. [See par. 21f(3)]. Rheostat R has no control.
	Regulating circuit may be in trouble. Try to change voltage by moving rheostat R.

Trouble	Possible Cause
Erratic output voltage	Tube has high firing point, [see par. 21f(3)] or there is other trouble in tube. Replace.
	Trouble in reference voltage circuit.
	Loose connections, probably at one of the capacitors.

(2) Point-to-point Voltage Table.

(a) These typical point-to-point voltages are based on the use of a Weston 772 analyzer which has 20,000 ohms per volt. If the high-resistance instrument is not available, a 1000-ohms per volt instrument may be substituted, using the largest scale that gives a good reading. They are also based on an a-c input voltage of 115-volts, 60-cycles, a 130-volt d-c load from output terminals 1 and 3 of 0.3 ampere and an a-c output at zero. Such voltages vary not only with input voltage and load but also with different apparatus such as tubes, varistors, capacitors, etc. Low resistance in the analyzer due to use of wrong scale or wrong instrument affects some readings materially.

(b) The cover switch SW1 must be held closed while the voltages are being checked. A convenient way to do this is to make up locally a 1-5/8-inch C clip from light metal and insulate it with friction tape. The clip should be slipped over the end of the operated plunger and the rear of the switch box. Be sure to remove this C clip before replacing the cover and putting the rectifier back into service.

WARNING: DO NOT TOUCH LIVE TERMINALS WITH THE HANDS AS HIGH VOLTAGES ARE PRESENT. DO NOT ALLOW A TEST PICK TO TOUCH TWO METAL PARTS AT THE SAME TIME OR DESTRUCTIVE AND DANGEROUS SHORT CIRCUITS MAY OCCUR.

(c) A-c voltages.

Reading	Connect A-c Terminals of Analyzer to Terminal	Use Analyzer Scale	Typical A-c Volts
Rectifier input	1 and 3 on AC terminal strip	250	115
Varistor A & B input	2 of varistor A and 2 of varistor B	250	54
Varistor H input	15 and 16 transformer T1	50	15
A-c output	6 and 5 of 8-point terminal strip 2 and 7 of tube	10	6.4

Reading	Connect A-c Terminals of Analyzer to Terminal	Use Analyzer Scale	Typical A-c Volts
Filament	2 and 7 of tube V1 or V2	10	2.4
Varistor C input (rectifier C only)	12 and 20 on transformer T1	50	10

(d) D-c Voltages.

Reading	+ of Analyzer to Terminal	- of Analyzer to Terminal	Use Analyzer Scale	Typical D-c Volts
Grid bias	+ of capacitor C3	Rear terminal of capacitor A	50	2-4
Reference voltage	Rear terminal of capacitor F	Front terminal of capacitor F	50	42-50
Resistor A	+ of capacitor C3	3 of rheostat R	50	31
Varistor H output	0 of timer TD	Rear terminal of capacitor A	50	11.8
Resistor G	0 of timer TD	Rear terminal of capacitor F	10	1.4
Retardation coil L1	1 of retardation coil L1	2 of retardation coil L1	10	3.8
Varistor C output (rectifier C only)	3 of varistor C	1 of varistor C	10	5.5

b. Disc-type Rectifier (KS-5844).

(1) Trouble Location Chart.—Should any of the following troubles develop, it is suggested that the possible causes be checked in the order listed. If trouble is not found, check point-to-point voltages.

Trouble	Possible Cause
No d-c output voltage	Blown line fuse. Failure of power supply. Open in line cord or in rectifier wiring. 115/230V AC switch or one of the voltage adjusting switches may not be making contact. Shorted electrolytic capacitor C1 or C2. Opened winding in transformer T or in retardation coil L.
Low d-c output voltage	Low a-c line voltage. 115/230V AC switch may be on 230-volt position when input is 115-volts alternating current. Rectifier discs may be aging.
High d-c output voltage	High a-c line voltage. 115/230V AC switch may be on 115-volt position when input is 230-volts alternating current. Resistor R may be opened. (High voltage will appear at light or no load only.)
Erratic d-c output voltage	Loose connection in rectifier wiring.
Excessive noise on d-c output	Electrolytic capacitor C1 or C2 may be too old. (See par. 32c.)

(2) Point-to-point Voltages.

(a) These voltage measurements vary not only with input voltage and load but also with different specimens of apparatus such as transformers, varistors, capacitors, etc.

(b) All measurements are with the rectifier operating at 130-volts, 0.24-ampere, d-c output from a 115-volt a-c input.

(c) To make measurements, remove the grilled cover secured at the front of the rectifier frame by two screws.

WARNING: DO NOT TOUCH LIVE TERMINALS WITH THE HANDS AS HIGH VOLTAGES ARE PRESENT. DO NOT ALLOW A TEST PICK TO TOUCH TWO METAL PARTS AT THE SAME TIME OR DESTRUCTIVE AND DANGEROUS SHORT CIRCUITS MAY OCCUR.

A-c Voltages Measured	Connect Voltmeter	Typical A-c Volts
Input voltage to transformer T	Across primary winding of transformer T	115
Input voltage to varistor	Across a-c input terminals of varistor	170
Varistor output	+ and - terminals of varistor	133
Rectifier output	+ and - output terminals	130
Voltage drop across retardation coil L	Negative voltmeter lead to - terminal on varistor, positive voltmeter lead to - rectifier output terminal	3

34. VACUUM TUBE SOCKET VOLTAGES.

a. General.

(1) The voltages in the table in paragraph b below, are based on the use of a Western Electric Co. KS-8295 volt-ohmmeter (resistance, 1000 ohms per volt). Due to allowable tolerances in the electrical constants of the apparatus, reasonable deviations from the values shown in the table may be expected.

(2) When making some of the measurements, the initial indication on the meter will be higher than the steady state. In such cases, wait for a steady indication.

b. Preparation for Test.—Adjust the rectifier voltage to 130 volts. Make all measurements with no input signal.

c. Voltage Measurements.

Voltage Measured	Tube	Measure Between Terminals	Use Voltmeter Scale	Approximate Voltage
Current Limiter (See Fig. 42)				
Heater	IN	2-7	0-15 a-c	6.3
Plate	IN	8-Grd	0-150 d-c	27
Screen	IN	6-Grd	0-150 d-c	23
Cathode	IN	5-Grd	0-15 d-c	1.1
Heater	LIM	7-8	0-15 a-c	6.3
Plate	LIM	2-Grd	0-150 d-c	50
Cathode	LIM	3-Grd	0-15 d-c	16

Voltage Measured	Tube	Measure Between Terminals	Use Voltmeter Scale	Approximate Voltage
Current Limiter (Cont'd.)				
Heater	AMP	2-7	0-15 a-c	6.3
Plate	AMP	8-Grd	0-150 d-c	58
Cathode	AMP	5-Grd	0-15 d-c	2.9
Detector (See Fig. 43)				
Heater	MVA or SVA	2-7	0-15 a-c	6.2
Plate	MVA or SVA	8-Grd	0-150 d-c	120
Screen	MVA or SVA	6-Grd	0-150 d-c	128
Cathode	MVA or SVA	5-Grd	0-15 d-c	3.4
Heater	MVB or SVB	2-7	0-15 a-c	6.2
Plate	MVB or SVB	3-Grd	0-150 d-c	130
Screen	MVB or SVB	4-Grd	0-150 d-c	79
Cathode	MVB or SVB	8-Grd	0-15 d-c	12.8
Heater	VA	2-7	0-15 a-c	6.2
Plate	VA	8-Grd	0-150 d-c	78
Screen	VA	6-Grd	0-150 d-c	129
Grid	VA	4-Grd	0-30 d-c	2
Cathode	VA	5-Grd	0-150 d-c	33
Heater	VB	2-7	0-15 a-c	6.2
Plate	VB	8-Grd	0-150 d-c	107
Screen	VB	6-Grd	0-150 d-c	129
Cathode	VB	5-Grd	0-150 d-c	12
Heater	VC	2-7	0-15 a-c	6.2
Plate	VC	8-Grd	0-150 d-c	78
Screen	VC	6-Grd	0-150 d-c	129
Cathode	VC	5-Grd	0-150 d-c	12
Frequency Indicator (See Fig. 45)				
Heater	VA	2-7	0-15 a-c	6.2
Plate	VA	3-Grd	0-150 d-c	73
Screen	VA	4-Grd	0-150 d-c	67
Grid	VA	5-Grd	0-30 d-c	2.4
Cathode	VA	6-Grd	0-15 d-c	1.6
Heater	VB	2-7	0-15 a-c	6.2
Plate	VB	8-Grd	0-150 d-c	52

Voltage Measured	Tube	Measure Between Terminals	Use Voltmeter Scale	Approximate Voltage
Frequency Indicator (Cont'd.)				
Screen	V8	6-Grd	0-150 d-c	130
Cathode	V8	5-Grd	0-15 d-c	4.6
Heater	V9	2-7	0-15 a-c	6.2
Plate	V9	8-Grd	0-150 d-c	130
Screen	V9	6-Grd	0-150 d-c	130
Cathode	V9	5-Grd	0-15 d-c	5.3
Suppressor	V9	3-Grd	0-150 d-c	130
Heater	V10	2-7	0-15 a-c	6.2
Plate	V10	3-Grd	0-150 d-c	117
Screen	V10	4-Grd	0-150 d-c	130
Cathode	V10	8-Grd	0-15 d-c	60
Automatic Frequency Control (See Fig. 49)				
Heater	V1	2-7	0-15 a-c	5.6
Plate	V1	8-Grd	0-150 d-c	94
Screen	V1	6-Grd	0-150 d-c	18
Heater	V2	2-7	0-15 a-c	5.6
Plate	V2	8-Grd	0-300 d-c	24
Screen	V2	6-Grd	0-300 d-c	20
Heater	V3	2-7	0-15 a-c	5.6
Plate	V3	8-Grd	0-150 d-c	122
Screen	V3	6-Grd	0-150 d-c	130
Cathode	V3	5-Grd	0-15 d-c	3.6
Heater	V4	2-7	0-15 a-c	5.6
Cathode	V4	8-Grd	0-150 d-c	22
Heater	V5	2-7	0-15 a-c	5.6

35. TABULAR LIST OF REPLACEABLE PARTS.

a. General.

(1) The table in paragraph 35c lists the replaceable parts for the Radio Teletype Terminal Equipment in nine groups according to the major components as follows:

	Sig. Corps Stock No.
Automatic Frequency Control Unit	4TW61789-F1
Frequency Indicator Panel	4TW61789-B1
Receive Relay Panel	4TW61789-E1
Detector Panel	4TW61789-D1
Current Limiter Panel	4TW61789-C1
Rectifier Panels X-61680B	3H4956-10
Rectifier Panels X-61680C	3H4956-11
Disc-type Rectifier, 130 Volts	3H4956-24
Cabinet Equipment	-
Spare Fuse Panel	-
Terminal Strips	-
Jack Strip	-
Fuse Panel	-
Alarm and Miscellaneous	-
Utility Outlet and Heater Panel	-
Miscellaneous	-
Maintenance Tools and Materials	-

(2) The reference designations shown in the first column of the List of Replaceable Parts (par. 35c) correspond to the designations shown in the schematic circuits. These designations are also stamped on the equipment or on the mounting adjacent thereto.

(3) The explanation of the symbols shown in the manufacturer's column (par. 35c) are explained in full together with the manufacturers' address in paragraph 35b, List of Manufacturers.

b. List of Manufacturers.

Abbreviation in Par. 35c	Name	Address
Alden	Alden Products Co.	Brockton, Mass.
Appleton	Appleton Electric Co.	Chicago, Ill.
Buss	Bussman Manufacturing Co.	St. Louis, Mo.
C-H	Cutler-Hammer Inc.	Milwaukee, Wisc.
Cinch	Cinch Manufacturing Corp.	Chicago, Ill.
D & R	Devoe and Raynolds Co., Inc.	New York, N. Y.

Abbreviation in Par. 35c	Name	Address
Eby	H. H. Eby, Inc.	Philadelphia, Pa.
G-E	General Electric Co.	Schenectady, N. Y.
H & H	Arrow-Hart & Hageman Elec. Co.	Hartford, Conn.
Hubbell	Harvey Hubbell, Inc.	Bridgeport, Conn.
IRC	International Resistance Co.	Philadelphia, Pa.
Jones	H. B. Jones Co.	Chicago, Ill.
K-K	Kurz-Kasch, Inc.	Dayton, Ohio
Kennedy	Kennedy Mfg. Co.	Van Wert, Ohio
Littel	Littelfuse, Inc.	Chicago, Ill.
Mal	P. R. Mallory & Co., Inc.	Indianapolis, Ind.
Micro	Micro Switch Corp.	New York, N. Y.
Ohmite	Ohmite Manufacturing Co.	Chicago, Ill.
Pwr Eq	Power Equipment Co.	Detroit, Mich.
RCA	R.C.A. Manufacturing Co.	Harrison, N. J.
Simplex	Simplex Wire and Cable Co.	Boston, Mass.
W. E. Co.	Western Electric Co.	New York, N. Y.
W.E.&M.	Westinghouse Electric & Mfg. Co.	East Pittsburgh, Pa.

c. List of Replaceable Parts.

(1) Automatic Frequency Control Unit.

Reference Designation	Sig. C Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
-	4TW61789-F1	AUTOMATIC FREQUENCY CONTROL UNIT: An assembly unit which occupies the space of four mounting plates and includes among other items a 1700-2550-cycle band-pass filter, five vacuum tubes, output transformer, potentiometer, and two keys. All but one of the resistors and several of the capacitors are of the pigtail type. (6-31/32" wide x 19" long.)	This unit automatically restores the frequency to the proper limits in case it should deviate from these limits.	W. E. Co.	X-61789F1
A	3DB1.229C	CAPACITOR: Fixed, paper 1μf ±15% 250 w-v d-c at 32F to 150F ambient temperature. Hermetically sealed in a wax-filled rectangular metal case 1" x 1-1/2" x 3-1/2". Two 1/2" mounting studs on 1" vertical and 3/8" horizontal centers and 15/16" rubber-insulated terminals at same end of case. Same as F, L.	Blocking capacitor for control grid of vacuum tube V1.	"	229C
B C	3DB3.13	CAPACITOR: Fixed, paper, 3μf ±15% 250 w-v d-c at 0°F to 150F ambient temperature. Hermetically sealed in a wax-filled rectangular metal case 1-1/2" x 1-21/32" x 3-1/2". Two 1/2" mounting studs on 1" centers and 7/8" insulated terminals at same end of case. Same as E, G.	With capacitor C reduces the ripple of the AVC potential applied to vacuum tube V1 and with resistance W delays the action of AVC. With capacitor B reduces the ripple of the AVC potential applied to vacuum tube V1.	"	231A
D1 D2	3DA750-1	CAPACITOR: Fixed, paper two units (0.64μf minimum to 0.84μf maximum) and (0.1μf minimum to 0.130 f maximum) 250 w-v d-c at ambient temperature of 32F to 150F. Hermetically sealed in a rectangular metal case 4-3/8" x 1-1/2" x 1". Two 1/2" mounting studs on 1" centers and 15/16" terminals at same end of case.	Blocking capacitor in control grid circuit of vacuum tube V1. Blocking capacitor in control grid circuit of vacuum tube V2.	" "	330C
E	3DB3.13	CAPACITOR: Same as B.	Reduces the ripple of AVC potential applied to vacuum tube V2 and with resistor T delays action of AVC.	"	231A
F	3DB1.229C	CAPACITOR: Same as A.	Screen grid by-pass capacitor for vacuum tube V2.	"	229C
G	3DB3.13	CAPACITOR: Same as B.	By-pass capacitor to prevent interaction between plate circuits of vacuum tubes V1 and V2.	"	231A
H	3DA455	CAPACITOR: Fixed, paper, 0.455μf ±3% 650 w-v d-c at 32F to 150F ambient temperature. Hermetically sealed in wax-filled rectangular metal case 3-9/16" x 1-1/2" x 19/32". Single mounting stud 15/32" long and 7/8" rubber-insulated terminals at same end of case.	Blocking capacitor between plate circuit of vacuum tube V2 and grid circuit of V3.	"	234D

(1) Automatic Frequency Control Unit. (Cont'd.)

Reference Designation	Sig. C Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
J	3DB2-7	CAPACITOR: Same as B except 2μf ±15%.	Cathode by-pass capacitor for vacuum tube V3.	W. E. Co.	228A
K	3DA100-136.1	CAPACITOR: Same as H except 0.1μf ±15%.	Blocking capacitor in AVC circuit.	"	234C
L	3DB1-229C	CAPACITOR: Same as A.	With resistors U and V forms a timing circuit in the AVC.	"	229C
M	3DA1.700	CAPACITOR: Fixed, silvered mica, 1700μμf ±(1% + 1μμf) 500 w-v d-c at -40F to +185F ambient temperature. Rectangular molded phenol plastic (1-1/4" x 27/32" x 9/32") with 1-1/2" tinned wire terminals at each end. Same as P.	Part of high-pass branch of discriminator.	"	401C 1700μμf
N	3DA6.500	CAPACITOR: Fixed, silvered mica, 6500μμf ±(1% + 1μμf) 300 w-v d-c at -40F to +167F ambient temperature. Rectangular molded phenol plastic (1-7/8" x 1-1/8" x 9/32") with 1-1/2" tinned wire terminals at each end.	Part of low-pass branch of discriminator.	"	402C 6500μμf
P	3DA1.700	CAPACITOR: Same as M.	Part of high-pass branch of discriminator.	"	401C 1700μμf
Q	3DB16-1.1	CAPACITOR: Fixed, paper 16μf ±15%, 400 w-v d-c at -40F to +185F ambient temperature. Oil impregnated and hermetically sealed in rectangular metal case 4-23/32" x 4-15/16" x 1-1/2". Four mounting studs on 3/4" x 4" centers. 7/8" terminals insulated with phenol plastic. Same as R, T, and U.	With resistor AF slows the response of the control voltage to changes in current through the high-pass branch of the discriminator.	"	293A
R	3DB16-1.1	CAPACITOR: Same as Q.	With resistor AG slows the response of the control voltage to changes in current through the low-pass branch of the discriminator.	"	401C
S	3DB7-1.1	CAPACITOR: Fixed, paper, 7μf ±15% 400 w-v d-c at -40F to +185F ambient temperature. Oil impregnated and hermetically sealed in a rectangular metal case 4-23/32" x 4-15/32" x 1-1/2". Four mounting studs on 3/4" x 1-3/4" centers. 7/8" terminals insulated with phenol plastic.	With resistor AH prevents hunting of AFC circuit.	"	289A

(1) Automatic Frequency Control Unit. (Cont'd.)

Reference Designation	Sig. C Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
T, U	3DB16-1.1	CAPACITOR: Same as Q.	Slows the response of the control voltage to frequency changes, also reduces the effect of any interference in the frequency-control lead to the radio receiver.	W. E. Co.	401C
A, B	3C1987-03	COIL, RETARDATION: Inductance between terminals 1 and 4 with 2 connected to 3 and .001 ampere at 1000 cps through coil is 2.424 henries maximum and 2.376 henries minimum, effective resistance 409Ω, d-c resistance at 68F 324Ω. Toroidal-type coil, permalloy core, hermetically sealed in a rectangular metal case 1" x 1-1/2" x 2-3/8". Two mounting studs on 1" centers and 7/8" terminals at same end of case.	Part of low-pass branch of discriminator.	"	D-166003
C	3D1987-30.1	COIL, RETARDATION: Inductance between terminals 1 and 4 with 2 connected to 3 and .001 ampere at 1000 cps through coil is 1 henry and resistance 148Ω, d-c resistance 121Ω. Torodial-type coil, permalloy core, hermetically sealed in a rectangular metal case 1" x 1-1/2" x 2-3/8". Two mounting studs on 1" centers and 7/8" terminals at same end of case.	Part of high-pass branch discriminator.	"	D-166130
IN	3Z1892-3.24	FILTER: Frequency band 1770 to 2480 cps, unbalanced to ground, designed to operate between 600Ω terminations. Retardation coils and capacitors enclosed in a rectangular metal case 1-5/8" x 6-15/16" x 5-1/8" with two mounting studs on 5-3/4" centers and 15/16" terminals at same end of case. Moisture-resistant.	Prevents interference outside of the band 1700 to 2500 cps from affecting the operation of the frequency control.	"	D-165627
OFF-ON	4C5105-52A	KEY: Two transfer contacts. Black turn-bottom type. Fits 13/32" drilling. Single mounting lug 9/16" x 13/16" x 3-7/8" over-all.	In off position disables the frequency-control circuit.	"	552A
DISCHG	4C5105.47A	KEY: Single-make contact. Nonlocking push-button type. Fits 29/64" drilling. Single mounting lug. 9/16" x 13/16" x 3-41/64" over-all.	Discharges capacitors T and U.	"	547A
A	2Z7281.1	POTENTIOMETER: 20,000Ω ±10%, 3 watts. Wire-wound, phenolic insulating material, silver plate finish on contact shoe. Round metal case 1-17/32" diameter x 11/16" thick, 1/2" x 1/4" shaft and 7/16" terminals.	Adjusts the loss of the low-pass branch of the discriminator to be the same as the high-pass loss at 2125 cps.	"	KS-8680

(1) Automatic Frequency Control Unit. (Cont'd.)

Reference Designation	Sig. C Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
A	3Z6610-7	RESISTOR: Fixed, 10,000Ω +5%, -10%, 1/2 watt, cylindrical glass filament resistance unit molded in phenol plastic compound. 3/16" diameter x 5/8" long. 1-1/2" axial wire lead at each end. Same as J, Z, AJ	Limits the shunting effect of the frequency-control circuit on Channel A receiver output.	W. E. Co.	KS-8058B 10,000Ω
B	3Z6100-9	RESISTOR: Same as A except 1000Ω +5%, -10%, 1/2 watt. Same as D.	Forms correct input impedance for IN filter.	"	KS-8058B 1000Ω
C	3Z6470-12	RESISTOR: Same as A except 4700Ω +5%, -10%, 1/2 watt.	With resistor D forms a potentiometer to reduce the input voltage of vacuum tube V1.	"	KS-8058B 4700Ω
D	3Z6100-9	RESISTOR: Same as B.	With resistor C forms a potentiometer to reduce the input voltage of vacuum tube V1.	"	KS-8058B 1000Ω
E	3Z6068	RESISTOR: Same as A except 680Ω +5%, -10%, 1/2 watt. Same as R.	Supplies correct output impedance for IN filter.	"	KS-8058B 680Ω
F	3Z6220	RESISTOR: Same as A except 2200Ω +5%, -10%, 1/2 watt.	Decreases the loss in the output circuit of vacuum tube V1 through the shunt path to ground.	"	KS-8058B 2200Ω
G	3Z6647	RESISTOR: Same as A except 47,000Ω +5%, -10%, 1/2 watt. Same as K and N.	Reduces the output of vacuum tube V1.	"	KS-8058B 47,000Ω
H	3Z4529	RESISTOR: Same as A except 10,000Ω ±10%, 1/2 watt.	Grid leak resistor for vacuum tube V2.	"	KS-8058C 10,000Ω
J	3Z6610-7	RESISTOR: Same as A.	With resistor K reduces the voltage on the screen grid of vacuum tube V1.	"	KS-8058B 10,000Ω
K	3Z6647	RESISTOR: Same as G.	With resistor J reduces the voltage on the screen grid of vacuum tube V1.	"	KS-8058B 47,000Ω
L	3Z6615-46	RESISTOR: Same as A except 15,000Ω +5%, -10%, 1/2 watt.	Plate circuit resistor of vacuum tube V1.	"	KS-8059B 15,000Ω
M	3Z6612-6	RESISTOR: Same as A except 12,000Ω +5%, -10%, 1/2 watt. Same as AC.	With resistor N reduces the voltage on the screen grid of vacuum tube V2.	"	KS-8058B 12,000Ω
N	3Z6647	RESISTOR: Same as G.	With resistor M reduces the voltage on the screen grid of vacuum tube V2.	"	KS-8058B 47,000Ω

(1) Automatic Frequency Control Unit. (Cont'd.)

Reference Designation	Sig. C Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
P	3Z6700-72	RESISTOR: Same as A except 0.1 megohm ±10%, 1/2 watt. Same as U and V.	Plate circuit resistor for vacuum tube V2.	W. E. Co.	KS-8058C 0.1 megohm
Q	3Z5974	RESISTOR: Same as A except 0.47 megohm ±10%, 1/2 watt. Same as AH.	Grid leak resistor for vacuum tube V3.	"	KS-8058C 0.47 megohm
R	3Z6068	RESISTOR: Same as E.	Cathode bias resistor for vacuum tube V3.	"	KS-8058B 680Ω
S	3Z6300-43	RESISTOR: Fixed, flat type, 3000Ω ±5%, 5 watts. Wire-wound on core of heat-resisting material. Two mounting studs on 1-15/16" centers. 1-1/2" x 13/64" x 4-21/32" overall. (Same as W.E.Co. 18DB except it is moisture-resistant.)	Reduces the interaction between vacuum tubes V1, V2, and V3.	"	D-161699DB
T	3Z5971-1	RESISTOR: Same as A except 0.18 megohm ±10%, 1/2 watt.	With capacitor E delays action of AVC.	"	KS-8058C 0.18 megohm
U	3Z6700-72	RESISTOR: Same as P.	With resistor V forms a potentiometer to reduce the AVC voltage applied to vacuum tube V2.	"	KS-8058C 0.1 megohm
V					
W	3Z5991-14	RESISTOR: Same as A except 1.5 megohm ±10%, 1/2 watt.	With capacitors B and C reduces the ripple of AVC potential applied to vacuum tube V1.	"	KS-8058C 1.5 megohm
X	3Z5971	RESISTOR: Same as A except 0.15 megohm ±10%, 1/2 watt.	With resistor Y forms a potentiometer to reduce the signal voltage on the plates of vacuum tube V4.	"	KS-8058C 0.15 megohm
Y			With resistor X forms a potentiometer to reduce the signal voltage on the plates of vacuum tube V4.		
Z	3Z6610-7	RESISTOR: Same as A.	Cathode-bias resistor of vacuum tube V4.	"	KS-8058B 10,000Ω
AA	3Z6647-3	RESISTOR: Same as A except 47,000Ω ±10%, 1/2 watt.	Limits the positive cathode bias of vacuum tube V4.	"	KS-8058C 47,000Ω
AB	3Z6622	RESISTOR: Same as A except 22,000Ω +5%, -10%, 1/2 watt. Same as AD and AE.	Provides correct input impedance for low-pass branch of discriminator.	"	KS-8058B 22,000Ω
AC	3Z6612-6	RESISTOR: Same as M.	Provides correct input impedance for high pass branch of discriminator.	"	KS-8058B 12,000Ω

(4) Automatic Frequency Control Unit. Cont'd.

Reference Designation	Sig. C Stock No.	Name and Description	Function	Manufacturer's Name	Manufacturer's Part No.
AD, AE	3Z6022	RESISTOR: Same as AB.	Provides correct output impedance for low-pass branch of discriminator. Provides correct output impedance for high-pass branch of discriminator.	W. E. Co.	KS-8058B 22,000Ω
AF	3Z5972	RESISTOR: Same as A except 0.22 megohm ±10%, 1/2 watt. Same as AG.	With capacitor Q slows the response of the control voltage to changes in current through the high-pass branch of the discriminator.	"	KS-8058C 0.22 megohm
AG	3Z5972	RESISTOR: Same as AF.	With capacitor R slows the response of the control voltage to changes in current through the low-pass branch of the discriminator.	"	KS-8058C 0.22 megohm
AH	3Z5974	RESISTOR: Same as Q.	With capacitor S prevents hunting of AFC circuit.	"	KS-8058C 0.47 megohm
AJ	326610-7	RESISTOR: Same as A.	Limits the shunting effect of the frequency-control circuit on channel B receiver output.	"	KS-8058B 10,000Ω
-	2Z9418	RESISTOR MOUNTING ASSEMBLY: 3-7/8" x 3-7/16" over-all. Seven eyelet terminals on each 3-7/16" side. Two steel angle mounting brackets with mounting centers 3-1/2".	For mounting resistors.	"	D-263397
-	2Z9408.4	TERMINAL STRIP: 1-9/32" x 1-15/32" x 1-9/16" over-all. Eight double-end terminals staggered on 5/32" centers, molded in blocks, phenol plastic base.	For connections between internal and external wiring of unit.	"	D-166220
OUT	2Z9648.3	TRANSFORMER: Impedance ratio 50,000:150,000 between windings (1-2) and (3-4). Winding (3-4) is designed to operate with approximately .01 ampere d-c. With 3v at 200 cps across output, inductance is 12 henries minimum. Transformation ratio between windings (3-4) and (1-2) is 1.77:1 maximum 1.7:1 minimum. D-c resistance winding (1-2) 683Ω, (3-4) 1800 . Shell-type, silicon-steel core mounted in rectangular metal case 1-11/16" x 2-17/32" x 3-7/16". Two mounting studs on 1-3/4" centers and 3/4" terminals at same end of case.	Connects the discriminator to the output of vacuum tube V3.	"	D-163145
V1	2T11o	VACUUM TUBE: Pentode, sharp cutoff, 6-prong metal tube, 2-5/8" x 1-5/16" diameter. Same as V2 and V3.	By-passes IN filter when the signal frequency is outside of 1700-2500 cps.	RCA	6SJ7

(1) Automatic Frequency Control Unit. (Cont'd.)

Reference Designation	Sig. C Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
V2	2T11b	VACUUM TUBE: Pentode, sharp cutoff, 8-prong metal tube, 2-5/8" x 1-5/16" diameter. Same as V1 and V2.	Variable gain amplifier vacuum tube.	RCA	6SJ7
V3			Amplifier vacuum tube.		
V4	2V6Hb	VACUUM TUBE: Twin diode, 6.3 filament voltage, 3 amperes filament current, 420v maximum inverse peak, .048 ampere per plate, d-c heater to cathode potential 330v maximum a-c plate voltage per plate RMS 150v maximum d-c output current per plate .008 ampere maximum 1-3/4" high x 1-9/16" diameter. Metal shell, seven prongs, used in octal socket.	Rectifier tube in AVC circuit.	"	6H6
V5			Rectifies the output of the discriminator.	"	6H6
-	2Z[illegible]5-10	VACUUM-TUBE SOCKET: 1-1/2" x 1-1/8" elliptical x 3/4" thick over-all, socket for 8-prong vacuum tube made of molded insulating material 1-1/8" diameter x 5/8" thick, two metal mounting lugs on opposite side of socket, screw holes in lugs on 1-1/4" centers, terminal extends approximately 1/4" beyond insulating material.	Sockets for vacuum tubes.	CINCH	EXP-7086B

(2) Frequency Indicator Panel.

Reference Designation	Sig. C Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
ALM	4C310D	BELL: Operating voltage d-c 14 volts to 40 volts, operating voltage a-c 25 volts to 50 volts, 50-60 cps, d-c resistance is approximately 248Ω, effective d-c resistance or a-c impedance during operation is approximately 732Ω. 3-1/2" x 5-1/2" over-all black finished case with 5" black finished gong, equipped with heavy silver contacts and reed-mounted armature with a flat retractile spring and a stop, surface mounted, intended for d-c or a-c operation.	Rings if difference between marking and spacing frequency is excessive.	W. E. Co.	7A
A	3DB1.229C	CAPACITOR: 1μf ±15%, 250 w-v d-c at +32F to +150F ambient temperature. 1" x 1-1/2" x 3-1/2" rectangular metal case, hermetically sealed, 15/16" rubber-insulated terminals, wax-filled, paper dielectric, two 1/2" long mounting studs on 1" vertical centers, and staggered on 3/8" horizontal centers, studs and terminals on same end of case. Same as E, K, and M.	Blocking capacitor for a-c meter circuit.	"	229C
B	3DA100-135.1	CAPACITOR: 0.1μf ±5%, 650 w-v d-c at +32F to +150F ambient temperature. 3-9/16" x 1-1/2" x 19/32" rectangular metal case, hermetically sealed, wax-filled, paper dielectric, single mounting stud 15/32" long, 7/8" rubber-insulated terminals, stud and terminals on same end of case.	Limit amplitude of oscillation for vacuum tube VA.	"	234B
C	3DA99.400	CAPACITOR: 0.1μf ±1/2% 250 w-v d-c at -40F to +150F ambient temperature. 1-31/32" x 2-1/2" x 11/16" rectangular metal case, hermetically sealed, silvered mica, mounting lugs extend 3/8" from 11/16" sides and are flush with 11/16" x 2-1/4" side, terminals are rubber insulated and extend 25/32" beyond 11/16" x 2-1/4" side.	Tuning capacitor for oscillator.	"	D-162051
		Or			
		CAPACITOR: 1-7/8" x 1-1/8" x 9/32" rectangular, molded in plastic, silvered mica laminations, 1-1/2" tinned wire terminals at each end,	Tuning capacitors for oscillator. Required number selected to tune oscillator to proper frequency.		
C1, C2, C3, C4	3DA20-51	0.02μf ±(5% + 1μμf) 300 w-v d-c at -40F to +167F ambient temperature.		"	402D 0.02μf
C5	3DA10-157	0.01μf ±(5% + 1μμf) 300 w-v d-c at -40F to +167F ambient temperature.		"	402D 0.01μf
C6	3DA4-31	0.004μf ±(5% + 1μμf) 300 w-v d-c at -40F to +167F ambient temperature.		"	402D 0.004μf
C7	3DA3-32	0.003μf ±(5% + 1μμf) 300 w-v d-c at -40F to +167F ambient temperature.		"	402D 0.003μf

(2) Frequency Indicator Panel. (Cont.d)

Reference Designation	Sig. C Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
		CAPACITOR: 1-7/8" x 1-1/8" x 9/32" rectangular, molded in plastic, silvered mica laminations, 1-1/2" tinned wire terminals at each end,	Tuning capacitors for oscillator. Required number selected to tune oscillator to proper frequency.		
C8	3DA2-93	0.002μf ±(5% + 1$\mu\mu$f) 300 w-v d-c at -40F to +167F ambient temperature.		W. E. Co.	402D 0.002μf
C9	3DA1-94	0.001μf ±(5% + 1$\mu\mu$f) 300 w-v d-c at -40F to +167F ambient temperature.		"	402D 0.001μf.
C10	3DA400-19	400$\mu\mu$f ±(5% + 1$\mu\mu$f) 300 w-v d-c at -40F to +167F ambient temperature.		"	402D 400$\mu\mu$f
C11	3DA300-11	300$\mu\mu$f ±(5% + 1$\mu\mu$f) 300 w-v d-c at -40F to +167F ambient temperature.		"	402D 300$\mu\mu$f
C12	3DA200-40	200$\mu\mu$f ±(5% + 1$\mu\mu$f) 300 w-v d-c at -40 F to +167F ambient temperature.		"	402D 200$\mu\mu$f
C13	3DA100-93	100$\mu\mu$f ±(5% + 1$\mu\mu$f) 300 w-v d-c at -40F to +167F ambient temperature.		"	402D 100$\mu\mu$f
D	3DB3.13	CAPACITOR: 3μf ±15%, 250 w-v d-c at +32F to +150F ambient temperature. 3-1/2" x 1-1/2" x 1-21/32" rectangular metal can 7/8" terminals, wax filled, paper dielectric, stud mounted. Same as F, G, and L.	Cathode by-pass capacitor for vacuum tube VA.	"	231A
E	3DB1.229C	CAPACITOR: Same as A.	Blocking capacitor between output of vacuum tube VA and grid circuit of vacuum tube V3.	"	229C
F	3DB3.13	CAPACITOR: Same as D.	Screen grid by-pass capacitor. With resistor G forms filter in screen grid circuit.	"	231A
G			Cathode by-pass capacitor of vacuum tube VA.		
H	3DA200-5	CAPACITOR: 0.2μf ±4%, 650 w-v d-c at +32F to +150F ambient temperature. 3-9/16" x 1-1/2" x 13/32" rectangular metal case, hermetically sealed, wax filled, paper dielectric, single mounting stud 13/32" long, 7/8" rubber insulated terminals, stud terminals on same end of case.	Blocking capacitor in plate circuit of vacuum tube VB.	"	234A

(2) Frequency Indicator Panel. (Cont'd.)

Reference Designation	Sig. C Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
J	3DA455	CAPACITOR: 0.455 μf ±3%, 650 w-v d-c at +32F to +150F ambient temperature. 3-9/16" x 1-1/2" x 19/32" rectangular metal case, hermetically sealed, wax filled, paper dielectric, single mounting stud 13/32" long, 7/8" rubber insulated terminals, stud and terminals on same end of case.	By-pass a-c components of rectified currents from varistor A.	W. E. Co.	234D
K	3DB1.229C	CAPACITOR: Same as A.	Blocking capacitor in test level circuit.	"	229C
L	3DB3.13	CAPACITOR: Same as D.	Cathode by-pass capacitor of vacuum tube VA.	"	231A
M	3DB1.229C	CAPACITOR: Same as A.	Blocking capacitor between vacuum tubes VC and VD.	"	229C
N	3DA400-5	CAPACITOR: 0.38 μf +10% -20%, 230 w-v d-c at 0°F to 150F ambient temperature. 3-9/16" x 1-1/2" x 19/32" rectangular metal case, hermetically sealed, wax filled, paper dielectric, 9/16" rubber insulated terminals, single mounting stud 15/32" long, stud and terminals on same end of case.	Improve transmission of low-frequency impulser through OUT transformer.	"	364A
P	3DA12-4	CAPACITOR: 0.012 μf ±(5% + 1 μμf) 300 w-v d-c at -40F to +167F ambient temperature. 1-7/8" x 1-1/8" x 9/32" rectangular, molded plastic, silvered mica laminations, 1-1/2" tinned wire terminals at each end, bracket mounted.	Filter capacitor in output circuit of vacuum tube VA.	"	402D 0.012 μf
Q	3DA20-51	CAPACITOR: Same as P except 0.02 μf.	Filter capacitor in output circuit of vacuum tube VA.	"	402D 0.2 μf
R	3DA8-9	CAPACITOR: Same as P except 0.008 μf.		"	402D 0.008 μf
S	3DA4-32	CAPACITOR: 0.004 μf ±(5% + 1 μμf) 300 w-v d-c at -40F to +167F ambient temperature. 1-1/4" x 27/32" x 9/32", rectangular, molded phenol plastic, silvered mica capacitor with 1-1/2" tinned wire terminals at each end.		"	401D 0.004 μf
T	3DA3-33	CAPACITOR: Same as S except 0.003 μf.	Make voltage across retardation coil D proportional to frequency.	"	401D 0.003 μf
U	3DA2-94	CAPACITOR: Same as S except 0.002 μf.	Filter capacitor in input circuit of frequency indicator.	"	401D 0.002 μf
V, W	3DA2-94	CAPACITOR: Same as S except 0.002 μf.	Filter capacitor in input circuit of frequency indicator.	"	401D 0.002 μf

(2) Frequency Indicator Panel (Cont'd.)

Reference Designation	Sig. C Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
OSC	2Z9647.5	INPUT TRANSFORMER: Autotransformer, impedance ratio between windings (1-3) and (2-3) is 75:1 and the inductance of winding (1-3) is approximately 26 millihenries, d-c resistance of winding 1-3 at 68F is maximum 4.7Ω, ratio of transformation windings (1-2) (2-3) maximum 8.1:1 and minimum 7.4:1, 2550 cps. 1" x 1-1/2" x 2-3/8" rectangular metal case, hermetically sealed, moisture resistant, three 7/8" terminals on 1/2" centers, two mounting studs on 1" centers, toroidal type, molybdenum permalloy core, terminals and studs on same end of case, nuts and lockwashers furnished for mounting.	Oscillator tuning coil.	W. E. Co.	D-164711
CURR LIM A	4C4716A	JACK: Five terminals viz. tip, sleeve break contact on tip and extra set of break contacts. 9/16" x 13/16" x 3-15/32" over-all, mounts in 29/64" drilling, heavily insulated, singly mounted. Single mounting lug, mounting screw furnished, mounting centers horizontal 5/8" vertical 7/8", terminal of tip spring and one that makes contact with it takes two no. 16 B&S wires, other terminals take two no. 19 B&S wires, used with nos. 47, 116, 144, and similar plugs.	Jack for patching frequency indicator output of current limiter A.	"	216A
FREQ IND IN			Jack for patching input of frequency indicator.		
CURR LIM B	2Z5524	JACK: Three terminals as follows: one tip, one sleeve and one contact connected to tip which breaks when plug is in jack. 9/16" x 13/16" x 3-15/32" over-all, heavily insulated, singly mounted. Terminal of tip spring and of spring which makes contact with it are arranged to accommodate two no. 16 B&S gauge wires, one mounting lug, provided with mounting screws.	Jack for patching frequency indicator output of current limiter B.		
NORMAL TEST LEVEL			Jack for patching approximately -6 dbm test level of 2550 cps.	"	218A
LOW TEST LEVEL			Jack for patching approximately -50 dbm test level of 2550 cps.		
A-C METER	4C4823A	JACK: Two conductors, viz. tip and sleeve. 9/16" x 13/16" x 3-15/32" over-all, heavily insulated, singly mounted. Tip terminal arranged to accommodate two no. 15 B&S gauge wires and sleeve terminal arranged to accommodate two no. 19 B&S gauge wires, single mounting lug, mounting screw furnished, fits in 29/64" drilling, arranged to mount on 5/8" vertical and 7/8" horizontal centers, may be used with W.E.Co. nos. 47,116, and similar plugs.	Jack for patching a-c meter.	"	223A
D-C METER	2Z5522	JACK: Three terminals viz. tip, ring, and sleeve. 9/16" x 13/16" x 3-23/64" over-all, mounts in 29/64" drilling, heavily insulated, singly mounted. Single mounting lug, mounting screw furnished, mounting centers 5/8" horizontal, 7/8" vertical, terminals accommodate two no. 19 B&S gauge wires, used with nos. 110, 150, 184, 202, 207, and 213 plugs.	Jack for patching d-c meter.	"	238A

(2) Frequency Indicator Panel (Cont'd.)

Reference Designation	Sig. C Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
FREQ IND OUT	4C4839A	JACK: Five terminals viz. tip, ring, sleeve, break contact on tip, break contact on ring. 9/16" x 13/16" x 3-23/64" over-all, mounts in 29/64" drilling, heavily insulated, singly mounted. Single mounting lug, mounting screw furnished, mounting center 5/8" horizontal 7/8" vertical, terminals accommodate two no. 19 B&S wires, used with nos. 110, 150, 184, 202, 207, and 213 plugs.	Jack for patching frequency indicator output.	W. E. Co.	239A
METER	4C5105.52A	KEY: Two transfer contacts. 9/16" x 13/16" x 3-7/8" over-all including terminals and mounting lug, turn button, black button, mounts in 13/32" drilling, single mounting lug, mounting screw furnished, mounting centers 5/8" horizontal, 7/8" vertical.	Switches the meter to measure a-c level or d-c current.	"	552A
FREQ IND CAL	4C5105.47B	KEY: Two transfer spring combinations. 13/16" x 9/16" x 3-41/64" over-all, mounts in 29/64" drilling, nonlocking push button, single lug, mounting screw furnished.	Switches frequency indicator circuit to calibrating or measuring condition.	"	547B
METER	3F910-16	MILLIAMMETER (D-c): Scale 100-0-100, 40 scale divisions, accuracy ±2% of full scale deflection, 1 milliampere d-c, approximately 26Ω. Calibrated for use on 0.09" thick steel plate. 3-1/2" surface type, bakelite case, self-contained, moving coil, permanent magnet. Terminal posts 1-5/16" long.	Milliammeter or Weston 301 KS-8693 1-0-1 milliampere 100-0-100. Used to measure a-c levels and d-c currents.	"	D-164680
OUT	229648.8	OUTPUT TRANSFORMER: Impedance ratio 6000:500 operates over frequency range of 60 cps to 5000 cps, d-c resistance of windings (1-2) (3-4) in series approximately 104Ω, d-c resistance of winding (5-6) is approximately 695Ω. 2-7/8" x 2-7/8" x 3-7/16" steel case, 9/16" terminals, shell type silicon steel core, four mounting holes in base on 2-3/8" vertical and horizontal centers.	Connects output of vacuum tube VD to alarm bell circuit.	"	131A
ZERO ADJ	22728.1	POTENTIOMETER: 20,000Ω ±10%, 3 watts. 1-17/32" diameter x 11/16" thick, round metal case, 7/16" terminals, 1/2" x 1/4" shaft, contact shoe has silver plate finish, wire wound, phenolic insulating material.	Adjusts input level of frequency indicator.	"	KS-8680 20,000Ω
A B	3Z6300-30	RESISTOR: Two windings, wire wound on core of heat resisting material. Fixed resistances 3000Ω ±1% and 3000Ω ±1%, 5 watts either winding or both. 1-1/2" x 13/64" x 4-21/32" (including 1-5/32" terminals), flat type, two mounting studs on 1-5/16" centers, three terminals on 21/32" centers.	Correct calibration voltage. (Strapped at the factory) Same as A, B, C, D, E, and F.	"	D-161700RP

(2) Frequency Indicator Panel. (Cont'd.)

Reference Designation	Sig. C Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
C	3Z6160-5	RESISTOR: Two windings, wire wound on core of heat resisting material. Fixed resistances 1200Ω ±1% and 1600Ω ±1%, 5 watts either winding or both windings. 1-1/2" x 13/64" x 4-21/32" (including 1-5/32" terminals), flat type, two mounting studs on 1-5/16" centers, three terminals on 21/32" centers. Moisture resistant W.E.Co. no. 19 PS.	Same as A.	W. E. Co.	D-161700PS
D	3Z6080-22	RESISTOR: Two windings, wire wound on core of heat resisting material. Fixed resistances 400Ω ±1% and 800Ω ±1%, 5 watts either winding or both windings. 1-1/2" x 13/64" x 4-21/32" (including 1-5/32" terminals) flat type, two mounting studs on 1-5/16" centers, three terminals on 21/32" centers. Moisture resistant W.E.Co. no. 19 NT.		"	D-161700NT
E	3Z6020-33	RESISTOR: Two windings, wire wound on core of heat resisting material. Fixed resistances 100Ω ±1% and 200Ω ±1%, 5 watts either winding or both windings. 1-1/2" x 13/64" x 4-21/32" (including 1-5/32" terminals), flat type, two mounting studs on 1-5/16" centers, three terminals on 21/32" centers. Moisture resistant W.E.Co. no. 19 NU.	Same as A.	"	D-161700NU
F	3Z6005-38	RESISTOR: Two windings, wire wound on core of heat resisting material. Fixed resistances, 25Ω ±1% and 50Ω ±1%, 5 watts either winding or both windings. 1-1/2" x 13/64" x 4-21/32" (including 1-5/32" terminals), flat type, two mounting studs on 1-5/16" centers, three terminals on 21/32" centers. Moisture resistant W.E.Co. no. 19 NS.		"	D-161700NS
G	3Z6610-16	RESISTOR: Metallized glass tube filament resistance element. Fixed resistance 10,000Ω ±10%, 2 watts. 1-3/4" x 5/16" diameter, molded in phenol plastic compound, cylindrical, 1-1/2" axial wire lead at each end.	With capacitor F forms filter for screen grid of vacuum tube VA.	"	KS-8060C 10,000Ω
H	3Z6620-55	RESISTOR: Wire wound on bakelite core. Fixed resistance 30,000Ω ±1%, 1/2 watt, low resistance. 1-1/2" x 1/2" diameter, phenol fibre outer tube with 2" axial lead at each end.	Makes a-c voltage across coil D cause correct frequency indication.	"	107A 30,000Ω
J	3Z6620.56.1	RESISTOR: Same as H except 20,000Ω.	Reduces voltage across resistors A, B, C, D, E, F, and G.	"	107A 20,000Ω
K	3Z6060-23	RESISTOR: Wire wound on bakelite core, 600Ω ±1%, 1/4 watt, low reactance. 1" x 5/16" diameter, phenol fibre outer tube with 2" axial lead at each end.	With resistor L, makes LOW TEST LEVEL about -50 dbm.	"	106A 600Ω

(2) Frequency Indicator Panel. (Cont'd.)

Reference Designation	Sig. C Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
L	3Z6700-76	RESISTOR: Same as H except 0.1 megohm.	With resistor K makes LOW TEST LEVEL about -50 dbm.	W. E. Co.	107A 0.1 megohm
M	3Z6050-60	RESISTOR: Same as K except 500$^{\omega}$.	Makes NORMAL TEST LEVEL about -6 dbm.	"	106A 500$^{\omega}$
N	3Z6620-60	RESISTOR: Metallized glass tube filament resistance element, 20,000$^{\omega}$ ±10%, 1/2 watt. 5/8" x 3/16" diameter, molded in phenol plastic compound, cylindrical, 1-1/2" axial lead at each end.	Grid leak for vacuum tube VA.	"	KS-8058C 20,000$^{\omega}$
P	3Z6020-31	RESISTOR: Wire wound on bakelite core, 200$^{\omega}$ ±1%, 1/4 watt, low reactance. 1" x 5/16" diameter phenol fibre outer tube with 2" axial lead at each end. Same as X and Y.	Cathode bias resistor for vacuum tube VA.	"	106A 200$^{\omega}$
Q	3Z6615-46	RESISTOR: Metallized glass tube filament resistance element. Fixed resistance 15,000$^{\omega}$ +5%, -10%, 1 watt. 1-1/4" x 1/4" molded in phenol plastic compound in cylindrical form, 1-1/2" axial lead at each end.	Limits the amplitude of oscillation by reducing the plate potential of vacuum tube VA.	"	KS-8059B 15,000$^{\omega}$
R	3Z4529	RESISTOR: Same as N except 10,000$^{\omega}$.	Terminating resistance for filter.	"	KS-8058C 10,000$^{\omega}$
S	3Z6150-20	RESISTOR: Same as N except 1500$^{\omega}$.	Cathode bias resistor for tube VB.	"	KS-8058C 1500$^{\omega}$
T	3Z6750-30	RESISTOR: Same as N except 0.5 megohm.	Presents proper output impedance to varistor A.	"	KS-8058C 0.5 megohm
U	3Z6630-28	RESISTOR: Metallized glass tube filament resistance element. Fixed resistance 30,000$^{\omega}$ ±10%, 1 watt. 1-1/4" x 1/4" diameter molded in phenol plastic compound in cylindrical form, 1-1/2" axial lead at each end.	Prevents interaction between circuits of screen grid and plate of vacuum tube VB.	"	KS-8059C 30,000$^{\omega}$
V	3Z6610-18	RESISTOR: Metallized glass tube filament resistance element. Fixed resistance 10,000$^{\omega}$ +5%, -10%, 2 watts. 1-3/4" x 5/16" diameter, molded in phenol plastic compound in cylindrical form, 1-1/2" axial lead at each end.	Cathode bias resistor of vacuum tube VC.	"	KS-8069B 10,000$^{\omega}$
W	3Z6640-19	RESISTOR: Same as H except 40,000$^{\omega}$.	With plate circuit of tube VC forms a wheatstone bridge. Current due to unbalance is a measure of the departure of the signal frequencies from their normal values.	"	107A 40,000$^{\omega}$

(2) Frequency Indicator Panel. (Cont'd.)

Reference Designation	Sig. C Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
X Y	3Z6020-31	RESISTOR: Same as P.	With plate circuit of vacuum tube VC forms a wheatstone bridge. Current due to unbalance is a measure of the departure of the signal frequencies from their normal values.	W. E. Co.	106A 200Ω
Z	3Z6030-4C	RESISTOR: Same as N except 300Ω.	Cathode bias resistor for vacuum tube VD.	"	KS-8058C 300Ω
AA	3Z4550	RESISTOR: Same as N except 0.1 megohm.	Grid resistance for vacuum tube VD.	"	KS-8058C 0.1 megohm
AB	3Z6100-76	RESISTOR: Same as P except 1000Ω.	Determines sensitivity of a-c meter.	"	106A 1000Ω
A	3C1987-84	RETARDATION COIL: Inductance tested between terminals 1 and 2 with 0.042 ampere at 500 cps 0.46 henry maximum 0.44 henry minimum effective resistance 75Ω, d-c resistance at 68F 53Ω. 1" x 1-1/2" x 2-3/8" hermetically sealed rectangular metal case, two 7/8" terminals on 1" centers, two mounting studs on 1" centers, toroidal type coil, molybdenum permalloy core, mounting studs and terminals on same end of case, mounting nuts and lockwashers furnished.	Filter coil input circuit of frequency indicator.	"	D-163784
B	3C1987-25	RETARDATION COIL: With 0.002 ampere at 1800 cps through two windings in series measured between terminals 1 and 4 with terminals 2 and 3 connected together, the inductance is minimum 3.069 henrys and maximum 3.131 henrys and the resistance is 794Ω. The d-c resistance at 68F measured between terminals 1 and 3 with terminal 2 connected to terminal 4 is 480Ω. 1" x 1-1/2" x 2-3/8" rectangular metal can, hermetically sealed four 7/8" rubber insulated terminals, two mounting studs on 1" centers, terminals and studs on same end of case, torodial coil, molybdenum permalloy powder cord, two individual windings. Same as D.	Filter coil in output circuit for vacuum tube VA. Same as C.	"	D-164625
C	3C1987-03	RETARDATION COIL: Inductance measured between terminals 1 and 4 with terminal 2 connected to terminal 3 and 0.001 ampere at 1000 cps through coil 2.424 henrys maximum and 2.376 henrys minimum effective resistance 409Ω, d-c resistance at 68F 324Ω. 1" x 1-1/2" x 2-3/8" rectangular metal case, hermetically sealed, two mounting studs on 1" centers, four 7/8" terminals, torodial type coil, molybdenum permalloy core, mounting nuts and lockwashers furnished.	Same as B.	"	D-166003

(2) Frequency Indicator Panel. (Cont'd.)

Reference Designation	Sig. C Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
D	3C1987-25	RETARDATION COIL: Same as B.	Discriminator coil.	W. E. Co.	D-164625
VA	2T150	VACUUM TUBE: Pentagrid converter, heater type tube, heater voltage 6.3v heater current 0.3 ampere. 2-5/8" x 1-5/16" over-all, metal tube eight prongs.	Oscillator.	RCA	6SA7
VB	2T116	VACUUM TUBE: Pentode, sharp cutoff. 2-5/8" x 1-5/16" over-all, metal tube, eight prongs.	A-c amplifier tube.	"	6SJ7
VC			D-c amplifier tube.		
VD	2V6VGT	VACUUM TUBE: Pentode, beampower amplifier, heater type tube, heater voltage, 6.3v, heater current 0.45 ampere. 3-5/16" x 1-5/16" over-all, glass tube, seven prongs.	Amplifies impulses passing through capacitor M.	"	6V6GT
A	3H4957-1	VARISTOR: When connected as a full wave bridge rectifier at an ambient temperature of 105F its maximum continuous output rating will be 0.015 ampere d-c at 45v and the maximum a-c input voltage should be 67v rms. 1-9/32" x 1-1/2" x 3-15/32", rectangular metal case, contains two units of thirty 3/16" copper-oxide discs each unit, two 7/16" mounting lugs on 1" centers, 3/4" terminals, nuts and lockwashers for mounting are furnished.	Rectifier output tube VB.	W. E. Co.	34A
M	3H4956-8	VARISTOR: Used as bridge type rectifier, maximum input 4.5v rms, maximum continuous output 3v at 15 milliamperes, d-c, maximum power output 0.024 watt. 3/4" x 1" x 1-1/4" rectangular metal case containing assembly of four 3/16" copper oxide rectifier discs, over-all including terminals and mounting lugs 3/4" x 1-9/16" x 1-13/16", two mounting lugs at right angles to each 3/4" side and flush with bottom of case and staggered so that mounting screws are on vertical and horizontal centers of 5/16" and 1-3/8", six 9/16" terminals.	Full-wave rectifier in a-c meter circuit.	"	D-97966

(3) Receive Relay Panel.

Reference Designation	Sig. C Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
A	3DA500-81	CAPACITOR: 0.5 μf ±15% 650 w-v d-c at 0°F to 150F ambient temperature. 1" x 1-1/2" x 3-1/2" rectangular metal case, hermetically sealed, 15/16" rubber insulated terminals, wax filled, paper dielectric, two 1/2" mounting studs on 1" vertical centers and staggered on 3/8" horizontal centers.	With resistance H provides spark protection for S contact of the REC relay.	W. E. Co.	227A
-	4E318E	CONNECTING BLOCK: 2-31/64" x 2-1/32" x 1-25/32" over-all, eight terminals arranged to engage with guide posts and terminals of relay and hold relay in position by spring tension, furnished with mounting screws, arranged to mount 255A relay or other similar relay.	To mount REC relay.	"	18B
REC 88D FILTER	3Z1892-5	FILTER: Will suppress radio frequencies by 50 db or more from 300 kc to 5000 kc. 2-1/2" x 2-11/16" x 1-13/16" over-all, consists of two 269A retardation coils, two KS-8058 resistors, (400 Ω) and one 313C capacitor mounted on metal bracket, 0.138-32 tapped holes in bracket on 1-3/4" centers for mounting, screws for mounting furnished.	Prevents interference to radio receivers.	"	88D
TST	4C5105.52A	KEY: Two transfer contacts. 9/16" x 13/16" x 3-7/8" over-all, including terminals and mounting lug, turn button, black button, mounts in 13/32" drilling, single mounting lug, mounting screw furnished, mounting centers 5/8" horizontal, 7/8" vertical.	Opens holding circuit of relay REC.	"	552A
A	4C8920.567	RELAY: Single winding, 2000 Ω ±10%, two make contacts top, one set make before break contacts bottom, slow acting. 1-7/16" x 1-3/16" x 4-17/32" (including 3/4" terminals) flat type, round core, palladium twin contacts, mounts by screws in tapped holes, mounting screws furnished, insulated from mounting plate.	Operated by the closure of a contact in the radio receiver cabinet, it actuates the monitoring circuit, operating relay C and connecting holding circuits to the relay REC and the loop.	"	U567
B	4C8939.159	RELAY: Single winding 1300 Ω ±10%, one make contact one set of transfer contacts, slow release. 1-7/16" x 1-3/16" x 4-17/32" (including 3/4" terminals) flat type, round core, heavy palladium twin contacts, mounts by screws in tapped holes, mounting screws, furnished, insulated from mounting plate, two buffer springs on top and one buffer spring on bottom set of springs.	Released by a steady marking signal and releases relays A and B.	"	Y159
C	4C8920.1129	RELAY: Single winding 2000 Ω ±5%, two sets of transfer contacts, slow acting. 1-7/16" x 1-1/16" x 4-17/32" (including 3/4" terminals) flat type, round core, palladium twin contacts, mounts by screws in tapped holes, mounting screws furnished, insulated from mounting plate buffer springs top and bottom.	Transfers the control of relay B to the armature of relay REC.	"	U1129

(3) Receive Relay Panel. (Cont'd.)

Reference Designation	Sig. C Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
REC	4TRY30	RELAY: Two parallel windings 136Ω ±10%, each winding, one set of transfer contacts. 2-11/16" x 2-11/16" x 4-3/4" exclusive of 1-1/32" guide pins, square base, cylindrical cover, permalloy reed type armature, antichatter contacts, jack mounted on 18B connecting block.	Operated by signals from the detectors, sends d-c polar signals into loop circuit.	W. E. Co.	255A
A	3Z6502	RESISTOR: Two windings, three terminals, wire wound on core of heat resisting material, 1705Ω ±1%, 3 watts, 5200Ω±1% 5 watts, both windings 5 watts maximum. 1-1/2" x 13/64" x 4-21/32" long (including 1-5/32" terminals) flat type, mounting studs on 1-5/16" centers, mounting washers 3/8" diameter. Moisture resistant W.E.Co. no. 19 TJ.	Controls holding current to correct value in relay REC.	"	D-161700TJ
B	3Z6289-H8	RESISTOR: Wire wound on core of heat resisting material, 2898Ω1%, 5 watts. 1-1/2" x 13/64" x 4-21/32" long (including 1-5/32" terminals) flat type, mounting studs on 1-5/16" centers, mounting washers 3/8" diameter. Moisture resistant W.E.Co. no. 18 EK.	With resistor C forms meter shunt.	"	D-161699EK
C	3Z6006B2-1	RESISTOR: Same as A except 62Ω ±1% each winding, 5 watts either winding or maximum both windings.	With resistance B forms meter shunt.	"	D-161700PN
D	3Z6012-6	RESISTOR: Same as B except 120Ω ±5%. Same as E and M.	Limits maximum current from disc-type rectifier.	"	D-161699D
E	3Z6012-6	RESISTOR: Same as D.	Limits maximum current from disc-type rectifier.	"	D-161699D
F	3Z6300-39	RESISTOR: Same as B except 3000Ω ±2%.	To give correct value of operating current for relay A.	"	D-161699HC
G	3Z6130-1	RESISTOR: Same as A except 100Ω ±1%, 1 watt and 1300Ω ±1%, 5 watts, maximum both winding 5 watts.	To give correct value of holding current in loop circuit.	"	D-161700RB
H	3Z6160-4	RESISTOR: Same as A except 1600Ω ±5% each winding. 5 watts either winding or both windings.	With capacitors A and B forms spark protection for contacts of relay REC.	"	D-161700JE
J	3Z6240-10	RESISTOR: Same as A except 1100Ω ±1%, 4 watts and 2400Ω ±1%,5 watts or both windings 5 watts maximum.	Forms return path to disc-type rectifier for marking loop signals.	"	D-161700SN

(3) Receive Relay Panel. (Cont'd.)

Reference Designation	Sig. C Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
K	326240-10	RESISTOR: Same as J.	Forms return path to disc-type rectifier for spacing loop signals.	W. E. Co.	D-161700SN
L	326350-9	RESISTOR: Same as A except 102.6Ω ±1/2% 1 watt and 3505Ω ±1/2% 5 watts, both windings 5 watts maximum.	To give correct value of operating current for relay C.	"	D-161700PC
M	326012-6	RESISTOR: Same as D.	Limits current from disc-type rectifier which may be caused by trouble condition.	"	D-161699D
N	326220-9	RESISTOR: Same as B except 2200Ω ±1%, 5 watts.	Limits current through winding of relay B to give correct current value for operation.	"	D-161699HB

(4) Detector Panel.

Reference Designation	Sig. C Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
A	3DA3-34	CAPACITOR: Mineral oil impregnated, paper dielectric 0.003 μf ±20%, 800 w-v d-c at -40F to 185F ambient temperature. 13/16" x 13/16" 19/64" thick, rectangular, molded plastic, 1-5/16" wire terminals at ear end.	With resistors ME and SE controls speed of response of noise-suppression circuit.	W. E. Co.	404B 0.003 μf
		Or			or
	3DA-33	CAPACITOR: Silvered mica, 0.003 μf ±(5% + 1 $\mu\mu$f) 300 w-v d-c at -40F to +167F ambient temperature. 1-1/4" x 27/32" x 9/32", rectangular, molded plastic 1-1/2" tinned wire terminals at each end.		"	401D 0.003 μf
MA	3DB2-7	CAPACITOR: Paper dielectric, wax filled, 2 μf ±15%, 250 w-v d-c at 0°F to 150F ambient temperature. 1-1/2" x 1-21/32" x 3-1/2" rectangular metal case, hermetically sealed, two rubber insulated 7/8" terminals, two 1/2" mounting studs on 1" centers. Same as SA.	Cathode by-pass capacitor for vacuum tube MVA.	"	228A
MB	3DA25-8	CAPACITOR: Paper dielectric, wax filled, 0.025 μf +2% -4% 650 w-v d-c at 0°F to +150F ambient temperature. 3-9/16" x 1-1/2" x 19/32" rectangular metal case, hermetically sealed, single mounting stud 15/32" long, 7/8" rubber insulated terminals. Same as SB.	Forms a shunt path for a-c component from varistor M DET.	"	D-159526
SA	3DB2-7	CAPACITOR: Same as MA.	Cathode by-pass capacitor for vacuum tube SVA.	"	228A
SB	3DA25-8	CAPACITOR: Same as MB.	Forms a shunt path for a-c components from S DET varistor.	"	D-159526
M CH	3Z1892-3.24	FILTER: Frequency band 1770 to 2480 cps unbalanced to ground, operates between 600Ω terminations. 1-5/8" x 6-15/16" x 5-1/8" rectangular metal case enclosing retardation coils and capacitors, 15/16" terminals, two mounting studs on 5-3/4" centers, moisture resistant.	Passes marking signals from current limiter to marking detector.	"	D-165627
S CH	3Z1892-3.25	FILTER: Same as M CH except frequency band 2620 to 3330 cps.	Passes spacing signal from current limiter to spacing detector.	"	D-165628

(4) Detector Panel. (Cont'd.)

Reference Designation	Sig. C Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
CURR LIM	4C4904.10A	JACK: Twin jacks with single frame and two sleeves. Tips of twin jacks connected together electrically with no plug in either jack and disconnected from each other with plug in either or both jacks, sleeves permanently electrically connected together. 9/16" x 1-11/16" x 3-15/32" over-all, heavily insulated, singly mounted, will mount on 5/8" horizontal centers and 1-3/4" vertical centers.	For patching current limiter output.	W. E. Co.	410A
OUT PAD IN			For patching to input of 9 db pad.		
CH FILTS IN			For patching to inputs of M CH and S CH filters in parallel.		
PAD OUT			For patching to output of 9 db pad.		
S CH F OUT			For patching to the output of S CH filter.		
S DET IN			For patching to input of space detector.		
M CH F OUT			For patching to output of M CH filter.		
M DET IN			For patching to input of marking filter.		
ADJ REC GAIN	4C5105.47B	KEY: Two sets of transfer contacts. 9/16" x 13/16" x 3-41/64" nonlocking push button, fits 29/64" drilling, single mounting lug.	Inserts 9 db pad for testing and adjusting.	"	547B
M IN	2Z9647.4	INPUT TRANSFORMER: Two windings with electrostatic field between them, impedance ratio 600:25,000 between windings (1-2) and (3-4), frequency range 255 to 3145 cps, d-c resistance of winding (1-2) 50 and (3-4) 2700. 1-11/16" x 2-17/32" x 3-7/16" rectangular metal case, two 9/16" mounting studs on 1-3/4" centers, five 3/4" terminals, shell type coil with silicon steel core.	Connects output of M CH filter to input circuit of vacuum tube M VA.	"	628A
S IN			Connects output of S CH filter to input circuit of vacuum tube S VA.		
M OUT	2Z9648.3	OUTPUT TRANSFORMER: Impedance ratio 50,000:150,000 between windings (1-2) and (3-4), ratio of transmission between windings (3-4) and (1-2) 1.77:1 maximum, 1.70:1 minimum, d-c resistance of winding (1-2) 683Ω, winding (3-4) 1800Ω. 1-11/16" x 2-17/32" x 3-7/16" rectangular metal case, two mounting studs on 1-3/4" centers, 3/4" terminals, moisture resistant, shell type, silicon steel core.	Connects vacuum tube M VA to varistor M DET.	"	D-163145
S OUT			Connects vacuum tube S VA to varistor S DET.		
ADJ S REC GAIN	2Z7281.1	POTENTIOMETER: 20,000Ω ±10%, 3 watts. 1-17/32" diameter x 11/16" thick, round metal case, 7/16" terminals, 1/2" long 1/4" diameter shaft, wire wound, silver plate finish on contact shoe, phenolic insulating material.	To adjust spacing detector sensitivity.	"	KS-8680 20,000Ω
ADJ N REC GAIN			To adjust marking detector sensitivity.		

(4) Detector Panel. (Cont'd.)

Reference Designation	Sig. C Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
A	3Z6028D4	RESISTOR: Two windings, three terminals, wire wound on core of heat resisting material, each winding 284Ω ±1%, 5 watts either winding or both windings. 1-1/2" x 13/64" x 4-21/32" long (including 1-5/32" terminals) flat type, mounting studs on 1-5/16" centers, stud washer 3/8" diameter.	Series member of 9 db pad.	W. E. Co.	D-161700UN
B	3Z6025-30	RESISTOR: Same as A except 240Ω ±1% and 250Ω ±1%, 5 watts either winding or both windings.	Shunt member of 9 db pad.	"	D-161700GD
C	3Z6035-10	RESISTOR: Wire wound on core of heat resisting material, 350Ω ±1%, 5 watts. 1-1/2" x 13/64" x 4-21/32" long (including 1-5/32" terminals) flat type, mounting studs on 1-6/16" centers stud washer 3/8" diameter.		"	D-161699AS
D	3Z6001-23	RESISTOR: Same as A except 10Ω ±5% each winding, 5 watts either winding or both windings. Same as F.		"	D-161700W
E	3Z6100-89	RESISTOR: Same as C except 1000Ω ±1% 5 watts.	Resistors C, D, E, F, and G form cathode bias circuits for vacuum tubes MVB, SVB, VC, and VB.	"	D-161699BM
F	3Z6001-23	RESISTOR: Same as D.		"	D-161700W
G	3Z6011-3	RESISTOR: Same as A except 75Ω ±1% and 110Ω ±1%, 5 watts either winding or both windings.		"	D-161700GC
H	3Z6300-30	RESISTOR: Same as A except each winding 3000Ω ±1%.	Varies the potential on the screen grids of tubes MVB and SVB under the control of vacuum tubes in the noise-suppression circuits.	"	D-161700RP
J	3Z6615-47	RESISTOR: Metallized glass tube filament resistance element, 15,000Ω +5% -10%, 2 watts. 1-3/4" x 5/16" diameter, cylindrical molded in phenol plastic compound, 1-1/2" axial lead at each end.	Limits voltage on screen grid of vacuum tube VA.	"	KS-8060B 15,000Ω
L	3Z6060-34	RESISTOR: Metallized glass tube filament resistance element, 600Ω +5% -10%, 1/2 watt. 5/8" x 3/16" diameter, cylindrical molded in phenol plastic compound, 1-1/2" axial lead at each end.	Cathode bias resistor for vacuum tube VB.	"	KS-8058B 600Ω
M	3Z4526	RESISTOR: Same as L except 2000Ω.	Cathode bias resistor for vacuum tube VA.	"	KS-8058B 2000Ω

(4) Detector Panel. (Cont'd.)

Reference Designation	Sig. C Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
N	3Z4540	RESISTOR: Same as J except 30,000Ω	Plate current of vacuum tube VB through varistor N reduces the potential of the control grid of vacuum tube VA.	W. E. Co.	KS-8060B 30,000Ω
P	3Z6802-12	RESISTOR: Same as L except 2 megohms.	Resistors P and R form a potentiometer in supply circuit to control grid of vacuum tube VA.	"	KS-8058B 2 megohms
R		RESISTOR: Same as L except 1 megohm.			KS-8058B 1 megohm
MA	3Z6500-77	RESISTOR: Wire wound on bakelite core, 5000Ω ±1%, 1/4 watt, low reactance. 1" x 5/16" phenol fibre outer tube with 2" axial lead at each end. Same as SA.	With ADJ M REC GAIN potentiometer forms the correct impedance termination for SN transformer and results in a favorable sensitivity adjustment of the marking detector.	"	106A 5000Ω
MB	3Z6060-34	RESISTOR: Metallized glass tube filament resistance element, 600Ω±10%, 1/2 watt. 5/8" x 3/16" diameter, cylindrical, molded in phenol plastic compound, 1-1/2" axial lead at each end. Same as SB.	Cathode bias resistor for vacuum tube MVA.	"	KS-8058C 600Ω
MC	3Z6650-60	RESISTOR: Wire wound on bakelite core 50,000Ω ±1%, 1/2 watt, low reactance. 1-1/2" x 1/2" diameter phenol fibre couter tube with 2" axial lead at each end. Same as SC.	Forms correct impedance termination for varistor M DET.	"	107A 50,000Ω
MD	3Z6700-72	RESISTOR: Same as MB except 0.1 megohm ±20%. Same as SD.	Limits plate current in vacuum tube MVB when the signal makes the control grid positive.	"	KS-8058D 0.1 megohm
ME	3Z6801-1	RESISTOR: Same as MB except 1 megohm ±5%. Same as SE.	Controls potential from marking detector to input of noise-suppression circuit.	"	KS-8058A 1 megohm
SA	3Z6500-77	RESISTOR: Same as MA.	With the ADJ S REC GAIN potentiometer forms the correct impedance termination for transformer SN and results in a favorable sensitivity adjustment of the spacing detector.	"	106A 5000Ω
SB	3Z6060-34	RESISTOR: Same as MB.	Cathode bias resistor for vacuum tube SVA.	"	KS-8058C 600Ω
SC	3Z6650-60	RESISTOR: Same as MC.	Forms correct impedance termination for S DET varistor.	"	107A 50,000Ω

(4) Detector Panel. (Cont'd.)

Reference Designation	Sig. C Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
SD	3Z6700-72	RESISTOR: Same as MD.	Limits plate current in vacuum tube SVD when the signal makes the control grid positive.	W. E. Co.	KS-8058D 0.1 megohm
SE	3Z6801-1	RESISTOR: Same as ME.	Controls potential from spacing detector to input of noise-suppression circuit.	"	KS-8058A 1 megohm
VA	2T116	VACUUM TUBE: Pentode, sharp cutoff. 2-5/8" x 1-5/16", metal tube, eight prongs. Same as VC, MVA, and SVA.	The plate current of vacuum tube VA in the noise-suppression circuit of one channel plus the plate current of vacuum tube VC in the noise-suppression circuit of the second channel flowing through resistor H controls the potential of the control grids of vacuum tubes MVB and SVB in the second channel.	RCA	6SJ7
VB			Controls plate current of vacuum tube VA to make the sum of the plate currents in vacuum tubes VA and VC nearly constant.		
VC	2T116	VACUUM TUBE: Same as VA.	See VA.	"	6SJ7
MVA			Amplifies marking signals.		
SVA			Amplifies spacing signals.		
MVB	2V6V6GT/G	VACUUM TUBE: Pentode, beam power amplifier, heater type tube, heater voltage 6.3 volts, heater current 0.45 ampere. 3-5/16" x 1-5/16", glass tube, seven prongs.	Amplifies rectified output of varistor M DET.	"	6V6GT
SVB					
-	2Z8678.10	VACUUM TUBE SOCKET: 1-1/2" x 1/8" oval, 3/4" thick, for 8-prong tube, made of molded insulating material 1-1/8" diameter x 5/8" thick, two metal mounting holes on opposite sides of socket, screw holes in lugs on 1-1/4" centers, terminals extend approximately 1/4" beyond insulating material.	Sockets for vacuum tube VA, VB, VC, MVA, SVA, SVB, and MVB.	Cinch	EXP-7086-B
M DET	3H4957-1	VARISTOR: When connected as a full wave bridge rectifier at an ambient temperature of 105F, the maximum continuous output rating will be 0.015 ampere d-c at 45v and the maximum a-c input voltage should be 67v rms. 1-9/32" x 1-1/2" x 3-15/32", rectangular metal case, contains two units of thirty 3/16" copper-oxide discs per unit, two 7/16" mounting lugs on 1" centers, 3/4" terminals, nuts and lockwashers for mounting are furnished.	Rectifies marking signals.	W. E. Co.	34A
S DET			Rectifies spacing signals.		

(5) Current Limiter Panel.

Reference Designation	Sig. C Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
A	3DA25-8	CAPACITOR: 0.025 μf +2% -4% 650 w-v d-c at 0°F to +150F ambient temperature. 3-9/16" x 1-1/2" x 19/32" rectangular metal case, hermetically sealed wax filled, paper dielectric, single mounting stud 15/32" long, 7/8" rubber insulated terminals.	Cathode bias capacitor for LIM vacuum tube.	W. E. Co.	D-159526
B	3DB3.13	CAPACITOR: 3 μf ±15%, 250 w-v d-c at 0°F to 150F ambient temperature. 3-1/2" x 1-1/2" x 1-21/32" rectangular metal case, hermetically sealed, wax filled, paper dielectric, two 1/2" mounting studs on 1" centers two 7/8" rubber insulated terminals. Same as AA, AC.	With resistor R forms a filter for the plate supply of the LIM vacuum tube.	"	231A
C			With resistor P forms a filter for the plate supply of AMP vacuum tube.		
E	3D9150-17	CAPACITOR: 150 $\mu\mu$f, ±5 $\mu\mu$f, 500 w-v d-c. 1-19/64" x 5/16" diameter, cylindrical, 1-1/2" axial wire leads at each end, silver plates with ceramic dielectric and ceramic outer case. Same as G.	With coil A forms a filter to remove high frequencies.	"	KS-8951
F	3DA6-49	CAPACITOR: 0.006 μf ±20% w-v d-c 800 at -40F to +185F. 13/16" x 13/16" x 19/64", rectangular molded plastic, paper dielectric, mineral oil impregnated, 1-5/16" wire terminal at each end.	Blocking capacitor to keep plate potential from grid of AMP vacuum tube.	"	404A 0.006 μf
		Or			or
	3DA4-32	CAPACITOR: 0.004 μf ±(5% + 1 $\mu\mu$f), 300 w-v d-c at -40F to 167F ambient temperature. 1-1/4" x 27/32" x 9/32", rectangular, molded phenol plastic, silvered mica, 1/12" tinned wire terminals at each end.			401D 0.004 μf
G	3D9150-17	CAPACITOR: Same as E.	Attenuates high frequencies.	"	KS-8951
AA	3DB3-13	CAPACITOR: Same as B.	Cathode by-pass for vacuum tube IN.	"	231A
AB	3DA100-136.1	CAPACITOR: 0.1 μf ±15%, 650 w-v d-c at +32F to +150F ambient temperature. 3-9/16" x 1-1/2" x 19/32" rectangular metal case, hermetically sealed, wax filled, paper dielectric, single mounting stud 15/32" long, 7/8" rubber insulated terminals.	Screen grid by-pass capacitor for vacuum tube IN.	"	234C
AC	3DB3-13	CAPACITOR: Same as B.	Prevents interaction between the plate and screen grid of vacuum tube IN.	"	231A

(5) Current Limiter Panel. (Cont'd.)

Reference Designation	Sig. C Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
AK	3DA3-34	CAPACITOR: 0.003 μf ±20%, 800 w-v d-c, ambient temperature -40F to +185F. 13/16" x 13/16" x 19/64" thick, rectangular, molded plastic, 1-5/16" wire terminals at each end, mineral oil impregnated, paper dielectric.	Keeps plate potential from grid of vacuum tube LIM.	W. E. Co.	404B 0.003 μf
		Or			or
	3DA2-94	CAPACITOR: 0.002 μf ±(5% + 1 $\mu\mu$f) 300 w-v d-c at -40F to +167F ambient temperature. 1-1/4" x 27/32" x 9/32", rectangular, molded plastic silvered mica, 1-1/2" tinned wire terminals at each end.			401D 0.002 μf
INPUT	3Z1892-3.23	FILTER: Frequency band 1700 to 3400 cps, unbalanced to ground, designed to operate between 600Ω terminations. 1-5/8" x 8-11/16" x 5-1/8" rectangular metal case enclosing retardation coils and capacitors, 15/16" terminals, two mounting studs on 7-1/2" centers, moisture resistant.	To attenuate undesired currents that are outside 1700 cps to 3500 cps.	"	D-165626
IN	2Z9631.23	INPUT TRANSFORMER: Impedance ratio 300:357,000, frequency range 250 to 3000 cps, five taps at 4 db intervals. 1-11/16" x 1-11/16" x 4-5/16" high (including 3/4" terminals) shell type coil with permalloy core in metal case, mounts by screws in tapped holes on 5/16" vertical and 7/16" horizontal centers..	Steps up signal voltage and connects input filter to control grid circuit of vacuum tube IN.	"	626A
MON	4C4823A	JACK: 9/16" x 13/16" x 3-15/32" over-all, heavily insulated, single mounted two terminals viz. tip and sleeve, tip terminal accommodates two 16 B&S gauge wires and sleeve terminal accommodates two 19 B&S gauge wires, single mounting lug, mounting screw furnished, fits 29/64" drilling arranged to mount on 5/8" vertical and 7/8" horizontal centers, used with W.E.Co. 47, 116, 137, and similar type plugs.	To provide convenient means for monitoring the input to the current limiter.	"	223A
INP FILT IN	4C4904.10A	JACK: Twin jacks with single frame and two sleeves, tips of twin jacks connected together electrically with no plug in either jack and disconnected from each other with plug in either or both jacks, sleeves permanently electrically connected together. 9/16" x 1-11/16" x 3-15/32" over-all, heavily insulated, singly mounted, will mount on 5/8" horizontal centers and 1-3/4" vertical centers.	For connecting to the input of the input filter.	"	410A
RADIO REC OUT			For connecting to the output of the radio receiver.		
CURR LIM IN			For connecting to the input of the current limiter.		
INP FILT OUT			For connecting to the output of the input filter.		

(5) Current Limiter Panel. (Cont'd.)

Reference Designation	Sig. C Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
OUT	2Z9648.2	OUTPUT TRANSFORMER: Four windings on shell type core, average d-c resistance of windings (1-2) (5-6) in series approximately 6Ω and of windings (3-4) (7-8) in series 3100Ω. Impedance ratio 23,000:500Ω between windings (3-4) (7-8) and (1-2) (5-6). Frequency range 60 cps to 5000 cps. 2-5/8" x 3-3/16" x 3-29/32" iron case, rectangular rounded at corners, four holes for no. 8 mounting screws on 2-7/8" vertical and 2-5/16" horizontal centers.	Provides outputs from vacuum tube AMP to detector and frequency indicator circuits.	W. E. Co.	127C
OUT	2Z7278.2	POTENTIOMETER: 300Ω ±10%, 3 watts. 1-17/32" diameter x 11/16" thick round metal case, 7/16" terminals, wire wound, phenolic insulating material, silver plated contact shoe.	With varistor D provides correct impedance termination for winding (1-2) of output transformer.	"	KS-8680 300Ω 1/2" shaft length
A	3Z6024-2	RESISTOR: Two windings, three terminals, wire wound on core of heat resisting material, each winding 240Ω ±1%, 5 watts either winding or both windings. 1-1/2" x 13/64" x 4-21/32" long (including 1-5/32" terminals) flat type, mounting studs on 1-5/16" centers, stud washer 3/8" diameter. Moisture resistant W.E.Co. no. 19 LE.	With resistor B forms 7 db pad to provide correct impedance terminations for input filter.	"	D-161700LE
B	3Z6067	RESISTOR: Wire wound on core of heat resisting material, 670Ω ±1%, 5 watts. 1-1/2" x 13/64" x 4-21/32" long (including 1-5/32" terminals) flat type, mounting studs on 1-5/16" centers, stud washer 3/8" diameter. Moisture resistant W.E.Co. no. 18 KC.	With resistor A forms 7 db pad to provide correct impedance terminations for input filter.	"	D-161699KC
C	3Z6029-1	RESISTOR: Same as A except 260Ω ±1% and 290Ω ±1%.	For balancing plate impedance of vacuum tube AMP.	"	D-161700FN
D	3Z6025-5	RESISTOR: Same as A except 232Ω ±5%, 270Ω ±5%.	With potentiometer OUT provides correct impedance termination for winding (1-2) of output transformer.	"	D-161700DA
E	3Z6050-62	RESISTOR: Same as B except 500Ω ±5%.	Provides correct impedance termination for detector circuit.	"	D-161699AC
F	3Z6026-1	RESISTOR: Same as A except each winding 260Ω ±5%.	Provides correct impedance termination for winding (6-5) of OUT transformer.	"	D-161700AN
G	3Z6200-55	RESISTOR: Same as B except 2000Ω ±5%.	Protects input to detector circuit against accidental short circuits.	"	D-161699BA

(5) Current Limiter Panel. (Cont'd.)

Reference Designation	Sig. C Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
H	SUBSTITUTE* 3Z6720	RESISTOR: Metallized glass tube filament resistance element 0.2 megohm ±10%, 1/2 watt. 5/8" x 3/16" diameter molded in phenol plastic compound, cylindrical, 1-1/2" axial leads at each end.	Coupling resistor between vacuum tubes IN and LIM.	W. E. Co.	KS-8058C 0.2 megohm
J	SUBSTITUTE* 3Z4542	RESISTOR: Same as H except 2 megohms.	Grid leak resistor for LIM vacuum tube.	"	KS-8058C 2 megohms
K	3Z6622-19	RESISTOR: Same as H except 22,000Ω.	Grid bias resistor for LIM vacuum tube.	"	KS-8058C 22,000Ω
L	SUBSTITUTE* 3Z4542	RESISTOR: Same as H.	Plate resistor for LIM vacuum tube.	"	KS-8058C 0.2 megohm
M	SUBSTITUTE* 3Z6740	RESISTOR: Same as H except 0.4 megohm.	Coupling resistor between LIM and AMP vacuum tubes.	"	KS-8058C 0.4 megohm
N	SUBSTITUTE* 3Z6090-2	RESISTOR: Same as H except 900Ω.	Grid bias resistor for AMP vacuum tube.	"	KS-8058C 900Ω
P	3Z6630-28	RESISTOR: Metallized glass tube filament resistance element, 30,000Ω ±10%, 1 watt. 1-1/4" x 1/4" diameter molded in phenol plastic compound, cylindrical, 1-1/2" axial leads at each end.	Part of plate circuit filter for AMP vacuum tube.	"	KS-8059C 30,000Ω
R	SUBSTITUTE* 3Z6620-12	RESISTOR: Same as P except 20,000Ω.	Plate battery filter resistor for LIM vacuum tube.	"	KS-8059C 20,000Ω
S	SUBSTITUTE* 3Z4527	RESISTOR: Same as H except 3000Ω.	To reduce effect of monitoring circuit on input current level.	"	KS-8058C 3000Ω
AA	SUBSTITUTE* 3Z4550	RESISTOR: Same as H except 0.1 megohm.	IN transformer terminating resistance.	"	KS-8058C 0.1 megohm
AB	3Z6125-1	RESISTOR: Same as H except 1250Ω.	Grid bias.	"	KS-8058C 1250Ω

*Note: "Substitute (Stock No.)" indicates a similar unit stocked by signal corps depot on max. - min. list and is equal to described item in value, tolerance, and mechanical details.

(5) Current Limiter Panel. (Cont'd.)

Reference Designation	Sig. C Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
AC	3Z6750-30	RESISTOR: Same as H except 0.5 megohm.	Grid leak for IN vacuum tube.	W. E. Co.	KS-8058C 0.5 megohm
AD	SUBSTITUTE* 3Z6733	RESISTOR: Same as H except 0.33 megohm.	Screen grid resistor for IN vacuum tube.	"	KS-8058C 0.33 megohm
AE	3Z4550	RESISTOR: Same as H except 0.1 megohm.	Plate circuit resistor for IN vacuum tube.	"	KS-8058C 0.1 megohm
AF	SUBSTITUTE* 3Z6620-12	RESISTOR: Same as P except 20,000Ω.	Plate battery filter resistor for IN vacuum tube.	"	KS-8059C 20,000Ω
A	3C1988-1	RETARDATION COIL: Inductance 108 to 113 millihenries, maximum d-c resistance 440Ω. 1-7/16" x 1-5/32" x 1" over-all, molded black phenol plastic spool on which is a duolateral wound coil with cellulose acetate cover.	With capacitor E forms a filter to remove high frequencies.	"	200Y
IN	2T116	VACUUM TUBE: Pentode, sharp cutoff, 2-5/8" x 1-5/16", metal tube, eight prongs.	Amplifies signal currents and limits strong signals.	RCA	6SJ7
AMP			Limits peaks of polarity opposite those limited by LIM vacuum tube to obtain a square and symmetrical output wave.		
LIM	2V6SL7GT	VACUUM TUBE: Twin triode amplifier, filament voltage 6.3v filament current 3 amperes. 3-5/16" over-all length x 1-5/16" diameter, glass tube, intermediate shell, octal, eight prongs.	Limits peaks of polarity opposite those limited by AMP vacuum tube to obtain a square and symmetrical output wave.	"	6SL7GT
-	2Z8678.10	VACUUM TUBE SOCKETS: 1-1/4" x 1-1/8" oval, x 3/4" thick, socket for 8-prong vacuum tube, molded insulating material with two metal mounting lugs on opposite sides of socket, mounting screw holes on 1-1/4" centers, terminals approximately 1/4" beyond insulating material.	For vacuum tubes IN, AMP, and LIM.	Cinch	EXP-7086B

*Note: "Substitute (Stock No.)" indicates a similar unit stocked by signal corps depot on max. - min. list and is equal to described item in value, tolerance, and mechanical details.

(6) Rectifier Panels X-61680B and X-61680C.

Reference Designation	Sig. C Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
H	3H4956-10	RECTIFIER: Regulated tube type, input 120v or 240v 50-60 cps, output d-c 120-150v, 0.8 or 0.6 ampere and a-c 10.2v 5 amperes, 6.6v 10 amperes, or 6.4v 10 amperes.	-	W. E. Co.	X-61680B
C	3H4956-11	RECTIFIER: Same as B except input 25 cps to 60 cps, and d-c output 0.6 ampere or 0.5 ampere.	-	"	X-61680C
A*	3DB2-7	CAPACITOR: 2 μf ±15%, 250 w-v d-c at +32F to +150F ambient temperature. 1-1/2" x 1-21/32" x 3-1/2", rectangular metal case, paper dielectric, wax filled, 7/8" terminals, stud mounted. Moisture resistant W.E.Co. 228A Same as F*.	Suppress ripple in regulating circuit.	"	D-163135
A**	3D4-52	CAPACITOR: Same as A* except 4 μf. Same as F**. Moisture resistant W.E.Co. no. 287A.	Suppress ripple in regulating circuit.	"	D-162003
B	3DA750	CAPACITOR: Sealed, oil filled, paper dielectric, 0.75 μf ±7%, 400 w-v d-c at -40F to 185F ambient temperature. 3-1/2" x 1" x 1-1/2" rectangular metal can, terminals extend 15/16" above the top, neoprene insulated terminals, stud mounted.	Ripple feedback.	"	D-161556
C1, C2, C3, C4, C5, C6, C7, C8 **	3DB125-1	CAPACITOR: 125 μf minimum, at 120 cps 350 w-v d-c electrolytic, temperature range -40F to +160F, impedance at -40F, 125 maximum polarized, mounting lugs negative, single terminal positive. 1-3/8" x 3" cylindrical metal container 1/2" terminal, mounted by means of four mounting lugs which extend through panel and are twisted to hold capacitor in place.	Load filter.	"	KS-8665 125 μf
C1, C2 C3, C4 C5, C6 C7, C8 C9, C10 **	3DB200-1	CAPACITOR: Same as C1 to C8* except 200 μf.	Load filter.	"	KS-8678 200 μf
D	3DA20-54	CAPACITOR: Paper dielectric, two separate capacities with common terminal, two mounting studs, .02 μf ±15% each unit, 1500 w-v d-c at -40F to +185F ambient temperature. 4-7/16" (including 15/16" terminals) x 1-1/2" x 1" rectangular metal can, terminals rubber insulated, oil filled.	Radio-frequency filter.	"	D-162002

*Provided only on rectifier X-61680B.
**Provided only on rectifier X-61680C.

(6) Rectifier Panels X-61680B and X-61680C. (Cont'd.)

Reference Designation	Sig. C Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
E*	3DB1.306A	CAPACITOR: Paper dielectric, aroclor impregnated, 1 μf ±15%, 950 w-v d-c -40F to +150F ambient temperature. 4-25/32" (including 7/8" terminals) X 1-1/2" x 1-21/32" rectangular metal can, two mounting studs. Moisture resistant W.E.Co. 306A.	Carrier and radio-frequency filter.	W. E. Co.	D-162400
E**	3DB2.860	CAPACITOR: Same as E* except 2 μf. Moisture resistant W.E.Co. no. 288A.	Carrier and radio-frequency filter.	"	D-162860
F*	3DB2-7	CAPACITOR: Same as A*.	Ripple filter.	"	D-163135
F**	3DB4-52	CAPACITOR: Same as A**.	Ripple filter.	"	D-162003
H H1	3DA1D-152	CAPACITOR: Paper dielectric 0.01 μf ±10%, 1500 w-v d-c at -40F to +185F. 2-5/8" high not including terminals, 2-3/8" wide over mounting lugs, 1" deep, rectangular steel can, terminals project 5/8" above top, oil filled, hermetically sealed, two molded terminals, two mounting lugs soldered to narrow side and flush with top.	Radio-frequency filter.	"	D-164763
AC1 AC2	3Z2603.2	FUSES: 1/4" x 1-1/4" glass tube with fuse enclosed, 3 amperes.	Input fuses.	Littel or Buss	1043 3AG-3
AC1 AC2	3Z3275-1 or 3Z3285-2	FUSE MOUNTING: Terminal at end, cylindrical, molded black bakelite, finger operated knob, mounts in 1/2" hole in panel by threads on body. Littel - 2-1/8" x 7/16" with 1/4" terminal and 1/2" diameter knob. Or Bussman - 2" x 7/16" with 3/8" terminal and 11/16" diameter knob.	To mount Littel 1043 on Bussman 3AG-3 fuse.	Littel or Buss	1075A HKM
-	6Z4847	GRIP, CORD: Fits 1/2" diameter hole, provided with nut to hold it in hole, 17/32" diameter cord hole, suitable for cord 1/4" to 1/2".	Output cord.	H & H	7327
R*	2Z7693-6	RELAY: Coil voltage rating 6.3v, range 5.5 to 7.5v, 0.5 ampere 60 cps, impedance 18$^{\Omega}$, d-c resistance 5.15$^{\Omega}$, contact current 5 amperes at 115v, single-pole double-throw. 1-5/8" x 1-3/16" x 15/16", single coil, iron core, magnetic yoke which also forms support and pivot for the armature as well as a support for the stationary contacts, moving contacts attached to springs supported by armature, arranged for front of board wiring and assembled on a base for panel mounting.	Open telegraph output lead when rectifier is not operating. (B only).	W. E. Co.	KS-5819-L01

*Provided only on rectifier X-61680B.
**Provided only on rectifier X-61680C.

(6) Rectifier Panels X-61680B and X-61680C (Cont'd.)

Reference Designation	Sig. C Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
R**	2Z7693-10	RELAY: Same as R* except, coil voltage rating 5.6v, range 4.4 to 7.0v, 0.22 ampere d-c 51Ω contact current 0.1 ampere at 115v, equipped with shading coil for pulsating d-c.	Open telegraph output when rectifier is not operating. (C only)	W. E. Co.	KS-5819-L04
A	3Z6360-3	RESISTOR: Metallized glass tube filament resistance element. Fixed resistance, 3600Ω ±10%, 1 watt, 1-1/4" x 1/4" diameter molded in phenol plastic compound, cylindrical, 1-1/2" axial lead at each end.	In control potentiometer.	"	KS-8059C 3600Ω
B (V Wiring)	3Z6582-4	RESISTOR: Metallized glass tube filament resistance element. Fixed resistance 8200Ω ±10%, 2 watts. 1-3/4" x 5/16" diameter, molded in phenol plastic compound, cylindrical, 1-1/2" axial wire lead at each end.	In control potentiometer.	"	KS-8060C 8200Ω
B (W Wiring)	3Z6591-2	RESISTOR: Same as B above except 9100Ω.	In control potentiometer.	"	KS-8060C 9100Ω
B (S Wiring)	3Z6611-3	RESISTOR: Same as B above except 11,000Ω.	In control potentiometer.	"	KS-8060C 11,000Ω
B (R Wiring)	3Z6612-16	RESISTOR: Same as B above except 12,000Ω.	In control potentiometer.	"	KS-8060C 12,000Ω
C	3Z6070-7	RESISTOR: Fixed resistance total 700Ω ±2%, 2 watts total. Made up of one 520Ω ±2% and three 60Ω ±2% windings connected in series. 3" x 1/2" diameter with five 1/4" terminals at side, wire wound on phenol fabric tube, four windings consecutively connected in series, mounted by phenol fabric screw through center of core. Moistureproof coating.	In reference voltage circuit.	"	D-162813A
D	3Z6475	RESISTOR: Fixed resistance 4750Ω ±1% 5 watts. 3-1/2" x 1-1/2" x 13/64" flat type, stud mounted 1-5/32" terminals. Wire wound on a core of heat resisting material. Moisture resistant W.E.Co. 18 type. Same as J.	In reference voltage circuit.	"	D-163016
E & F	3Z6622-16	RESISTOR: Metallized glass tube filament resistance element. Fixed resistance, 22,000Ω ±20%, 1/2 watt (formerly 25,000Ω). 5/8" x 3/16" diameter, molded in phenol plastic compound, cylindrical, 1-1/2" axial wire lead at each end.	Grid current limiter.	"	KS-8058D 22,000Ω

**Provided only on rectifier X-61680C.

(6) Rectifier Panels X-61680B and X-61680C. (Cont'd.)

Reference Designation	Sig. C Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
G	3Z6622-16	RESISTOR: Same as A except 22,000 Ω ±20%, 1 watt.	Filter of reference voltage circuit.	W. E. Co.	KS-8059D 22,000 Ω
H**	3Z6016E-1	RESISTOR: Fixed resistance, 165 Ω ±5% 40 watts. 29/32" x 3-1/2", tubular, 5/8" terminals at each end at right angles to axis, wire wound, vitreous enamel coating. Mounts by screw through center of core. Same as K.	In timer supply.	"	D-166102
J	3Z6475	RESISTOR: Same as D.	In reference voltage circuit.	"	D-163016
K**	3Z6016E-1	RESISTOR: Same as H.	In timer supply.	"	D-166102
L1	301987-23	RETARDATION COIL: D-c resistance of winding (1-2) 12.2 Ω maximum at 68F, effective inductance of winding (1-2) with 100 ±2v, 60 cps applied to winding 5.50 henrys with 0.1 ampere d-c in winding and 0.48 henry with 0.6 ampere d-c in winding. 3-7/16" x 4-5/8" x 4-3/8" rectangular metal case, shell type, stud mounted, nuts and washers for mounting are furnished.	Ripple suppression.	"	D-162823
L2 ("X" & "Y" wiring only)	301987-24	RETARDATION COIL: D-c resistance windings (1-2) 1.82 maximum at 68F inductance .07 henry with 0.6 ampere d-c through winding and 3v 60 cps across winding. 1-3/4" x 1-3/4" x 3-1/4" rectangular metal case, shell type, silicon steel core, flexible leads, mounted by tapped holes, flexible leads and tapped holes on same 1-3/4" x 1-3/4" side.	Ripple suppression.	"	D-162824
R	2Z7288-6	RHEOSTAT: 2200 Ω ±10%, 2 watts. 1-27/32" diameter x 31/32" thick, 17/32" shaft with screwdriver slot, three 3/8" terminals, mounts by 3/8" diameter x 1/2" bushing which is furnished with lock nut and lock washer, equipped with dust cover. Moisture resistant.	Adjustable part of control potentiometer.	"	KS-55-63-L5 2200 Ω
SW1	3Z9558	SWITCH: A-c rating 10 amperes 125v, 5 amperes 250v, 3 amperes 460v, 2 amperes 600v. Over-all size 1-15/16" long, 11/16" wide, 1-3/4" high, normally open contacts, bakelite enclosed, panel mounted, 15/32" 32 threaded bushing and two lock nuts for mounting on maximum 3/8" thick panel.	Cover switch.	Micro	YZ-RQ1

**Provided only on rectifier X-61680C.

(6) Rectifier Panels X-61680B and X-61680C. (Cont'd.)

Reference Designation	Sig. C Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
AC	2Z9403.6	TERMINAL STRIP: Three double screw terminals, 6-32 x 1/4" brass nickel-plated screws in bakelite base with bakelite barriers between terminals, 1-1/8" wide x 1/2" high x 2" long, terminals on 7/16" centers, surface mounted, two screwholes at each end for mounting.	Change from 120 to 240v.	Jones	3-141
A		TERMINAL STRIP: 1-3/8" long, 1-3/4" wide (including terminals) 31/32" high, consists of two 1-3/4" long 0.04" thick brass soldering terminals with solder dip finish, two hard rubber strips and one hard maple block, rubber strips and maple block are each 1-3/8" long x 1/2" wide and vary only in thickness, terminals mounted in 11/16" thick on 15/32" centers and held in place by 13/64" thick hard rubber block, these two blocks are assembled with a hard maple base block 3/8" thick by means of two brass eyelets. Moisture resistant W.E.Co. 220A.	A-c input.	W. E. Co.	D-166266
B	2Z9408.4	TERMINAL STRIP: 1-9/32" x 1-15/32" x 1-9/16" over-all eight double end terminals staggered and on 5/32" centers, molded in black phenol plastic base. Moisture resistant W.E.Co. 700A.	Output.	"	D-166220
T	3Z6926	THERMISTOR: 0.025 ampere d-c through thermistor produces a voltage drop of approximately 30v. 1" (+19/32" lugs) x 3/4" x 1-1/4" (+9/16" terminals) rectangular metal can, surface mounted by mounting lugs flush with bottom, consists of two directly heated leads individually sealed in helium filled glass envelopes, potted in metal can, moisture resistant finish.	In reference voltage circuit.	"	D-160956
TD*	4DW8708	TIMER: 110v, 60 cps. 3-3/8" x 3-1/16" x 2-13/32" over-all, 10" lead wires, motor-operated, spring reset, time adjustable, set for 15 seconds operate, 2 seconds restore.	Provides delay for filament heating.	"	KS-8708-L2
TD**	4DW5839	TIMER: 17 to 24v, 60 cps or 105 to 126v 25-60 cps when in series with 330Ω. 4-3/4" x 3-5/16" x 2-7/8" over-all, with terminals having 0.0625" hole for lead connection. Motor-operated spring reset SPDT. Set for 15 to 18 seconds operate at 60 cps or 36 seconds operate at 25 cps, 2 seconds restore.	Provides delay for filament heating.	"	KS-5839-L01

*Provided only on rectifier X-61680B.
**Provided only on rectifier X-61680C.

(6) Rectifier Panels X-61680B and X-61680C (Cont'd.)

Reference Designation	Sig. C Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
T1*	2Z9623.1	TRANSFORMER: With 120v 50-60 cps applied to terminals 1 and 2, with terminal 1 connected to terminal 3 and 2 connected to terminal 4, or with 240v, 50-60 cps applied to terminals 1 and 4 with terminal 2 connected to terminal 3, winding (10-11) and (11-12) each delivers 3 amperes at approximately 2.5v, winding (13-14) delivers 0.03 ampere at approximately 347v, winding (15-16) delivers 0.02 ampere at approximately 15v, either winding (17-20) delivers 5 amperes at approximately 10.2v or winding (17-19) delivers 10 amperes at 6.6v or winding (17-18) delivers 10 amperes at 6.4v and either winding (5-9) or winding (6-8) working into vacuum tubes operating as a full-wave rectifier, inductively terminated, delivers 0.45 ampere at approximately 470v or 420v respectively. Terminals 7 and 11 are the center taps of windings(5-9) and (10-12) respectively. 7-1/4" (including 5/8" mounting studs) x 5-5/32" x 6-11/16" rectangular metal case, shell type silicon steel core, moisture resistant, stud mounted nuts and lockwashers furnished for mounting, electrostatic shield between primary and secondary windings is connected to the core and case.	Changes line voltage to voltage required by rectifier and auxiliary tube filaments. Rectifier B only.	W. E. Co.	D-164688
T1**	2Z9623.3	TRANSFORMER: With 120v, 50-60 cps applied to terminals 1 and 2 with terminal 1 connected to terminal 3 and terminal 2 connected to terminal 4 or with 240v, 50-60 cps applied to terminals 1 and 4 with terminal 2 connected to terminal 3, windings (10-11) and (11-12) each delivers 3 amperes at approximately 2.5v, winding (13-14) delivers 0.03 ampere at approximately 347v; winding (15-16) delivers 0.02 ampere at approximately 15v; either winding (17-20) delivers 5 amperes at approximately 10.2v or winding (17-19) delivers 10 amperes at 6.6v, or winding (17-18) delivers 10 amperes at 6.4v and either winding (5-9) or (6-8) working into vacuum tubes operating as a full-wave rectifier, inductively terminated, delivers approximately 0.45 ampere at approximately 470v or 420v, respectively. Terminals 7 and 11 are the center taps of winding (5-9) and (10-12) respectively. An electrostatic shield between the primary and secondary windings is connected to the core and case. 6-21/32" x 6-11/16" x 6-17/32" rectangular metal case, four 5/16" 18 mounting studs, shell type, silicon steel core, moisture resistant, nuts and lockwashers for mounting furnished.	Changes line voltage to voltage required by rectifier and auxiliary tube filaments. Rectifier C only.	"	D-165675

*Provided only on rectifier X-61680B.
**Provided only on rectifier X-61680C.

(6) Rectifier Panels X-61680B and X-61680C. (Cont'd.)

Reference Designation	Sig. C Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
V1 V2	2V394A	VACUUM TUBE: Thyratron, filament voltage 2-1/2, filament amperes 3-1/4, maximum peak voltage between anode and grid 1250, maximum average anode current 0.64 ampere. 3-5/16" long, 1-25/32" diameter.	Rectification.	W. E. Co.	394A
-	228678.1	VACUUM TUBE SOCKET: 2" x 1-5/8" elliptical base 1/4" high, 1-3/8" diameter x 7/16" high round part on top of base, over-all height 11/16", molded bakelite, octal socket for 8-prong vacuum tube, for top of panel or subpanel mounting, mounting centers 1-11/16".	For holding vacuum tubes V1 and V2.	Eby	12-8
-	222642.2	VACUUM TUBE CLAMP: 2-1/8" x 1-3/8" x 1/32" thick, oval steel with hole in center to fit around and grip a vacuum tube, screw holes 1-11/16" centers.	For clamping vacuum tubes in sockets.	Cinch	8526
-	222708.3	VACUUM TUBE CAP: 19/32" x 21/32" tinned phosphor bronze clip enclosed in black molded insulating material, fits 23/64" tube cap, 6" Alden glass wire lead.	Provides means for connection to plate terminal.	Alden	91H1 6" Alden glass wire
A B	3H4956-6	VARISTOR: Assembly of 40 copper-oxide discs. Two of these varistors required to make a bridge connected full-wave rectifier with an output rating of 0.050 ampere at 60v d-c at an ambient temperature of 105F maximum 3-1/4" long x 13/16" diameter. 11/16" mounting stud at each end, three 7/32" terminals at each side, four nuts and four lockwashers are furnished for mounting, has enveloping gray lacquer finish over black asphalt varnish, same as W.E.Co. 39A except it has mounting studs at both ends instead of one end only and is moisture resistant.	In reference voltage circuit.	W. E. Co.	D-162395
H	3H4956-5	VARISTOR: Consists of 16, 3/4" diameter oxidized copper discs with an enveloping lacquer finish. 0.075 ampere d-c maximum continuous output at 12v d-c, maximum ambient temperature 105F, discs arranged electrically to form a bridge. 2-7/16" long including 11/16" long mounting stud, 27/32" diameter, cylindrical, 7/32" terminals at side. Moisture resistant W.E.Co. 17A varistor.	Compensation for line voltage changes.	"	D-161870
C**	3H4956-4	VARISTOR: Four 1-3/8" diameter selenium rectifier discs. D-c output 0.157 ampere at 4.4v d-c ambient temperature -20F to +120F. 1-13/16" long including 3/8" mounting stud x 1-3/8" diameter, no. 8 mounting stud 3/8" long, 5/16" terminals on side, moisture resistant lacquer finish.	Operate relay R.	"	KS-9151

**Provided only on rectifier X-61680C.

(7) Disc-type Rectifier, Manual Regulation, 0.24 Ampere Direct Current, 130 Volts.

Reference Designation	Sig. C Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
-	3H4956-24	POWER UNIT: This equipment consists of a transformer to the primary of which is connected a switch for the selection of operation from 115 or 230v a-c service, a selenium disc varistor and a retardation coil capacitor-type filter. The transformer also has two sets of taps, coarse and fine on the secondary winding to which are connected tap switches for the control of the output voltage. This apparatus is assembled on a steel mounting plate 5" wide which is equipped with a removable cover and drilled for 19" relay rack. A 2'-0" cord with a polarized cap is provided for the input connection and a terminal block is provided for connecting the output leads.	Changes 115-230v a-c into 130v d-c.	W. E. Co.	KS-5844 List 01
-	3Z-930	CAP: (Extractor) Bakelite, part of fuse mounting HKM which holds fuse and is used in connection with removing the fuse. 11/16" diameter x 3/4" long.	Part of fuse mounting.	Buss	9363 1/2
-	6Z1727-1	PLUG CAP: Polarized, 2-conductor, 10A 250v 15A 125v. 1-1/2" diameter x 1-3/4" high over-all, armored, cord grip for cord 0.296" to 0.562" diameter, parallel blades.	Used on a-c line cord.	Hubbell	7059
C1 C2	3DB500-7	CAPACITOR: Electrolytic 500 μf +100% -10% at 120 cps, 200 w-v d-c, ambient temperature 40 to +85C. Cylindrical bakelite case, moisture-proofed, one positive and one negative, solder-type terminal at one end, mounted by means of a circular bracket. Approximately 2-1/16" diameter x 4-3/8" high.	Load filter.	Mal	94748-ONSP
F	3Z-2601.16	FUSE: One ampere 250v fuse in a glass tube 1/4" diameter x 1-1/4" long with nickel-plated caps at each end. Fuse has a thermal cutout which operates on low overloads of long duration and a fuse link which operates on high overloads of short duration.	Overcurrent protection.	Buss Littel	MDL-1 1268
-	3Z3285-2	FUSE MOUNTING: Molded black bakelite, cylindrical, terminal at end and at side, finger operated knob 11/16" diameter mounts in 1/2" hole in panel. Threads on body with nut and washer for mounting. 7/16" diameter x 2" long.	Holds fuse.	Buss	HKM
-	2Z5822-2	KNOB: Black insulating material, bar knob with pointer and white line on pointer, radius 3/4", height 7/8".	Used with voltage adjusting switches 212-6.	K-K	S-246-3L

(7) Disc-type Rectifier, Manual Regulation, 0.24 Ampere Direct Current, 130 Volts. (Cont'd.)

Reference Designation	Sig. C Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
-	4Z-6720	TERMINAL PANEL: 4" x 1-3/4" x 3/16" black bakelite with four H.B.Jones no. 50 screw terminals attached, two mounting holes 7/32" diameter on 3-1/4" centers.	Input and output lead connection.	Pwr Eq	PL238
L	3C323-3A	REACTOR-FILTER: Resistance 10.8Ω at 24C. Inductance 3.5 henrys with 0.25 ampere d-c, measured at 60 cps. 2-1/2" stack of iron 3-3/4" x 3-1/8", four 10-24 studs 3/8" long on 2-1/2" x 3-1/8" centers for mounting through 3-1/4" x 2-9/16" cutout. Steel shell on rear. Solder terminals on front.	Voltage ripple suppression.	"	RF70
R3	3Z-6400-31	RESISTOR: Fixed, 4000Ω ±10%, 316v maximum 0.079 ampere maximum, 25 watts. Wire wound on tubular ceramic core, vitreous enameled. 9/16" diameter x 2" long approximately. Radial terminals near each end and radial supporting lugs at each end.	Voltage stabilizer at light load.	Ohmite	0211
SW4	3Z-9849.31	SWITCH: SPST, toggle, rated one ampere 250v. 3 amperes 125v. solder lug type 1" x 17/32" x 1/2" over-all.	A-c line transfer.	C-H	8282
SW17	3Z8300-4	SWITCH: (TAP) Six taps, rotary motion 150 degrees, 15 amperes 150v 2-1/4" diameter x 1-7/16" thick with 1/4" diameter shaft 7/8" long. 3/8"-32 threaded bushing and hexagonal nut for mounting.	Voltage adjusting.	Ohmite	212-6
T	-	TRANSFORMER: Continuous input rating 120 watts. Primary wound for 115/230v at 25-60 cps a-c, With 115/230v on primary and rated load on secondary, the voltage on secondary is 223.75v. The secondary has five coarse steps of 19v each and five fine steps of 4.8v each. 7" x 4-3/4" x 2-1/4" stack of iron laminations with 3" x 3-1/2" cutout in center for coil, steel shell on rear projecting approximately 1-3/8", solder terminals on front of coil. Four 10-24 studs 3/8" long on 6-1/8" x 3-7/8" centers for mounting.	Changes input voltage to voltage required by rectifier.	Pwr Eq	T127
A1-A4	3H4956-19	VARISTOR: Full-wave bridge. Furnishes 0.24 ampere at 130v. Selenium disc type. Four 3-1/2" arms each equipped with twleve 1-1/2" diameter discs.	Rectification.	G-E	6RS5E4V

(8) Cabinet Equipment.

Reference Designation	Sig. C Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
-	-	CABINET: 7'-0" high, 1'-10-1/4" wide, 1'-5" deep, sheet steel cabinet with front and rear door. Capacity of 45 mounting plates 1-3/4" x 19". Weight of complete cabinet approximately 425 pounds. List 1 Framework, assembly wiring, and equipment for one complete cabinet of Radio Teletype Terminal Equipment AN/FGC1 for use with a-c power supply of 120v or 240v, 50-60 cps, (includes equipment per X-61789-B1, X-61789-C1, X-61789-D1, and X-61789-E1). List 2 same as above except 25-60 cps.	Provides a housing for the following equipment panels and associated wiring: Spare fuse holder X-61789A-1, fig. G Terminal Strips X-61789A-1, fig. B Auto. Freq. Cont. X-61789F-1, L1 Frequency Indicators X-61789B-1, L1 Jack Strip X-61789A-1, fig. E Rec. Relay Ckts. 1 & 2 X-61789E-1, L1 Detector B X-61789D-1, L2 Detector A X-61789D-1, L1 Current Limiter B X-61789C-1, L2 Current Limiter A X-61789C-1, L1 Fuse panel X-61789A-1, fig. F Rectifier (50-60 cps) X-61680B-1, L1, 2, 4, or Rectifier (25-60 cps) X-61680C-1, L1, 2, 4 Rectifier KS-5844, L01 Alarm & Misc. X-61789A-1, fig. D Utility Outlet & Heater X-61789A-1, fig. H Miscellaneous X-61789A-1	W. E. Co.	X-61789A-1

(a) Spare Fuse Panel, X-61789A-1, Figure G.

SPARE	3Z3285-7	FUSE MOUNTING: Oak block 1-5/8" long, 1-23/32" base and 1-23/32" high cut at angle of 60° from vertical. Four holes 5/16" diameter x 3/4" deep, drilled in block for mounting spare cartridge type fuses. Holes in two rows centered 1/2" horizontally and 5/8" vertically. Top rows centered 11/16" from top edge. Holes 9/16" from ends.	Holds four spare cartridge-type fuses.	"	P-264138
SPARE	3Z2875-1	FUSE HOLDER: Made up of a metal support and a flat spring, each with nickel plate finish 3-1/4" long x 13/16" high and 1/2" wide.	Holds seven spare W.E.Co. no. 35 type fuses or seven spare W.E.Co. no. 74 type heat coils.	"	ES-800238, G1
-	3Z2135N	FUSE: Indicator alarm type. Rated 5 amperes 90-150v. Operates on 6-1/2 amperes in less than 5 minutes. Alarm-type fuse with green bead on indicator and fuse wire in a porcelain tube to prevent side flash. 1-43/64" x 13/32" x 3/8" over-all. Fits no. 6 screw, mounting screws on 1-3/16" centers.	Overload protection.	"	35N
-	3Z2135R	FUSE: Indicator alarm type. Rated 0.18 ampere 90v operates on 0.27 ampere in less than 1-1/2 minutes. Alarm type fuse with yellow bead on indicator. 1-43/64" x 13/32" x 3/8" over-all. Fits no. 10 screw, mounting screws on 1-3/16" centers.	Overload protection.	"	35R

(8) Cabinet Equipment. (Cont'd.)

Reference Designation	Sig. C Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
(a) Spare Fuse Panel, X-61789A-1, Figure G. (Cont'd.)					
-	3C600	HEAT COIL: Indicator alarm type. 6.5Ω to 8Ω, will carry 0.185 ampere for three hours, will operate in 3-1/2 minutes on a current of 0.265 ampere at 68F ambient temperature. 1-43/64" x 13/32" x 1-3/16" over-all. Fits no. 6 screw mounting screws on 1-3/16" centers.	Overload and sneak current protection.	W. E. Co.	74E
(b) Terminal Strips, X-61789A-1, Figure B.					
-	4E9981A-1	TERMINAL STRIP: 2-9/32" long x 1-3/4" wide x 2-5/8" deep. Four rows of eight terminals per row. Brass double ended solder terminals with solder dip finish, terminal mounting strips made of hard rubber. (Moisture resistant W.E.Co. no. 181A.)	Connecting point between equipment wiring and exterior cables.	"	D-163568
(c) Jack Strip, X-61789A-1, Figure E.					
-	4C5723B	JACK MOUNTING: 5/8" x 1-23/32" x 19" black insulating material reinforced by metal strips and equipped with mounting lugs. Four mounting screws on 1-1/4" x 18-1/4" centers. Drilled for 28 jacks. Number plates at each end. Designation strips above and below jacks.	For mounting test jacks.	"	230B
CURRENT SPR A	4C4839A	JACK: Singly mounted, five terminals viz: tip, ring, sleeve, break contact on tip, break contact on ring. Heavily insulated, single mounting lug, mounts in 29/64" drilling, terminals take two 19 B&S wires. 9/16" x 13/16" x 3-23/64" over-all. Used with W.E.Co. no. 110, 150, 184, 202, 207, and 213 plugs.	For measuring noise-suppression control current of channel A.	"	239A
SPR B			For measuring noise-suppression control current of channel B.		
REC REL 1			For measuring receiving relay current of circuit 1.		
REC REL 2			For measuring receiving relay current of circuit 2.		
LOOP			For measuring current in receiving loop.		
DET OUT CH A M	4C4716A	JACK: Singly mounted, five terminals viz: tip, sleeve, break contact on tip and extra set of break contacts. Heavily insulated, single mounting lug, mounts in 29/64" drilling. Terminals of tip and tip break contact spring takes two 16 B&S wires other terminals take two 19 B&S wires, 9/16" x 13/16" x 3-15/32" over-all. Used with W.E.Co. no. 47, 116, 144, 151, 153, 154, 217, 241, and 305 plugs.	For patching the output of channel A marking detector.	"	216A
CH A S			For patching the output of channel A spacing detector.		
CH B M			For patching the output of channel B marking detector.		
CH B S			For patching the output of channel B spacing detector.		

(8) Cabinet Equipment. (Cont'd.)

Reference Designation	Sig. C Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
(c) Jack Strip, X-61789A-1, Figure E. (Cont'd.)					
CH A&B M	555004	JACK: Singly mounted, three terminals viz: tip, sleeve, and break contact on tip. Heavily insulated, single mounting lug, mounts in 29/64" drilling. Terminal of sleeve spring takes two 19 B&S wires, other terminals take two 16 B&S wires. 9/16" x 13/16" x 3-15/32" over-all. Used with same plugs as CH A M.	For patching the combined outputs of channels A and B marking detectors.	W. E. Co.	218A
DET OUT CH A&B S			For patching the combined outputs of channels A and B spacing detectors.		
REC REL IN CKT 1 M			For patching the input of relay circuit 1.		
CKT 1 S			For patching the input of relay circuit 1.		
REL OUT 1			For patching the output of receive relay circuit 1.		
REL OUT 2			For patching the output of receive relay circuit 2.		
REC LOOP			For patching the receive loop.		
CKT 2 M CKT 2 S	225535	JACK: Singly mounted, five terminals viz: tip, sleeve, and one set of transfer contacts. Heavily insulated, single mounting lug, mounts in 29/64" drilling. Terminal of tip spring takes two 16 B&S wires, other terminals take two 19 B&S wires. 9/16" x 13/16" x 3-15/32" over-all. Used with same plugs as CH A M.	For patching the input of relay circuit 2. Also when there is no plug in the jacks it connects the disc-type rectifier to receive relay circuit 1. When plugs are in the jacks the disc-type rectifier is connected to relay circuit 2.	"	226A
TST SET BAT	225523	JACK: Singly mounted, three terminals viz: tip, ring, and sleeve. Heavily insulated, single mounting lug, mounts in 29/64" drilling. Terminals take two 19 B&S wires. 9/16" x 13/16" x 3-15/32" over-all. Used with 109 and similar type plugs.	Provides operating power for the I-193 relay test set.	"	246
PLT V TEST	225522	JACK: Same as TEST SET BAT except for use with 110 and similar type plugs.	For measuring voltage of regulated tube rectifier.	"	238A
TLG V TEST			For measuring voltage of disc-type rectifier.		

(8) Cabinet Equipment. (Cont'd.)

Reference Designation	Sig. C Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
(d) Fuse Panel, X-61789A-1, Figure F.					
+6.3V FIL					
AFC V1-3			Protects filaments of tubes V1-3 of AFC.		
AFC V4-5			Protects filaments of tubes V4-5 of AFC.		
ALM-BUZ			Protects fuse alarm buzzer.		
ALM-REL			Protects buzzer when energized through relay contacts.		
DET A M			Protects the marking detector circuit channel A.		
DET A S			Protects the spacing detector circuit channel A.		
DET A NS			Protects the noise-suppression circuit, channel A.		
DET B M	3Z2135N	FUSE: Indicator alarm type. Rated 5 amperes 90-150v. Operates on 6-1/2 amperes in less than 5 minutes. Green bead on indicator and fuse wire in a porcelain tube to prevent side flash. 1-43/64" x 13/32" x 3/8" over-all. Fits no. 6 screw, mounting screws on 1-3/16" centers.	Protects the marking detector circuit, channel B.	W. E. Co.	35N
DET B S			Protects the spacing detector circuit, channel B.		
DET B NS			Protects the noise-suppression circuit, channel B.		
F I A,B			Protects filament supply to VA and VB tubes.		
F I C,D			Protects filament supply to VC and VC tubes.		
LIM A			Protects current limiter A.		
LIM B			Protects current limiter B.		
+130V PLT					
AFC			Protects automatic-frequency control.		
ALM			Protects plate alarm relay.		
DET A			Protects detector A.		
DET B			Protects detector B.		
F I	3Z2135R	FUSE: Indicator alarm type. Rated 0.18 ampere 90v. Operates on 0.27 ampere in less than 1-1/2 minutes. Yellow bead on indicator. 1-43/64" x 13/32" x 3/8" over-all. Fits no. 10 screw, mounting screw on 1-3/16" centers.	Protects frequency indicator.	"	35R
LIM A			Protects current limiter A.		
LIM B			Protects current limiter B.		
REC R 1			Protects receiving relay 1.		
REC R 2			Protects receiving relay 2.		
TST SET			Protects power supply to test set battery jack.		

(8) Cabinet Equipment. (Cont'd.)

Reference Designation	Sig. C Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
(d) Fuse Panel, X-61789A-1, Figure F. (Cont'd.)					
+130V TLG ALM REC REL	3Z2135S	FUSE: Indicator alarm type. Rated 0.25 ampere. Has nickel chromium iron fuse wire. Operates on 0.375 ampere in less than 1-1/2 minutes. Clear glass bead on indicator. 1-43/64" x 13/32" x 3/8" over-all. Fits no. 10 screws, mounting screws on 1-3/16" centers.	To be used in place of W.E.Co. no. 74E heat coils if available.	W. E. Co.	35S
+130V TLG ALM REC REL	3C600	HEAT COIL: Indicator alarm type. 6.5 to 8 will carry 0.185 ampere for 3 hours, will operate in 3-1/2 minutes on a current of 0.265 ampere at 68F ambient temperature 1-43/64" x 13/32" x 1-3/16" over-all. Fits no. 6 screw, mounting screws on 1-3/16" centers.	For protection of P and T relay circuits. For protection of receive relay circuit.	"	74E
	3Z5995-8	RESISTOR: Fixed cylindrical 5^{Ω} ±10% 1/2 watt. Wire wound, molded in phenol plastic, compound, 3/16" diameter x 5/8" long.	When fuse operates it prevents adjacent fuses from operating.	IRC	BW 1/2 5^{Ω}
(e) Alarm and Misc. X-61789A-1, Figure D.					
ALM	4Z1107A	BELL: D-c 14 to 40v, a-c 25 to 50v 50-60 cps; coil resistance 248^{Ω}, impedance 732^{Ω}, 3-1/2" x 5-1/2" over-all, black case 3" black gong, heavy silver contacts, reed mounted armature, flat retractible spring, surface mounted.	Operates when frequency is outside of predetermined limits.	W. E. Co.	7A
FA	4C1707B	BUZZER: Operates on 2-6v d-c or 4-9v. 60 cps, a-c, approximate resistance 10.5^{Ω}. Effective d-c resistance or 60 cps, a-c impedance is approximate 31^{Ω}. 2-1/8" x 1-31/32" x 1-1/8" black case enclosing buzzer equipped with heavy silver contacts with reed mounted armature with a flat retractible spring and stop.	Indicates that fuse is operated.	"	7B
P T	4C8827.29	RELAY: Flat type, single winding 5000^{Ω} 5%. Operate 0.0066 ampere. One set of make contacts on top and bottom. Semielliptical core. 4-1/16" x 1-3/8" x 27/32" over-all.	Operates when a PLT fuse operates thereby closing circuit to energize buzzer. Operates when a TELEG fuse operates thereby closing circuit to energize buzzer.	"	R291
-	4Z3501	RELAY COVER: 1-9/16" x 1-5/32" x 3-51/64" over-all. Rectangular metal cover for "R" type relays.	Cover for P and T relays.	"	R1
A1	3Z6289H8	RESISTOR: Fixed, flat type, 2898^{Ω} ±1%, 5 watts. Wire wound on core of heat resisting material. Mounting studs on 1-5/16" centers. 1-1/2" x 13/64" x 4-21/32" over-all. (Moisture resistant W.E.Co. no. 18 EK.)	With resistor B1 causes the meter to indicate full scale with a 50 milliampere loop current.	"	D-161699EK

(8) Cabinet Equipment. (Cont'd.)

Reference Designation	Sig. C Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
	(e) Alarm and Misc. X-61789A-1, Figure D. (Cont'd.)				
B1	3Z6003F2	RESISTOR: Fixed, flat type, two windings 28-1/2$^{\omega}$ ±1% and 32$^{\omega}$ ±1%, 5 watts either or both windings. Wire wound on core of heat resisting material. Mounting studs on 1-5/16" centers. 1-1/2" x 13/64" x 4-21/32" overall. Moistureproof W.E.Co. no. 19FC.	With resistor A1 causes the meter to indicate full scale with 50 milliamperes loop current.	W. E. Co.	D-161700FC
C1 C2	3Z6006-10	RESISTOR: Same as A1 except 60$^{\omega}$ ±1%, Moisture resistant W.E.Co. no. 18BR.	With resistor D1, it causes the meter to indicate full scale with 20 milliamperes through the SPR A jack. With resistor D2, it causes the meter to indicate full scale with 20 milliamperes through the SPR B jack.	"	D-161699BR
D1 D2	3Z6092	RESISTOR: Same as B1 except 191$^{\omega}$ ±1% 2 watts, 920$^{\omega}$ ±1% 5 watts, both windings 5 watts. Moisture resistant W.E.Co. no. 19MN.	With resistor C1, it causes the meter to indicate full scale with 20 milliamperes through the SPR A jack. With resistor C2, it causes the meter to indicate full scale with 20 milliamperes through the SPR B jack.	"	D-161700MN
E F G H	3Z6700-76	RESISTOR: Fixed, tubular, 100,000$^{\omega}$ ±1%, 3/4 watt, low reactance. Wire wound on bakelite core, phenol fibre outer tube with 2" axial lead at each end. 1/2" diameter x 1-1/2" long.	With resistor F, it causes the meter to indicate full scale in PLT V TST jack for 200v plate voltage. With resistor E, it causes the meter to indicate full scale in PLT V TST jack for 200v plate voltage. With resistor H, it causes the meter to read full scale in TLG V TST jack for 200v telegraph voltage. With resistor G, it causes the meter to read full scale in TLG V TST jack for 200v telegraph voltage.	"	107A 100,000$^{\omega}$
-	2Z9408.10	RESISTOR MOUNTING ASSEMBLY: 1/2" x 2-19/32" x 2-1/8" phenol fabric sheet with eight terminals (four on each 2-19/32" side) and two steel brackets at each end for mounting. Brackets extend 1-1/16" from panel.	For mounting and connecting resistors E, F, G, and H.	"	P-263392

(8) Cabinet Equipment. (Cont'd.)

Reference Designation	Sig. C Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
		(f) Utility Outlet and Heater Panel, X-61789A-1, Figure H.			
-	1B816.23	CORD: 16 guage 4-conductor 3'-0" long. Four stranded rubber conductors with outer rubber jacket.	Connects the AN/FGC1 equipment to a-c power through a receptacle in the radio receiver bay.	Simplex	SJ-4 16 AWG
-	6Z3178	CORD CONNECTOR: Malleable iron detail which fits 1/2" knockout in outlet box and has two screws for holding rubber jacketed cords.	Holds cord in outlet box and in Jones P-504CE plug.	Appleton	7286-2"
-	6Z6820-9	LAMP: 50 watt, 120v 4-7/16" long x 2-3/8" diameter, pear shaped bulb, medium screw base.	Heater lamps.	G.E. or W.E. & M.	A19
-	6Z7809-1.1	OUTLET: Convenience, duplex, double "T" slots. 10 amperes 250v, 15 amperes 125v. Bakelite body, side wired, double binding screws.	A-c supply for rectifier and appliances.	Hubbell	9575
-	6Z7591-5	PLUG: Rated 5000v 25 amperes. Four terminals. 2-1/2" x 3-7/8" x 2-1/4" over-all, metal case rounded at top, cable entrance 1-3/4" diameter.	Used on cord that connects AN/FGC1 equipment to a-c power.	Jones	P-504-CE
-	6Z7807-6	RECEPTACLE: One piece, medium base, porcelain, sign. 660 watt 250v. Fits in 1-3/8" hole and supported by two screws on 1-13/16" centers. 1-3/4" x 2" x 2" approximate over-all.	Holder for heater lamps.	Hubbell	4003
		(g) Miscellaneous X-61789A-1			
-	3Z6801.16	FUSETRON: Rated 1 ampere 250v 1/4" x 1-1/4" fuse in glass tube with thermal cutout which operates on low overloads of long duration and a fuse link to operate on high overloads of short duration. Designed not to operate on a moderate overload of short duration.	In input circuit to KS-5844 rectifier to protect rectifier.	Buss	MDL-1
-	2B740	HEADBAND: Wire band with pad 6" diameter x 2-3/32" at widest parts. Moisture resistant W.E.Co. no. 11A.	Used with 716C receiver.	W. E. Co.	D-142091
-	6Z6840	LAMP: 50 watt 240v. Medium screw base, pear shaped bulb, 2-5/8" diameter, 4-7/16" long.	Heater lamp used when supply is 230v.	G.E. or W.E. & M.	A-21
-	4C7365C	PLUG: Dummy, black insulating material, 7/16" diameter x 2-3/32" long over-all. Used with jacks that take W.E.Co. no. 47 and similar type plugs.	Used for opening jack circuit.	W. E. Co.	165C

(8) Cabinet Equipment. (Cont'd.)

Reference Designation	Sig. C Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
	(g) Miscellaneous X-61789A-1. (Cont'd.)				
-	2B2116	RECEIVER: Watch case type, controlled diaphram magnetic type receiver unit, 2250 at 1000 cps. 2-3/8" diameter x 1-5/16" thick.	Used for monitoring on the telegraph circuit.	W. E. Co.	716C
-	3E4035-14	CORD: 2-conductor, 4'-0" long, tinsel with cotton covering, rubber insulation and outer cotton braid. Equipped with a W.E.Co. no. 47 plug at one end and W.E.Co. no. 129 cord tips at the other.	Receiver cord.	"	D-161768
-	3E2P1B	CORD: Patching, 2-conductor, waterproof 2'-0" long. Rubber insulated tinsel conductors with red glazed cotton covering and a red shell W.E.Co. no. 347A (2-conductor) plug at each end.	For use with W.E.Co. no. 215 to 221 and similar type jacks.	"	2P1B
-	3E2P1C	CORD: Same as 2P1B except 4'-0" long.	For use with W.E.Co. no. 215 to 221 and similar type jacks.	"	2P1C
-	3E2P13D	CORD: Patching, 2-conductor, moistureproof, 2'-0" long. Tinsel conductors with slate glazed cotton covering and a black shell W.E.Co. no. 241A plug at each end.	For use with W.E.Co. no. 215 to 221 and similar jacks.	"	2P13D
-	3E3P7D	CORD: Patching, 3-conductor, waterproof, 2'-0" long. Rubber insulated tinsel conductors with slate glazed cotton covering and a red shell W.E.Co. no. 310 (3-conductor) plug at each end.	For use with W.E.Co. no. 49 and similar type jacks.	"	3P7D
-	1B7012-2	CORD: Two stranded rubber conductors with outer rubber jacket. 18 AWG 2'-6" long.	A-c power supply for X-61680 rectifier.	Simplex	SJ-18 2'-6"
-	6Z1727-1	PLUG - CAP: Parallel blades, polarized, 2-conductor, armored, grip for cords 0.296" to 0.562" diameter. Rated 10 amperes 250v 15 amperes 125v 1-1/2" diameter x 1-3/4" high over-all.	A-c power supply for X-61680 rectifier.	Hubbell	7059

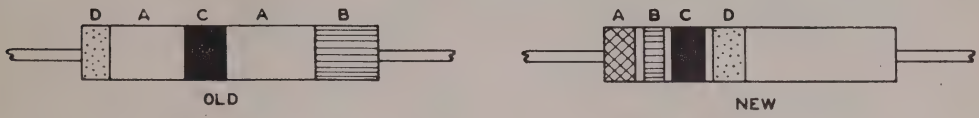
(9) Maintenance Tools and Material.

Reference Designation	Sig. C Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
-	6Q11824	BOX: Metal, 16" x 7" x 7" over-all, hinged cover, two fasteners and lock.	Holder for tools.	Kennedy	B16
-	6N1624	CLOTH: White cotton twill approximately, 9" squares.	For cleaning equipment.	W. E. Co.	KS-2423
-	3E1W13A	CORD: One conductor, 3'-0" long, tinsel, red cotton covered, W.E.Co. no. 360A tool at each end. Moistureproof W.E.Co. no. 1W13A cord.	For use with 364, 365, 419 tools.	"	D-165536
-	3E1W13B	CORD: One conductor, 6'-0" long, tinsel, red cotton covered, W.E.Co. no. 360A tool at each end. Moistureproof W.E.Co. no. 1W13B cord.		"	D-165537
-	3E2W17A	CORD: 2-conductor, 6'-0" long, tinsel, slate glazed cotton outer covering. A W.E.Co. no. 310 plug is at one end and one W.E.Co. no. 360B and one 360C tool at the other end. Moistureproof W.E.Co. no. 2W17A cord.		"	D-162184
-	6R40867A	GAUGE: Thickness 0.015".	For general use.	"	67A
-	6R40870J	GAUGE: Gram tension, 0-150.	For measuring relay spring tensions.	"	70J
-	6R40932A	GAUGE: Thickness 0.008".	For use with U-type relays.	"	132A
-	6R40932B	GAUGE: Thickness 0.010".		"	132B
-	6R40932C	GAUGE: Thickness 0.013".		"	132C
-	6R40932L	GAUGE: Thickness 0.035".		"	132L
-	6M-750	PAPER: Bell seal bond, 1/4" x 2-1/2" strips.	For cleaning relay contacts.	"	KS-7188
-	4C7365C	PLUG: Black, insulating, dummy plug.	Used with jack that takes W.E.Co. no. 47 and similar type plugs.	"	165C
-	4C7365D	PLUG: Red, insulating, dummy plug.		"	165D
-	3G2400-10	SLEEVING: Tubular, unbleached braided cotton fabric, 5/8" inside diameter.	For cleaning plugs.	"	AT-6839
-	3F4316	TEST SET: (Receiver) Consists of no. 509, receiver, no. 11A headband, no. 360A tool, no. 518A tool, no. 106A adapter assembled together with a no. W3S cord.	For general testing; continuity checking, testing for battery or ground; monitoring.	"	67B

(9) Maintenance Tools and Material. (Cont'd.)

Reference Designation	Sig. C Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
-	6R40872	TOOL: Double socket wrench and screwdriver fits 5/32" and 3/16" hexagonal nuts.	For general use.	W. E. Co.	72
-	6R41006	TOOL: 30 degree offset screwdriver. 5" long.	For adjusting relay spring pile-up screws, etc.	"	206
-	6R41007	TOOL: 90 degree offset screwdriver. 5" long.			207
-	6R41164	TOOL: Spade tip for test cords.	Used with D-165536, D-165537, and D-162184 cords for general testing.	"	364
-	6R41165	TOOL: Connecting clip for test cords.			365
-	6R41219A	TOOL: Relay spring connector clip for test cords.			419
-	6R41274A	TOOL: Wrench, double end, enclosed, offset. Fits 1/4" and 3/16" hexagonal nuts.	For adjusting armature travel of flat-type relays.	"	474A
-	6R41305A	TOOL: Spring adjuster. Fits springs maximum 0.014" thick.	For adjusting springs of U-type relays.	"	505A
-	6R41307A	TOOL: Spring adjuster. Fits springs maximum 0.032" thick.	For adjusting springs of U-type relays.	"	507A
-	6R41308A	TOOL: Armature blocking, U-shape metal clip.	For blocking U-type relays either operated or unoperated.	"	508A
-	6R41353A	TOOL: Switchboard lamp extractor.	For removing no. 2-type lamps from sockets.	"	553A
-	3Z-1087-2	TOOL: 2" long steel alligator clip with screw connection.	General testing.	"	ITE-8507
-	6Q-28775	TOOL: Cord repair screwdriver.	For use on assembly screws of plugs.	"	KS-2348
-	6Q28775	TOOL: Connecting clip, alligator type. Jaws 3/16" wide and 1-5/64" long.	Used with D-165536, D-165537, and D-162184 cords.	"	KS-6278
-	6Z7360	TOOL: Orange stick, 7/32" diameter x 6-7/8" long.	For general use.	"	KS-6320
-	6R25351	TOOL: Fibre spudger, 5/16" diameter x 5-1/2" long.	For general use.	"	R-1102
-	6Z1565-1	TOOL: Sash brush, chisel edge, 15/16" wide, bristles 1-3/4" long.	For cleaning.	D&R	5340 no. 5
-	6Z8666	TOOTHPICKS: Standard size, hardwood.	For general use.	W. E. Co.	RM-717053

d. RMA Standard Color Code for Resistors in Ohms and Capacitors in Microfarads.



A - Color for 1st significant figure.
B - Color for 2nd significant figure.
C - Color for number of ciphers or multiplier.
D - Gold or silver indicates tolerance, when applied.

COLOR	SIGNIFICANT FIGURE	MULTIPLYING VALUE
Black	0	1
Brown	1	10
Red	2	100
Orange	3	1000
Yellow	4	10,000
Green	5	100,000
Blue	6	1,000,000
Violet	7	10,000,000
Gray	8	100,000,000
White	9	1,000,000,000
Gold	±5% tolerance	0.1
Silver	±10% tolerance	0.01
No Color	±20% tolerance	-

EXAMPLES

43,000 ohms	Yellow (4)	Orange (3)	Orange (X1000)
3000 ohms	Orange (3)	Black (0)	Red (X100)
3.3 ohms	Orange (3)	Orange (3)	Gold (0.1)

GLOSSARY OF TERMS

(Explanation of terms as used in this Book.)

Bias - If the average mark is lengthened by the circuit, the circuit is said to have marking bias; if shortened, spacing bias. When referring to tubes, "bias" usually designates a grid or cathode potential.

Battery - This term is sometimes used loosely to designate any source of direct current, particularly, in this book, a rectifier source.

Channel - In this book, "channel" designates the communication path or equipment in the receiving circuit from a radio receiving antenna to the receiving relay. With space diversity, the relay is common to two channels.

Detector - A device for changing a-c signals to d-c signals.

Db - Abbreviation for decibels: Two amounts of power differ by N decibels according to the relation $N = 10 \log_{10} P_1/P_2$. The number of decibels may be obtained from current ratios if the currents are measured in equal inpedances as follows: $N = 20 \log_{10} I_1/I_2$.

Dbm - Abbreviation for "db above or below one milliwatt"; positive sign indicates above, negative sign below.

Frog - A term derived from railroad designation of a track crossing. "To frog" two circuits means to transpose them so that each follows the path which the other followed previously.

Loop - A d-c extension line between a telegraph terminal and the printer and associated equipment.

Mark - A telegraph signaling interval during which current flows through the printer magnet. During this time, the circuit is said to be marking. The interval during which no current flows through the printer magnet is called a space.

Polar operation - Marking signals are formed by current pulses of one polarity and spacing signals by current pulses of equal magnitude but of opposite polarity.

Rectifier - A device for changing alternating current to direct current. In this book, it refers principally to the arrangements provided on the telegraph terminal bays for changing 50- to 60-cycles or 25- to 60-cycle a-c power to 130-volts d-c power; in the figures, the regular convention for a battery is used to indicate the rectifier.

Reversals - Repeated marks and spaces all of equal length.

Space - See Mark.

Space diversity - Refers to radio reception in which two or more receivers are connected each to a separate antenna and the outputs are combined.

Station - A printer and its associated equipment.

Telegraph terminal - This term usually designates one bay of AN/FGC1 equipment.

Thermistor - A resistor whose resistance varies largely with temperature.

Varistor - A copper-oxide rectifier.

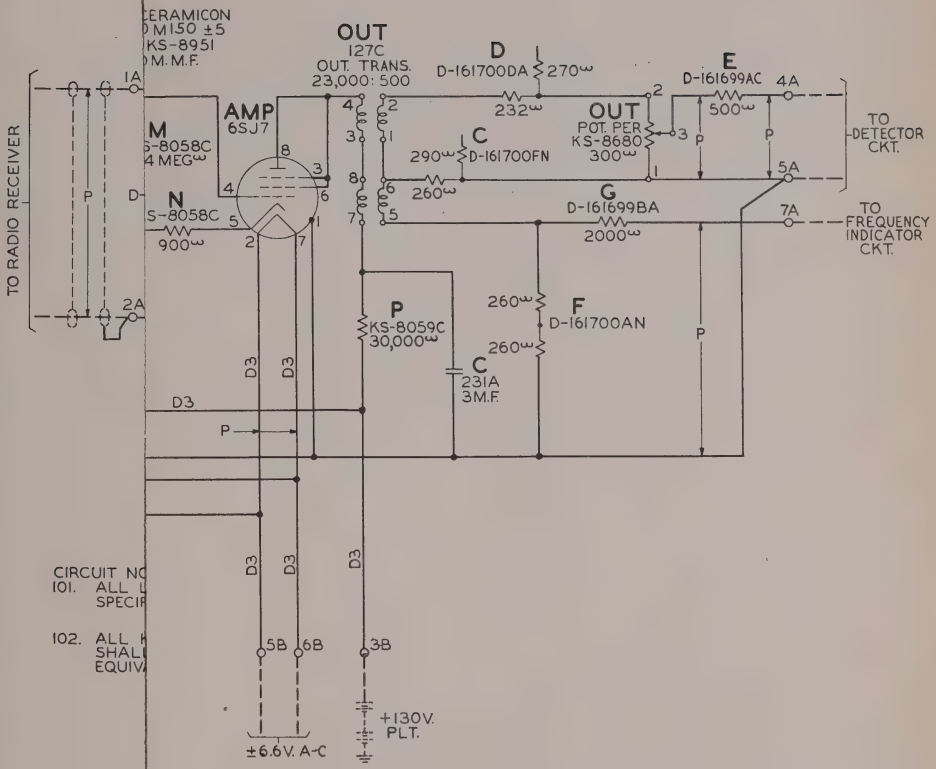
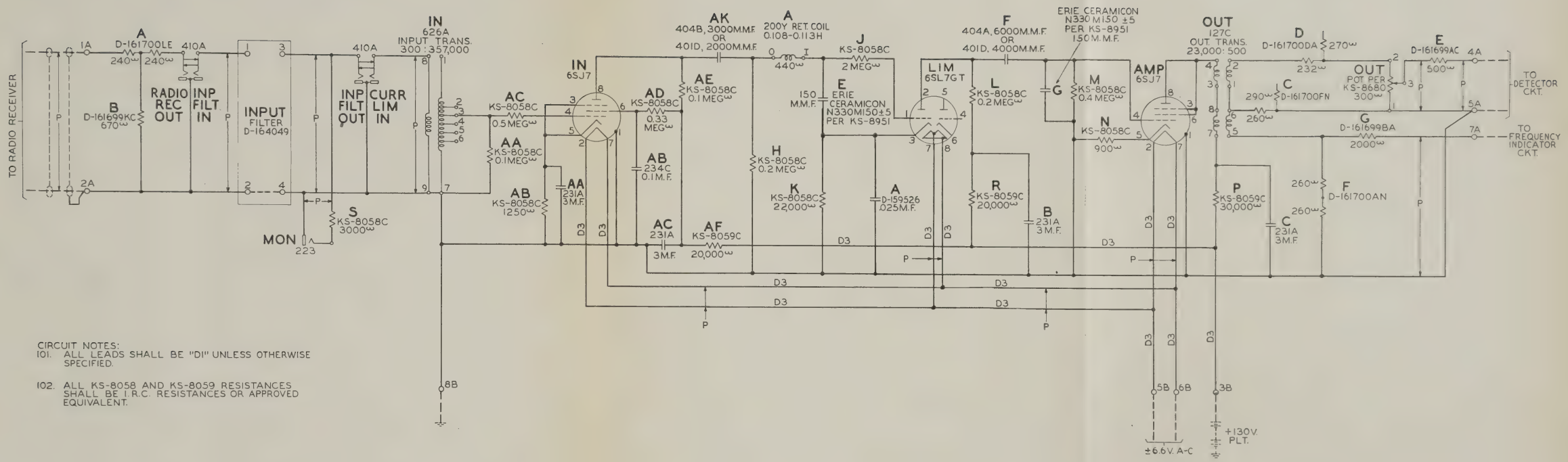


Fig. 33
Page 134

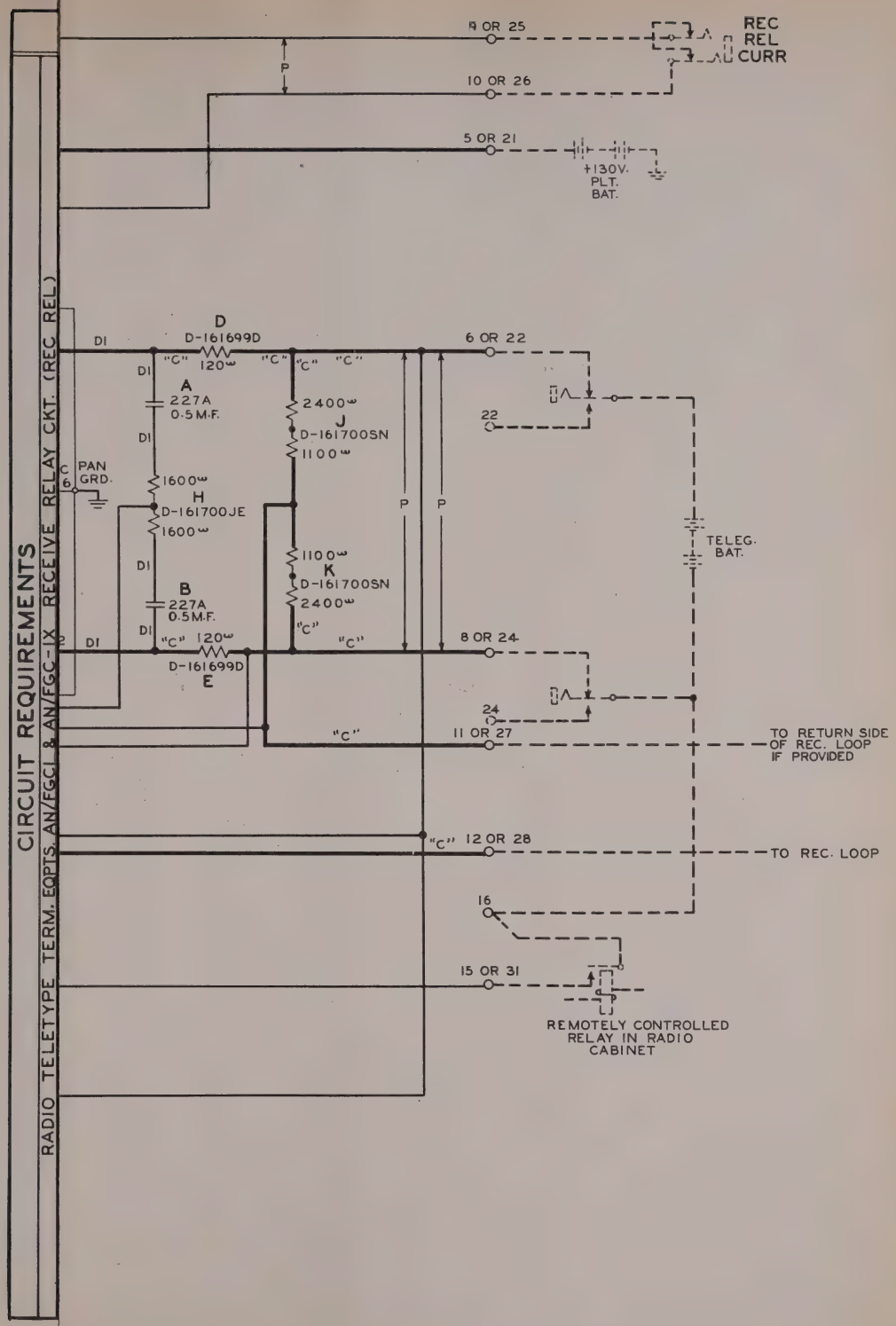


CIRCUIT NOTES:

101. ALL LEADS SHALL BE "D1" UNLESS OTHERWISE SPECIFIED.

102. ALL KS-8058 AND KS-8059 RESISTANCES SHALL BE I.R.C. RESISTANCES OR APPROVED EQUIVALENT.

Figure 33 - Current Limiter, Schematic Diagram



e Relay, Schematic Diagram

Fig. 34
Page 135

CIRCUIT REQUIREMENTS

RADIO TELETYPE TERM. EQPTS. AN/FGCI & AN/FGC-1X RECEIVE RELAY CKT. (REC REL.)

APPARATUS DESIG.	APPARATUS CODE	MECH. REQ. BSP FIG.	MECH. REQ. CONT. PRESS.	MECH. REQ. ARM. TRVL.	CIRCUIT PREPARATION BLOCK OR INSULATE	CIRCUIT PREPARATION TEST CLIP DATA CONN. BAT.	CIRCUIT PREPARATION TEST CLIP DATA CONN. GRD.	TEST SET PREP.	SEE TEST NOTE NO.	DIRECT CURRENT FLOW REQ. TEST WDG.	DIRECT CURRENT FLOW REQ. TEST FOR	DIRECT CURRENT FLOW REQ. AFTER SOAK MA	DIRECT CURRENT FLOW REQ. TEST MA	DIRECT CURRENT FLOW REQ. READJ. MA	REMARKS
RELAYS FIG. 1															
A	U567	111/106	H	44		T (A)		BAT.	1/2		O		16.5	15.5	
B	Y159	175/115	H	47			B (B)	GRD.	1/3/4		O	31.5	21	20	
					3B(C)		B (B)	GRD.	1/3/4		H	31.5	2.1	2	
							B (B)	GRD.	1/3/4		R	31.5	1.1	1.5	
C	U1129	132/132	H	65		T (C)		BAT.	1/2		O		18	17	
						T (C)		BAT.	1/2		NO		13.5	14.5	
REC	255A														ADJUST BY MEANS OF RELAY TEST SET FURNISHED.

TEST NOTES:

1. OPERATE (TST) KEY.
2. CONNECT TEST SET TO TERMINAL PCHG. 16 ON RECEIVE RELAY UNIT INSTEAD OF TO BAT.
3. ADJACENT RELAYS SHALL NOT BE ENERGIZED. SEE BSP.
4. CONNECT TEST SET TO TERMINAL PCHG.22 ON RECEIVE RELAY UNIT INSTEAD OF TO GRD.

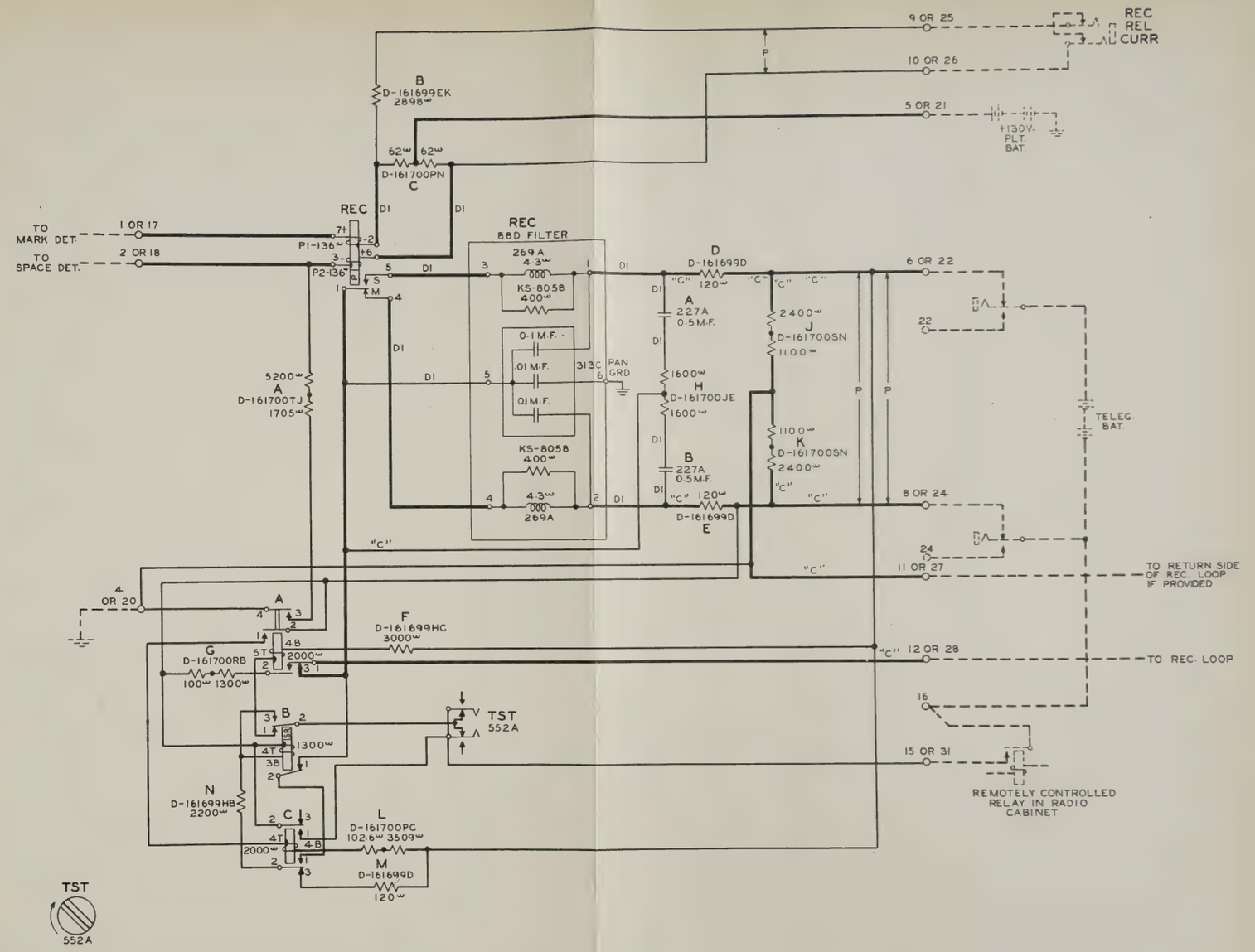
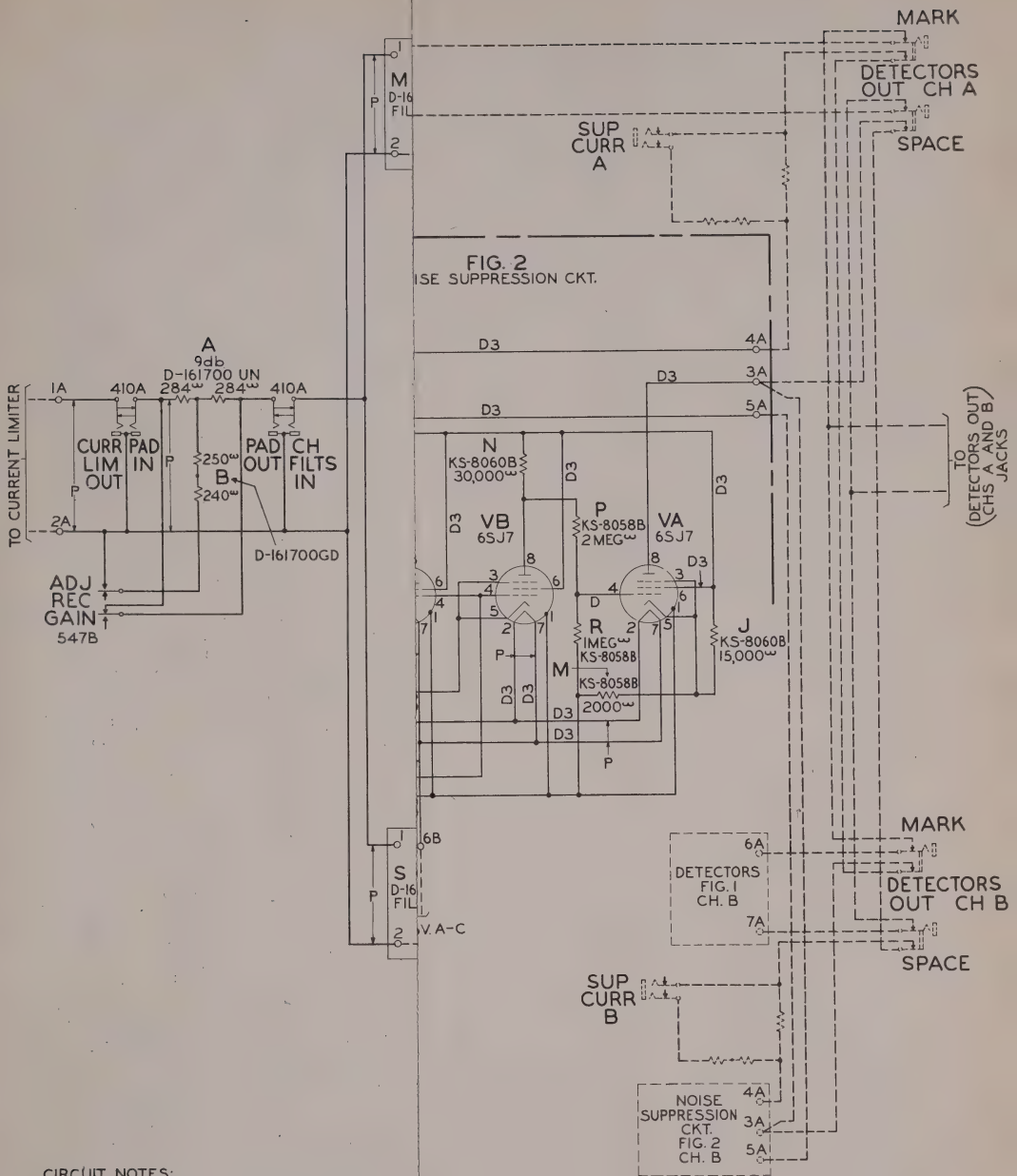


Figure 34 - Receive Relay, Schematic Diagram



CIRCUIT NOTES:

101. ALL LEADS SHALL BE "DI" UNLESS OTHERWISE SPECIFIED.

102. ALL KS-8058 AND KS-8060 RESISTANCES SHALL BE I.R.C. RESISTANCES OR APPROVED EQUIVALENT.

Fig. 35
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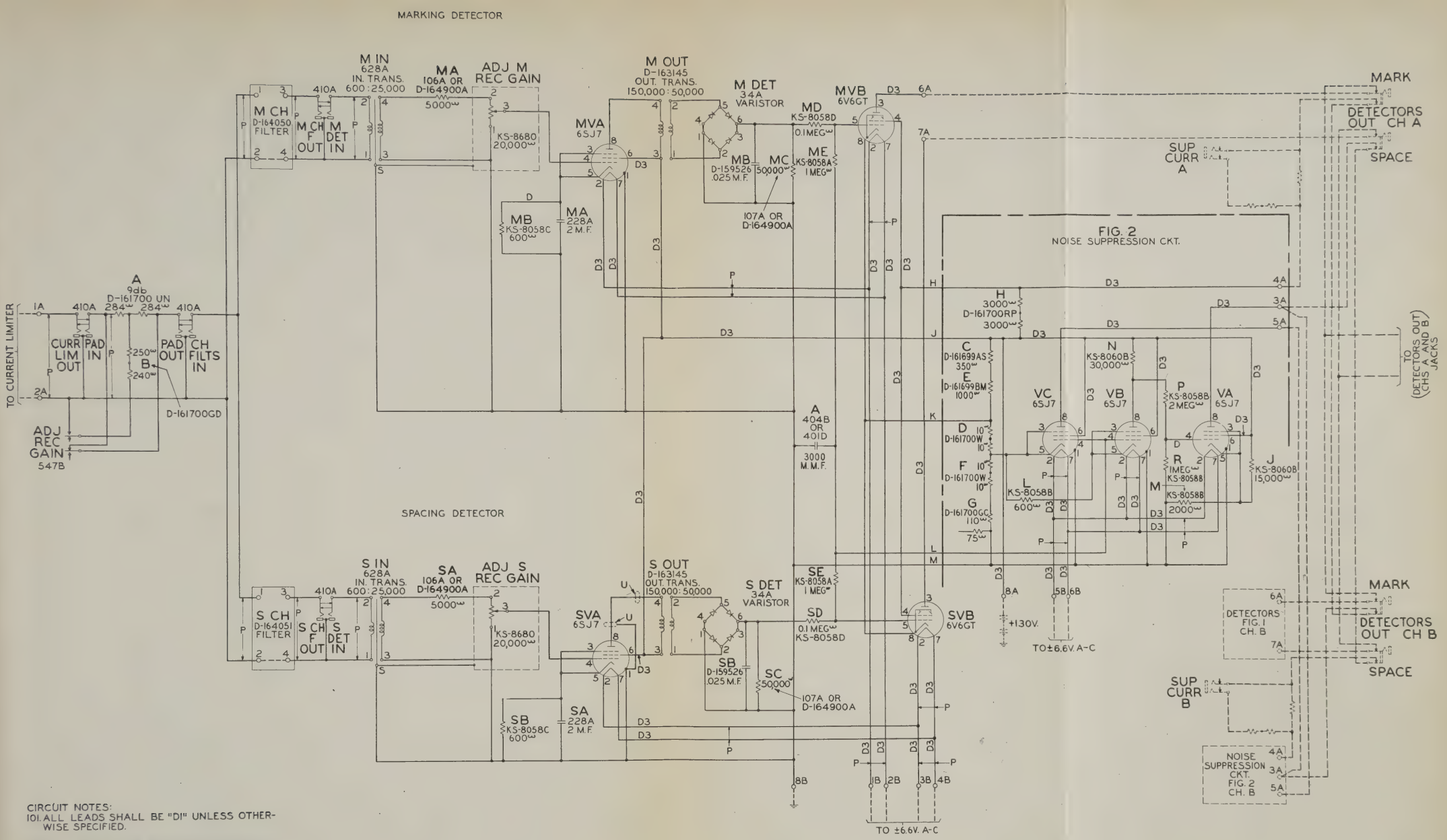
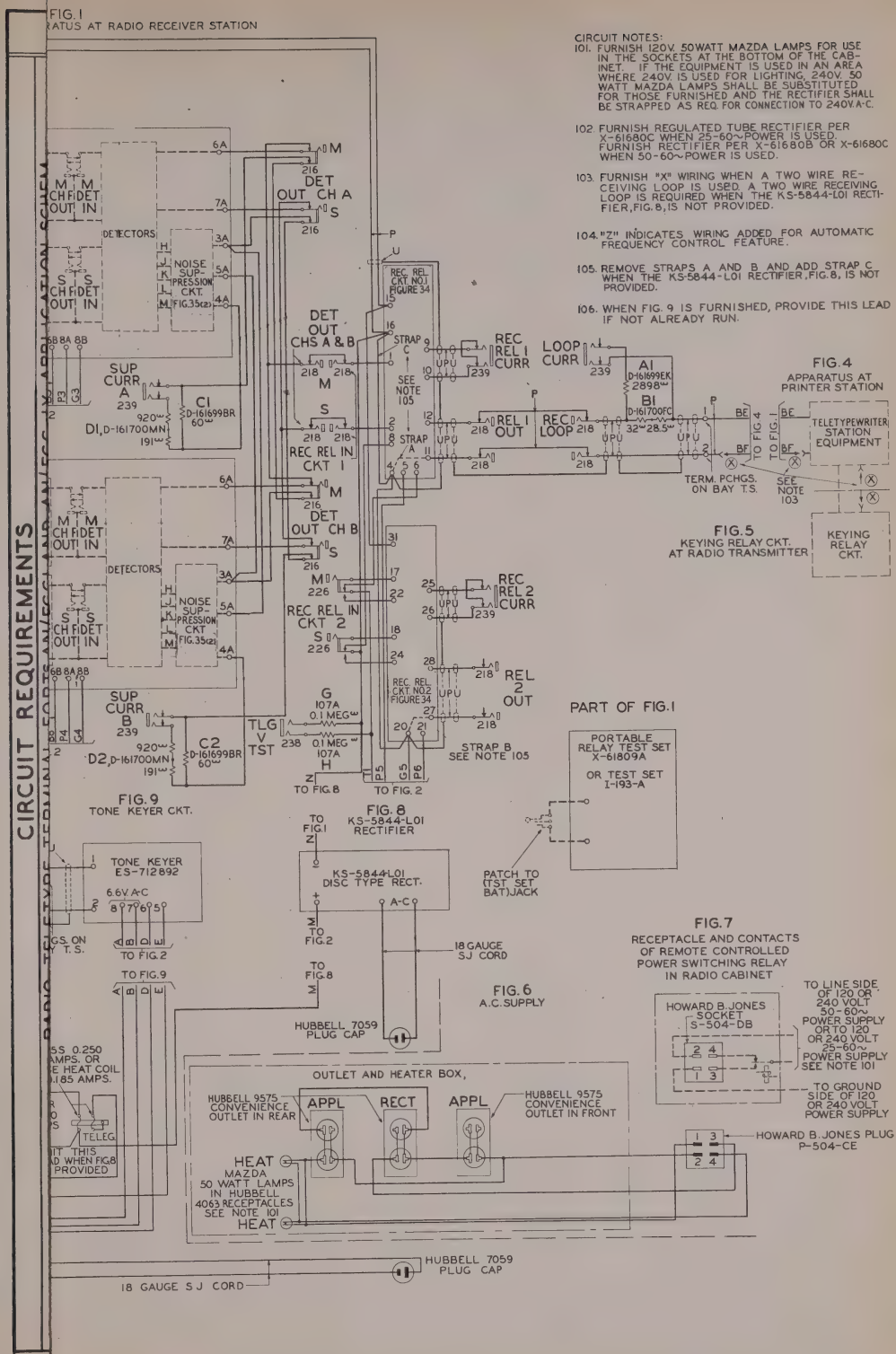


Figure 35 - Detector, Schematic Diagram



ication Schematic Diagram

CIRCUIT REQUIREMENTS

RADIO TELETYPE TERMINAL EQPTS AN/FGC1 AND AN/FGC-1X APPLICATION SCHEM.

APPARATUS DESIG.	APPARATUS CODE	MECH. REQ. BSP FIG.	MECH. REQ. CONT. PRESS.	MECH. REQ. ARM. TRVL.	CIRCUIT PREPARATION BLOCK OR INSULATE	CIRCUIT PREPARATION TEST CLIP DATA CONN. BAT.	CIRCUIT PREPARATION TEST CLIP DATA CONN. GRD.	SET TEST PREP.	SEE TEST NOTE NO.	DIRECT CURRENT FLOW REQ. TEST WDG FOR	DIRECT CURRENT FLOW REQ. TEST AFTER SOAK MA	DIRECT CURRENT FLOW REQ. TEST READJ. MA	DIRECT CURRENT FLOW REQ. TEST READJ. MA	REMARKS
RELAYS FIG. 1														
P,T	R291	1/1	H	15	RB	RELAY UNDER TEST	BAT.	1		O		7	6.6	

TEST NOTES:
1. REMOVE ASSOCIATED FUSE OR HEAT COIL.

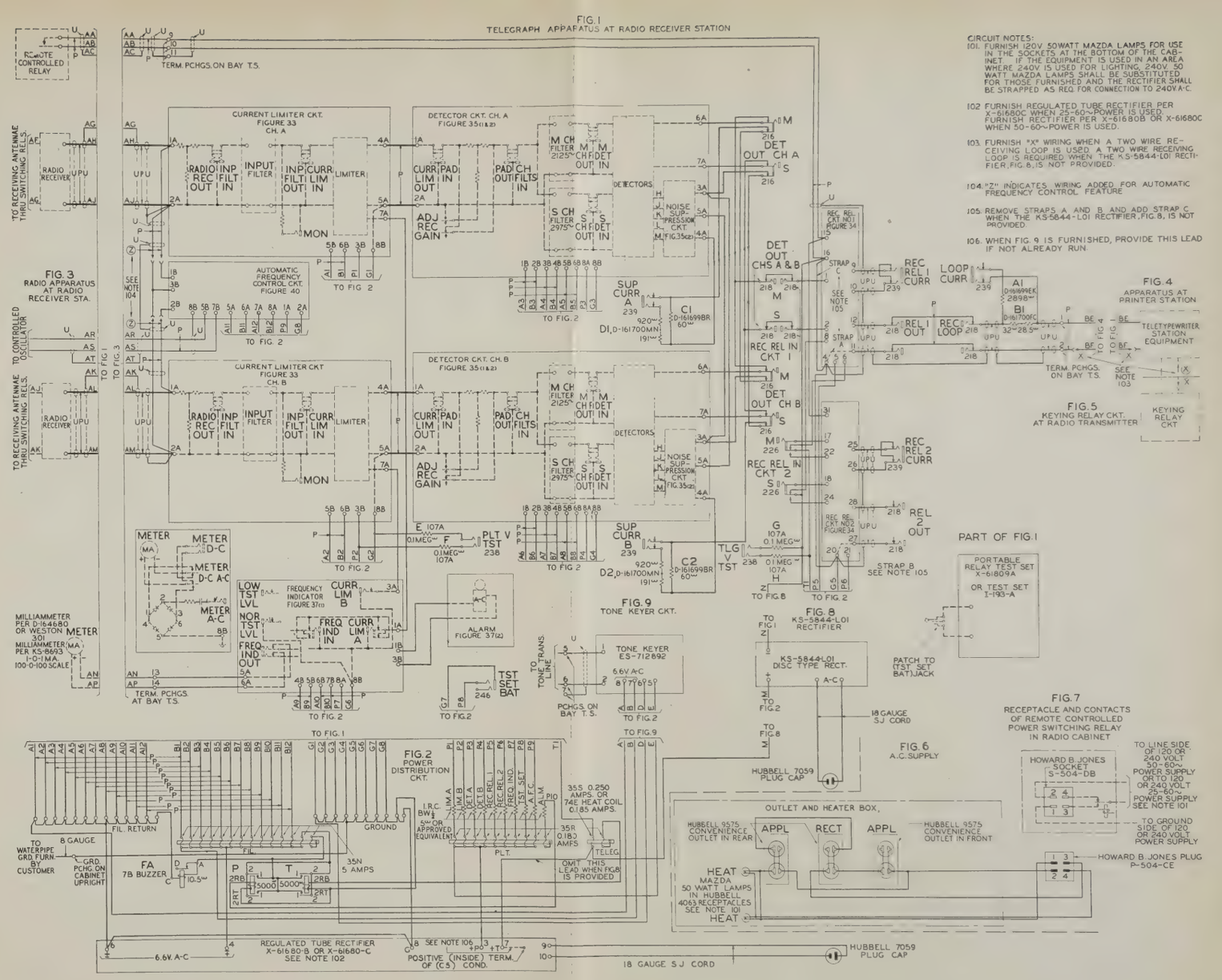
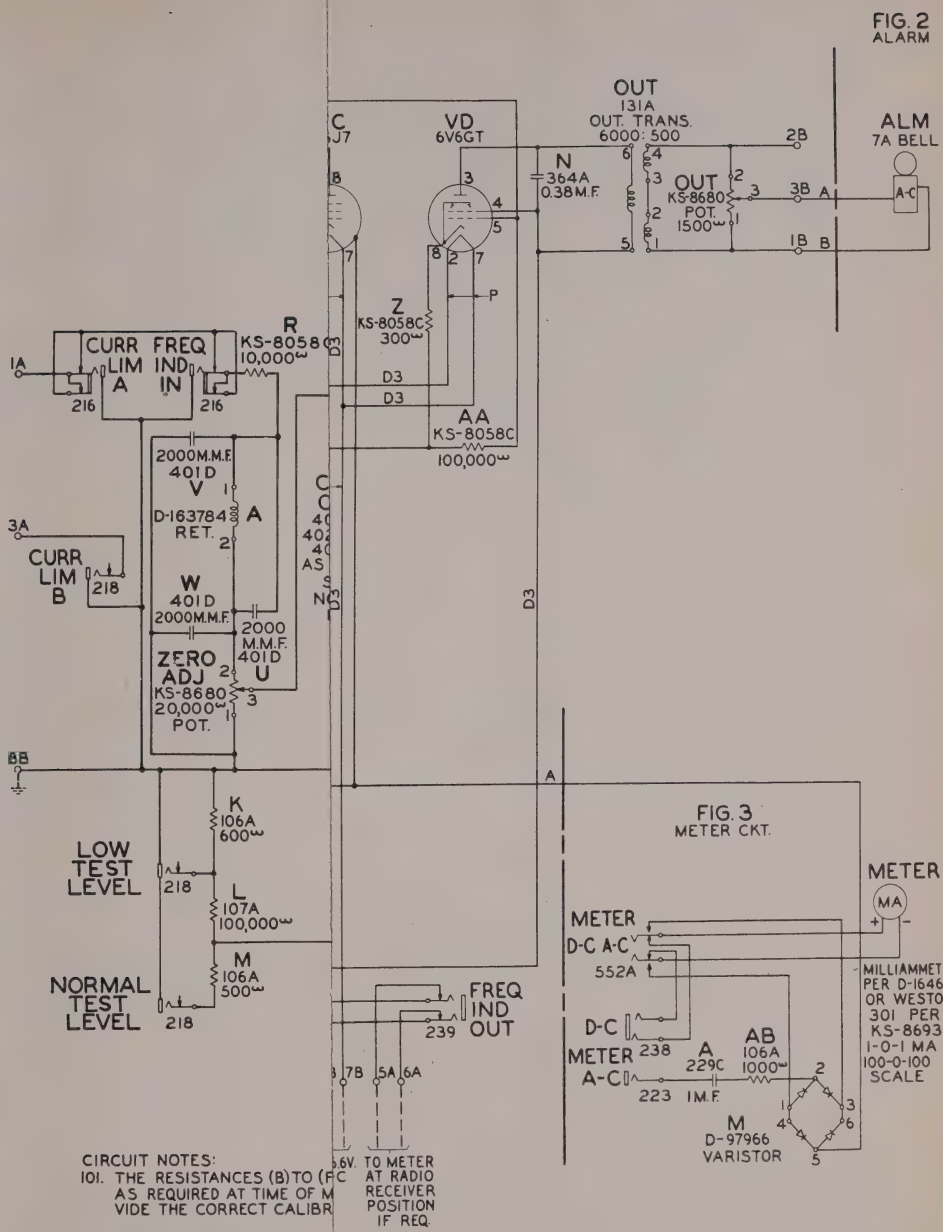
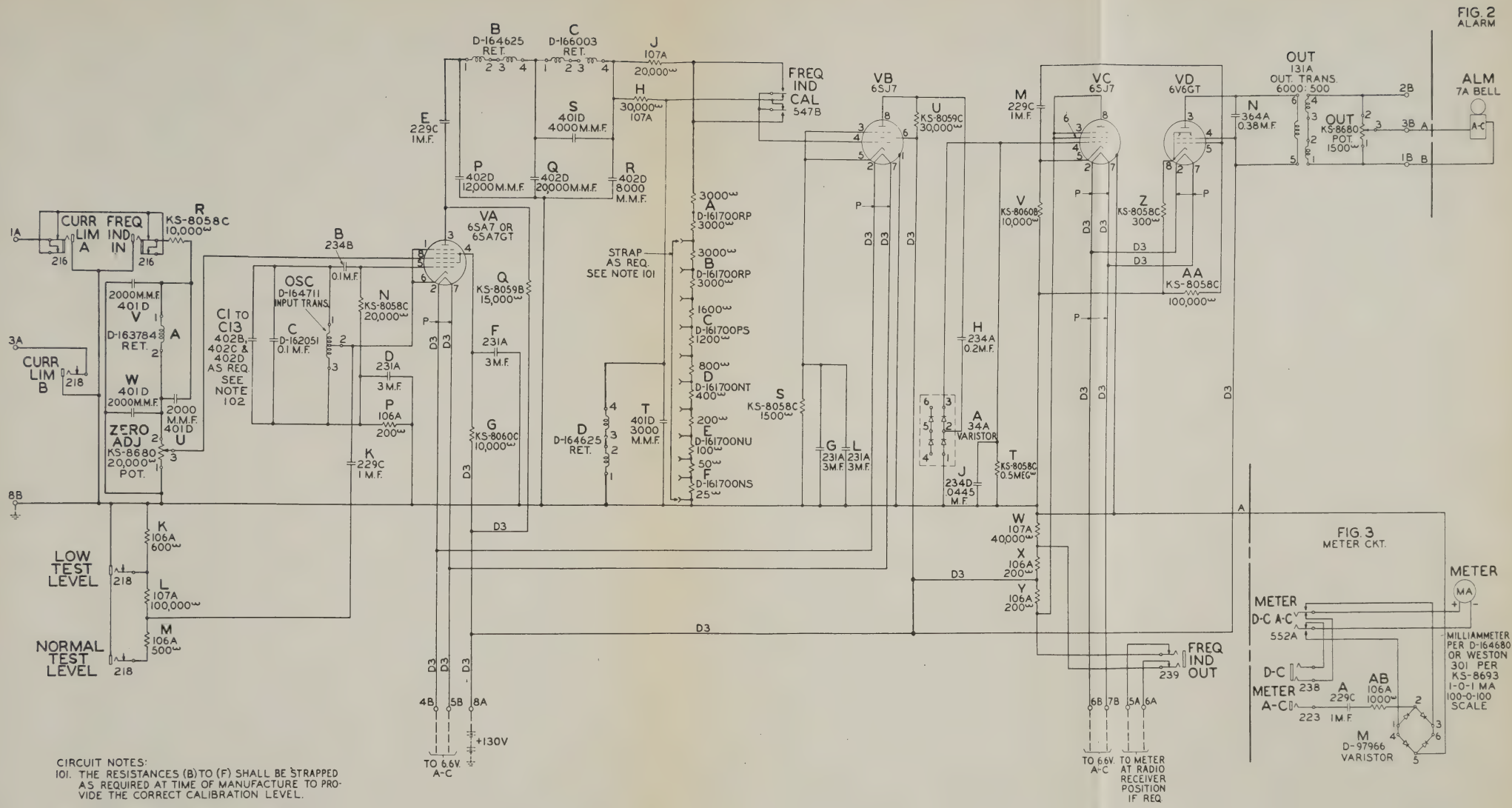


Figure 36 - Application Schematic Diagram


FIG. 2
ALARM
OUT
131A
OUT. TRANS.
6000: 500
ALM
7A BELL
VD
6V6GT
N
364A
0.38M.F.
OUT
KS-8680
POT.
1500Ω
Z
KS-8058C
300Ω
R
KS-8058
10,000Ω
CURR LIM A
FREQ IND IN
AA
KS-8058C
100,000Ω
2000M.M.F.
401D
V
D-163784
RET.
W
401D
2000M.M.F.
CURR LIM B
ZERO ADJ
KS-8680
20,000Ω
POT.
2000
M.M.F.
401D
U
K
106A
600Ω
LOW TEST LEVEL
L
107A
100,000Ω
M
106A
500Ω
NORMAL TEST LEVEL
FREQ IND OUT
239
FIG. 3
METER CKT.
METER
MA
METER
D-C A-C
552A
D-C
238
METER
A-C
223
A
229C
AB
106A
1000Ω
1.M.F.
M
D-97966
VARISTOR
MILLIAMMETER
PER D-164680
OR WESTON
301 PER
KS-8693
1-0-1 MA
100-0-100
SCALE
CIRCUIT NOTES:
101. THE RESISTANCES (B) TO (F
AS REQUIRED AT TIME OF M
VIDE THE CORRECT CALIBR
102. SELECT AND EQUIP THE OS
MINIMUM NUMBER OF CON
TO TUNE THE OSCILLATOR
APPROXIMATE TUNING CAP
CONDENSER (C) IS 0.15 M.F.
103. ALL KS-8058, KS-8059 A
ANCES SHALL BE I.R.C.
APPROVED EQUIVALENT
104. ALL LEADS SHALL BE "DI"
SPECIFIED.
6V. TO METER
AT RADIO
RECEIVER
POSITION
IF REQ.



CIRCUIT NOTES:

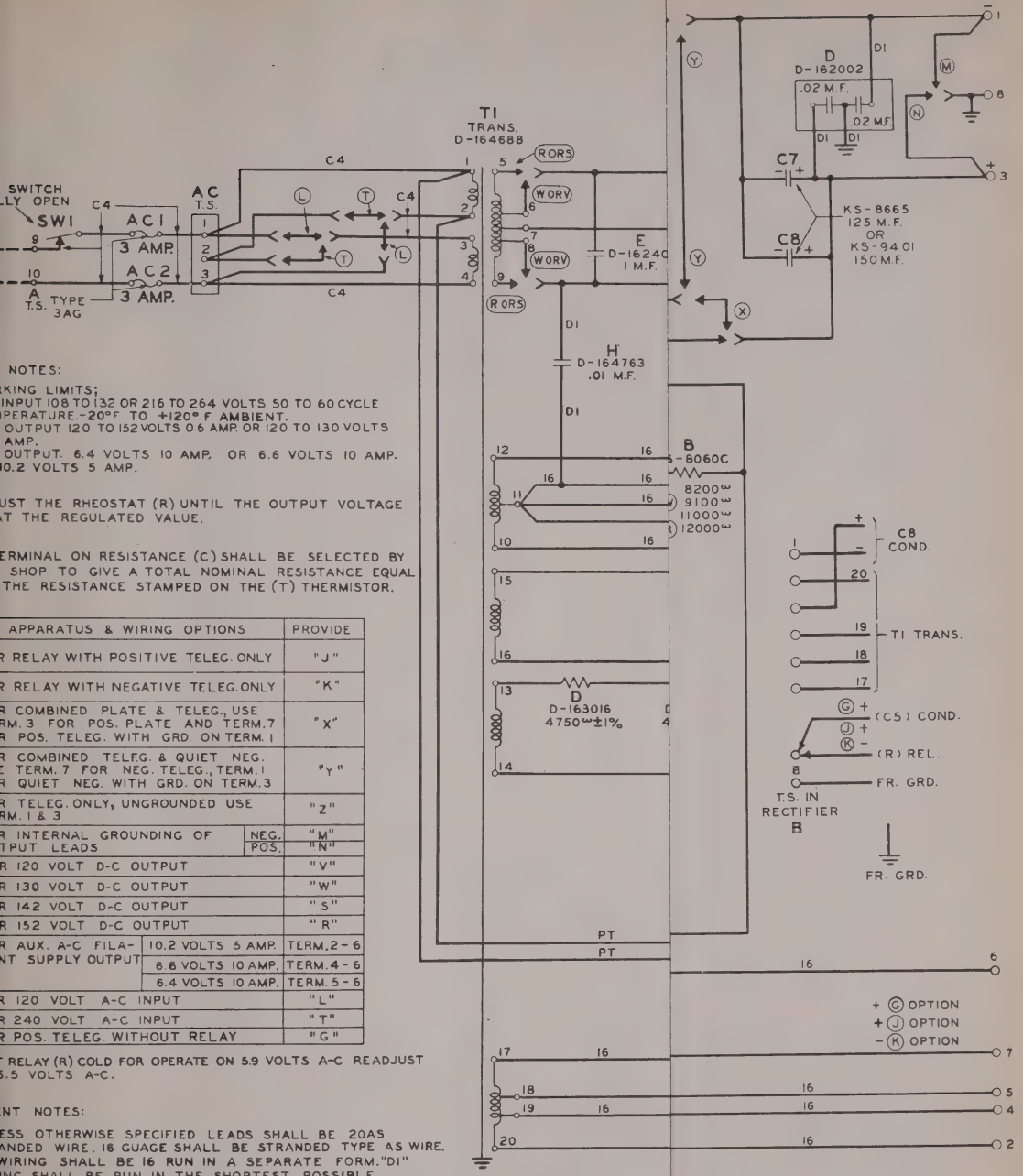
101. THE RESISTANCES (B) TO (F) SHALL BE STRAPPED AS REQUIRED AT TIME OF MANUFACTURE TO PROVIDE THE CORRECT CALIBRATION LEVEL.

102. SELECT AND EQUIP THE OSCILLATOR WITH THE MINIMUM NUMBER OF CONDENSER UNITS REQ. TO TUNE THE OSCILLATOR TO 2550~ THE APPROXIMATE TUNING CAPACITY INCLUDING CONDENSER (C) IS 0.15 M.F.

103. ALL KS-8058, KS-8059 AND KS-8060 RESISTANCES SHALL BE I.R.C. RESISTANCES OR APPROVED EQUIVALENT.

104. ALL LEADS SHALL BE "D1" UNLESS OTHERWISE SPECIFIED.

Figure 37 - Frequency Indicator, Schematic Diagram



NOTES:

KING LIMITS;
INPUT 108 TO 132 OR 216 TO 264 VOLTS 50 TO 60 CYCLE
PERATURE.-20°F TO +120° F AMBIENT.
OUTPUT 120 TO 152 VOLTS 0.6 AMP. OR 120 TO 130 VOLTS
AMP.
OUTPUT. 6.4 VOLTS 10 AMP. OR 6.6 VOLTS 10 AMP.
10.2 VOLTS 5 AMP.

UST THE RHEOSTAT (R) UNTIL THE OUTPUT VOLTAGE
T THE REGULATED VALUE.

ERMINAL ON RESISTANCE (C) SHALL BE SELECTED BY
SHOP TO GIVE A TOTAL NOMINAL RESISTANCE EQUAL
THE RESISTANCE STAMPED ON THE (T) THERMISTOR.

APPARATUS & WIRING OPTIONS		PROVIDE
R RELAY WITH POSITIVE TELEG. ONLY		"J"
R RELAY WITH NEGATIVE TELEG. ONLY		"K"
R COMBINED PLATE & TELEG., USE RM. 3 FOR POS. PLATE AND TERM. 7 R POS. TELEG. WITH GRD. ON TERM. 1		"X"
R COMBINED TELEG. & QUIET NEG. E TERM. 7 FOR NEG. TELEG., TERM. 1 R QUIET NEG. WITH GRD. ON TERM. 3		"Y"
R TELEG. ONLY, UNGROUNDED USE RM. 1 & 3		"Z"
R INTERNAL GROUNDING OF TPUT LEADS	NEG.	"M"
	POS.	"N"
R 120 VOLT D-C OUTPUT		"V"
R 130 VOLT D-C OUTPUT		"W"
R 142 VOLT D-C OUTPUT		"S"
R 152 VOLT D-C OUTPUT		"R"
R AUX. A-C FILA- NT SUPPLY OUTPUT	10.2 VOLTS 5 AMP.	TERM. 2 - 6
	6.6 VOLTS 10 AMP.	TERM. 4 - 6
	6.4 VOLTS 10 AMP.	TERM. 5 - 6
R 120 VOLT A-C INPUT		"L"
R 240 VOLT A-C INPUT		"T"
R POS. TELEG. WITHOUT RELAY		"G"

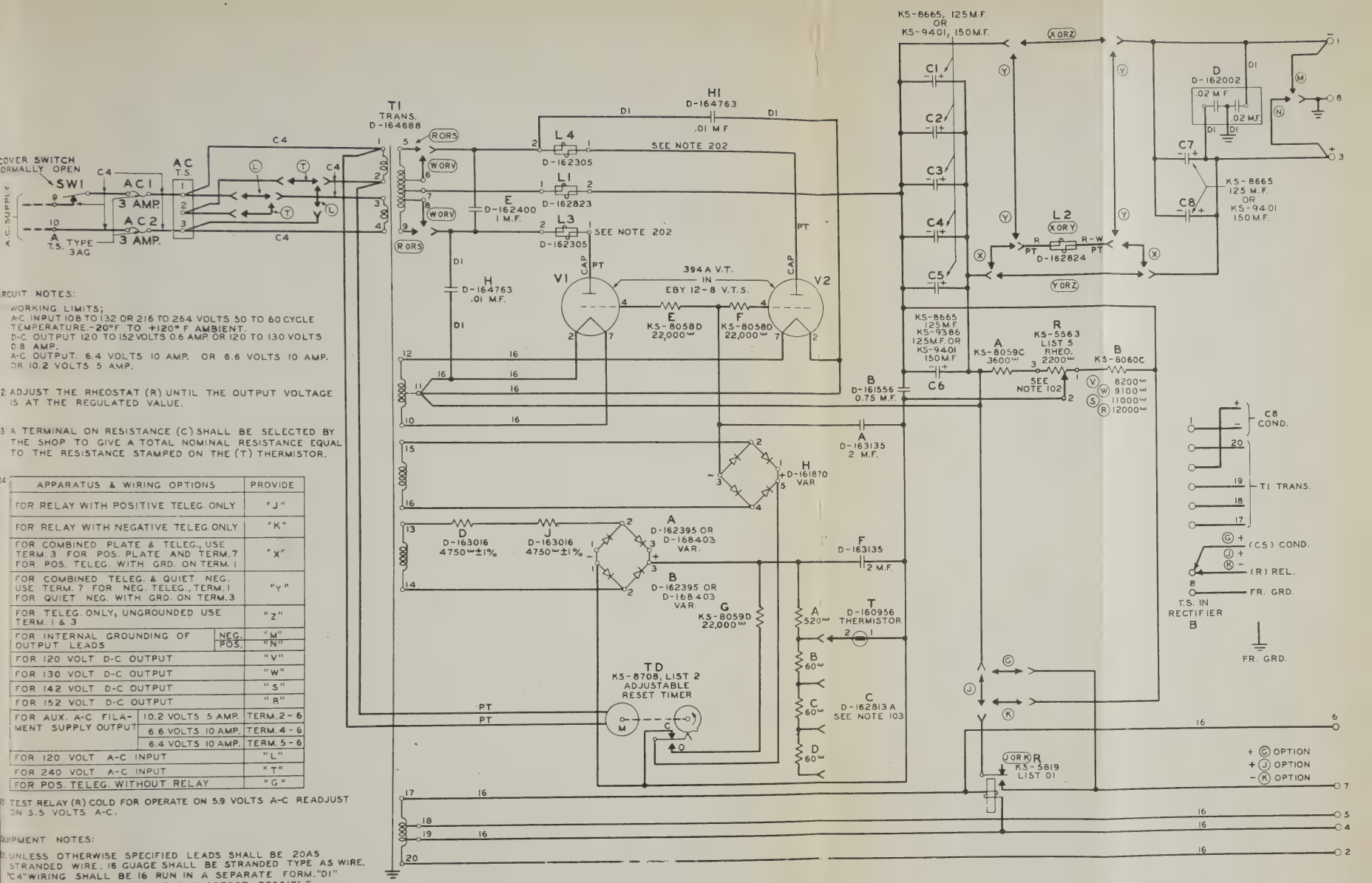
T RELAY (R) COLD FOR OPERATE ON 5.9 VOLTS A-C READJUST
5.5 VOLTS A-C.

NT NOTES:

ESS OTHERWISE SPECIFIED LEADS SHALL BE 20AS
ANDED WIRE. 16 GUAGE SHALL BE STRANDED TYPE AS WIRE.
WIRING SHALL BE 16 RUN IN A SEPARATE FORM. "DI"
ING SHALL BE RUN IN THE SHORTEST POSSIBLE
INER. LEADS MARKED "PT" ARE PART OF THE APPARATUS.

LEAD SHALL BE RUN DIRECTLY WITH ONLY SUFFICIENT
CK TO PERMIT REMOVAL OF TUBE CAP FROM TUBE.

Figure 38



CIRCUIT NOTES:

1. WORKING LIMITS;
A-C INPUT 108 TO 132 OR 216 TO 264 VOLTS 50 TO 60 CYCLE
TEMPERATURE.-20°F TO +120° F AMBIENT.
D-C OUTPUT 120 TO 152 VOLTS 0.6 AMP. OR 120 TO 130 VOLTS 0.8 AMP.
A-C OUTPUT. 6.4 VOLTS 10 AMP. OR 6.6 VOLTS 10 AMP. OR 10.2 VOLTS 5 AMP.

2. ADJUST THE RHEOSTAT (R) UNTIL THE OUTPUT VOLTAGE IS AT THE REGULATED VALUE.

3 A TERMINAL ON RESISTANCE (C) SHALL BE SELECTED BY THE SHOP TO GIVE A TOTAL NOMINAL RESISTANCE EQUAL TO THE RESISTANCE STAMPED ON THE (T) THERMISTOR.

APPARATUS & WIRING OPTIONS		PROVIDE
FOR RELAY WITH POSITIVE TELEG. ONLY		"J"
FOR RELAY WITH NEGATIVE TELEG. ONLY		"K"
FOR COMBINED PLATE & TELEG., USE TERM. 3 FOR POS. PLATE AND TERM. 7 FOR POS. TELEG. WITH GRD. ON TERM. 1		"X"
FOR COMBINED TELEG. & QUIET NEG. USE TERM. 7 FOR NEG. TELEG., TERM. 1 FOR QUIET NEG. WITH GRD. ON TERM. 3		"Y"
FOR TELEG. ONLY, UNGROUNDED USE TERM. 1 & 3		"Z"
FOR INTERNAL GROUNDING OF OUTPUT LEADS	NEG.	"M"
	POS.	"N"
FOR 120 VOLT D-C OUTPUT		"V"
FOR 130 VOLT D-C OUTPUT		"W"
FOR 142 VOLT D-C OUTPUT		"S"
FOR 152 VOLT D-C OUTPUT		"R"
FOR AUX. A-C FILAMENT SUPPLY OUTPUT	10.2 VOLTS 5 AMP.	TERM. 2 - 6
	6.6 VOLTS 10 AMP.	TERM. 4 - 6
	6.4 VOLTS 10 AMP.	TERM. 5 - 6
FOR 120 VOLT A-C INPUT		"L"
FOR 240 VOLT A-C INPUT		"T"
FOR POS. TELEG. WITHOUT RELAY		"G"

5. TEST RELAY (R) COLD FOR OPERATE ON 5.9 VOLTS A-C READJUST ON 5.5 VOLTS A-C.

EQUIPMENT NOTES:

1. UNLESS OTHERWISE SPECIFIED LEADS SHALL BE 20AS STRANDED WIRE, 18 GUAGE SHALL BE STRANDED TYPE AS WIRE. "C4" WIRING SHALL BE 16 RUN IN A SEPARATE FORM. "D1" WIRING SHALL BE RUN IN THE SHORTEST POSSIBLE MANNER. LEADS MARKED "PT" ARE PART OF THE APPARATUS.

2. THIS LEAD SHALL BE RUN DIRECTLY WITH ONLY SUFFICIENT SLACK TO PERMIT REMOVAL OF TUBE CAP FROM TUBE.

Figure 38 - Regulated Tube Rectifier X-61680B, Schematic Diagram

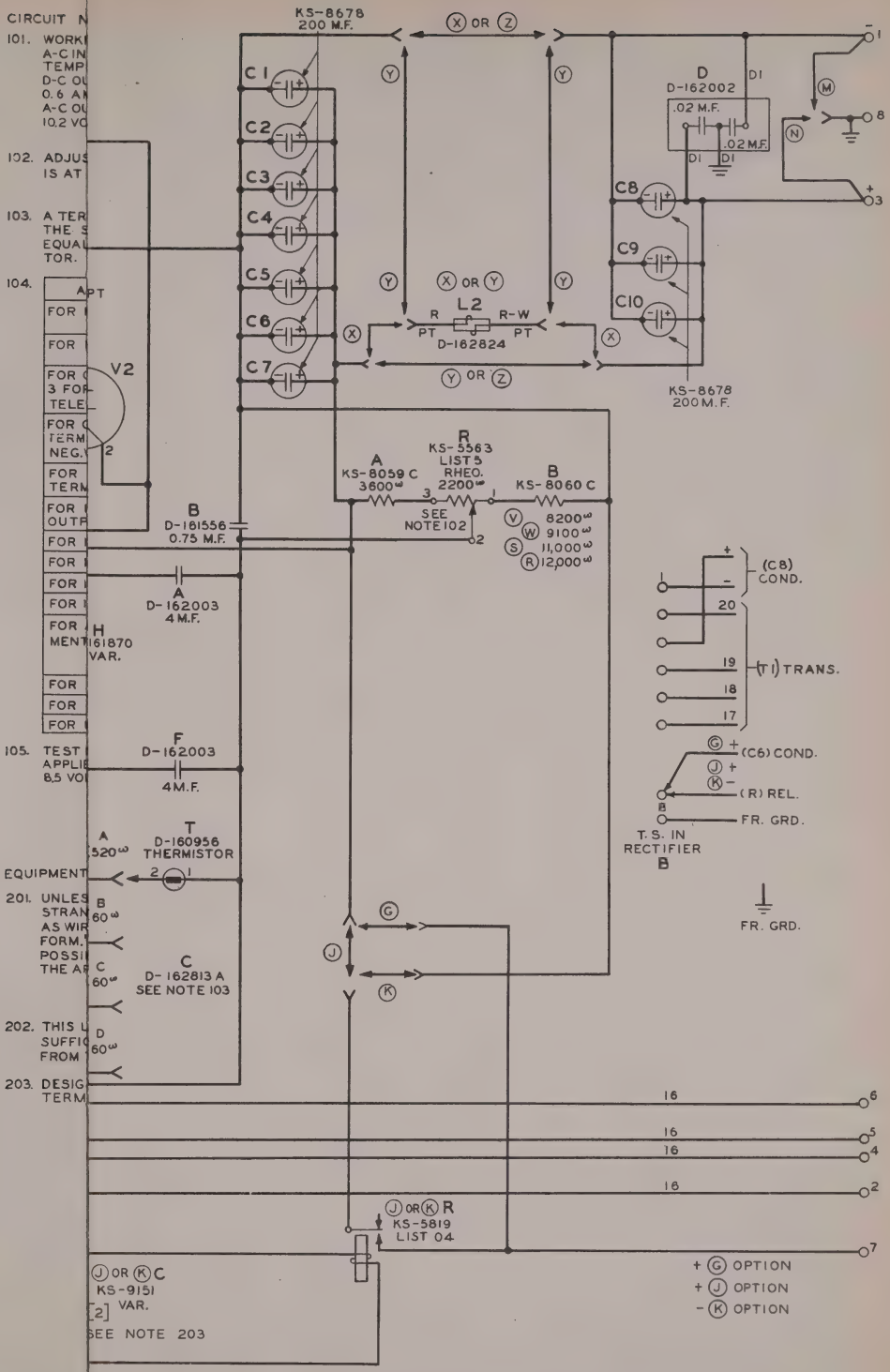


Fig. 39
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CIRCUIT NOTES:

101. WORKING LIMITS;
A-C INPUT. 108 TO 125 OR 216 TO 250 VOLTS 25 TO 60 CYCLE TEMPERATURE. -20°F TO+120°F AMBIENT.
D-C OUTPUT. 120 TO 152 VOLTS 0.5 AMP. OR 120 TO 130 VOLTS 0.6 AMP.
A-C OUTPUT. 6.4 VOLTS 10 AMP. OR 6.6 VOLTS 10 AMP. OR 10.2 VOLTS 5 AMP.

102. ADJUST THE RHEOSTAT (R) UNTIL THE OUTPUT VOLTAGE IS AT THE REGULATED VALUE.

103. A TERMINAL ON RESISTANCE (C) SHALL BE SELECTED BY THE SHOP TO GIVE A TOTAL NOMINAL RESISTANCE EQUAL TO THE RESISTANCE STAMPED ON THE (T) THERMISTOR.

104.

APPARATUS & WIRING OPTIONS		PROVIDE
FOR REL. WITH POSITIVE TELEG. ONLY		"J"
FOR REL. WITH NEGATIVE TELEG. ONLY		"K"
FOR COMBINED PLATE & TELEG., USE TERM. 3 FOR POS. PLATE AND TERM. 7 FOR POS. TELEG. WITH GRD. ON TERM. 1		"X"
FOR COMBINED TELEG. & QUIET NEG. USE TERM. 7 FOR NEG. TELEG., TERM. 1 FOR QUIET NEG. WITH GRD. ON TERM. 3		"Y"
FOR TELEG. ONLY, UNGROUNDED USE TERM. 1 & 3		"Z"
FOR INTERNAL GROUNDING OF OUTPUT LEADS	NEG.	"M"
	POS.	"N"
FOR 120 VOLT D-C OUTPUT		"V"
FOR 130 VOLT D-C OUTPUT		"W"
FOR 142 VOLT D-C OUTPUT		"S"
FOR 152 VOLT D-C OUTPUT		"R"
FOR AUX. A-C FILAMENT SUPPLY OUTPUT	10.2 VOLTS 5 AMP.	TERM. 2-6
	6.6 VOLTS 10 AMP.	TERM. 4-6
	6.4 VOLTS 10 AMP.	TERM. 5-6
FOR 120 VOLT A-C INPUT		"L"
FOR 240 VOLT A-C INPUT		"T"
FOR POS. TELEG. WITHOUT REL.		"G"

105. TEST RELAY (R) COLD FOR OPERATE WITH 9 VOLTS A-C APPLIED TO TERMS. 2 & 4 OF VARISTOR (C) READJUST ON 8.5 VOLTS A-C

EQUIPMENT NOTES:

201. UNLESS OTHERWISE SPECIFIED LEADS SHALL BE 20 AS STRANDED WIRE, 16 GAUGE SHALL BE STRANDED TYPE AS WIRE. "C4" WIRING SHALL BE 16 RUN IN A SEPARATE FORM. "D1" WIRING SHALL BE RUN IN THE SHORTEST POSSIBLE MANNER. LEADS MARKED "PT" ARE PART OF THE APPARATUS.

202. THIS LEAD SHALL BE RUN DIRECTLY WITH ONLY SUFFICIENT SLACK TO PERMIT REMOVAL OF TUBE CAP FROM TUBE.

203. DESIGNATIONS IN [ ] ARE NOT STAMPED. TERM. 1 NEAREST PANEL.

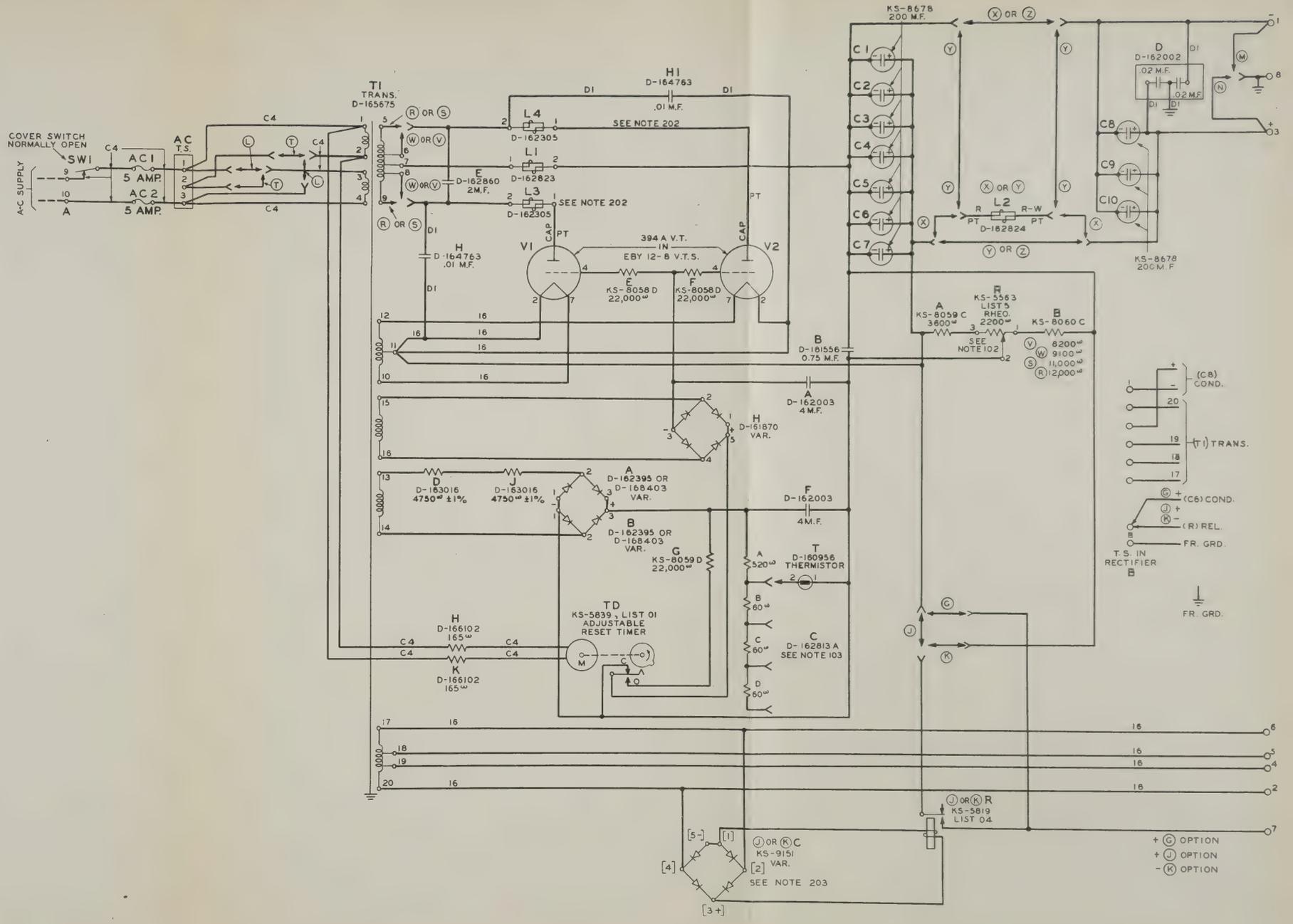


Figure 39 - Regulated Tube Rectifier X-61680C, Schematic Diagram

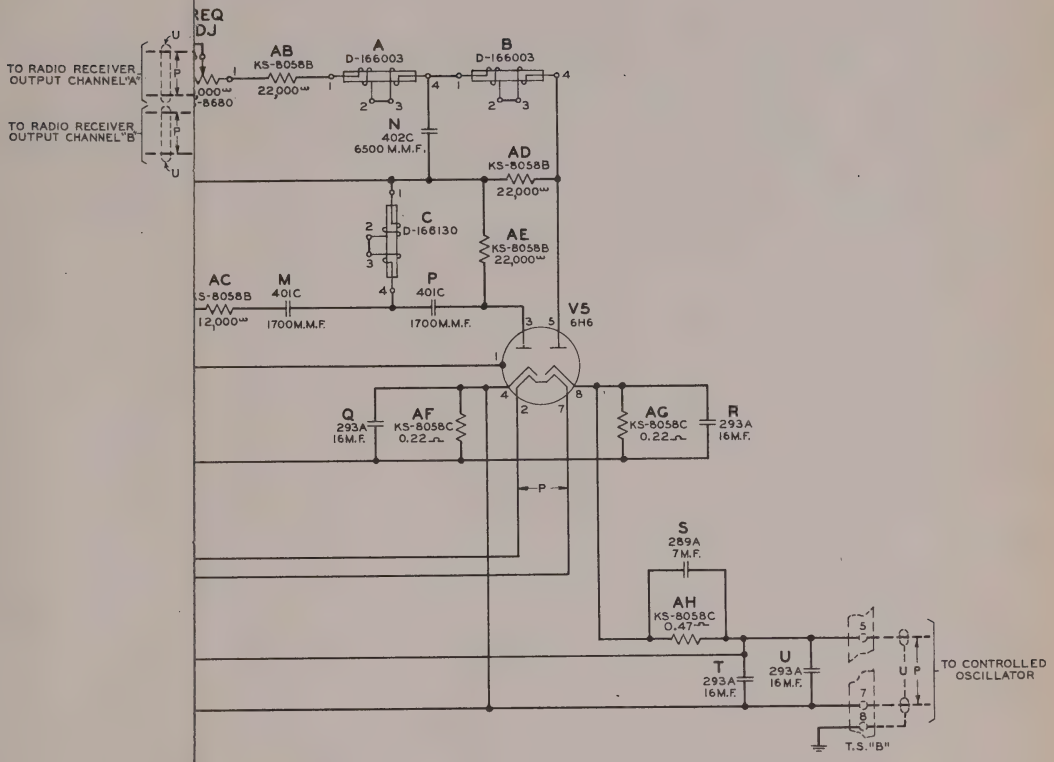


Fig. 40
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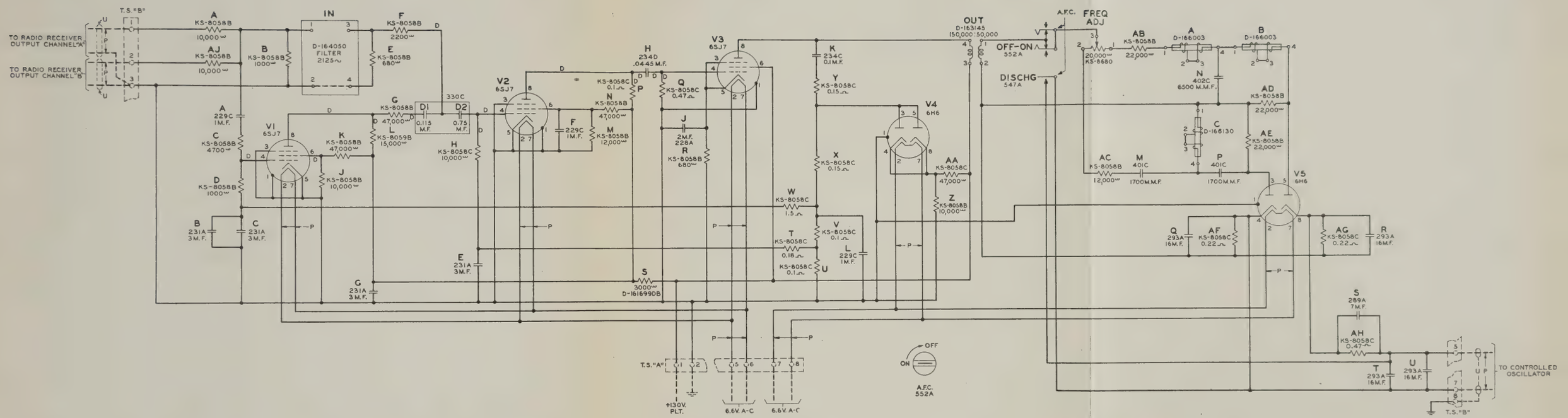
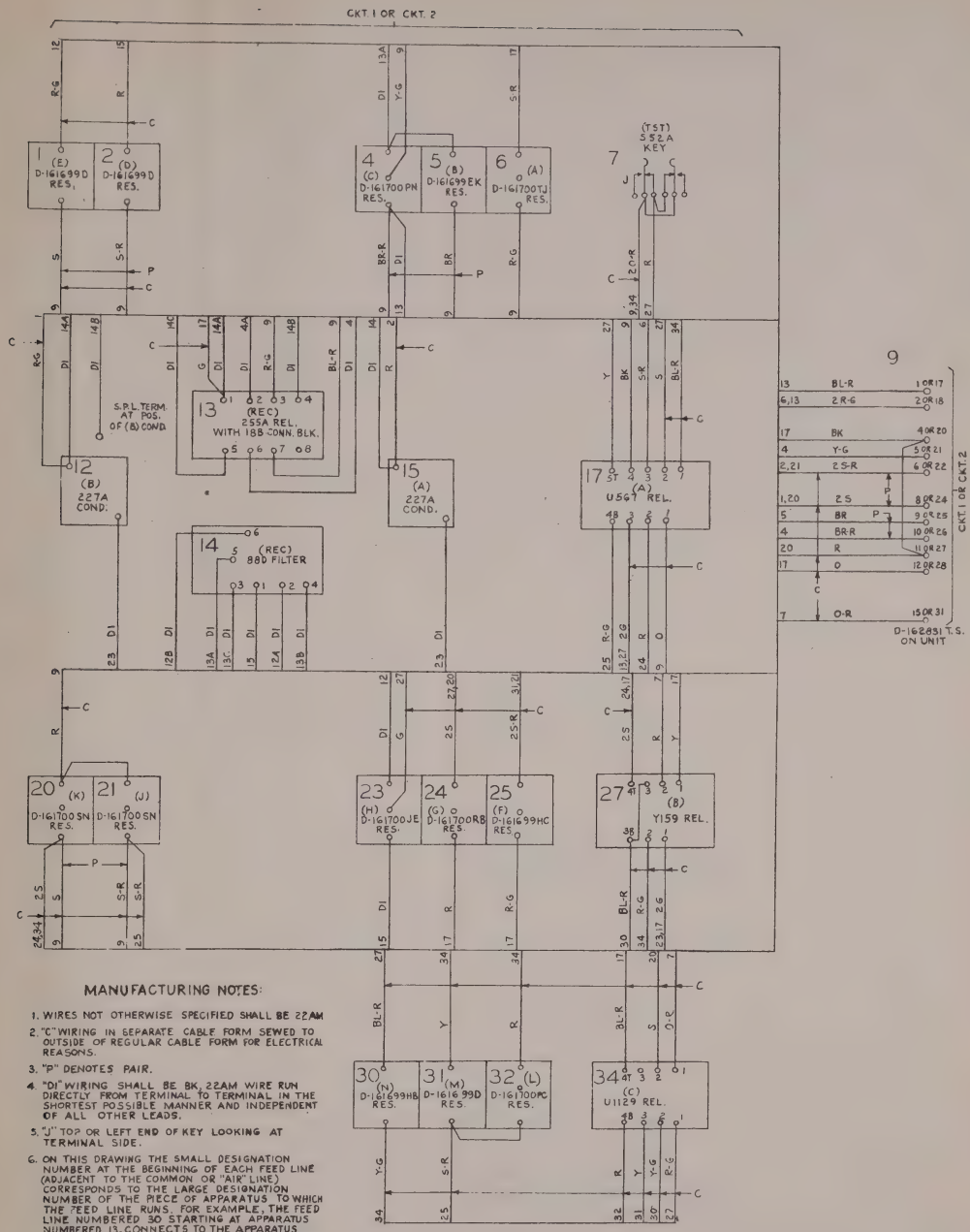


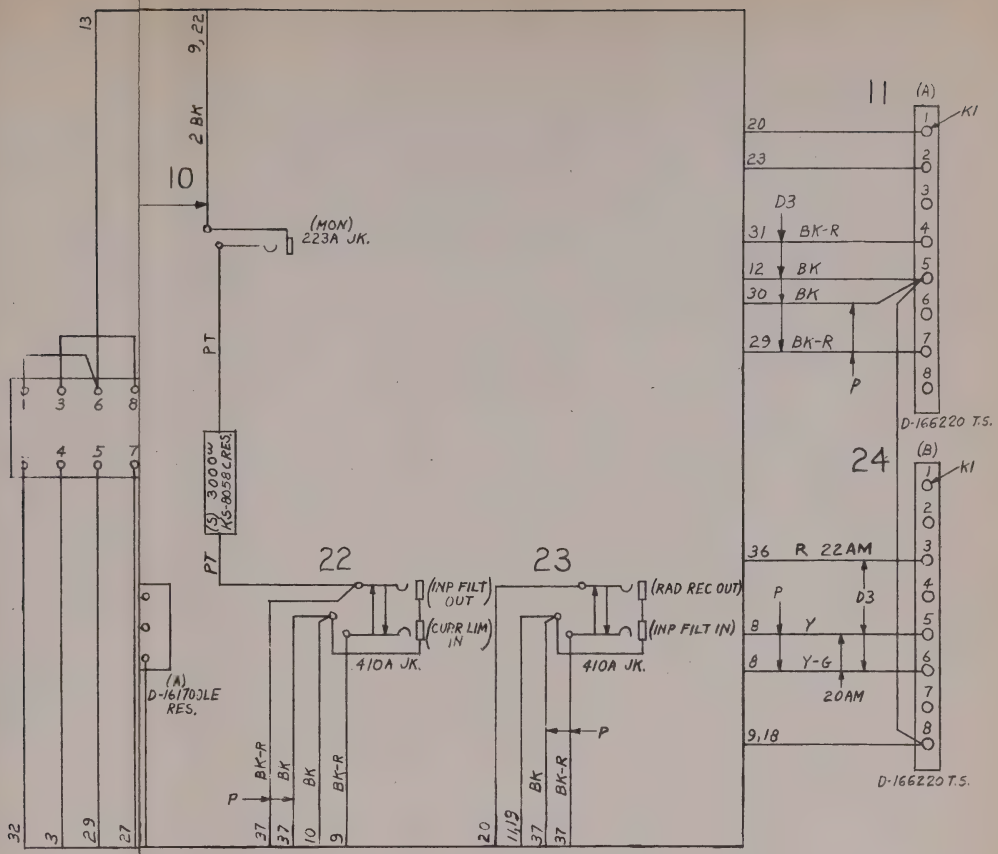
Figure 40 - Automatic Frequency Control, Schematic Diagram



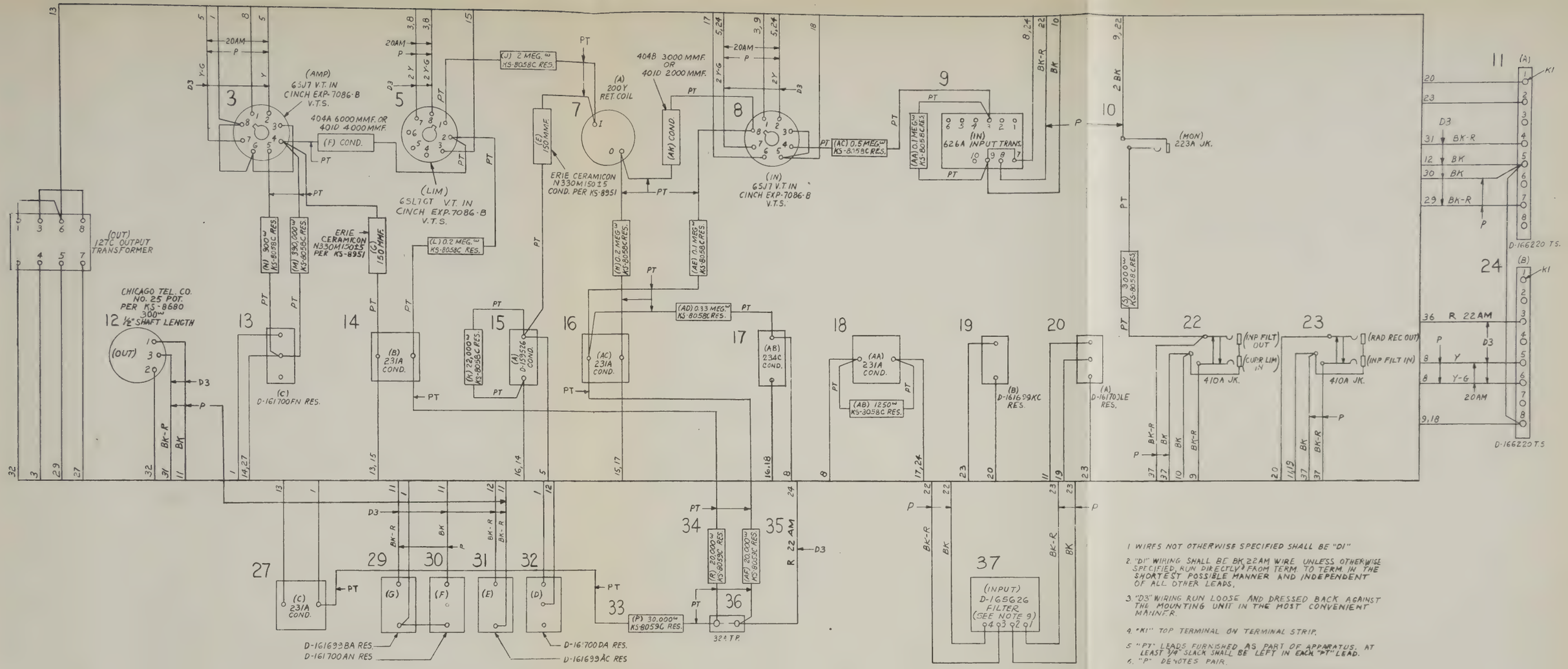
MANUFACTURING NOTES:

1. WIRES NOT OTHERWISE SPECIFIED SHALL BE 22AM
2. "C" WIRING IN SEPARATE CABLE FORM SEWED TO OUTSIDE OF REGULAR CABLE FORM FOR ELECTRICAL REASONS.
3. "P" DENOTES PAIR.
4. "DI" WIRING SHALL BE BK, 22AM WIRE RUN DIRECTLY FROM TERMINAL TO TERMINAL IN THE SHORTEST POSSIBLE MANNER AND INDEPENDENT OF ALL OTHER LEADS.
5. "J" TOP OR LEFT END OF KEY LOOKING AT TERMINAL SIDE.
6. ON THIS DRAWING THE SMALL DESIGNATION NUMBER AT THE BEGINNING OF EACH FEED LINE (ADJACENT TO THE COMMON OR "AIR" LINE) CORRESPONDS TO THE LARGE DESIGNATION NUMBER OF THE PIECE OF APPARATUS TO WHICH THE FEED LINE RUNS. FOR EXAMPLE, THE FEED LINE NUMBERED 30 STARTING AT APPARATUS NUMBERED 13, CONNECTS TO THE APPARATUS NUMBERED 30, AT WHICH POINT THIS FEED LINE IS NUMBERED 13. THE COLORING SERVES AS FURTHER IDENTIFICATION.

Figure 41 - Receive Relay, Wiring Diagram

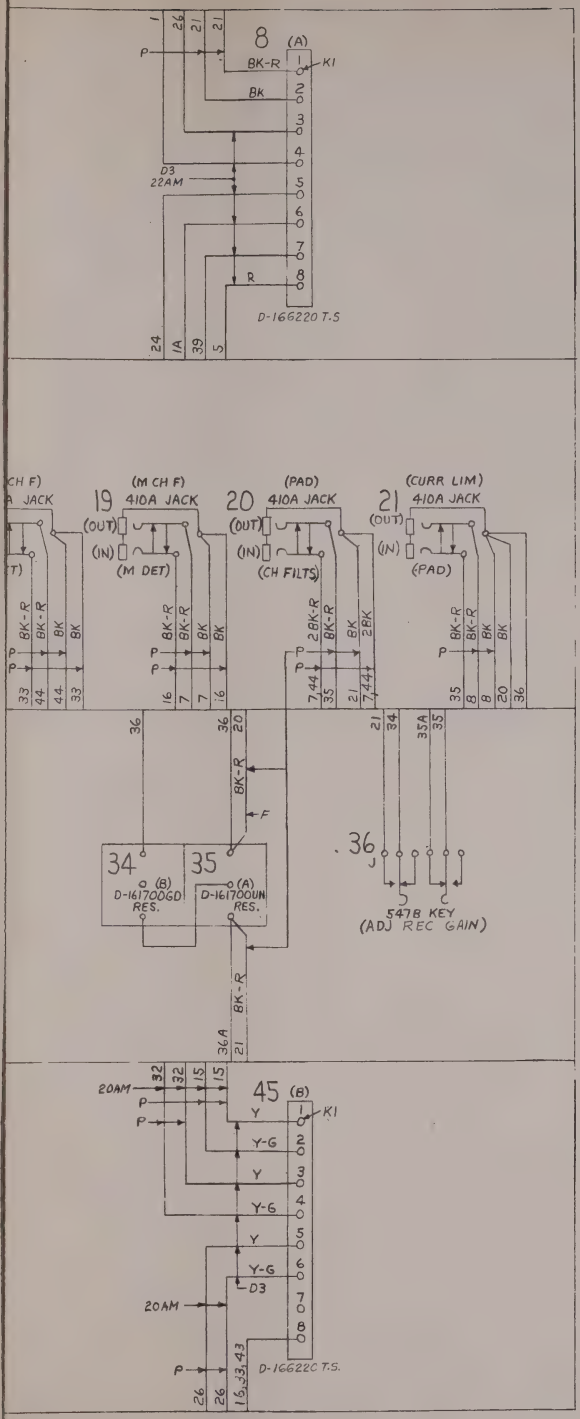


1. WIRES NOT OTHERWISE SPECIFIED SHALL BE "D1"
2. "D1" WIRING SHALL BE BK 22AM WIRE UNLESS OTHERWISE SPECIFIED, RUN DIRECTLY FROM TERM. TO TERM. IN THE SHORTEST POSSIBLE MANNER AND INDEPENDENT OF ALL OTHER LEADS,
3. "D3" WIRING RUN LOOSE AND DRESSED BACK AGAINST THE MOUNTING UNIT IN THE MOST CONVENIENT MANNER.
4. "K1" TOP TERMINAL ON TERMINAL STRIP.
5. "PT" LEADS FURNISHED AS PART OF APPARATUS, AT LEAST 3/4" SLACK SHALL BE LEFT IN EACH "PT" LEAD.
6. "P" DENOTES PAIR.
7. ALL STRAPS SHALL BE BK 22AM WIRE EXCEPT WHERE BARE STRAPS ARE PERMISSIBLE.
8. ON THIS DRAWING THE SMALL DESIGNATION NUMBER AT THE BEGINNING OF EACH FEED LINE (ADJACENT TO THE COMMON OR "AIR LINE") CORRESPONDS TO THE LARGE DESIGNATION NUMBER OF THE PIECE OF APPARATUS TO WHICH THE FEED LINE RUNS. FOR EXAMPLE, THE FEED LINE NUMBERED 36 STARTING AT APPARATUS NUMBERED 24 CONNECTS TO THE APPARATUS NUMBERED 36, AT WHICH POINT THIS FEED LINE IS NUMBERED 24. THE COLORING SERVES AS FURTHER IDENTIFICATION
9. D-164049 FILTER MAY BE USED UNTIL D-165626 FILTER BECOMES AVAILABLE.



1. WIRES NOT OTHERWISE SPECIFIED SHALL BE "DI"
2. "DI" WIRING SHALL BE BK 22AM WIRE UNLESS OTHERWISE SPECIFIED, RUN DIRECTLY FROM TERM TO TERM IN THE SHORTEST POSSIBLE MANNER AND INDEPENDENT OF ALL OTHER LEADS.
3. "D3" WIRING RUN LOOSE AND DRESSED BACK AGAINST THE MOUNTING UNIT IN THE MOST CONVENIENT MANNER.
4. "K1" TOP TERMINAL ON TERMINAL STRIP.
5. "PT" LEADS FURNISHED AS PART OF APPARATUS. AT LEAST 3/4" SLACK SHALL BE LEFT IN EACH "PT" LEAD.
6. "P" DENOTES PAIR.
7. ALL STRAPS SHALL BE BK 22AM WIRE EXCEPT WHERE BARE STRAPS ARE PERMISSIBLE.
8. ON THIS DRAWING THE SMALL DESIGNATION NUMBER AT THE BEGINNING OF EACH FEED LINE (ADJACENT TO THE COMMON OR "AIR LINE") CORRESPONDS TO THE LARGE DESIGNATION NUMBER OF THE PIECE OF APPARATUS TO WHICH THE FEED LINE RUNS. FOR EXAMPLE; THE FEED LINE NUMBERED 36 STARTING AT APPARATUS NUMBERED 24 CONNECTS TO THE APPARATUS NUMBERED 36; AT WHICH POINT THIS FEED LINE IS NUMBERED 24. THE COLORING SERVES AS FURTHER IDENTIFICATION
9. D-164049 FILTER MAY BE USED UNTIL D-165626 FILTER BECOMES AVAILABLE

Figure 42 - Current Limiter, Wiring Diagram



1. WIRES NOT OTHERWISE SPECIFIED SHALL BE D1
2. "D1" WIRING SHALL BE BK 22AM WIRE UNLESS OTHERWISE SPECIFIED, RUN DIRECTLY FROM TERM. TO TERM. IN THE SHORTEST POSSIBLE MANNER AND INDEPENDENT OF ALL OTHER LEADS.
3. "P" DENOTES PAIR.
4. "PT" DENOTES LEADS FURNISHED AS PART OF APPARATUS, AT LEAST 3/4" SLACK SHALL BE LEFT IN EACH "PT" LEAD.
5. "K1" DENOTES TOP OR LEFT TERMINAL ON STRIP.
6. "1" TOP OR LEFT END OF KEY LOOKING AT TERM. SIDE.
7. "D3" WIRING SHALL BE 20AM UNLESS OTHERWISE SPECIFIED, AND GREEN UNLESS OTHERWISE SPECIFIED, AND RUN LOOSE AND DRESSED BACK AGAINST THE MTG. UNIT IN THE MOST CONVENIENT MANNER.
8. (□□□□□) DENOTES SHIELD.
9. ALL STRAPS SHALL BE BK 22AM WIRE EXCEPT WHERE BARE STRAPS ARE PERMISSIBLE
10. ON THIS DRAWING THE SMALL DESIGNATION NUMBER AT THE BEGINNING OF EACH FEED LINE (ADJACENT TO THE COMMON OR "AIR" LINE) CORRESPONDS TO THE LARGE DESIGNATION NUMBER OF THE PIECE OF APPARATUS TO WHICH THE FEED LINE RUNS. FOR EXAMPLE, THE FEED LINE NUMBERED 15 STARTING AT APPARATUS NUMBERED 1, CONNECTS TO THE APPARATUS NUMBERED 15, AT WHICH POINT THIS FEED LINE IS NUMBERED 1. THE COLORING SERVES AS FURTHUR IDENTIFICATION.
11. D-164050 & D-164051 FILTERS MAY BE USED UNTIL D-165627 & D-165628 FILTERS RESP. ARE AVAILABLE.
12. "GT" DENOTES GROUND TRACER UNDER AND PART OF SHIELD.
13. "U" DENOTES 22P SHIELDED WIRE.

Fig. 43
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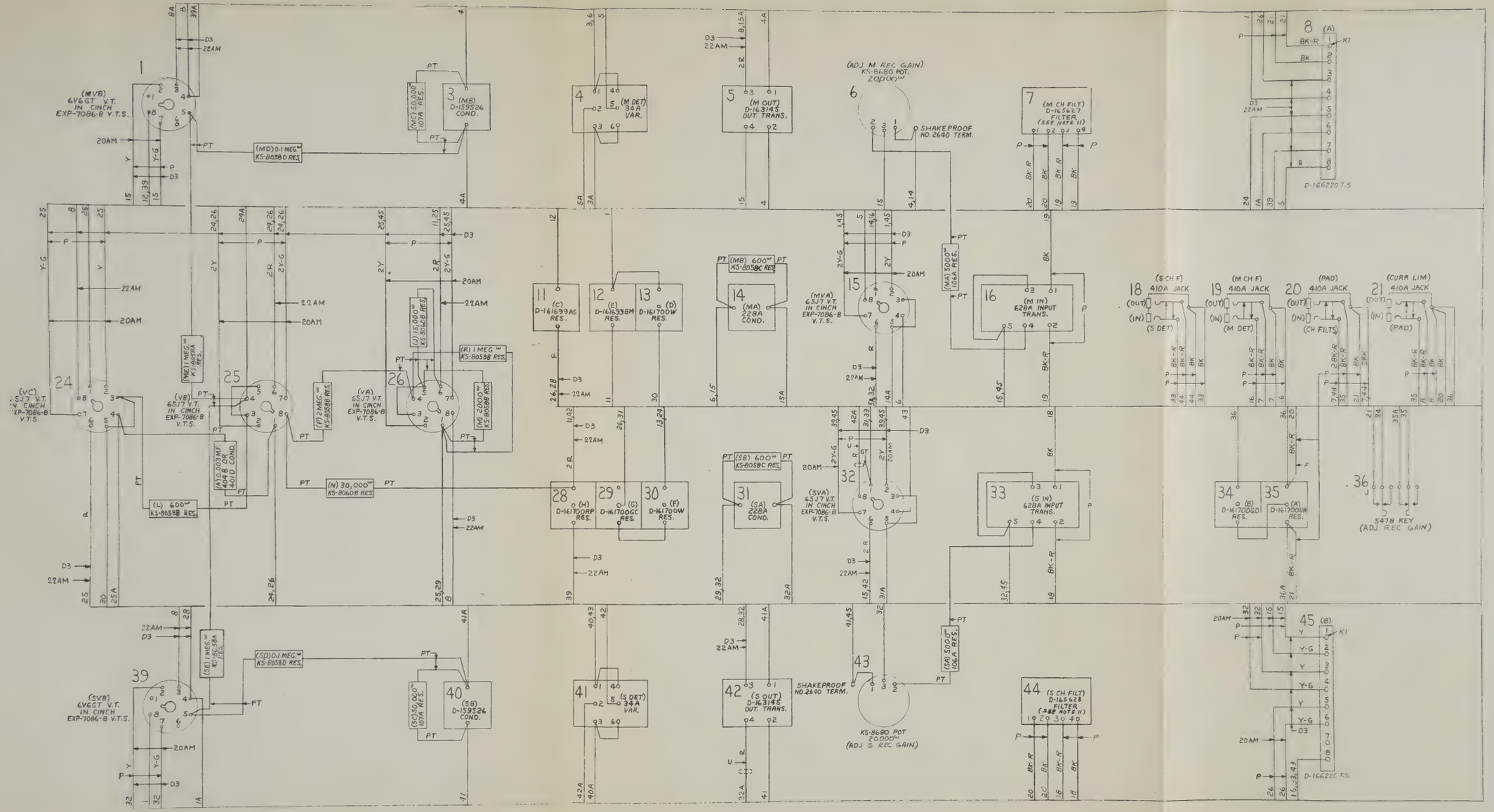


Figure 43 - Detector, Wiring Diagram

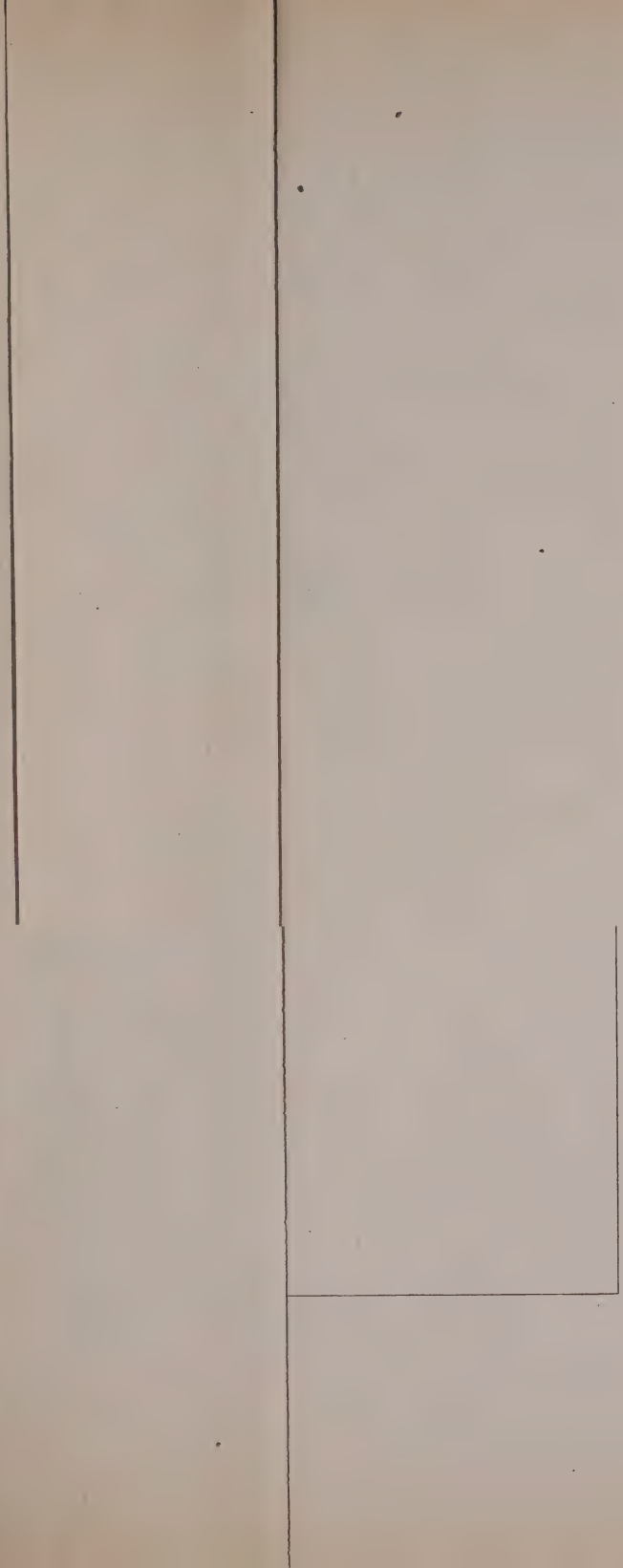
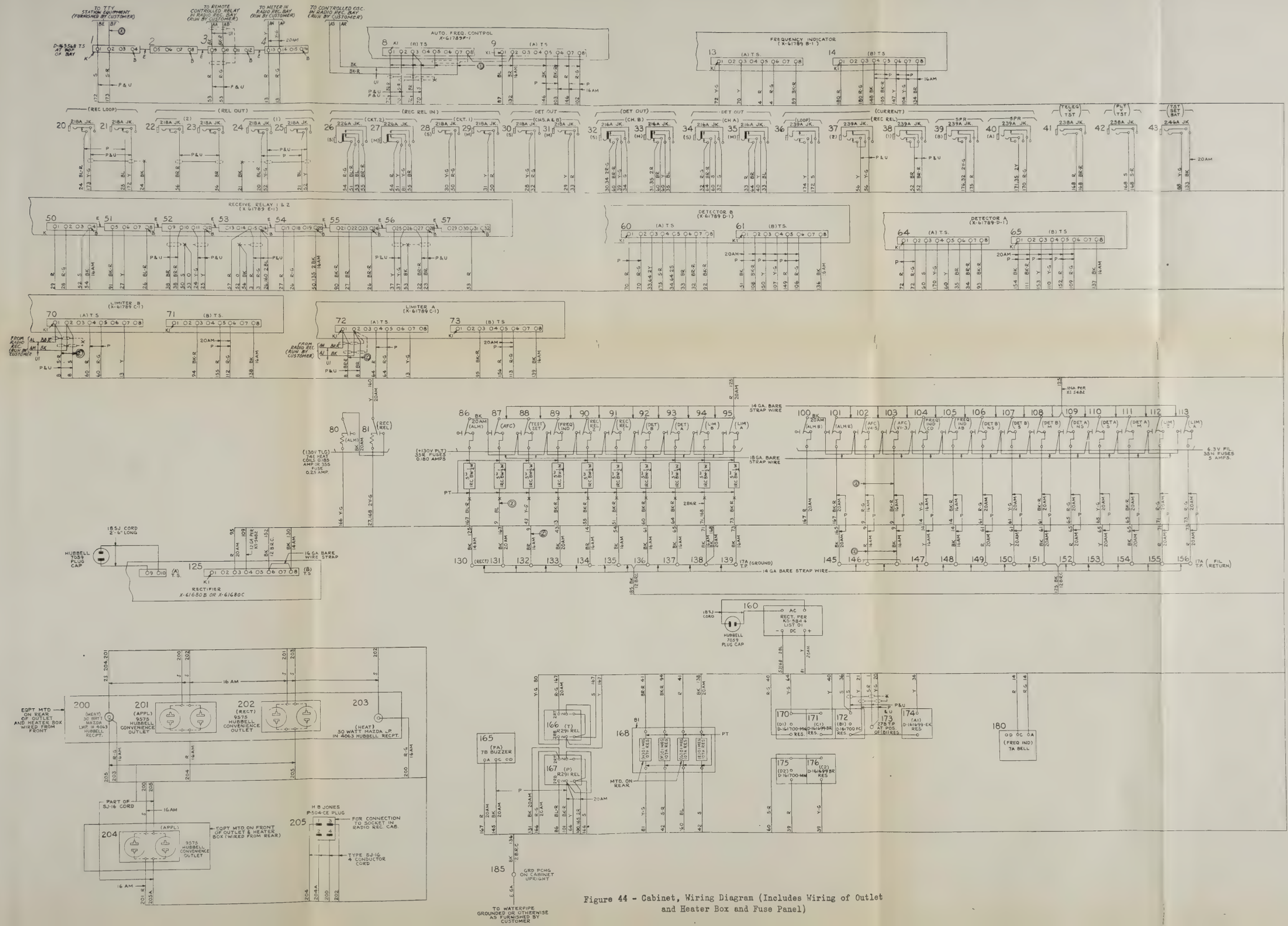
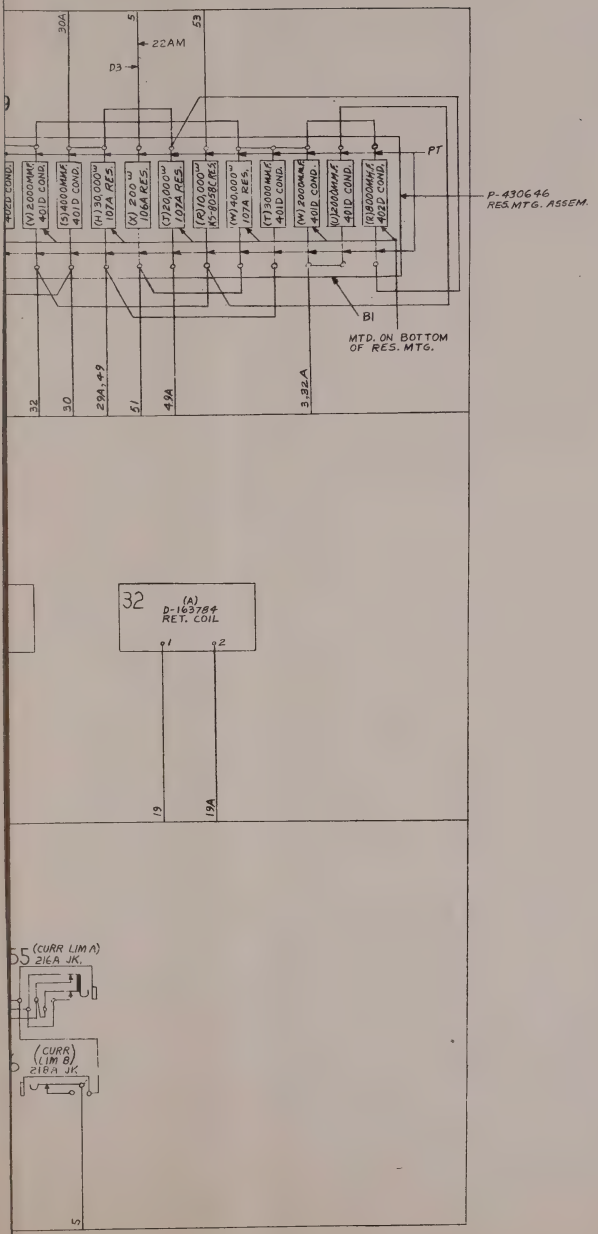


Fig. 44
Page 145



1. WIRES NOT OTHERWISE SPECIFIED SHALL BE 22 AM.
2. -X- DENOTES SPLICE
3. ⊏⊐ -- DENOTES SHIELD CONNECTION
4. "U" DENOTES 22P SHIELDED WIRE
5. "P" DENOTES PAIR.
6. "N" TERMINAL PUNCHING NEAREST BASE OF TERMINAL STRIP.
7. "PT" DENOTES LEADS FURNISHED AS PART OF APPARATUS
8. "E" DENOTES ADJACENT ROWS OF PUNCHINGS
9. "K" TOP OR LEFT ROW OF PUNCHINGS.
10. "K1" TOP OR LEFT TERMINAL ON STRIP.
11. "B1" DENOTES EDGE OF RESISTANCE MOUNTING NEAREST PANEL.
12. ⅄ DENOTES CONNECTION OF FEEDER LEAD TO FUSE PANEL STRAP WIRE
13. STRAPS BETWEEN NON-ADJACENT TERMINALS SHALL BE BK 22AM UNLESS OTHERWISE SPECIFIED.
14. UNLESS OTHERWISE INDICATED, ALL LEADS ON THIS DRAWING ARE TO BE RUN BY THE SHOP.
15. ON THIS DRAWING THE SMALL DESIGNATION NUMBER AT THE BEGINNING OF EACH FEED LINE (ADJACENT TO THE COMMON OR "AIR" LINE) CORRESPONDS TO THE LARGE DESIGNATION NUMBER OF THE PIECE OF APPARATUS TO WHICH THE FEED LINE RUNS. FOR EXAMPLE, THE LEAD NUMBERED 175 STARTING AT APPARATUS NUMBERED 60 CONNECTS TO THE APPARATUS NUMBERED 175 AT WHICH POINT THIS FEED LINE IS NUMBERED 60. THE COLORING SERVES AS FURTHER IDENTIFICATION
16. ② INDICATES WIRING ADDED FOR AUTOMATIC FREQUENCY CONTROL FEATURE
17. FURNISH ② WIRING WHEN TWO WIRE RECEIVING LOOP IS USED
18. "U" DENOTES 16 P WIRE SHIELDED PER M-13063

Figure 44 - Cabinet, Wiring Diagram (Includes Wiring of Outlet and Heater Box and Fuse Panel)



1. WIRES NOT OTHERWISE SPECIFIED SHALL BE D1.
2. "D1" WIRING SHALL BE BK 22AM WIRE RUN DIRECTLY FROM TERMINAL TO TERMINAL IN THE SHORTEST POSSIBLE MANNER.
3. "D3" WIRING NOT TO BE SEWED IN CABLE FORMS BUT RUN LOOSE AND DRESSED BACK AGAINST THE MOUNTING PLATE IN THE MOST CONVENIENT MANNER.
4. "PT" DENOTES LEADS FURNISHED AS PART OF APPARATUS. AT LEAST 3/4" SLACK SHALL BE LEFT IN ALL "PT" LEADS EXCEPT ITEMS 18 & 19.
5. "J" TOP OR LEFT SIDE OF KEY LOOKING AT TERMINAL SIDE.
6. ALL STRAPS SHALL BE BK 22AM WIRE EXCEPT WHERE BARE STRAPS ARE PERMISSIBLE.
7. "B1" EDGE OF RESISTANCE MOUNTING NEAREST PANEL.
8. "P" DENOTES PAIR.
9. THE OSCILLATOR SHALL BE EQUIPPED WITH THE MINIMUM NUMBER OF CONDENSERS REQUIRED TO TUNE TO 2550~ THE APPROX. TUNING CAPACITY IS 0.15 MF.
10. ON THIS DRAWING THE SMALL DESIGNATION NUMBER AT THE BEGINNING OF EACH FEED LINE (ADJACENT TO THE COMMON OR "AIR" LINE) CORRESPONDS TO THE LARGE DESIGNATION NUMBER OF THE PIECE OF APPARATUS TO WHICH THE FEED LINE RUNS. FOR EXAMPLE THE FEED LINE NUMBERED "30A" STARTING AT APPARATUS NUMBERED "9", CONNECTS TO THE APPARATUS NUMBERED "30" AT WHICH POINT THIS FEED LINE IS NUMBERED "9A". THE COLORING SERVES AS FURTHER IDENTIFICATION.
11. RESISTANCES (B) TO (F) SHALL BE STRAPPED AS REQUIRED TO PROVIDE THE CORRECT CALIBRATION LEVEL.

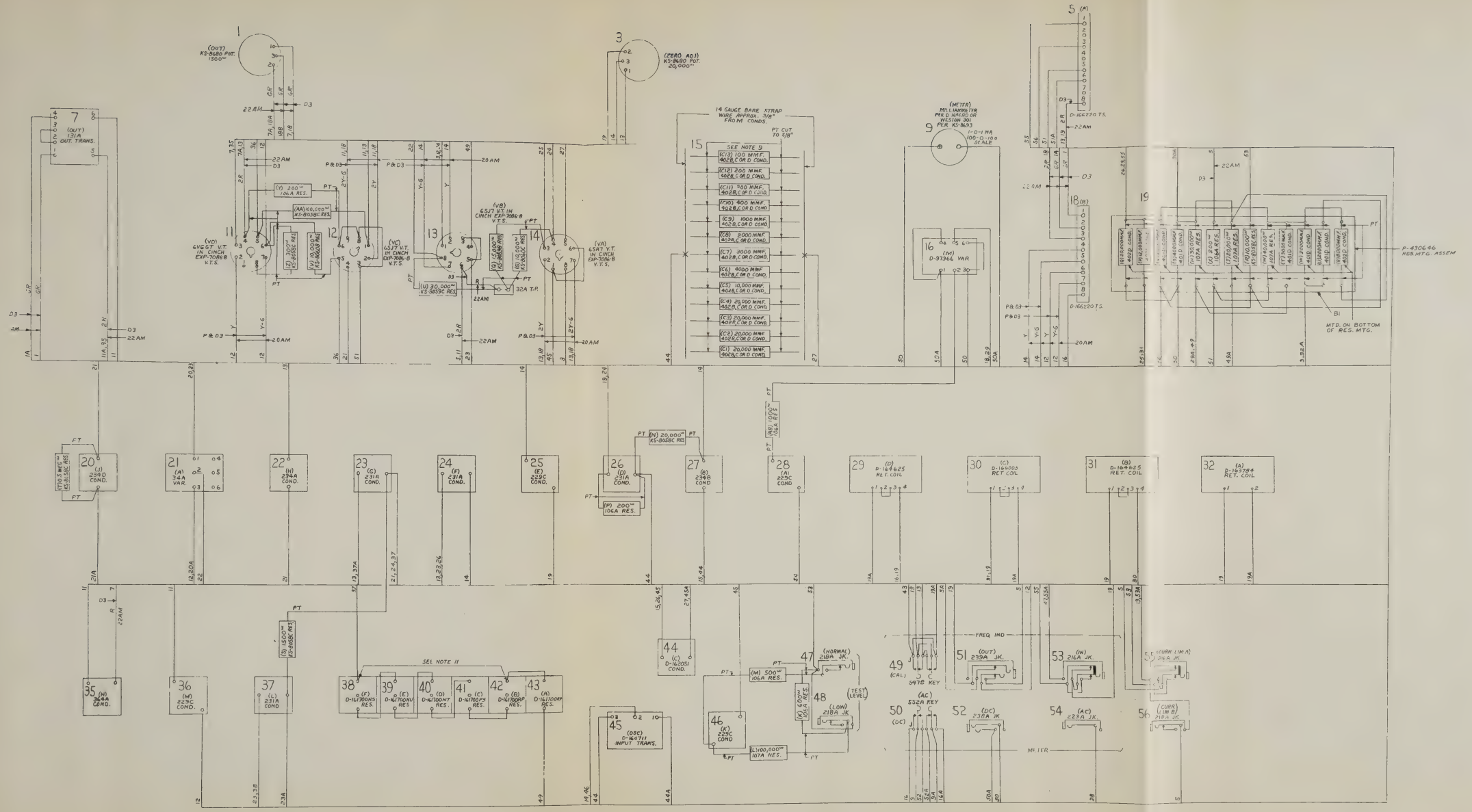
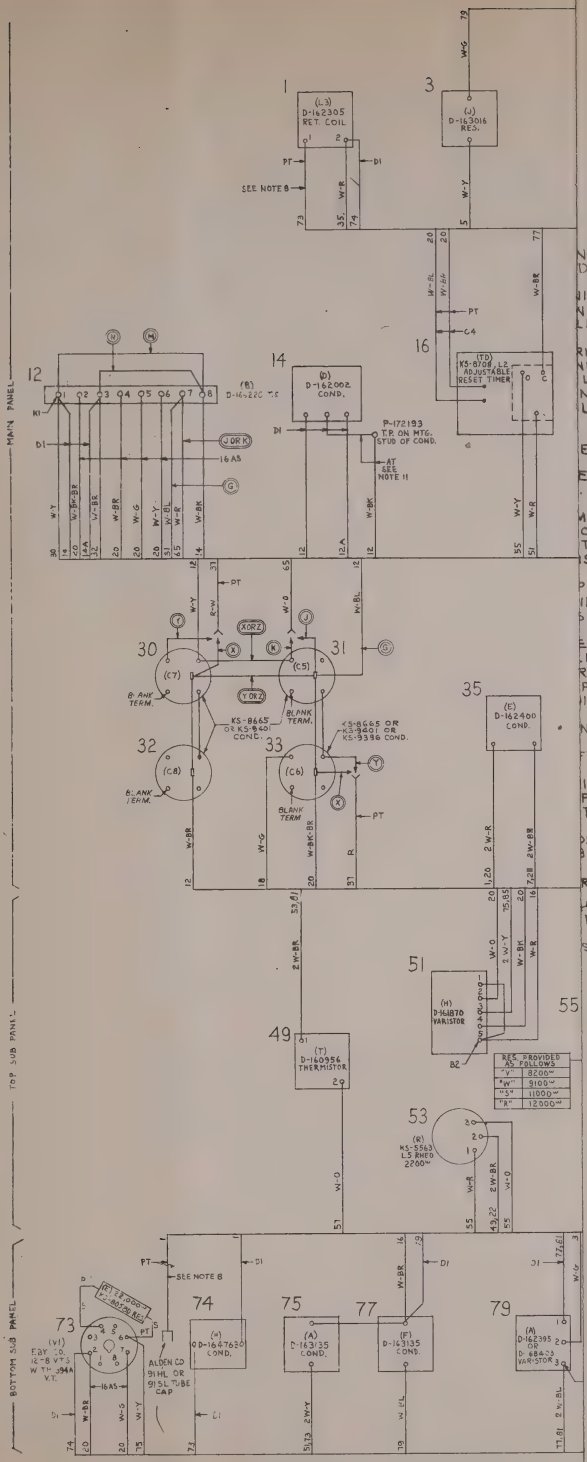


Figure 45 - Frequency Indicator, Wiring Diagram



NOT OTHERWISE SPECIFIED SHALL BE DED 20AS,

IRING SHALL BE STRANDED 16AS UNLESS NISE SPECIFIED AND SHALL BE KEPT SEPARATE LL OTHER LEADS.

RING SHALL BE W STRANDED 20AS NLESS OTHERWISE SPECIFIED, NOT INCLUDED LOCAL CABLE BUT RUN DIRECTLY FROM NAL TO TERMINAL IN THE SHORTEST LE MANNER AND INDEPENDENT OF ALL LEADS.

ERMINAL NEAREST PANEL.

EDGE OF RESISTANCE MOUNTING NEAREST

MINAL ON (CC) RES. SHALL BE SELECTED BY OP TO GIVE A TOTAL NOMINAL RESISTANCE TO THE RESISTANCE STAMPED ON THE ISTOR.

PING SHALL BE MADE WITH W ~~BK~~ STRANDED IRE EXCEPT WHERE BARE STRAPS ARE SSIBLE.

EAD SHALL BE RUN DIRECT WITH ONLY IENT SLACK TO PERMIT REMOVAL OF TUBE ROM TUBE. PROVIDE 2" OF NO.6 IRV-O-LITE PLASTIC TUBING OVER TERM. OF RET. COIL AND ING PARTLY ON LEAD.

NOTES LEADS FURNISHED AS PART OF APPARATUS

FT TERMINAL ON TERMINAL STRIP.

ING ON THIS DRAWING TO BE CONNECTED BY P EXCEPT "AT" LEADS WHICH SHALL NOT BE TED TO GROUND UNTIL AFTER THE SHOP TEST.

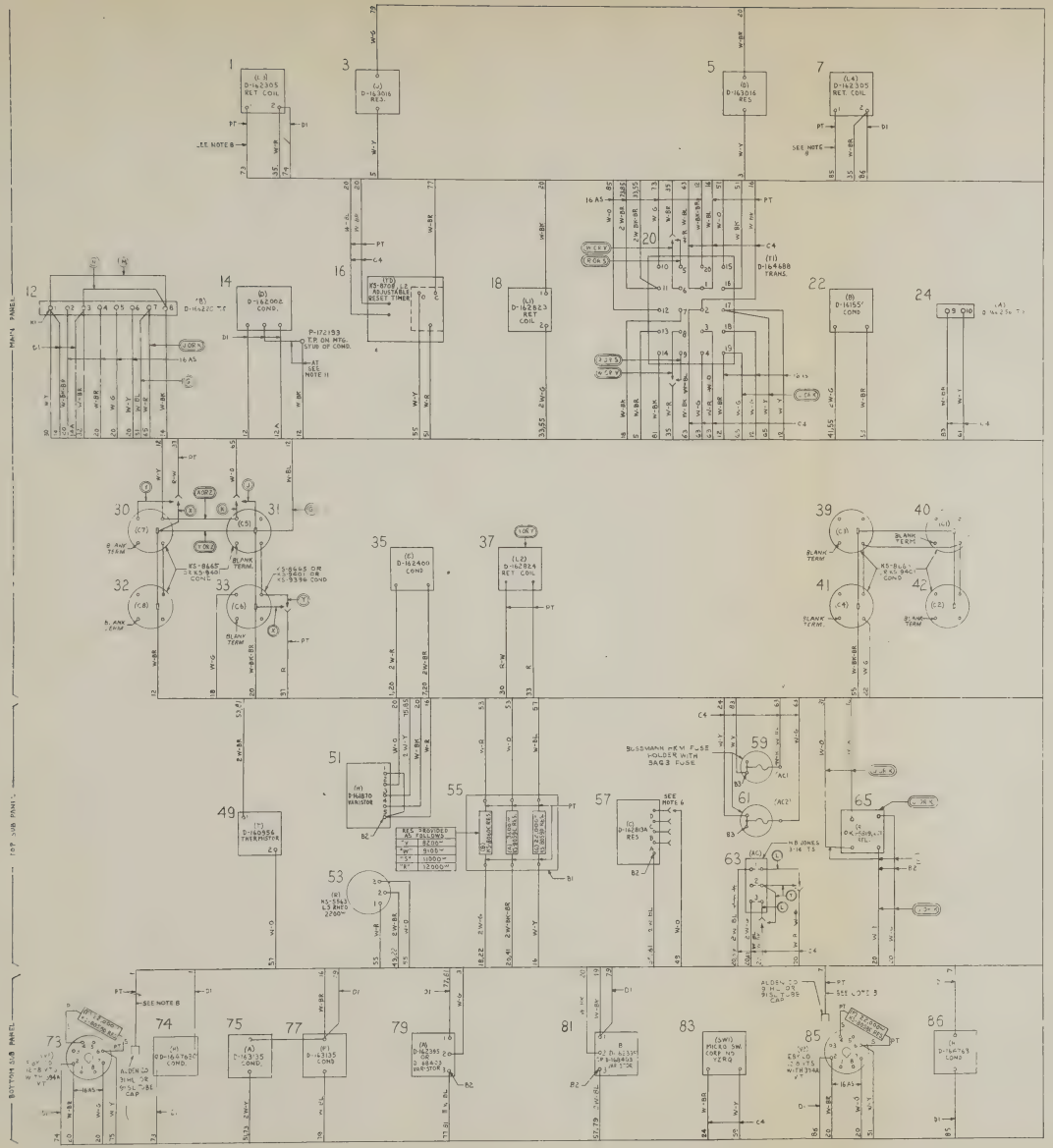
S SHALL BE FURNISHED WITH IRV-O-LITE CAT. BLACK XT6-30 WIRE SLEEVING AS REQUIRED

RMINAL AT END OF EXTRACTOR FUSE POST.

HOP Ⓔ DENOTES LIVE LEADS AT APPARATUS BE INSULATED IF NOT CONNECTED.

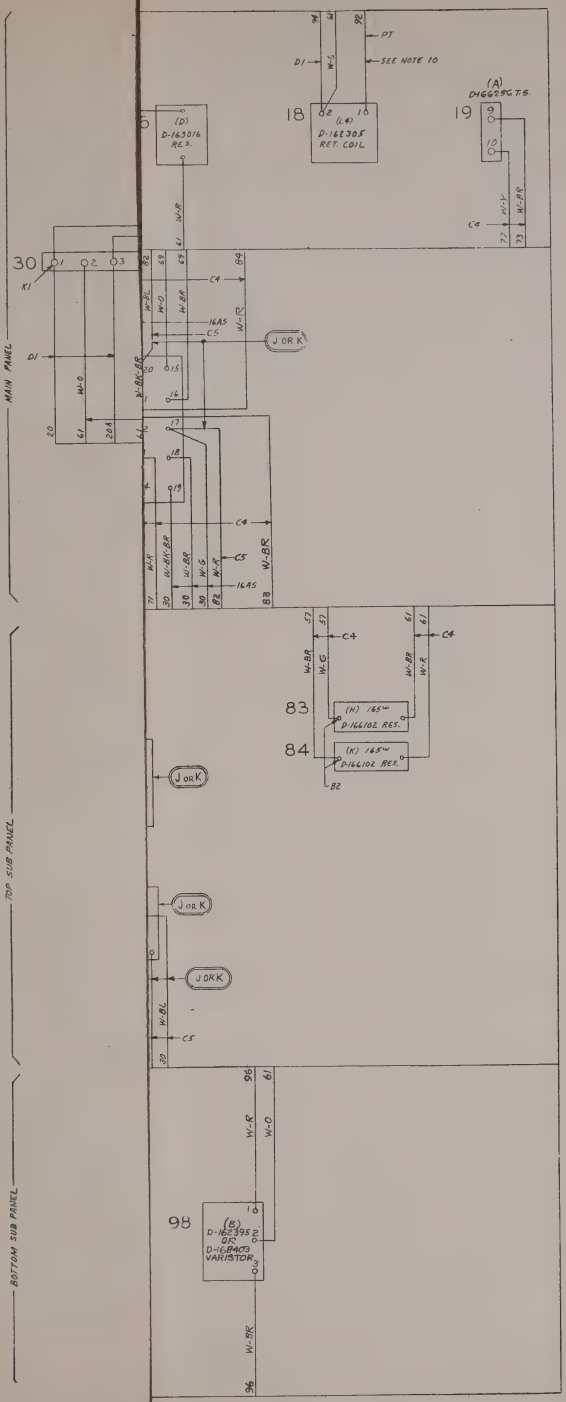
S SHOWN CROSSED OUT AT APPARATUS AND 63 AND IN NOTE 7 WERE USED ON 20 UNITS.

Fig. 46
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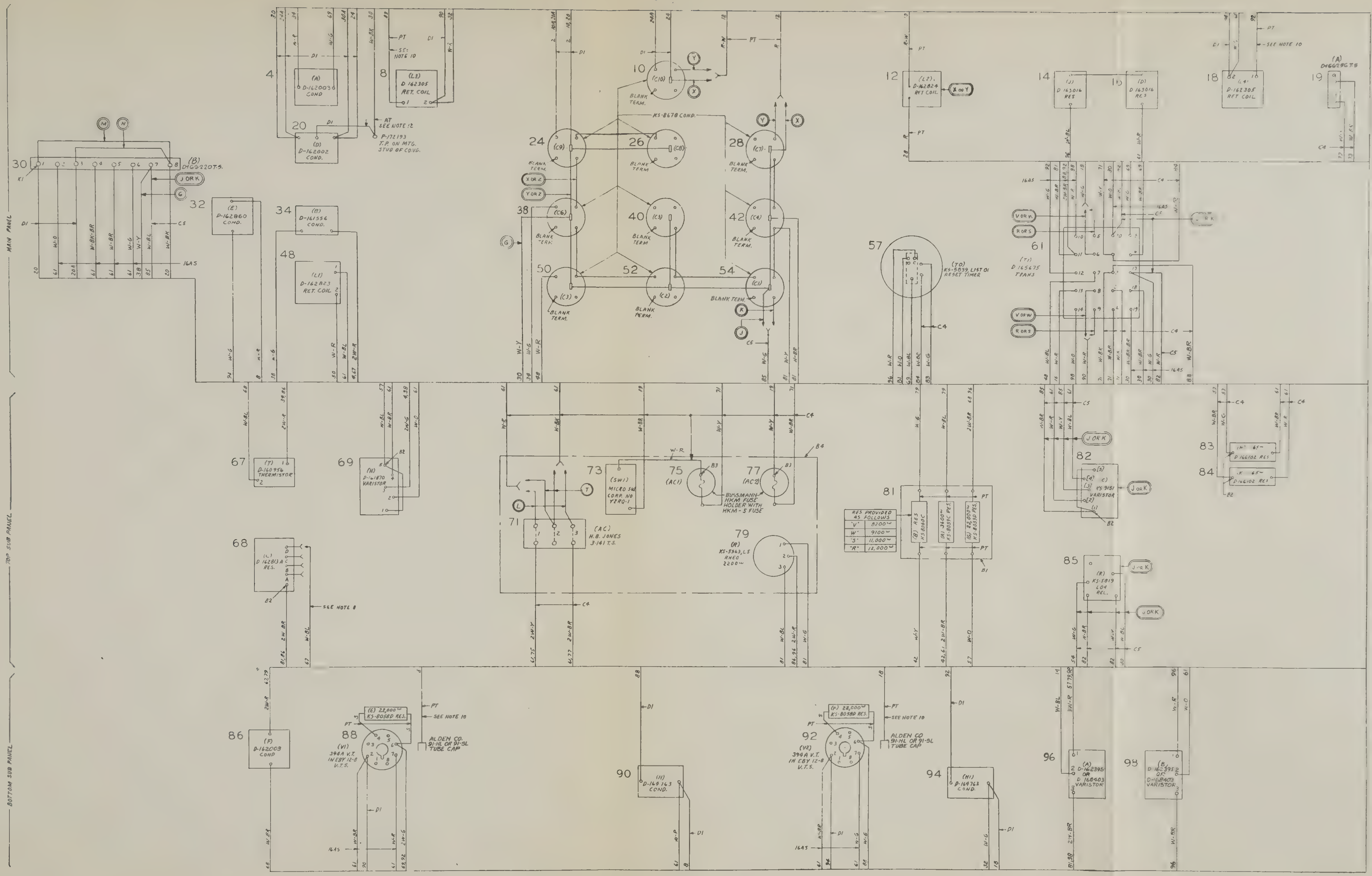
1. WIRES NOT OTHERWISE SPECIFIED SHALL BE STRANDED 20AS.
2. "C4." WIRING SHALL BE STRANDED 16AS UNLESS OTHERWISE SPECIFIED AND SHALL BE KEPT SEPARATE FROM ALL OTHER LEADS.
3. "D1" WIRING SHALL BE W STRANDED 20AS WIRE UNLESS OTHERWISE SPECIFIED, NOT INCLUDED IN THE LOCAL CABLE BUT RUN DIRECTLY FROM TERMINAL TO TERMINAL IN THE SHORTEST POSSIBLE MANNER AND INDEPENDENT OF ALL OTHER LEADS.
4. "B2" TERMINAL NEAREST PANEL.
5. "B1" EDGE OF RESISTANCE MOUNTING NEAREST PANEL.
6. A TERMINAL ON (CC) RES. SHALL BE SELECTED BY THE SHOP TO GIVE A TOTAL NOMINAL RESISTANCE EQUAL TO THE RESISTANCE STAMPED ON THE THERMISTOR.
7. STRAPPING SHALL BE MADE WITH W ~~BK~~ STRANDED 20AS WIRE EXCEPT WHERE BARE STRAPS ARE PERMISSIBLE.
8. THIS LEAD SHALL BE RUN DIRECT WITH ONLY SUFFICIENT SLACK TO PERMIT REMOVAL OF TUBE CAP FROM TUBE. PROVIDE 2" OF NO.6 IRV-O-LITE XTE-130 PLASTIC TUBING OVER TERM. OF RET. COIL AND EXTENDING PARTLY ON LEAD.
9. "PT" DENOTES LEADS FURNISHED AS PART OF APPARATUS
10. "K1" LEFT TERMINAL ON TERMINAL STRIP.
11. ALL WIRING ON THIS DRAWING TO BE CONNECTED BY THE SHOP EXCEPT "AT" LEADS WHICH SHALL NOT BE CONNECTED TO GROUND UNTIL AFTER THE SHOP TEST.
12. "S" LEADS SHALL BE FURNISHED WITH IRV-O-LITE CAT. NO. 20 BLACK XT6-30 WIRE SLEEVING AS REQUIRED
13. "B3" TERMINAL AT END OF EXTRACTOR FUSE POST.
14. FOR SHOP Ⓢ DENOTES LIVE LEADS AT APPARATUS 45 TO BE INSULATED IF NOT CONNECTED.
15. COLORS SHOWN CROSSED OUT AT APPARATUS 20, 59 AND 63 AND IN NOTE 7 WERE USED ON FIRST 20 UNITS.

Figure 46 - Rectifier X-61680B, Wiring Diagram



1. WIRES NOT OTHERWISE SPECIFIED SHALL BE 20 AS STRANDED.
2. "C4" WIRING SHALL BE 16AS STRANDED UNLESS OTHERWISE SPECIFIED AND SHALL BE KEPT SEPARATE FROM ALL OTHER LEADS.
3. "D1" WIRING SHALL BE WHITE 20AS STRANDED WIRE UNLESS OTHERWISE SPECIFIED, RUN DIRECTLY FROM TERMINAL TO TERMINAL IN THE SHORTEST POSSIBLE MANNER AND INDEPENDENT OF ALL OTHER LEADS.
4. "B1" EDGE OF RES. MTG NEAREST PANEL.
5. "B2" TERMINAL NEAREST PANEL.
6. "B3" TERMINAL AT END OF FUSE EXTRACTOR POST.
7. "B4" END OF PANEL NEAREST MTG. SCRS.
8. A TERMINAL ON (C) RES. SHALL BE SELECTED BY THE SHOP TO GIVE A TOTAL NOMINAL RES. EQUAL TO THE RES. STAMPED ON THERMISTOR.
9. STRAPPING SHALL BE MADE WITH W 20AS SOLID WIRE.
10. THIS LEAD SHALL BE RUN DIRECTLY WITH ONLY SUFFICIENT SLACK TO PERMIT REMOVAL OF TUBE CAP FROM TUBE. PROVIDE 2" OF NO 6 IRV-O-LITE XTE-130 PLASTIC TUBING OVER TERM. OF RET. COIL AND EXTENDING PARTLY ON LEAD.
11. "PT" DENOTES LEADS FURNISHED WITH APPARATUS.
12. ALL WIRING ON THIS DRAWING TO BE CONNECTED BY THE SHOP EXCEPT "AT" LEADS WHICH SHOULD NOT BE CONNECTED TO GROUND UNTIL AFTER THE SHOP TEST.
13. "S" LEADS SHALL BE FURNISHED WITH IRV-O-LITE CAT. NO. 20 BK XTE-30 WIRE SLEEVING AS REQUIRED.
14. "K1" LEFT TERMINAL ON TERMINAL STRIP
15. "C5" DENOTES SEPARATE CABLE FOR CUT OFF RELAY PROVIDED WITH LIST 7. "C5" CABLE SHALL BE SECURED TO D-C CABLE.
16. DESIGNATIONS IN [ ] ARE FOR WIRING INFORMATION ONLY AND SHALL NOT BE STAMPED.

Fig. 47
Page 148



RES PROVIDED AS FOLLOWS	
"V"	8100~
"W"	9100~
"S"	11,000~
"R"	12,000~

1. WIRES NOT OTHERWISE SPECIFIED SHALL BE 20 AS STRANDED.
2. "C4" WIRING SHALL BE 16AS STRANDED UNLESS OTHERWISE SPECIFIED AND SHALL BE KEPT SEPARATE FROM ALL OTHER LEADS.
3. "D1" WIRING SHALL BE WHITE 20AS STRANDED WIRE UNLESS OTHERWISE SPECIFIED, RUN DIRECTLY FROM TERMINAL TO TERMINAL IN THE SHORTEST POSSIBLE MANNER AND INDEPENDENT OF ALL OTHER LEADS
4. "B1" EDGE OF RES. MTG NEAREST PANEL.
5. "B2" TERMINAL NEAREST PANEL.
6. "B3" TERMINAL AT END OF FUSE EXTRACTOR POST.
7. "B4" END OF PANEL NEAREST MTG SCRS.
8. A TERMINAL ON (C) RES SHALL BE SELECTED BY THE SHOP TO GIVE A TOTAL NOMINAL RES. EQUAL TO THE RES. STAMPED ON THERMISTOR.
9. STRAPPING SHALL BE MADE WITH W 20AS SOLID WIRE
10. THIS LEAD SHALL BE RUN DIRECTLY WITH ONLY SUFFICIENT SLACK TO PERMIT REMOVAL OF TUBE CAP FROM TUBE. PROVIDE 2" OF NO 6 IRV-O-LITE XTE-130 PLASTIC TUBING OVER TERM. OF RET. COIL AND EXTENDING PARTLY ON LEAD.
11. "PT" DENOTES LEADS FURNISHED WITH APPARATUS.
12. ALL WIRING ON THIS DRAWING TO BE CONNECTED BY THE SHOP EXCEPT "AT" LEADS WHICH SHOULD NOT BE CONNECTED TO GROUND UNTIL AFTER THE SHOP TEST.
13. "S" LEADS SHALL BE FURNISHED WITH IRV-O-LITE CAT. NO 20 BK XTE-30 WIRE SLEEVING AS REQUIRED
14. "K1" LEFT TERMINAL ON TERMINAL STRIP
15. "C5" DENOTES SEPARATE CABLE FOR CUTOFF RELAY PROVIDED WITH LIST 7. "C5" CABLE SHALL BE SECURED TO D-C CABLE
16. DESIGNATIONS IN [ ] ARE FOR WIRING INFORMATION ONLY AND SHALL NOT BE STAMPED.

Figure 47 - Rectifier X-61680C, Wiring Diagram

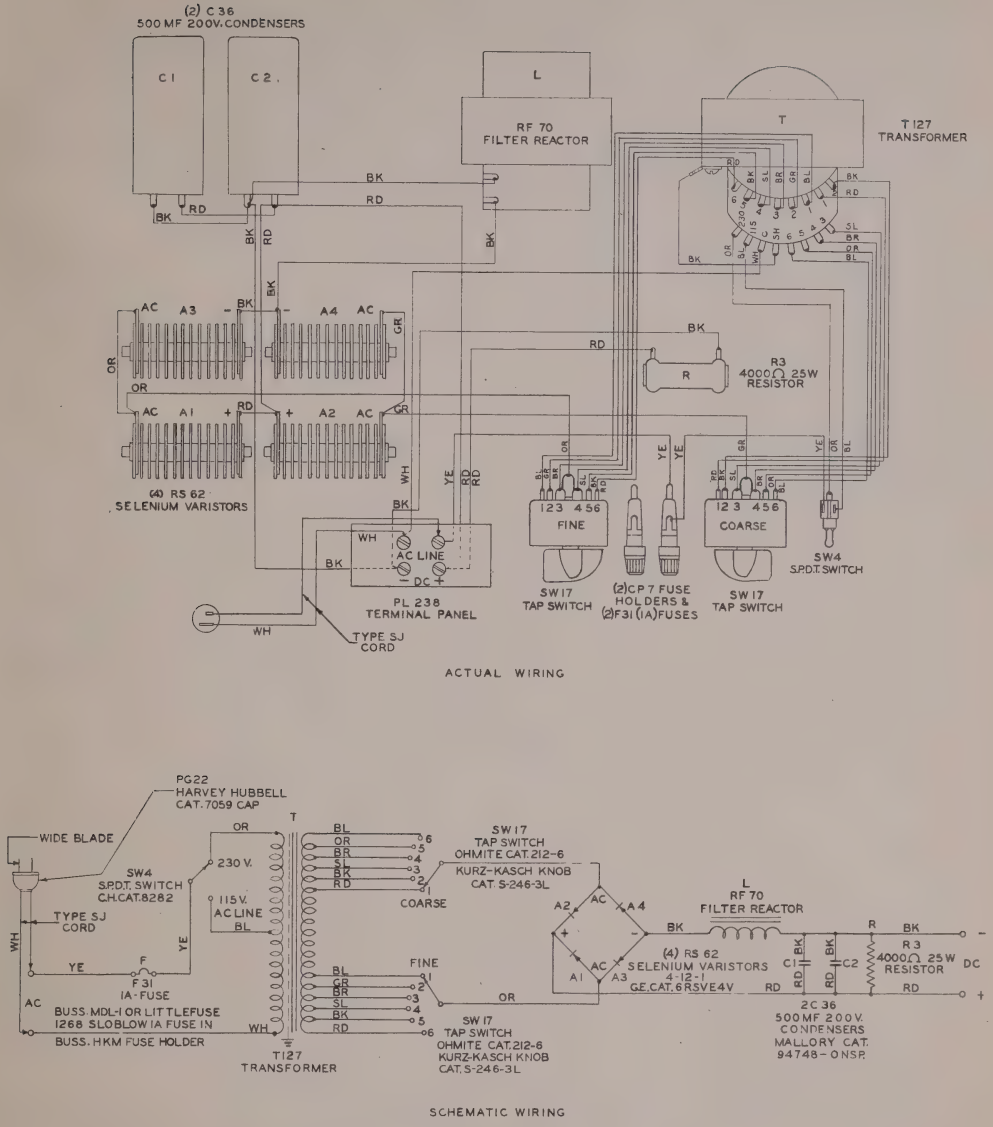
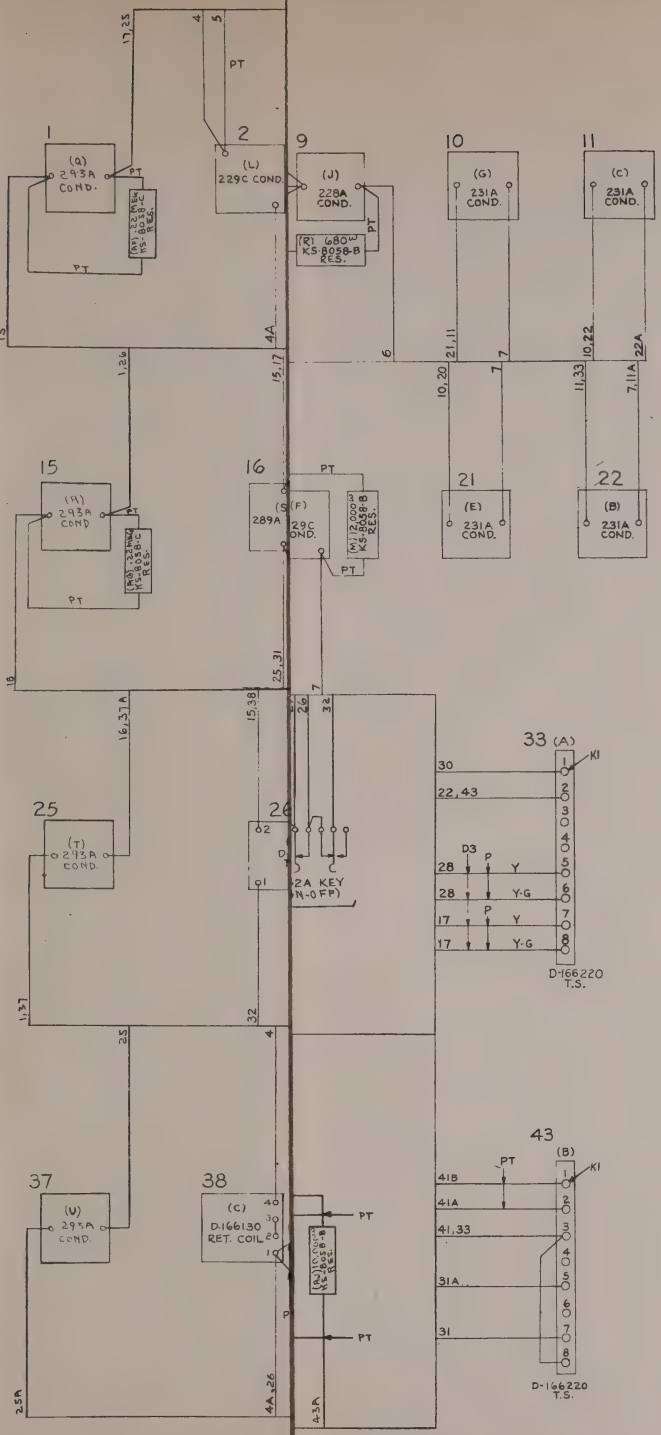


Figure 48 - Disc-type Rectifier KS-5844, Schematic and Wiring Diagram



1. WIRES NOT OTHERWISE SPECIFIED SHALL BE BLACK 22AM AND SHALL BE DI WIRING.
2. "DI" WIRING SHALL BE RUN DIRECTLY FROM TERMINAL TO TERMINAL IN THE SHORTEST POSSIBLE MANNER AND INDEPENDENT OF ALL OTHER LEADS.
3. "P" DENOTES PAIR.
4. "D3" WIRING SHALL BE 20AM RUN LOOSE AND DRESSED BACK AGAINST THE MOUNTING UNIT IN THE MOST CONVENIENT MANNER.
5. "J" TOP OR LEFT SIDE OF KEY LOOKING AT TERMINAL SIDE.
6. "BI" EDGE OF RESISTANCE MOUNTING NEAREST PANEL.
7. "PT" DENOTES LEADS FURNISHED AS PART OF APPARATUS.
8. ON THIS DRAWING THE SMALL DESIGNATION NUMBER AT THE BEGINNING OF EACH FEED LINE (ADJACENT TO THE COMMON OR "AIR" LINE) CORRESPONDS TO THE LARGE DESIGNATION NUMBER OF THE PIECE OF APPARATUS TO WHICH THE FEED LINE RUNS. FOR EXAMPLE, THE FEED LINE NUMBERED 7 STARTING AT APPARATUS NUMBERED 10, CONNECTS TO THE APPARATUS NUMBERED 7, AT WHICH POINT THIS FEED LINE IS NUMBERED 10.
9. "K1" DENOTES TOP OR LEFT TERMINAL ON STRIP.

Fig. 49
Page 150

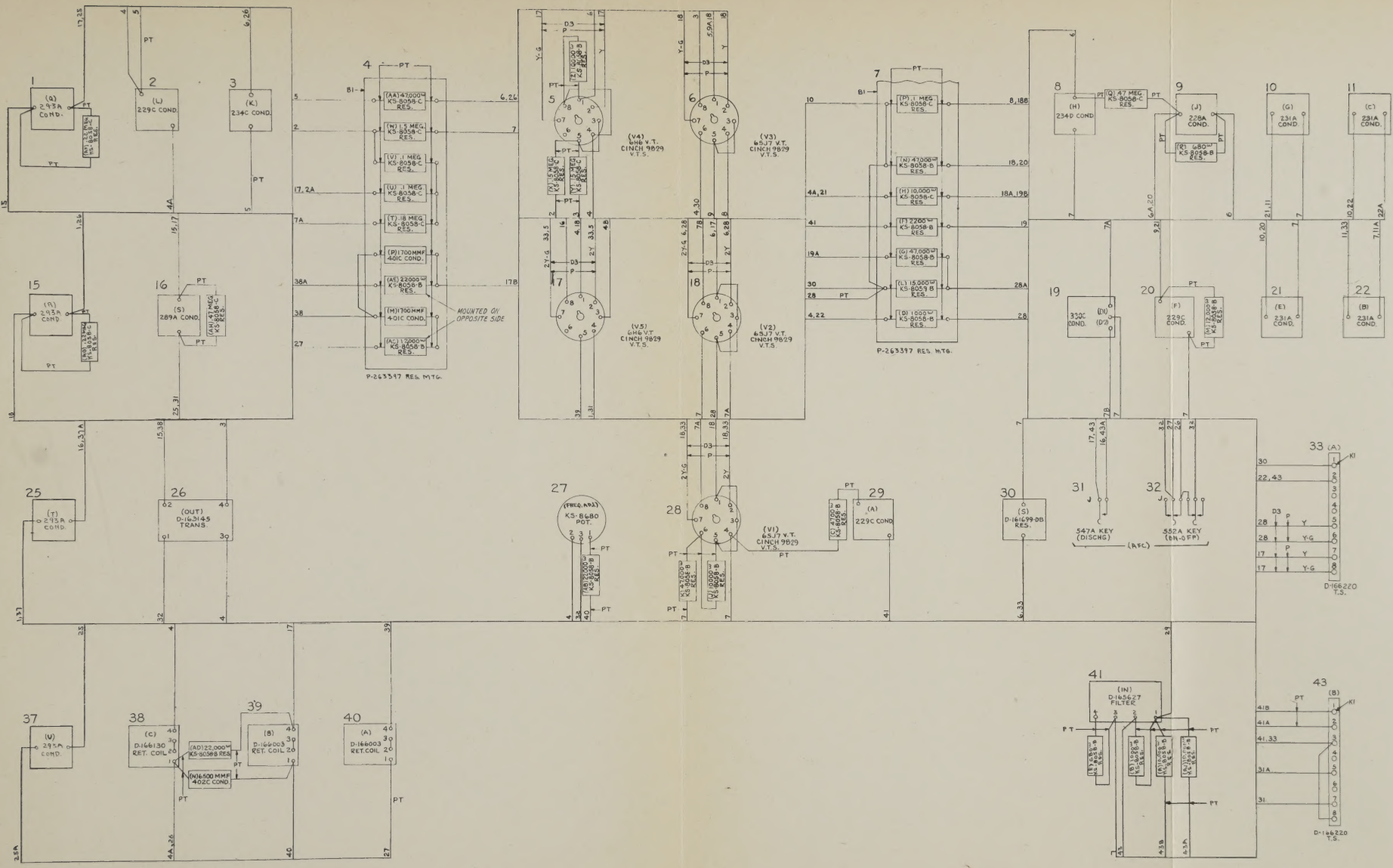


Figure 49 - Automatic Frequency Control, Wiring Diagram