TM 11-2241

DEPARTMENT OF THE ARMY TECHNICAL MANUAL

FREQUENCY SHIFT CONVERTER CV-116/URR

DEPARTMENT OF THE ARMY • MARCH 1955

TECHNICAL MANUAL

FREQUENCY SHIFT CONVERTERS CV-116/URR AND CV-116A/URR

TM 11-2241
CHANGES No. 1

DEPARTMENT OF THE ARMY
WASHINGTON 25, D. C., *31 October 1956*

TM 11-2241, 28 March 1955, is changed as follows:

The title of the manual is changed to read: **Frequency Shift Converters CV-116/URR and CV-116A/URR.**

Change Frequency Shift Converter CV-116/URR to **Frequency Shift Converter CV-116 (*)/URR** in the following places in the manual:

Page 2, figure 1. Caption
Page 3, paragraph 1*a*. Line 3
Page 4, paragraph 4*a*. Line 1
Page 4, figure 2. Call-out
Page 4, figure 2. Caption
Page 4, paragraph 4*a*. Line 7
Page 5, paragraph 6*a*. Line 2
Page 5, paragraph 9. Line 2
Page 6, figure 3. Block title
Page 6, figure 4. Caption
Page 7, paragraph 10. Line 7
Page 9, figure 5. Caption
Page 13, figure 8. Caption
Page 13, figure 9. Caption
Page 14, paragraph 18. Line 12
Page 17, paragraph 24. Line 2
Page 18, paragraph 30*b*. Line 3
Page 23, figure 13. Caption
Page 24, paragraph 36*a*(2). Line 1
Page 24, paragraph 36*a*(3). Line 3
Page 24, paragraph 36*a*(3). Line 17
Page 52, paragraph 53. Line 2
Page 56, figure 41. Caption
Page 57, paragraph 58*a*. Line 2
Page 58, figure 44. Block titles
Page 59, figure 45. Caption
Page 60, figure 46. Caption
Page 61, figure 47. Caption
Page 63, figure 49. Caption
Page 69, paragraph 64. Line 3
Page 70, figure 53. Block title
Page 70, figure 55. Block title
Page 72, figure 58. Block title
Page 3, paragraph 1*b*.

Note. (Added) Official nomenclature followed by (*) is used to indicate all models of the item of equipment included in this technical manual. Thus, Frequency Shift Converter CV-116(*)/URR represents Frequency Shift Converter CV-116/URR and CV-116A/URR.

10.1. Differences in Models (Added)

a. Frequency Shift Converter CV-116A/URR differs slightly from Frequency Shift Converter CV-116/URR. However, the different models of the equipment are interchangeable.

b. In Frequency Shift Converter CV-116A/URR, capacitor C96 (0.068 UF) has been added from terminal 3 of filter Z5 to ground. Meters M1 and M2, with an internal resistance of 900 ohms, are used. With these meters two 300-ohm resistors, R208 and R209, are connected in series with existing resistors R26 and R136.

Page 33, figure 22.

3. (Added) In Frequency Shift Converter CV-116A/URR, capacitor C96 (0.068 UF) has been added from terminal 3 of filter Z5 to ground.

Page 36, paragraph 41. Add the following sentence after the last sentence in paragraph 41*g*.

In Frequency Shift Converter CV-116A/URR, capacitor C96 has been added to the circuit to reduce the signal-plus-noise-to-noise ratio.

Page 40, figure 30. Add the following note:

R208, 300 ohms, has been added in series with R26 on Frequency Shift Converter CV-116A/URR.

Page 40, paragraph 43*d*. Line 4. Add the following after R26: (in series with R208 in Frequency Shift Converter CV-116A/URR).

Page 52, paragraph 52. Change the trouble-shooting data table as follows:

41	**Frequency Shift Converter CV-116(*)/URR, tube location**
42	**Tube socket resistance and voltage measurements for Frequency Shift Converter CV-116/URR, Serial numbers 201 up, and Frequency Shift Converter CV-116A/URR**
63	**Frequency Shift Converter CV-116/URR, serial numbers 201 and higher, and Frequency Shift Converter CV-116A/URR, schematic diagram**

TAGO 2488A—Nov. 400469°—56

Page 56, figure 42. Change the caption to read: **Tube socket resistance and voltage measurements for Frequency Shift Converter CV–116/URR, serial numbers 201 up, and Frequency Shift Converter CV–116A/URR.**

58.1. Replcement of Meters M1 and/or M2 in Frequency Shift Converter CV–116-A/URR

(Added)

If meters M1 and/or M2 in Frequency Shift Converter CV–116A/URR are defective, replace with meters which have an internal resistance of 500 ohms. When this is done remove resistor R208 and/or R209 from the circuit.

[AG 413.44 (29 Oct 56)]

Page 72, figure 58. Change note 2 to read: **Converter units with serial numbers above 200 and Frequency Shift Converter CV–116A/URR.**

Page 76, figure 63. Change the caption to read: **Frequency Shift Converter CV–116/URR, serial numbers 201 and higher, and Frequency Shift Converter CV–116A/URR, schematic diagram.**

Page 76, add the following note to figure 63.

9. Frequency Shift Converter CV–116A/URR has the following circuit changes:
   a. Capacitor C96 (0.068 UF) added from terminal 3 of filter Z5 to ground.
   b. Resistor R208, 300 ohms, connected in series with R26.
   c. Resistor R209, 300 ohms, connected in series with R136.

By Order of *Wilber M. Brucker*, Secretary of the Army:

MAXWELL D. TAYLOR,
General, United States Army,
Chief of Staff.

Official:

JOHN A. KLEIN,
Major General, United States Army,
The Adjutant General.

Distribution:

Active Army:

CNGB (1)
ASA (3)
Tec Svc, DA (1) except CSIGO(30)
Tec Svc Bd (1)
Hq CONARC (5)
CONARC Bd (incl ea Test Sec) (1)
Army AA Comd (2)
OS Maj Comd (5)
OS Base Comd (5)
Log Comd (5)
MDW (1)
Armies (5)
Corps (2)
Ft & Cp (2)
Sp Wpn Comd (2)
Army Cml Cen (4)
Gen & Br Svc Sch (5) except Sig Sch (25)
Gen Depots (2) except Atlanta Gen Depot (none)
Sig Sec. Gen Depots (10)
Sig Depots (17)
US Army Tng Cen (2)
POE (OS) (2)
Trans Terminal Comd (2)
Army Terminal (2)
OS Sup Agencies (2)
Army Elct PG (1)
Sig Fld Maint Shops (3)
Sig Lab (5)
ACS (3)
Mil Dist (1)
Units organized under following TOE's:
11–7C, Sig Co, Inf Div (2)
11–16C, Hq & Hq Co, Sig Bn, Corps or Abn Corps (2)
11–57C, Armd Sig Co (2)
11–127R, Sig Rep Co (2)
11–128C, Sig Depot Co (2)
11–500R, Sig Svc Org (2)
11–557C, Abn Sig Co (2)
11–587R, Sig Base Maint Co (2)
11–592R, Hq & Hq Co, Sig Base Depot (2)
11–597R, Sig Base Depot Co (2)

NG: State AG (6): units—same as Active Army except allowance is one copy to each unit.
USAR: None.
For explanation of abbreviations used, see SR 320–50–1.

U. S. GOVERNMENT PRINTING OFFICE: 1956

TECHNICAL MANUAL
No. 11-2241

DEPARTMENT OF THE ARMY
WASHINGTON 25, D. C., *28 March 1955*

FREQUENCY SHIFT CONVERTER CV-116/URR

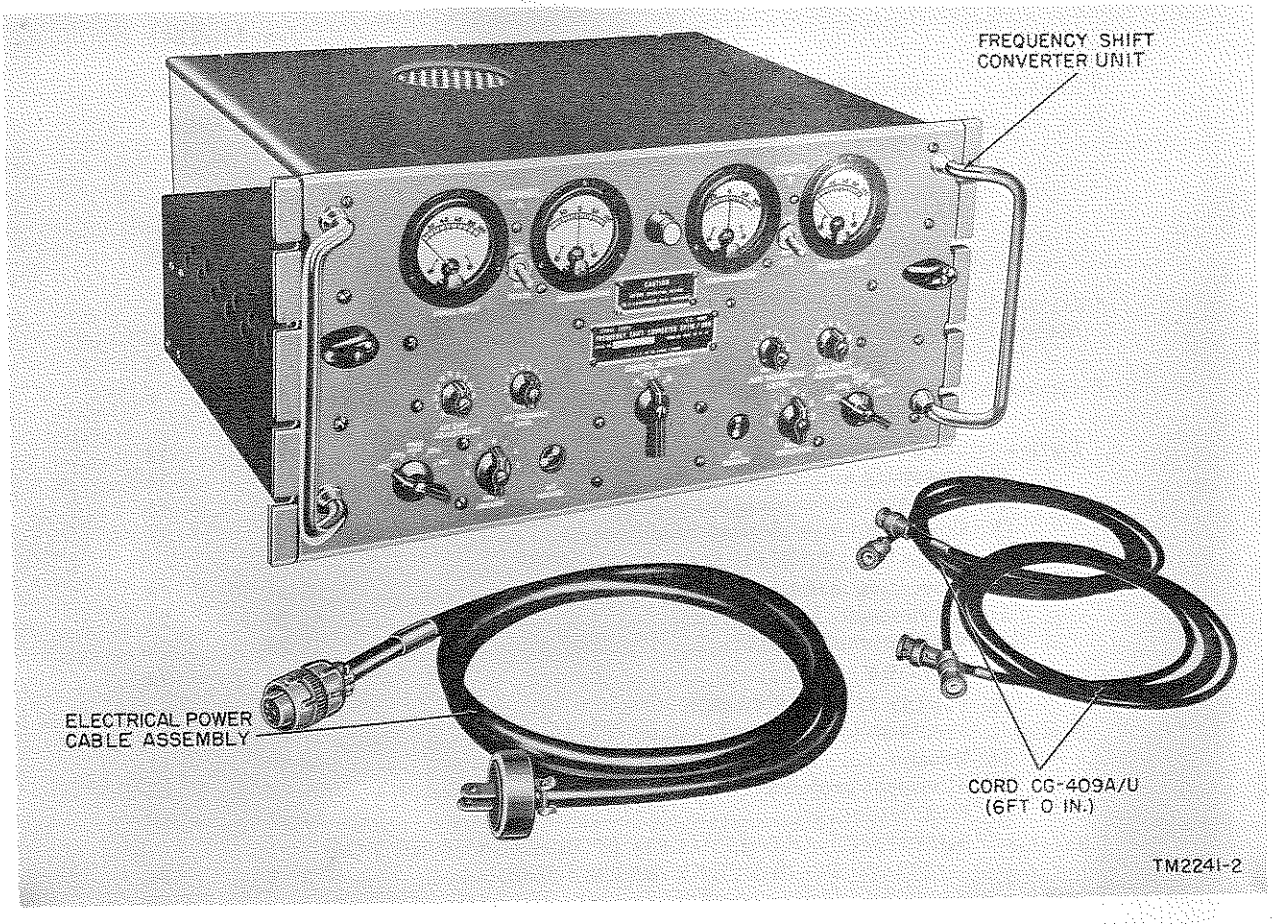

Figure 1. Frequency Shift Converter CV-116/URR.

CHAPTER 1

INTRODUCTION

Section I. GENERAL

1. Scope

a. This technical manual contains information on the installation, operation, and maintenance of Frequency Shift Converter CV–116/URR (fig. 1).

b. Comments on this publication should be forwarded directly to the Commanding Officer, The Signal Corps Publications Agency, Fort Monmouth, New Jersey, ATTN: Standards Branch.

2. Forms and Records

The following forms will be used for reporting unsatisfactory conditions of Army materiel and equipment and when performing preventive maintenance.

a. DD Form 6, Report of Damaged or Improper Shipment, will be filled out and forwarded as prescribed in SR 745–45–5 (Army); Navy Shipping Guide, Article 1850–4 (Navy); and AFR 71–4 (Air Force).

b. DA Form 468, Unsatisfactory Equipment Report, will be filled out and forwarded to the Office of the Chief Signal Officer as prescribed in SR 700–45–5.

c. DD Form 535, Unsatisfactory Report, will be filled out and forwarded as prescribed in SR 700–45–5 and TO 00–35D–54.

d. DA Form 11–238, Operator First Echelon Maintenance Check List for Signal Corps Equipment (Radio Communication, Direction Finding, Carrier, Radar), will be prepared in accordance with instructions on the back of the form (fig. 11).

e. DA Form 11–239, Second and Third Echelon Maintenance Check List for Signal Corps Equipment (Radio, Communication, Direction Finding, Carrier, Radar), will be prepared in accordance with instructions on the back of the form (fig. 12).

f. Use other forms and records as authorized.

Section II. DESCRIPTION AND DATA

3. Purpose and Use

a. The frequency shift converter unit (fig. 1) converts frequency-shifted signals into direct current (dc) output pulses that key the energizing loop circuit of automatic teletypewriter printers. This equipment is designed for continuous duty and operates from the intermediate frequency (if.) output of one receiver or from the output of two radio receivers (designated as Receiver A and Receiver B) operating in either a space- or frequency-diversity system. It is capable of translating frequency-shift radioteletype signals to neutral dc pulses only, at speeds as high as 100 dot cycles per second. Because the teletypewriter output connection of the converter does not match the input connection to a standard teletypewriter printer, an intermediate control unit is required between the converter and the teletypewriter printer.

b. The equipment consists of two separate radio frequency (rf) input channels which feed frequency-shift signals to a diversity section. In the diversity section, the two signals are combined and the result is converted from frequency-shift carriers to dc mark-space pulses. Each input circuit operates from the if. output of a radio receiver whose if. is within the range of 450 to 510 kilocycles (kc). One of the features of each converter channel is the automatic frequency control (afc) circuit, which tends to minimize loss of output or distortion in output teletypewriter (tty) signals if the received signals drift away from the normal frequency.

c. The converter has self-contained meters for measuring various currents and voltages through-

out the unit. The dc output in the diversity circuit produces a signal for neutral loop operation. The converter also has facilities to permit reversing the polarities of the output mark and space signals, and for establishing mark output signals for adjustment purposes.

4. System Application

a. Frequency Shift Converter CV–116/URR is a link in a complete radioteletype communications system. A typical system consists of a teletypewriter, a control unit, a frequency shift keyer, a radio transmitter and antenna in the transmitting section, and two radio receivers and antenna, a Frequency Shift Converter CV–116/URR, and a teletypewriter printer in the receiving section. The converter can be used with one radio receiver, or with two radio receivers operating in either a space-diversity or frequency-diversity system.

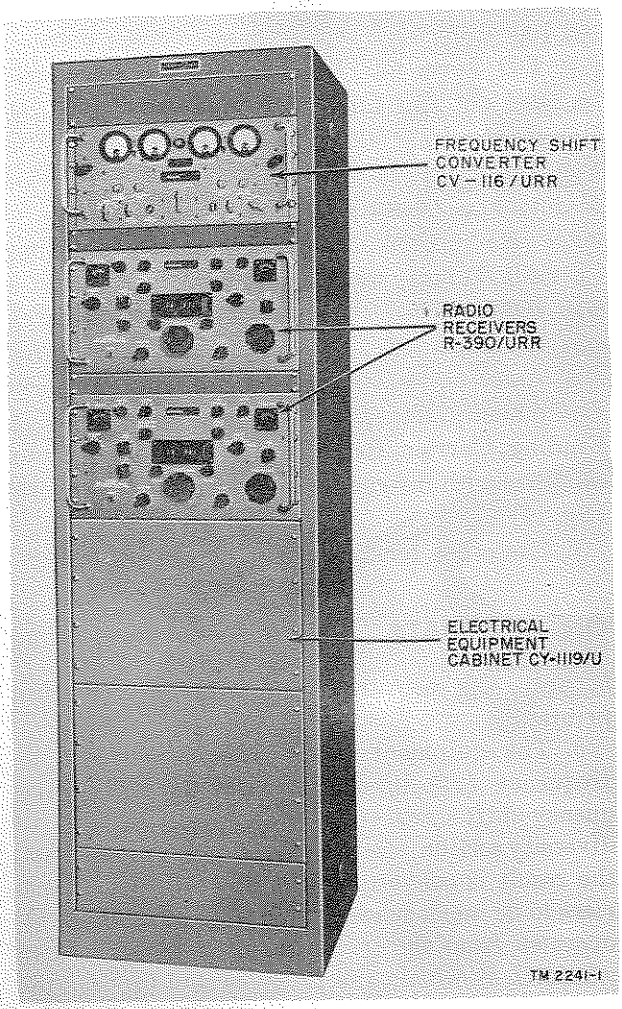

Figure 2. Frequency Shift Converter CV–116 in Radio Receiving Set AN/FRR–38.

b. Figure 2 shows the converter unit in a typical radio receiving set, Radio Receiving Set AN/FRR–38. Two Radio Receivers R–390/URR are used for diversity reception and the three units are housed together in Electrical Equipment Cabinet CY–1119/U. The block diagram in figure 3 shows the signal path through the receiving end of a typical radio teletypewriter communications system. Frequency-shifted signals are fed to each receiver from an associated antenna. At the receivers, conversion of the signals to an if. takes place and the if. signals are amplified. The if. amplifier output of each receiver is fed to its respective converter section. Both input sections, in turn, feed the diversity section where frequency-shifted signals are converted into dc pulses. These dc mark-space pulses are used to operate the teletypewriter printer. Normally, the output of the converter is fed to the tty through a control unit.

c. The CHANNEL SELECTOR switch located on the front panel permits selection of the output of either channel A or channel B, or the combined outputs of channels A and B for conversion to dc pulses in the diversity circuits.

5. Technical Characteristics

Converter if. center frequencies:

Channel A frequency	50 kc.
Channel B frequency	29.3 kc.
Input frequency	450 to 510 kc.
Required minimum input voltage	100 μv.
Input frequency-shift range	150 to 1,000 cycles.
Input impedance	50 ohms (approx.).
Number of input channels	2.
Number of tubes	45.
Output	Mark 0.060 ampere. Space 0.0 ampere.
Power source required	115 volts, 50–60 cycles, single phase ac.
Power consumption	200 watts.
Weight	69 lb.

6. Packaging Data

a. When packaged for shipment, the components of Frequency Shift Converter CV–116/URR are placed in a moisture-vaporproof container (fig. 4). The size, weight, and volume of the case follows:

Height	11¾ inches.
Length	27 inches.
Width	22½ inches.
Volume	4.13 cu ft.
Approximate gross weight	110 pounds.

b. The following list indicates the contents of the case. See packing list attached to each case for exact contents.

Contents	Notes
1 Frequency shift converter unit	With tubes, pilot lamp, crystals and fuses.
2 Cords CG–409A/U	
1 Electrical Power Cable Assembly CX–2491/U.	
1 Running spares	See par. 9.
2 Technical manual 11–2241	

7. Table of Components

Component	Required number	Height (in.)	Depth (in.)	Length (in.)	Volume (cu ft)	Unit weight (lb)
Frequency shift converter unit	1	8¾	17	19		65
Cord CG–409A/U	2			72		0.3
Electrical Power Cable Assembly CX–2491/U	1			72		1.1
Technical Manual 11–2241	2	11	¼	8½		
Running spares (spare tubes, fuses, crystals, and pilot lamp)	1					

Note. This list is for general information only. See appropriate supply publications for information pertaining to requisition of spare parts.

8. Description

a. The frequency-shift converter unit (fig. 1) is a self-contained unit 19 inches long, 8¾ inches high, and 17 inches wide, weighing approximately 69 pounds. It has a gray aluminum-alloy panel, base assembly, a black dust cover, and it is designed for rack mounting.

b. The base assembly is fitted with file-drawer-type double-extension drawer slides which support the chassis-panel dust cover assembly when it is completely extended from its associated rack. This is to facilitate inspection, adjustment, and maintenance. Two handles extend forward from the sides of the front panel for use in withdrawing the assembly.

c. Input, output, and power connections are made by means of connectors located at the rear of the chassis (fig. 9). The converter can be completely extended for maintenance and adjustment purposes without removing the connecting cables.

d. All operating controls and meters are located on the front panel. When the dust cover is removed, the adjustment controls, used in preparing the unit for operation, and the test switches can be reached. The dust cover is held in place by four fasteners. Fuses and discriminator transformer adjustment screws are located at the rear of the unit.

e. Do not attempt to remove the converter without first disconnecting all cables at the rear of the chassis. The converter can be removed from its base assembly by loosening the knob fastener at each end of the front panel, sliding the chassis-panel dust cover assembly completely out, and lifting upwards.

9. Running Spares

The group of running spares supplied with each Frequency Shift Converter CV–116/URR is packed in a corrugated fiberboard box taped to the side of the internal flanged corrugated packaging tubing. Spares are provided for all normally expendable items such as tubes, pilot lamps, fuses, and crystals. Following is a list of running spares:

1 panel indicator lamp	1 tube, 6AQ5W
12 fuses, 3-ampere	4 tubes, 6AU6
1 crystal, 405 kc	1 tube, 6BA7
1 crystal, 425.7 kc	4 tubes, 5814
4 tubes, 5726	

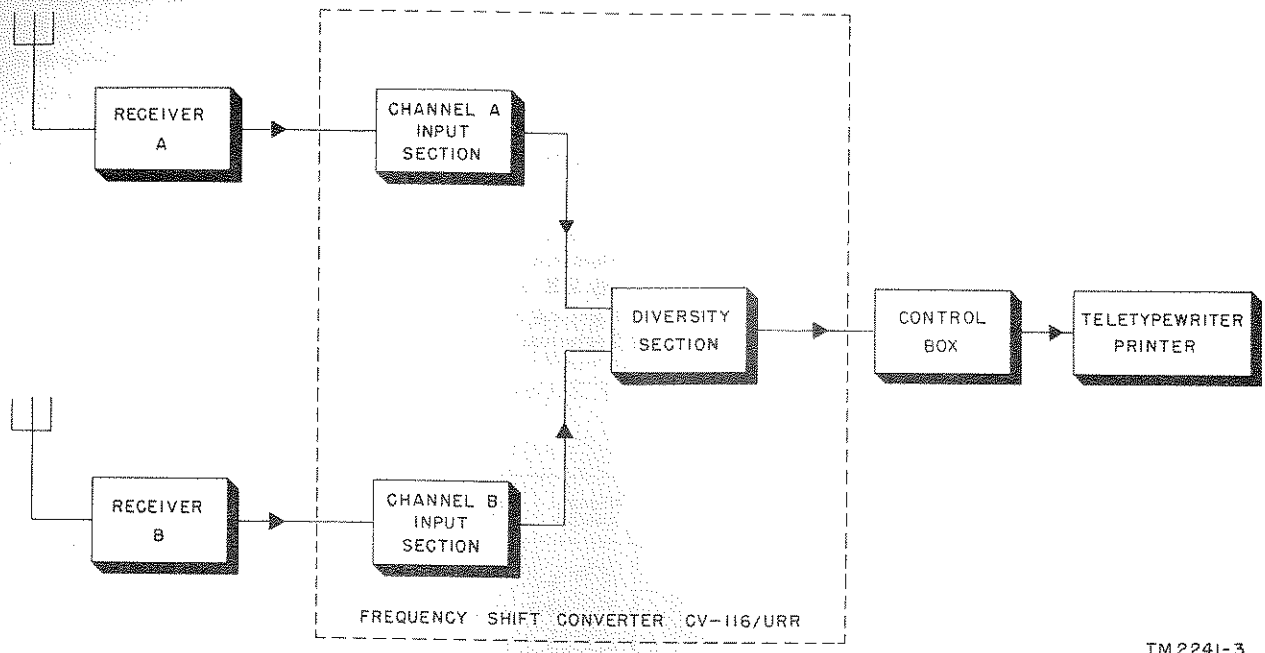

Figure 3. Radioteletypewriter communications reception system, simplified block diagram.

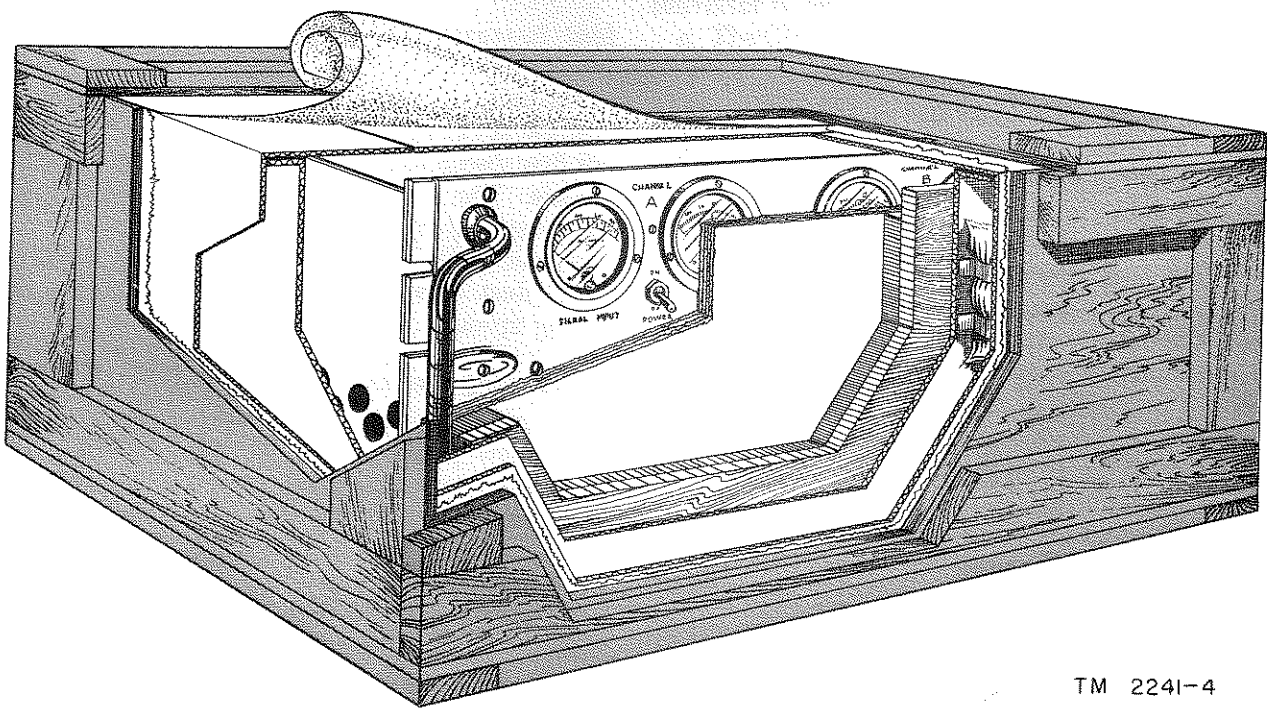

Figure 4. Frequency Shift Converter CV-116/URR packed for shipment.

10. Additional Equipment Required

Because the converter is part of a communications system, the other components of the system are required for operation. A typical receiving system would include the following equipment:

2 radio receivers and antennas. (1 required for single-channel operation.)
1 Frequency Shift Converter CV–116/URR.
1 Teletypewriter TG–7–B (receiving).
1 control unit or adapter connector (required to match the output connector of the converter to the input connector of the teletypewriter).
Additional crystals for crystal operation on a variety of receiver if. frequencies.

CHAPTER 2

INSTALLATION

11. Placement of Equipment

This equipment is designed to be rack mounted with two receivers. In a standard relay rack installation, it is suggested that one receiver be mounted above and the other below the converter to facilitate extension of the converter from the base assembly for servicing. Because the converter input cables (fig. 1) are 6 feet long, the receivers and the converter power source should not be more than 6 feet from the converter. The converter power connection must be made to a 115 v, 50–60 cycles per second (cps) single phase ac source. Power input connections and tty output connections are made at the rear of the chassis. Eight screws on the base assembly secure the equipment to the rack. See figure 6.

12. Uncrating, Unpacking, and Checking New Equipment

Note. For used or reconditioned equipment, refer to paragraph 15.

a. General. The equipment is shipped in a wooden packing case as in figure 4 When new equipment is received, select a location where the equipment may be unpacked without exposure to the elements and which is convenient for installation.

Note. Be careful when uncrating, unpacking, and handling the equipment; it is easily damaged. If it becomes damaged or exposed, a complete overhaul might be required or the equipment may be rendered useless.

b. Step-By-Step Instructions for Uncrating and Unpacking Shipments (fig. 5).

(1) Place the packing case as near the operating position as convenient.
(2) Remove the nails with a nail puller as shown in figure 5Ⓐ. Remove the top of the packing case. Do not attempt to pry off the top; the equipment may be damaged.
(3) Remove the outer cardboard carton from the case as shown in figure 5Ⓑ.
(4) Remove the equipment from the outer carton as shown in figure 5Ⓒ.
(5) Remove the moisture-vaporproof barrier from the inner carton.
(6) Open the inner carton as shown in figure 5Ⓓ, and remove the flanged cardboard tubing. Place the operating components and running spares on the work bench or near the final location.
(7) Inspect all equipment for possible damage incurred during shipment.

c. Checking. Check the contents against the master packing slips.

13. Installation

(fig. 6)

a. The converter unit is designed for rack mounting. It is secured to the rack by screws through holes in the side flanges of the base assembly.

b. Before installing the converter, make certain that the tubes (fig. 45) are firmly inserted in their sockets and that the proper fuses are inserted in the fuse holders (fig. 9).

c. To install the converter in the rack, first remove the chassis-panel assembly from the base assembly by loosening the knob fasteners at each end of the front panel and lifting upwards. Position the base assembly in the rack and secure it in place with the oval head machine screws and cup washers furnished with the rack as shown in figure 6Ⓐ. Extend the drawer slides, as shown in figure 6Ⓑ to replace the chassis-panel assembly in the base. Slide the converter into the rack and tighten the two knob fasteners (fig. 6Ⓒ and Ⓓ).

14. Connections

a. Connections between the converter unit, its associated receivers, the control box, and the tty printer vary, depending on whether one or two receivers are used. Typical conections are shown in figure 7. (Refer to TM 11–647 for if. output connections.)

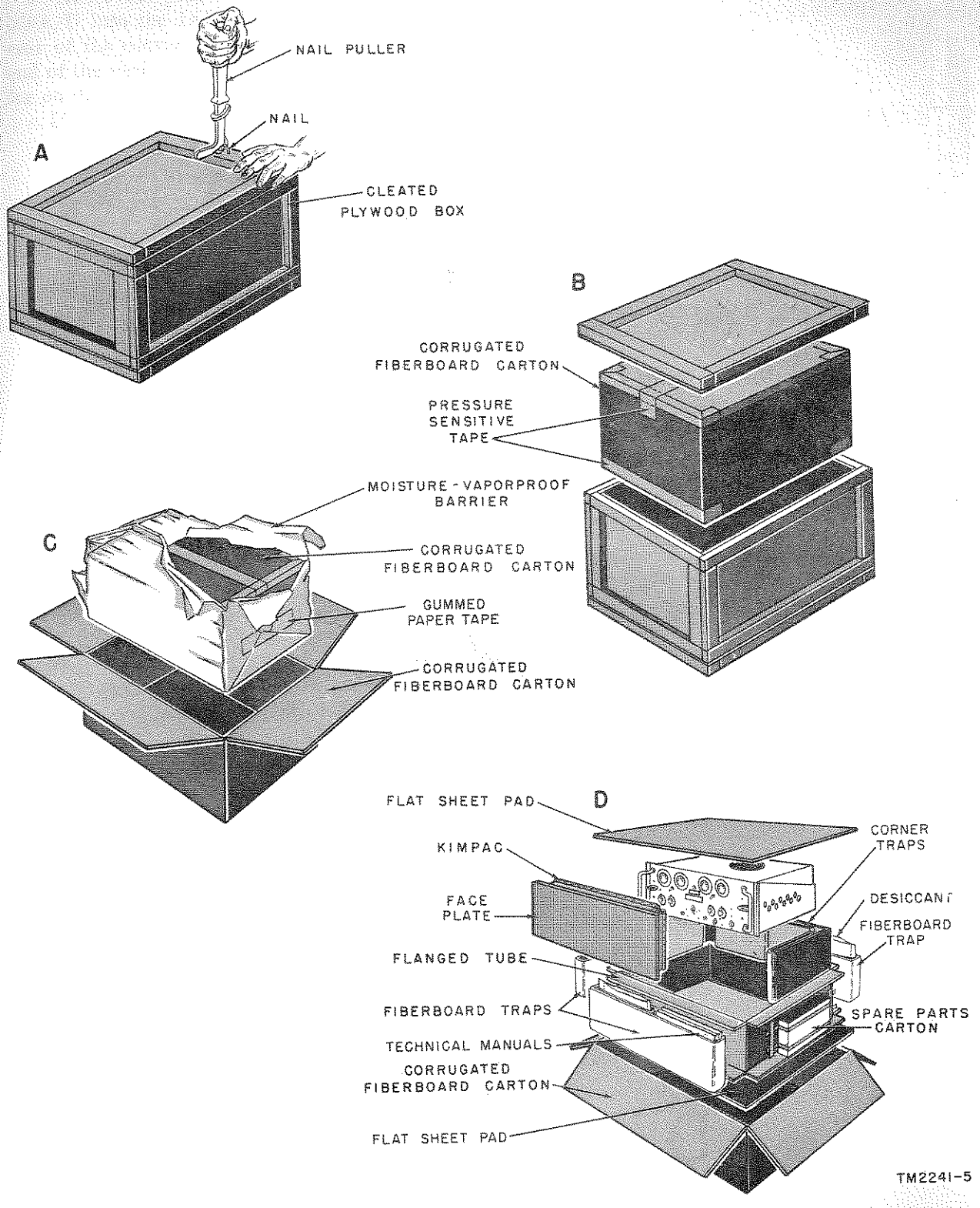

Figure 5. Frequency Shift Converter CV-116/URR, uncrating and unpacking.

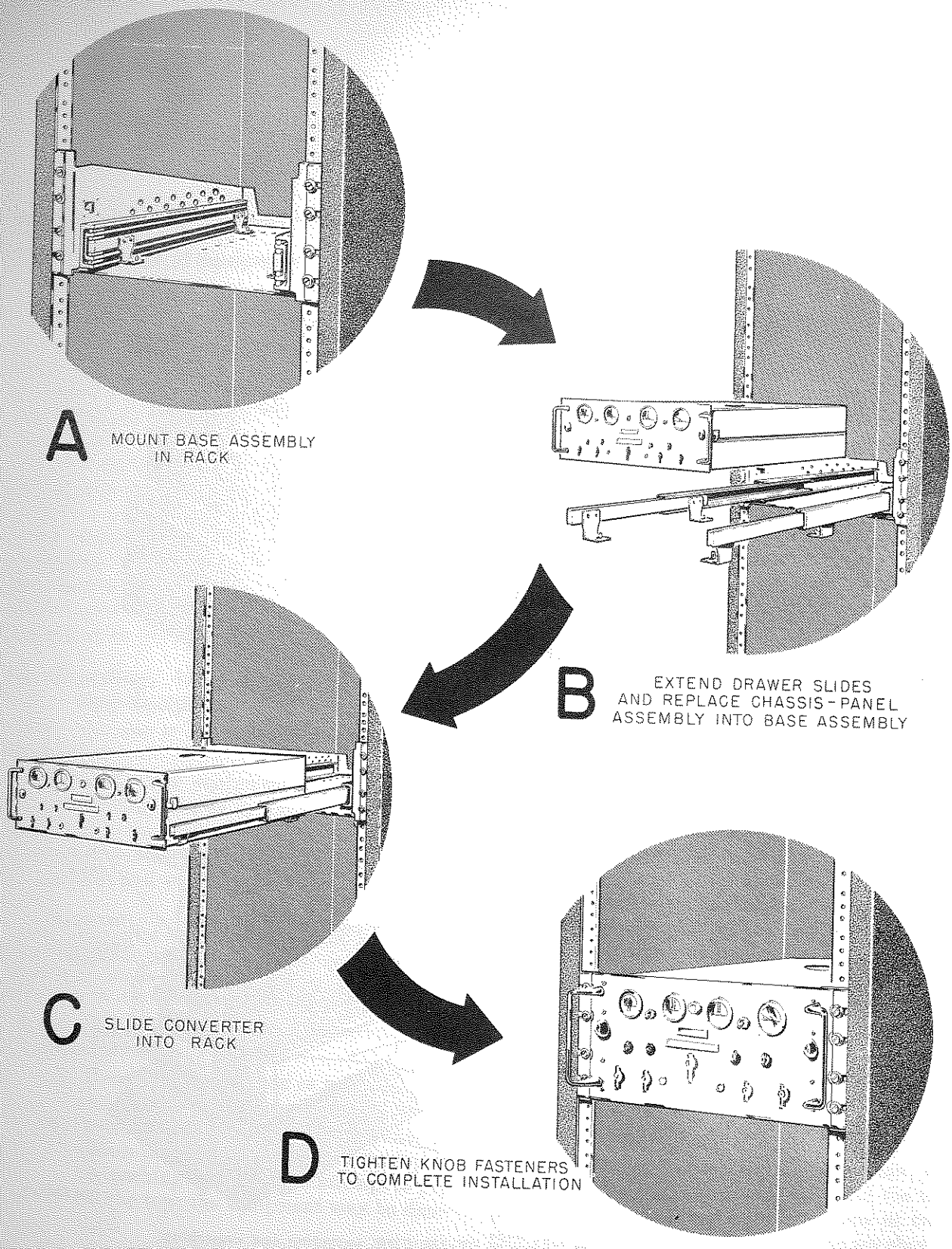

Figure 6. Rack mounting details.

b. Insert the plug at one end of Cord CG–409A/U into the INPUT A jack located at the rear of the converter and the plug at the other end of the cord into the coaxial if. output connector on the receiver, designated as receiver A.

c. If a second receiver is used for diversity operation, insert the plug at one end of a second Cord CG–409A/U into the INPUT B jack at the rear of the converter. Insert the plug at the other end of the cord into the coaxial if. output connector on the second receiver, designated as receiver B.

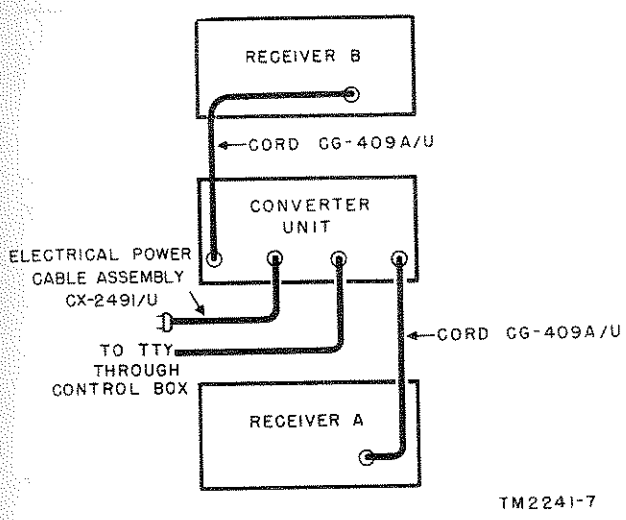

Figure 7. Dual-diversity operation, cording diagram.

d. The output connection (through a control box) to the tty selector magnet is made through pins A and D of the TT connector. (Refer to the technical manual of the teletypewriter for connections.) Provision has been made to place the converter MARK HOLD-XTAL-AFC switch in the MARK HOLD position from a remote position. This connection may be made by wiring a test key or lever switch between pin C of the TT connector and ground.

e. Insert the plug at one end of Electrical Power Cable Assembly CX–2491/U into the three-prong PWR. IN jack at the rear of the converter. Insert the two-prong plug at the other end of the power cord into the 115-volt ac power receptacle.

15. Service Upon Receipt of Used or Reconditioned Equipment

a. Follow the instructions given in paragraph 12 for uncrating, unpacking, and checking the equipment.

b. Check the used or reconditioned equipment for tags or other indications pertaining to changes in the wiring of the equipment. If changes in wiring have been made, note the changes in this manual, preferably on the schematic diagram.

c. Check the operating controls for ease of rotation. If lubrication is required, refer to the lubrication instructions in paragraphs 32 and 33.

d. Perform the installation and connection procedures given in paragraphs 13 and 14.

CHAPTER 3

OPERATION

Section I. CONTROLS AND INSTRUMENTS

16. General

Haphazard operation or improper setting of the controls can cause damage to electronic equipment. For this reason, it is important to know the function of every control. The actual operation of the equipment is discussed in paragraphs 18 and 19.

17. Controls and Instruments

(fig. 8)

The following chart lists the controls and instruments of the converter and indicates what they do.

Control or instrument	Function
POWER switch	In ON position, connects converter to ac power source.
AFC switch	In ON position, puts automatic frequency control into operation.
CHANNEL SELECTOR switch	Selects channel or channels to be fed to diversity circuits.
Channel A AFC SHIFT ADJUSTMENT	Adjusts balance of channel A afc dc amplifiers for signals of various frequency shifts.
Channel A AFC THRESHOLD	Determines the minimum level above which the channel A automatic frequency control circuit and keyer will operate.
Channel A AFC-XTAL-MARK HOLD switch	Selects method of frequency control for channel A oscillator and energizes the mark-hold circuit for test purposes. Using the right or left setting determines polarity of output mark-space signals.
Channel A DRIFT INDICATOR	Indicates amount of correction from original setting automatically applied to channel A oscillator circuit to compensate for signal drift when operating MARK HOLD-XTAL-AFC switch in AFC position and AFC switch in ON position. Clutch permits manual control and correction of channel A oscillator frequency when operating MARK HOLD-XTAL-AFC switch in AFC position.
Channel B AFC SHIFT ADJUSTMENT	Adjusts balance of channel B afc dc amplifiers for signals of various frequency shifts.
Channel B AFC THRESHOLD LEVEL	Determines the minimum level above which the channel B automatic frequency control circuit and keyer will operate.
Channel B AFC-XTAL-MARK HOLD switch	Selects method of frequency control for channel B oscillator and also to energize the mark-hold circuit for test purposes. Using the right or left setting determines polarity of output mark-space signals.
Channel B DRIFT INDICATOR	Indicates amount of correction from original setting automatically applied to channel B oscillator circuit to compensate for signal drift when operating MARK HOLD-XTAL-AFC switch in AFC position and AFC switch in ON position. Clutch permits manual control and correction of channel B oscillator frequency when operating MARK HOLD-XTAL-AFC switch in AFC position.
Channel A or B SIGNAL INPUT meter	Indicates the input level of the signal at the respective converter input terminals.
Channel B DISCRIMINATOR meter	Indicates channel B discriminator output.
Channel A DISCRIMINATOR meter	Normally indicates channel A discriminator output. May be used during alignment and final testing (ch. 5, Sec. III and IV) for metering various voltages throughout the converter.
AFC INDICATOR	Indicates by *spinner* disk whenever motor is operating to control oscillator frequency.
SPEED switch (fig. 9)	Selects correct filter circuit in discriminator section output for different keying speeds. HIGH: For keying speeds over 38 dot cycles per second. LOW: For keying speeds up to 38 dot cycles per second.

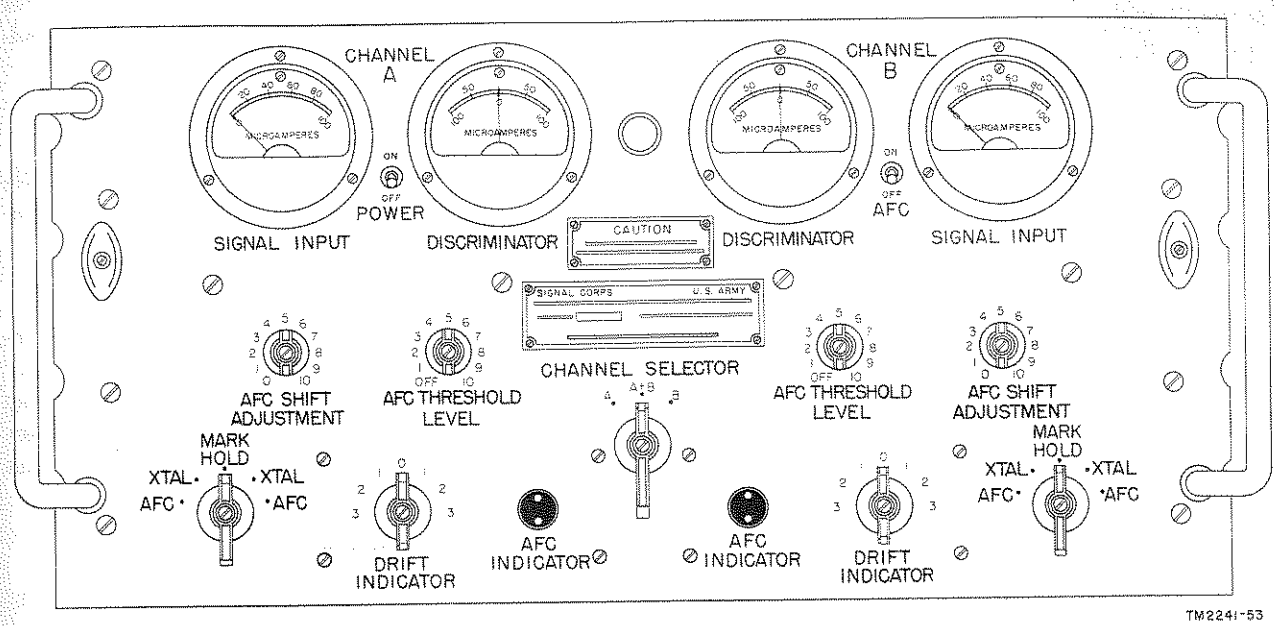

Figure 8. Frequency Shift Converter CV–116/URR, front panel.

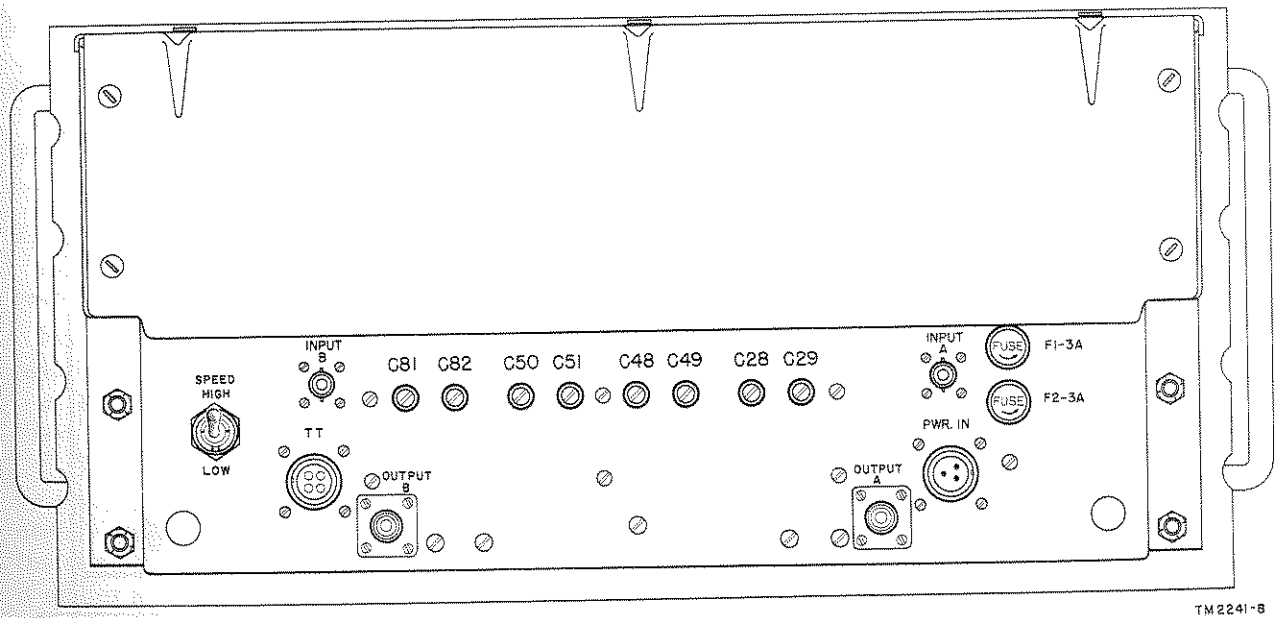

Figure 9. Frequency Shift Converter CV–116/URR, rear view.

Section II. PRESETTING AND INITIAL ADJUSTMENT

18. Presetting

The adjustment and operating instructions outlined in this and the following section apply to the equipment when it is used with radio receivers that have an if. output matching the present converter input frequency. In this case, no presetting of the converter should be necessary. Although the converter is preset for operation with a receiver having an if. frequency of 455 kc, it may be used with any receiver having an if. frequency in the range of 450–510 kc. A receiver having a different if. than that for which the converter has been preset cannot be used with the CV–116/URR until other crystals have been substituted for those installed in the converter and its if. input stages have been realined. The proper crystal frequencies for the converter may be determined from the following formulas:

for Channel A, $F = F_1 - 50$ kc
for Channel B, $F = F_1 - 29.3$ kc

where F = Crystal frequency in kc and F_1 = Receiver if. frequency in kc. A complete rf alinement procedure is given in paragraph 61.

19. Initial Adjustment

a. General. In teletypewriter-printer loop circuits a marking current of 60 milliamperes (ma) is normally used. Potentiometer adjustment R109 (fig. 10) is provided to maintain this current flow for external loop resistance variations

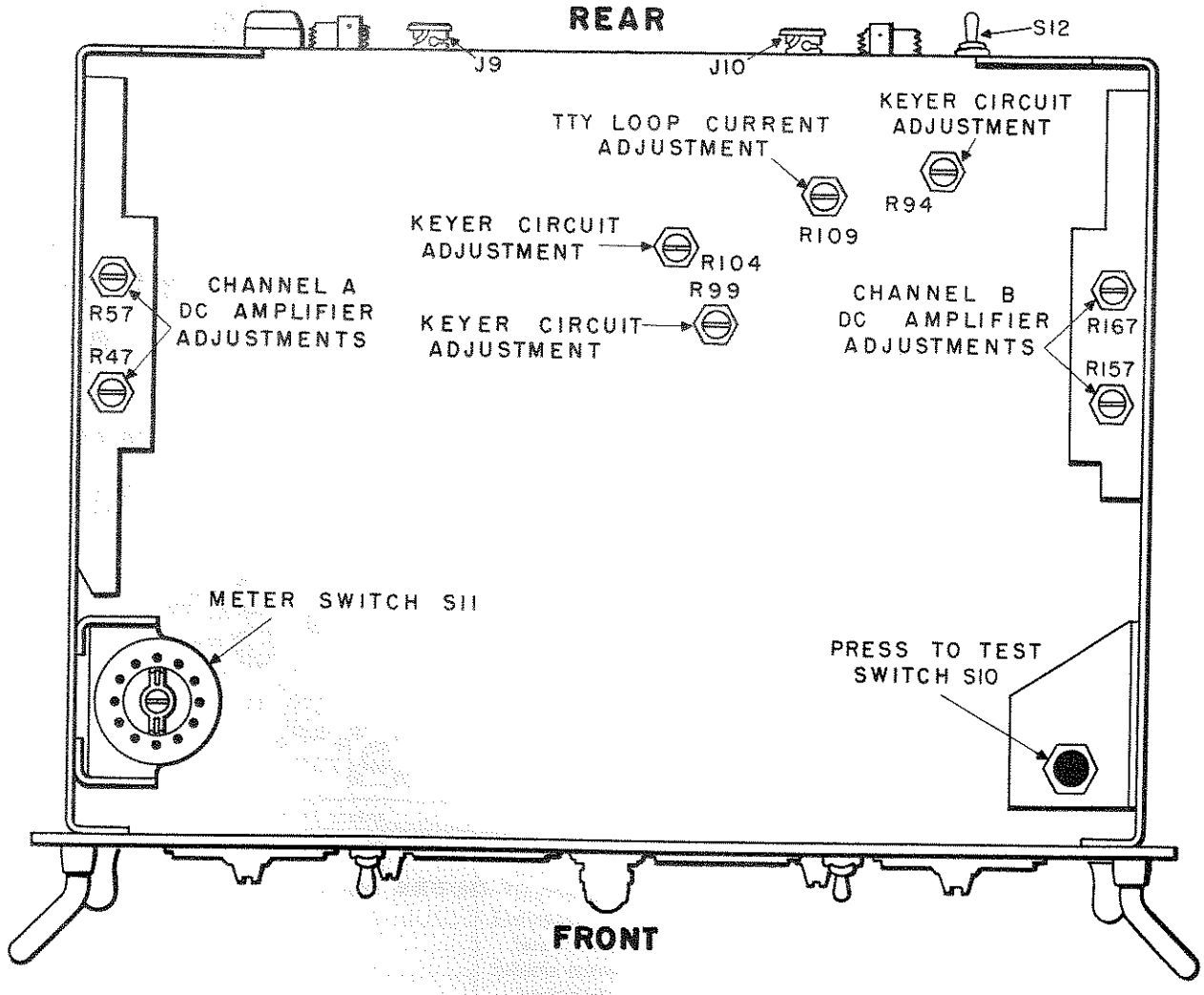

Figure 10. Converter unit top view, showing location of afc and keyer circuit adjustment controls and metering switches.

between 125 and 500 ohms. Once set for a given loop circuit, frequent adjustment of the output circuit should not be necessary. However, this initial adjustment is required whenever a different printer is used, whenever changes are made in the external loop circuit to compensate for tube or component aging, or whenever different ac power conditions exist.

b. Loop Current Adjustment. After checking to see that all required connections have been made as described in paragraph 14, throw the converter POWER switch to the ON position. The pilot lamp should light. Set the meter switch S11 (fig. 10) to position R109. Depress the PRESS TO TEST switch and adjust potentiometer R109 for a 60 microampere reading on the channel A DISCRIMINATOR meter. This reading multiplied by 1,000 is 60 ma, the required loop current.

Section III. OPERATION UNDER USUAL CONDITIONS

20. Preliminary Starting Procedure

Perform the preliminary starting procedure given below before using the starting procedure described in paragraph 21.

a. Be sure that a 115 volt, 50–60 cycle, power source is available and that the POWER switch is in the OFF position.

b. Be sure that the AFC switch is in the OFF position.

c. Turn both AFC SHIFT ADJUSTMENT controls to 0.

d. Turn both AFC THRESHOLD LEVEL controls to OFF.

e. Rotate the CHANNEL SELECTOR switch to A.

f. Rotate both AFC-XTAL-MARK HOLD switches to MARK HOLD position.

g. Turn both DRIFT INDICATOR controls to 0.

h. Set SPEED switch at the LOW position.

21. Starting Procedure

Note. If, during the starting procedure, an abnormal result is obtained see figure 40, troubleshooting chart.

See paragraph 20 before using this starting procedure.

a. Throw the POWER switch to ON and allow the converter to warm up.

b. Tune in a teletypewriter signal on receiver A by using a pair of earphones and the beat frequency oscillator (bfo) of the receiver to locate the station. Turn the receiver bfo off and leave it off for all subsequent operations.

c. Slowly retune radio receiver A while observing the channel A DISCRIMINATOR meter M4. Tune until the meter needle deflects to the right and to the left for miscellaneous keying signals. The deflections will be of approximately equal plus and minus values when the receiver is correctly tuned. The reading on meter M1, showing the SIGNAL INPUT level, should be at a maximum for the station being tuned in.

d. Rotate the channel A AFC-XTAL-MARK HOLD switch to the left-hand XTAL position. Turn the teletypewriter printer on and check the copy. If the printing has no meaning, rotate AFC-XTAL-MARK HOLD switch to the right-hand XTAL position. The teletypewriter should now print correct copy.

Note. Many teletypewriter stations transmit coded messages, in which case, correct operation can be determined by proper carriage return and line feed.

e. Rotate the CHANNEL SELECTOR switch to B.

f. Tune receiver B to the same teletypewriter signal using the bfo to set the signal by ear. Then turn the bfo off.

g. Slowly retune receiver B while observing the channel B DISCRIMINATOR meter M3. Tune until the miscellaneous deflections on meter M3 center around zero.

h. Rotate the channel B AFC–XTAL-MARK HOLD switch to the left-hand XTAL position. Check the copy on the teletypewriter printer. If the printing has no meaning, rotate the AFC-XTAL-MARK HOLD switch to the right-hand XTAL position.

i. With both receivers operating, rotate the CHANNEL SELECTOR switch to the A + B position. The converter is now set up for diversity operation.

22. Types of Operation

a. General. Whether using a diversity system or a single receiver input to the converter, three types of operation are possible. The type of operation used depends on the desired method for controlling the frequency of the converter oscillator. Three means of frequency control are available; the crystal controlled oscillator, the

variable frequency oscillator (vfo), and vfo with afc.

b. Crystal-Controlled Oscillator Operation. To place the converter in operation with crystal control, follow the steps outlined in paragraph 21. If either receiver A or B indicates a drift in frequency, retune the receiver carefully to obtain an average zero output on the DISCRIMINATOR meter.

c. Manually Tuned Vfo Operation. To operate the converter with manual control of the oscillator frequency, perform the steps outlined in paragraph 21 and proceed as follows:

(1) With both DRIFT INDICATOR controls set to zero, set the CHANNEL SELECTOR switch to position A and rotate the channel A AFC-XTAL-MARK HOLD switch to the right or left AFC position corresponding to the XTAL position required for correct copy (par. 21*d*).

(2) Carefully tune the channel A DRIFT INDICATOR control until the DISCRIMINATOR meter needle fluctuates about zero on miscellaneous keying signals.

(3) Adjust the channel A DRIFT INDICATOR control to correct for small frequency drifts that may occur in receiver A during operation.

(4) Rotate the CHANNEL SELECTOR switch to position B and the channel B AFC-XTAL-MARK HOLD switch to the right or left AFC-XTAL position as determined during the operation performed under paragraph 21*h*.

(5) Carefully tune the channel B DRIFT INDICATOR control until the channel B DISCRIMINATOR meter needle fluctuates about zero on miscellaneous keying signals.

(6) Adjust the channel B DRIFT INDICATOR control to correct for small frequency drifts that may occur in receiver B during operation.

(7) Rotate the CHANNEL SELECTOR switch to position A + B for diversity operation of the converter.

d. Afc Operation. To place the converter in operation with automatic frequency control, perform the steps outlined in paragraph 21. Move the AFC toggle switch to the ON position and proceed as follows:

(1) Rotate the CHANNEL SELECTOR switch to position A.

(2) Rotate the channel A AFC-XTAL-MARK HOLD switch to the right or left AFC position corresponding to the XTAL position required for correct copy (par. 21*d*), and immediately turn the channel A AFC SHIFT ADJUSTMENT until the AFC INDICATOR stops spinning. The teletypewriter should start printing.

(3) Adjust the channel A AFC THRESHOLD LEVEL control knob to the highest clockwise reading that does not allow weak signals to operate the teletypewriter. A practical way to find this setting is to advance the knob several divisions from the OFF position and check to see that the teletypewriter is printing correct copy. If the teletypewriter starts to print garbled copy, advance the knob further in the clockwise direction. The setting of the control is subject to change from time to time because of different transmission conditions. A steady marking condition results when the transmitting station shuts down or when the signal level drops below that set by the AFC THRESHOLD LEVEL.

(4) With the same teletypewriter signal tuned in on receiver B, rotate the CHANNEL SELECTOR switch to position B.

(5) Rotate the channel B AFC-XTAL-MARK HOLD switch to the right or left AFC position corresponding to the XTAL position required for correct copy (par. 21*h*), and immediately turn the channel B AFC SHIFT ADJUSTMENT until the AFC INDICATOR stops spinning. The teletypewriter should start printing.

(6) Adjust the channel B AFC THRESHOLD LEVEL control knob to the highest clockwise reading that does not allow weak signals to operate the teletypewriter ((3) above).

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(7) Rotate the CHANNEL SELECTOR switch to the A + B position. The teletypewriter should now print correct copy indicating that the converter is ready for dual diversity operation.

23. Stopping Procedure

The stopping procedure is the same for all types of operation. Throw the POWER switch to the OFF position.

Section IV. OPERATION UNDER UNUSUAL CONDITIONS

24. General

The operation of Frequency Shift Converter CV–116/URR may be difficult in regions where extreme cold, heat, humidity and moisture, or sand conditions prevail. In the following paragraphs, instructions are given on procedures for minimizing the effects of these unusual operating conditions.

25. Operation in Arctic Climates

Subzero temperatures and climatic conditions associated with cold weather affect the efficient operation of the equipment. Instructions and precautions for operation under such adverse conditions follow.

a. Handle the equipment carefully.

b. Keep the equipment warm and dry.

c. When equipment that has been exposed to cold temperature is brought into a warm room, it will sweat until it reaches room temperature. This condition also may occur when the equipment warms up after a cold night. When the equipment reaches room temperature, dry it thoroughly.

26. Operation in Tropical Climates

When operated in tropical climates, radio equipment may be installed in tents, huts, or, when necessary, in underground dugouts. When equipment is installed below ground and when it is set up in swampy areas, moisture conditions are more acute than normal in the tropics. Ventilation is usually very poor, and the high relative humidity causes condensation of moisture on the equipment whenever the temperature of the equipment becomes lower than the surrounding air. To minimize this condition, provide adequate ventilation.

27. Operation in Desert Climates

a. Conditions similar to those encountered in tropical areas often prevail in desert areas. Use the same measures to insure proper operation of the equipment.

b. Never tie cords to either the inside or the outside of tents. Desert areas are subject to sudden wind squalls which may jerk the connections loose or break the lines.

c. Keep the equipment as free from dust as possible. Make frequent preventive maintenance checks (pars. 28 through 31).

CHAPTER 4

ORGANIZATIONAL MAINTENANCE

Section I. PREVENTIVE MAINTENANCE SERVICES

28. Definition of Preventive Maintenance

Preventive maintenance is work performed on equipment to keep it in good working order so that breakdowns and needless interruptions in service will be kept to a minimum. Preventive maintenance differs from troubleshooting and repair in that its object is to prevent certain troubles from occurring.

29. General Preventive Maintenance Techniques

a. Use No. 000 sandpaper to remove corrosion.

b. Use a clean, dry, lint-free cloth or a dry brush for cleaning.

(1) If necessary, except for electrical contacts, moisten the cloth or brush with Solvent, Dry Cleaning (SD); wipe the parts dry with a cloth.

(2) Clean electrical contacts with a cloth moistened with carbon tetrachloride; wipe dry with a dry cloth.

Caution: Repeated contact of carbon tetrachloride with the skin, or prolonged breathing of fumes, is dangerous. Make sure adequate ventilation is provided.

c. If available, dry compressed air may be used at a line pressure not exceeding 60 pounds per square inch to remove dust from inaccessible places; be careful, however, or mechanical damage from the air blast may result.

Note. The initial airblast should be directed away from the equipment to prevent possible damage from any foreign matter which may have been in the air line.

d. For further information on preventive maintenance techniques, refer to TB SIG 178.

30. Use of Preventive Maintenance Forms (figs. 11 and 12)

a. The information in this paragraph is presented as a guide to the individual making an inspection of equipment in accordance with instructions on DA Forms 11–238 and 11–239. The decision as to which items on the forms are applicable to this equipment is a technical decision to be made in the case of first echelon maintenance, by the communication officer/chief or his designated representative, and in the case of second and third echelon maintenance, by the individual making the inspection. Instructions for the use of each form appear on the reverse side of the form.

b. Circled items on figures 11 and 12 are either partially or totally applicable to Frequency Shift Converter CV–116/URR. Paragraph numbers in the ITEM column refer to preventive maintenance information in this manual.

31. Performing Preventive Maintenance

a. Performing Exterior Preventive Maintenance.

Caution: Tighten screws, nuts, and bolts carefully. Fittings tightened beyond the pressure for which they are designed will be damaged or broken.

(1) Check for completeness and satisfactory condition of the converter unit (par. 7).

(2) Check suitability of location and installation for normal operation (pars. 11 and 13).

(3) Remove dirt and moisture from cords, jacks, plugs, and panels of the converter.

(4) Inspect the seating of the fuses (fig. 9) and all plugs and connectors.

(5) Inspect all controls for binding, scraping, excessive looseness, worn shafts, misalinement, and positive action (figs. 8, 9, and 10).

(6) Check for normal operation (pars. 18 through 23).

(7) Clean and tighten the panel mountings (fig. 6).

OPERATOR FIRST ECHELON MAINTENANCE CHECK LIST FOR SIGNAL CORPS EQUIPMENT

RADIO COMMUNICATION, DIRECTION FINDING, CARRIER, RADAR

INSTRUCTIONS: See other side

EQUIPMENT NOMENCLATURE | EQUIPMENT SERIAL NO.

LEGEND FOR MARKING CONDITIONS: ✓ Satisfactory; X Adjustment, repair or replacement required; (X) Defect corrected.
NOTE: Strike out items not applicable.

DAILY

NO.	ITEM	CONDITION S	M	T	W	T	F	S
1	COMPLETENESS AND GENERAL CONDITION OF EQUIPMENT (*receiver, transmitter, carrying cases, wire and cable, microphones, tubes, spare parts, technical manuals and accessories*). PAR. 31 a (1)							
2	LOCATION AND INSTALLATION SUITABLE FOR NORMAL OPERATION. PAR. 31 a (2)							
3	CLEAN DIRT AND MOISTURE FROM ANTENNA, MICROPHONE, HEADSETS, CHESTSETS, KEYS, JACKS, PLUGS, TELEPHONES, CARRYING BAGS, COMPONENT PANELS. PAR. 31 a (3)							
4	INSPECT SEATING OF READILY ACCESSIBLE "PLUCK-OUT" ITEMS: TUBES, LAMPS, CRYSTALS, FUSES, CONNECTORS, VIBRATORS, PLUG-IN COILS AND RESISTORS. PAR. 31 a (4)							
5	INSPECT CONTROLS FOR BINDING, SCRAPING, EXCESSIVE LOOSENESS, WORN OR CHIPPED GEARS, MISALIGNMENT, POSITIVE ACTION. PAR. 31 a (5)							
6	CHECK FOR NORMAL OPERATION. PAR. 31 a (6)							

WEEKLY

NO.	ITEM	CONDITION	NO.	ITEM	CONDITION
7	CLEAN AND TIGHTEN EXTERIOR OF COMPONENTS AND CASES, RACK MOUNTS, SHOCK MOUNTS, ANTENNA MOUNTS, COAXIAL TRANSMISSION LINES, WAVE GUIDES, AND CABLE CONNECTIONS. PAR. 31 a (7)		13	INSPECT STORAGE BATTERIES FOR DIRT, LOOSE TERMINALS, ELECTROLYTE LEVEL AND SPECIFIC GRAVITY, AND DAMAGED CASES.	
8	INSPECT CASES, MOUNTINGS, ANTENNAS, TOWERS, AND EXPOSED METAL SURFACES, FOR RUST, CORROSION, AND MOISTURE. PAR. 31 a (8)		14	CLEAN AIR FILTERS, BRASS NAME PLATES, DIAL AND METER WINDOWS, JEWEL ASSEMBLIES. PAR. 31 a (12)	
9	INSPECT CORD, CABLE, WIRE, AND SHOCK MOUNTS FOR CUTS, BREAKS, FRAYING, DETERIORATION, KINKS, AND STRAIN. PAR. 31 a (9)		15	INSPECT METERS FOR DAMAGED GLASS AND CASES. PAR. 31 a (13)	
10	INSPECT ANTENNA FOR ECCENTRICITIES, CORROSION, LOOSE FIT, DAMAGED INSULATORS AND REFLECTORS.		16	INSPECT SHELTERS AND COVERS FOR ADEQUACY OF WEATHERPROOFING.	
11	INSPECT CANVAS ITEMS, LEATHER, AND CABLING FOR MILDEW, TEARS, AND FRAYING. PAR. 31 a (10)		17	CHECK ANTENNA GUY WIRES FOR LOOSENESS AND PROPER TENSION.	
12	INSPECT FOR LOOSENESS OF ACCESSIBLE ITEMS: SWITCHES, KNOBS, JACKS, CONNECTORS, ELECTRICAL TRANSFORMERS, POWERSTATS, RELAYS, SELSYNS, MOTORS, BLOWERS, CAPACITORS, GENERATORS, AND PILOT LIGHT ASSEMBLIES. PAR. 31 a (11)		18	CHECK TERMINAL BOX COVERS FOR CRACKS, LEAKS, DAMAGED GASKETS, DIRT AND GREASE.	

19 IF DEFICIENCIES NOTED ARE NOT CORRECTED DURING INSPECTION, INDICATE ACTION TAKEN FOR CORRECTION. PAR. 31 a (15)

DA FORM 1 MAY 51 11-238 REPLACES DA AGO FORM 419, 1 DEC 50, WHICH IS OBSOLETE.

Figure 11. DA Form 11–238.

SECOND AND THIRD ECHELON MAINTENANCE CHECK LIST FOR SIGNAL CORPS EQUIPMENT

RADIO COMMUNICATION, DIRECTION FINDING, CARRIER, RADAR

INSTRUCTIONS: See other side

EQUIPMENT NOMENCLATURE | EQUIPMENT SERIAL NO.

LEGEND FOR MARKING CONDITIONS: ✓ Satisfactory; X Adjustment, repair or replacement required; Ⓧ Defect corrected.
NOTE: Strike out items not applicable.

NO.	ITEM	CONDITION
1	COMPLETENESS AND GENERAL CONDITION OF EQUIPMENT *(receiver, transmitter, carrying cases, wire and cable, microphones, tubes, spare parts, technical manuals and accessories).* PAR. 310 (1)	
2	LOCATION AND INSTALLATION SUITABLE FOR NORMAL OPERATION. PAR. 310 (2)	
3	CLEAN DIRT AND MOISTURE FROM ANTENNA, MICROPHONE, HEADSETS, CHESTSETS, RELAY, JACKS, PLUGS, TELEPHONES, CARRYING BAGS, COMPONENT PANELS. PAR. 310 (3)	
4	INSPECT SEATING OF READILY ACCESSIBLE "PLUCK-OUT" ITEMS: TUBES, LAMPS, CRYSTALS, FUSES, CONNECTORS, VIBRATORS, PLUG-IN COILS AND RESISTORS. PAR. 310 (4)	
5	INSPECT CONTROLS FOR BINDING, SCRAPING, EXCESSIVE LOOSENESS, WORN OR CHIPPED GEARS, MISALIGNMENT, POSITIVE ACTION. PAR. 310 (5)	
6	CHECK FOR NORMAL OPERATION. PAR. 310 (6)	
7	CLEAN AND TIGHTEN EXTERIOR OF COMPONENTS AND CASES, RACK MOUNTS, SHOCK MOUNTS, ANTENNA MOUNTS, COAXIAL TRANSMISSION LINES, WAVE GUIDES, AND CABLE CONNECTIONS. PAR. 310 (7)	
8	INSPECT CASES, MOUNTINGS, ANTENNAS, TOWERS, AND EXPOSED METAL SURFACES, FOR RUST, CORROSION, AND MOISTURE. PAR. 310 (8)	
9	INSPECT CORD, CABLE, WIRE, AND SHOCK MOUNTS FOR CUTS, BREAKS, FRAYING, DETERIORATION, KINKS, AND STRAIN. PAR. 310 (9)	
10	INSPECT ANTENNA FOR ECCENTRICITIES, CORROSION, LOOSE FIT, DAMAGED INSULATORS AND REFLECTORS.	
11	INSPECT CANVAS ITEMS, LEATHER, AND CABLING FOR MILDEW, TEARS, AND FRAYING. PAR. 310 (10)	
12	INSPECT FOR LOOSENESS OF ACCESSIBLE ITEMS: SWITCHES, KNOBS, JACKS, CONNECTORS, ELECTRICAL TRANSFORMERS, POWERSTATS, RELAYS, SELSYNS, MOTORS, BLOWERS, CAPACITORS, GENERATORS, AND PILOT LIGHT ASSEMBLIES. PAR. 310 (11)	
13	INSPECT STORAGE BATTERIES FOR DIRT, LOOSE TERMINALS, ELECTROLYTE LEVEL AND SPECIFIC GRAVITY, AND DAMAGED CASES.	
14	CLEAN AIR FILTERS, BRASS NAME PLATES, DIAL AND METER WINDOWS, JEWEL ASSEMBLIES. PAR. 310 (12)	
15	INSPECT METERS FOR DAMAGED GLASS AND CASES. PAR. 310 (13)	
16	INSPECT SHELTERS AND COVERS FOR ADEQUACY OF WEATHERPROOFING.	
17	CHECK ANTENNA GUY WIRES FOR LOOSENESS AND PROPER TENSION.	
18	CHECK TERMINAL BOX COVERS FOR CRACKS, LEAKS, DAMAGED GASKETS, DIRT AND GREASE.	
19	ELECTRON TUBES - INSPECT FOR LOOSE ENVELOPES, CAP CONNECTORS, CRACKED SOCKETS; INSUFFICIENT SOCKET SPRING TENSION; CLEAN DUST AND DIRT CAREFULLY; CHECK EMISSION OF RECTIFIER TYPE TUBES. PAR. 310 (1)	
20	INSPECT FUSE CUT-OUTS FOR LOOSE PARTS, DIRT, MISALIGNMENT AND CORROSION.	
21	INSPECT FIXED CAPACITORS FOR LEAKS, BULGES, AND DISCOLORATION. PAR. 31b (2)	
22	INSPECT RELAY AND CIRCUIT BREAKER ASSEMBLIES FOR LOOSE MOUNTINGS; BURNED, PITTED, CORRODED CONTACTS; MISALIGNMENT OF CONTACTS AND SPRINGS; INSUFFICIENT SPRING TENSION; BINDING OF PLUNGERS AND RUBBE PARTS. PAR. 31b (3)	
23	INSPECT VARIABLE CAPACITORS FOR DIRT, MOISTURE, MISALIGNMENT OF PLATES, AND LOOSE MOUNTINGS. PAR. 31b (4)	
24	INSPECT RESISTORS, BUSHINGS, AND INSULATORS, FOR CRACKS, CHIPPING, BLISTERING, DISCOLORATION AND MOISTURE. PAR. 31b (5)	
25	INSPECT TERMINALS OF LARGE FIXED CAPACITORS AND RESISTORS FOR CORROSION, DIRT AND LOOSE CONTACTS. PAR. 31b (6)	
26	CLEAN AND TIGHTEN SWITCHES, TERMINAL BLOCKS, BLOWERS, RELAY CASES, AND INTERIORS OF CHASSIS AND CABINETS NOT READILY ACCESSIBLE. PAR. 31b (7)	
27	INSPECT TERMINAL BLOCKS FOR LOOSE CONNECTIONS, CRACKS AND BREAKS. PAR. 31b (8)	
28	CHECK SETTINGS OF ADJUSTABLE RELAYS. PAR. 31b (9)	
29	LUBRICATE EQUIPMENT IN ACCORDANCE WITH APPLICABLE DEPARTMENT OF THE ARMY LUBRICATION ORDER. PAR. 31b (10)	
30	INSPECT GENERATORS, AMPLIDYNES, DYNAMOTORS, FOR BRUSH WEAR, SPRING TENSION, ARCING, AND FITTING OF COMMUTATOR.	
31	CLEAN AND TIGHTEN CONNECTIONS AND MOUNTINGS FOR TRANSFORMERS, CHOKES, POTENTIOMETERS, AND RHEOSTATS. PAR. 31b (11)	
32	INSPECT TRANSFORMERS, CHOKES, POTENTIOMETERS, AND RHEOSTATS FOR OVERHEATING AND OIL-LEAKAGE. PAR. 31b (12)	
33	BEFORE SHIPPING OR STORING - REMOVE BATTERIES.	
34	INSPECT CATHODE RAY TUBES FOR BURNT SCREEN SPOTS.	
35	INSPECT BATTERIES FOR SHORTS AND DEAD CELLS.	
36	INSPECT FOR LEAKING WATERPROOF GASKETS, WORN OR LOOSE PARTS. PAR. 31b (13)	
37	MOISTURE AND FUNGIPROOF. PAR. 31b (14)	
38	IF DEFICIENCIES NOTED ARE NOT CORRECTED DURING INSPECTION, INDICATE ACTION TAKEN FOR CORRECTION. PAR. 31b (15)	

DA FORM 1 MAY 51 11-239 REPLACES DA AGO FORM 419, 1 DEC 50, WHICH IS OBSOLETE.

TM2241-11

Figure 12. DA Form 11-239.

(8) Inspect case, mounting, and exposed metal surfaces for rust, corrosion, and moisture.

(9) Inspect cord and cable for cuts, breaks, fraying, deterioration kinks, and strain (fig. 7).

(10) Inspect cabling for tears, mildew, or fraying (fig. 7).

(11) Inspect for looseness of accessible items: switches, knobs, jacks, connectors, transformers, relays, motors, blower, capacitors, and pilot light assemblies.

(12) Clean the meter and indicator windows and jewel assembly.

(13) Inspect meters for damaged glass and cases.

b. Performing Interior Preventive Maintenance.

Caution: Disconnect all power before performing the following operations. Upon completion, reconnect the power and check for satisfactory operation.

(1) Do not work on tubes immediately after shutdown. Severe burns may result from contact with hot envelopes. Inspect glass envelopes for cracks and accumulation of dirt (see fig. 45 for tube location). Inspect firmness of tubes in their sockets. Press them firmly, but gently, straight down in their sockets. Do not jiggle the tubes from side to side as this may break the pins or spread the contacts of the socket. Inspect tube sockets at times when removal of the tubes is required. Check emission of tubes.

(2) Inspect terminals of the large fixed capacitors for corrosion and loose connections. Carefully inspect mountings to discover loose mounting screws, studs, or brackets. Examine leads for poor insulation, cracks, and evidences of dry rot. Cut away frayed strands on insulation. If wire is exposed, wrap it with friction tape. See that the terminals of capacitors are not cracked or broken. Thoroughly inspect the case of each large fixed capacitor for leaks, bulges, and discoloration. Clean the case of fixed capacitors, the insulating bushings, and all connections that are dirty or corroded. Capacitor cases and bushings usually can be cleaned with a dry cloth, however, if the deposit of dirt is hard to remove, moisten the cloth in solvent (SD).

(3) The relay is considered normal if the exterior is free from dirt or dust, the contacts are not burned, pitted, or corroded, the contacts are lined up and spaced correctly, the moving parts travel freely and function properly, the connections to the relay are tight, the wire insulation is not frayed or torn, the relay assembly is securely mounted, and the field coil shows no signs of overheating. Examine the contacts of the relay (par. 59) with the aid of a flashlight. Tighten all loose connections and mounting screws, but do not apply enough force to damage the screws or break the parts they hold. Brush the exterior with a soft brush. If it is very dirty, clean it with a brush dipped in solvent (SD). If loose connections are found, they should be corrected. If dirty or corroded, remove, clean, and replace them carefully.

(4) Inspect variable capacitor C8 (fig. 48) for dirt, moisture, misalinement of plates, and loose mountings.

(5) Inspect all resistors (figs. 43 and 46) for blistering, discoloration, and other signs of overheating. Inspect the coating of the cement-coated resistors for signs of cracks and chipping. Inspect all leads, but be careful not to move resistors with delicate pigtail leads or these leads may break at the point where they enter the resistor body. Resistors that have become discolored indicate that they have been overheated and that there may be circuit trouble which requires analysis and correction.

Note. When fungiproofed resistors are heated, a harmless brown stain may appear.

(6) Inspect terminals of large fixed capacitors and resistors for corrosion, dirt, and loose contacts ((2) above).

(7) Inspect the mechanical action of each switch. Look for signs of dirt and corrosion of all exposed elements of the switch (fig. 46). Examine the ganged switches to see that their shafts are lubricated properly (fig. 13) and that the electrical contacts are clean. The inspection is visual. Do not pry the leaves of the

switch apart. The rotating members should make good contact with the stationary members, and as the former slides into the latter, a spreading of the stationary contact levels should be noticed. Clean the exterior surfaces of switches with a stiff brush moistened with solvent (SD).

(8) Inspect terminal blocks for loose connections, cracks, and breaks.

(9) Check the settings of relays K1 and K2 (par. 59).

(10) Lubricate the equipment as described in paragraphs 32 and 33.

(11) Clean and tighten connections and mountings for transformers, motors, potentiometers, and rheostats.

(12) Inspect transformers, motors, potentiometers, and rheostats for overheating.

(13) Check the front panel and case to be certain that a waterproof bond is maintained.

(14) Check the adequacy of moistureproof and fungiproof treatment (pars. 34 and 35).

(15) If deficiencies noted are not corrected during inspection, indicate action needed for correction.

Section II. LUBRICATION

32. Lubrication

The lubrication of the converter is relatively simple. The points needing lubrication and the frequency with which they should be lubricated under normal operating conditions are shown in figure 13.

a. Switches. The switch shafts are accessible from the bottom or the top of the equipment. No disassembly is necessary for their lubrication. Clean the shafts and areas adjacent to the switch shaft bearings. Apply a small amount of oil, lubricating, preservative, special (PL) to the bearings. Wipe off excess. The detent ball bearings of the rotary switches should be given a light coating of grease at monthly intervals.

b. Converter Case. The guide rails inside the case and the contacting surfaces of the fasteners should be given a light coating of grease at monthly intervals.

c. Afc Unit Gears. The contacting gear surfaces, as well as the gear shafts, in the gear case of the afc unit, should be coated with grease at yearly intervals. See figure 48 and paragraph 58*b* for the method of disassembling the afc unit for lubrication.

d. Blower Motor. Lubricate the two ball bearings of the blower motor annually. The blower motor may be dissassembled for access to the ball bearings by removing the four screws that hold the end balls together. Use a few drops of Oil, Lubricating, Aircraft Instrument (Low Volatility) (MIL–L–6085). The oil may be introduced into the ball bearing race by using an awl as a dropper.

33. Lubrication Under Unusual Conditions

The effects of extreme cold and heat on lubrication materials and lubricants are explained in TB SIG 69. Observe all precautions outlined in TB SIG 69 and pay strict attention to all lubrication instructions when operating equipment under conditions of extreme cold or heat.

Section III. WEATHERPROOFING

34. Weatherproofing

a. General. Signal Corps equipment, when operated under severe climatic conditions such as those prevailing in tropical, Arctic, and desert regions, requires special treatment and maintenance. Fungus growth, insects, dust, corrosion, salt spray, excessive moisture, and extreme temperatures are harmful to most materials.

b. Tropical Maintenance. A special moistureproofing and fungiproofing treatment has been devised which, if properly applied, provides a reasonable degree of protection. This treatment is fully explained in TB SIG 13 and TB SIG 72.

c. Arctic Maintenance. Special precautions necessary to prevent equipment failure in areas subject to extremely low temperatures are fully explained in TB SIG 66 and TB SIG 219.

d. Desert Maintenance. Special precautions necessary to prevent equipment failure in areas subject to extremely high temperatures, low humidity, and excessive sand and dust are fully explained in TB SIG 75.

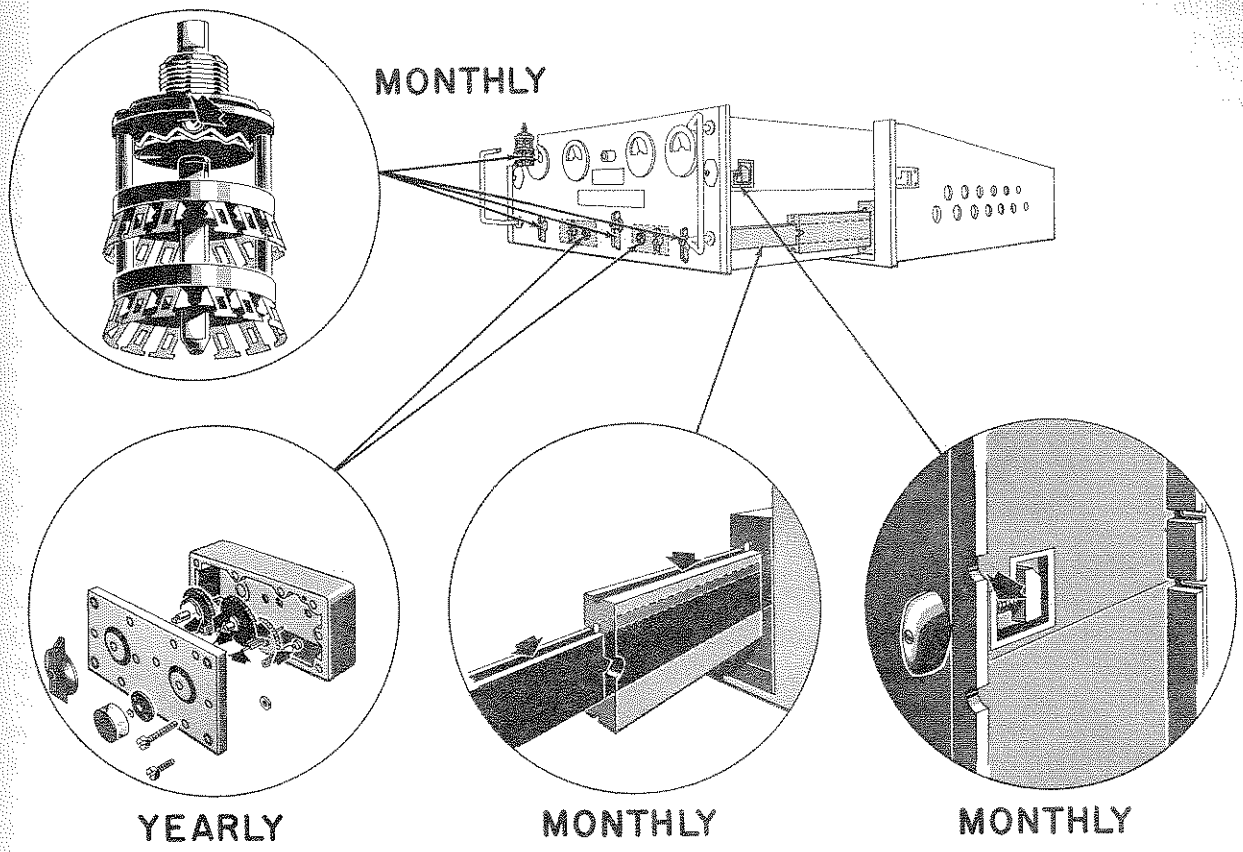

Figure 13. Frequency Shift Converter CV-116/URR, lubrication points.

35. Rustproofing and Painting

a. When the finish on the case has been badly scarred or damaged, rust and corrosion can be prevented by touching up bared surfaces. Use No. 00 or No. 000 sandpaper to clean the surface down to the bare metal; obtain a bright smooth finish.

Caution: Do not use steel wool. Minute particles frequently enter the case and cause harmful internal shorting or grounding of circuits.

b. When a touchup job is necessary, apply paint with a small brush. Remove rust from the case by cleaning corroded metal with solvent (SD). In severe cases, it may be necessary to use solvent (SD) to soften the rust and to use sandpaper to complete the preparation for painting. Paint used will be authorized and consistent with existing regulations.

CHAPTER 5

THEORY

36. Block Diagram
(fig. 14)

a. General.

(1) The frequency-shift method of communication is a system of automatic code transmission and reception that shifts the carrier frequency up and down between two distinct frequencies to designate, respectively, the mark and space portions of the code characters. It provides noise reduction and other advantages of frequency modulation for telegraph and teletypewriter signals. The frequency separation employed between mark and space signals with this equipment may be as little as 150 cps and as much as 1,000 cps.

(2) Frequency Shift Converter CV–116/URR is designed for use with two radio receivers operating in a dual-diversity system. In space diversity, the two receivers are tuned to the same frequency but the receiving antennas are spaced several wave lengths apart. In frequency-diversity reception, the two receivers are tuned to separate frequency-shift carriers which are simultaneously carrying the same mark-space characters. With this type of reception, the frequency separation between carriers is limited only by the range of the associated receivers and transmitters. The advantage of space-diversity operation results from the fact that a single rf carrier generally does not fade simultaneously at spots that are more than one wave length apart. The advantage of frequency diversity is that fading of carriers of different frequencies generally does not occur at the same time.

(3) The if. output of one receiver is connected to INPUT A of Frequency Shift Converter CV–116/URR and the if. output of the other receiver is connected to INPUT B. Each input circuit amplifies the signal and converts it to a lower if. The two frequency-shift signals, now operating at lower if. frequencies, are fed to the diversity circuits where they are amplified, limited, and combined. The resultant frequency shift signal is then converted into dc pulses which ultimately control a tty unit. In this manner, optimum signals are obtained from diversity reception. Figure 14 shows the path followed by the signals in Frequency Shift Converter CV–116/URR. A complete schematic diagram is shown in figure 62.

(4) The tty output circuit of the converter produces a *current on* and *current off* square wave signal of one polarity. This is known as the *neutral system* as opposed to the *polar system* which produces square wave current pulses of opposite polarities. Figure 15 contrasts the ideal neutral wave form and the practical neutral wave form as it is achieved in the output of the converter. In the neutral output of the converter, a marking current of 60 ma normally is used to operate the selector magnet of the teletypewriter printer. Absence of current is used as a space signal. In the polar system, the positive pulse would be used to mark, the negative pulse to space.

(5) The afc circuits correct for the effects of frequency drifts in the if. signals fed to the converter inputs. A motor-driven capacitor in the oscillator tuning circuit accomplishes this when actuated by an *off-frequency* voltage developed across the discriminator output.

b. Input Circuits. The input circuits for each channel consist of an rf amplifier V1 or V27, an oscillator V2 or V28, and a mixer stage V3 or V29 which amplify the if. output of the associated receiver and convert it to a lower if. The output of each input circuit is fed to the diversity limiter circuits and to the afc first limiting amplifier.

c. Diversity Limiting Amplifiers. Limiting stages V16, V17, V18, V19, and V20 are designed to apply a constant voltage to the input circuit of the diversity discriminators. Limiter diode V19 provides a clipping action which prevents voltage peaks from exceeding a predetermined value. Tube noises, circuit noises, and static appear as amplitude variations of the signal, therefore, the full potentialities of frequency modulation in reducing interference can be realized.

d. Diversity Discriminators. The individual discriminator circuits in conjunction with V21 and V22 (fig. 22) are identical, except for the operating frequency. Because they are tuned to different frequencies, one resonates only to channel A signals, and the other resonates only to channel B signals. Primarily, each discriminator functions to change frequency shifts about the carrier to dc voltages which correspond to the original mark-space pulses. The output networks of the two discriminators are in series, therefore, the voltages add and are fed to the keyer circuit.

e. Keyer Circuit. The keyer circuit consists of cathode follower V23A, keyer amplifier V24A, space-keyer V24B and mark-keyer stage V25 and V26. The keyer section opens or closes the loop supply and applies dc pulses across the two pins connected to the tty selector magnet.

f. Afc Limiting Amplifiers. The limiting amplifier section, consisting of V4, V5, V6, and V7 in channel A, amplifies part of the signal appearing across the output circuit of the mixer stage and feeds it to the discriminator diode (V8) as a constant amplitude alternating voltage. This voltage, after demodulation at the discriminator, is used to actuate the afc system which corrects for any frequency drift of the carrier or local oscillator. The afc limiting amplifier consisting of V30, V31, V32, and V33 serves the same function in channel B.

g. Afc Discriminator. Referring to channel A, discriminator diode V8, by rectification, produces a dc voltage at the grid of each section of V9 for any signal frequency appearing at the secondary of the discriminator transformer. The dc voltage is directly proportional to any frequency deviation from the correct center if. frequency of 50 kc up to ±1 kc, after which the output voltage drops off rapidly. A similar demodulation takes place in channel B discriminator, which responds to frequencies centering around 29.3 kc.

h. Sampler and Shift Reference Circuits. Referring to channel A, sampler V9 samples the voltage across the discriminator load and permits only long, general, frequency drifts to actuate the afc system. Otherwise the afc system would go into operation with every frequency shift caused by normal mark-space keying. The shift reference stage, tube V10A, permits adjustment for different discriminator voltage outputs so that the dc amplifier circuit can be balanced for various frequency shifts employed by the incoming signal. When properly adjusted for an incoming signal of a given frequency shift, only a drift in mark frequency will cause an unbalanced condition in the dc amplifiers. In channel B, sampler V35 and shift reference tube V36A serve similar functions.

i. Dc Amplifier Stages. The dc amplifier consists of two dc amplifier circuits and an inverter stage. Normally, with no *error* signal from the discriminator, the dc amplifier is in a balanced condition and a negative voltage is applied to the grids of the motor drive tube. Any if. frequency drift will disturb the dc amplifier balance and cause a voltage to be amplified and fed to the motor drive circuit.

j. Motor and Afc Motor Drive Circuit. Tubes V15 and V40 are the motor drive stages for their respective channel sections. Tube V15, associated with the motor drive stage of channel A, controls a small two-phase ac motor mechanically coupled to turn the tuning capacitor of oscillator V2. Any error signal due to a frequency drift is amplified and used to actuate the motor, which drives the tuning capacitor to correct the oscillator frequency. As soon as the frequency is corrected, balance is restored to the dc amplifiers and the input to the motor drive stage is again zero. In a similar manner, V40 drives another motor which is coupled to the tuning capacitor of channel B oscillator V28 to correct for any frequency drift.

k. Threshold Control Circuit. The threshold control circuit, consisting of a signal rectifier and a threshold amplifier, operates a relay. On weak signals, this action causes one set of relay contacts to open the afc tuning-capacitor motor circuit and

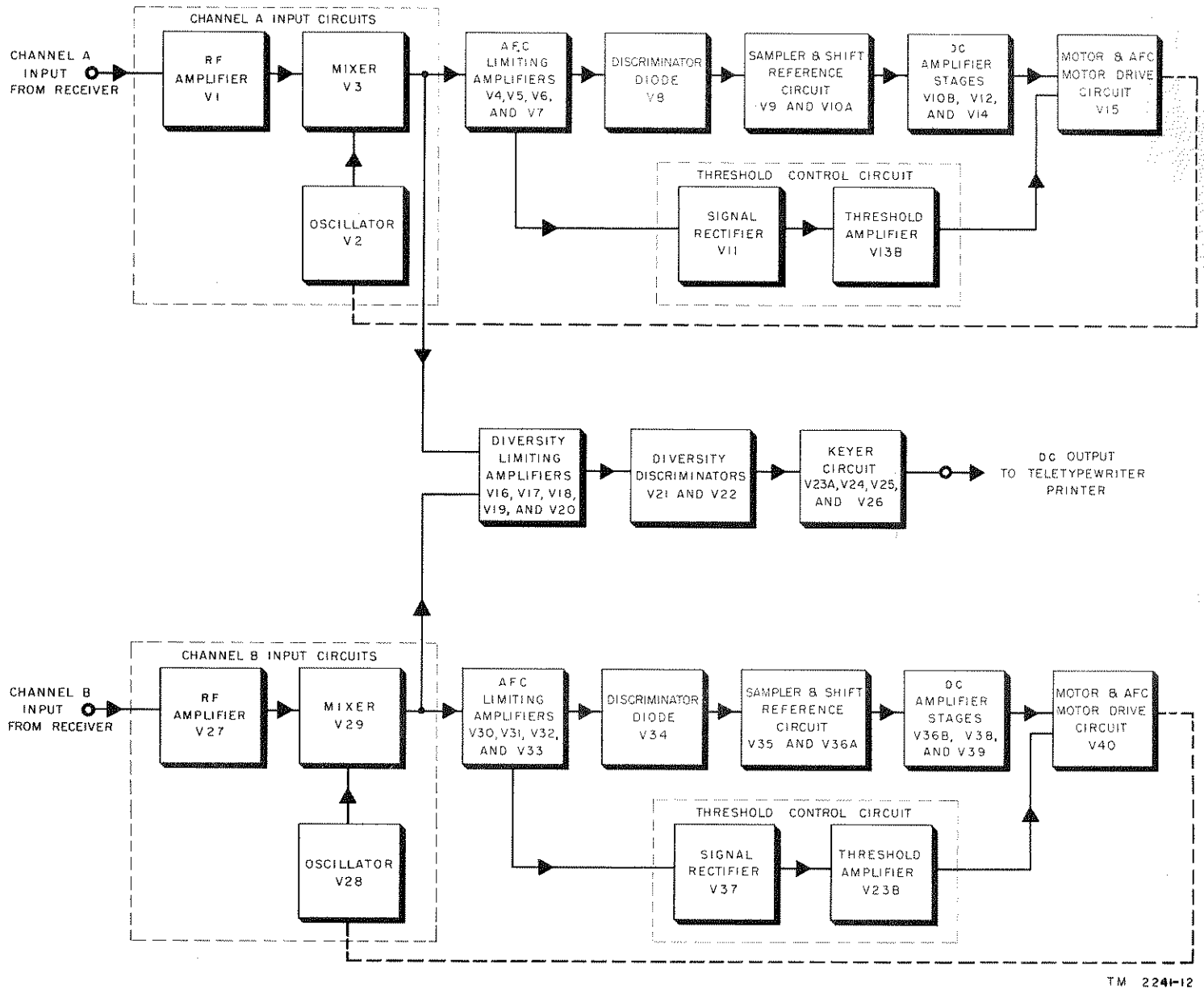

Figure 14. Converter unit, block diagram.

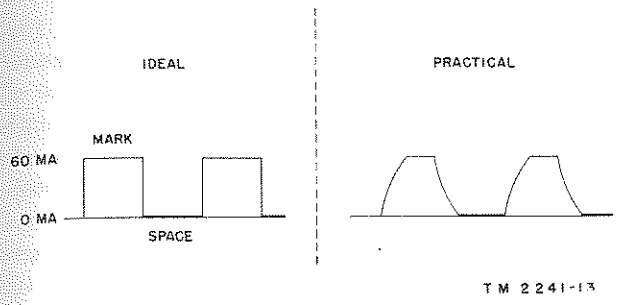

Figure 15. Neutral wave shapes.

the other set of contacts to ground the keyer amplifier so that a 60 ma mark-hold signal is fed to the teletypewriter printer.

37. Rf Amplifier

(figs. 16 and 62)

a. The first stage of each channel input circuit is an rf amplifier, V1 for channel A and V27 for channel B. The signal voltage from the channel A receiver is connected to input connector J1, and the signal voltage from the channel B receiver is connected to input connector J5. The signals applied to the input jacks are inductively coupled to the grids of V1 and V27 by transformers T1 and T3. In channel A, capacitor C1 combined with an adjustable iron core inserted in the secondary coil of T1 tunes the grid circuit of V1 within the range of 450 to 510 kc. Resistor R1 is the cathode resistor across which the grid-bias voltage is developed. Resistor R2 is a voltage dropping resistor and it is bypassed by capacitor C4 so that rf voltage is not developed across R2. The screen grid is connected to a voltage-dropping resistor R3, which is bypassed by capacitor C5. Resistor R4 and capacitor C6 form a decoupling network which prevents interaction between the various stages.

b. Amplified signals from V1 are inductively coupled to the control grid of mixer tube V3 by transformer T2. Fixed capacitor C3 and the primary winding of T2 form a tuned circuit in the plate circuit of V1. The circuit can be set to resonance at the input frequency by adjusting the iron slug in the primary winding. Once T1 and T2 are adjusted to the receiver if. frequency, no further adjustments are ordinarily required. Tube V27 serves as the rf amplifier for channel B. The theory of operation of this stage is the same as for channel A with the corresponding component parts serving identical purposes.

38. Oscillator

(figs. 17 and 18)

a. After being amplified by tubes V1 and V27, the input signals are heterodyned to a lower if. by beating with local signals generated by oscillators V2 and V28. In channel A, oscillator V2 produces a high frequency (hf) voltage which mixes in tube V3 with the rf signal from V1 for conversion to a lower frequency. This new if. is 50 kc

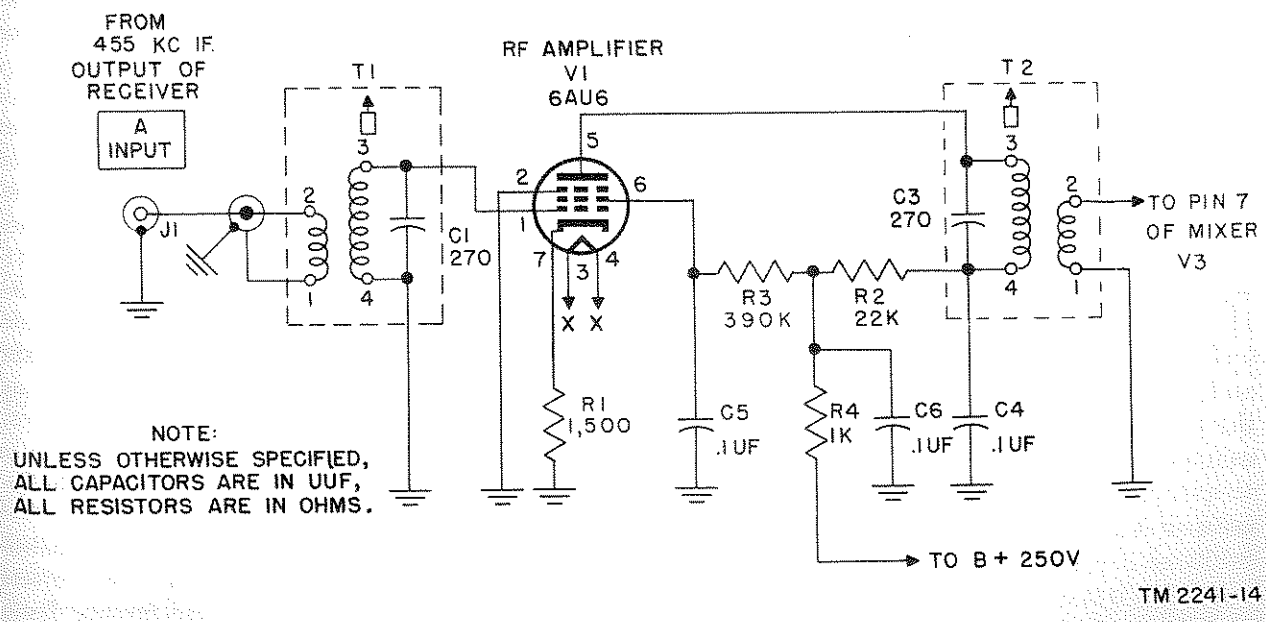

Figure 16. Channel A rf amplifier, simplified schematic diagram.

Figure 14. Converter unit, block diagram.

for channel A and 29.3 kc for channel B. These two signals are fed to the diversity circuits.

b. Each oscillator uses a dual-triode tube in a modified multivibrator circuit. A minute positive voltage applied at the control grid of section B of oscillator tube V2 will be amplified and appear, coupled through C15, at the control grid of section A. Section A further amplifies the signal and feedback is achieved through C14, C9, and S1E to the grid of V2B. Such an arrangement oscillates because each triode section produces a phase shift of 180°, the phase necessary to sustain oscillation. Resistors R9 and R18 are grid resistors for the two sections of tube V2. Resistors R16 and R17 are the plate load resistors. The oscillator output is coupled through capacitor C13 to the oscillator grid (pin 2) of the mixer tube, V3. The plate power supply for oscillator V2 is decoupled by R19 and C16. The circuit of oscillator V2 is identical with oscillator V28 in channel B.

c. The frequency of the oscillator can be controlled by either a crystal or a variable-frequency tuning circuit. When operated as a variable-frequency oscillator, the frequency may be controlled automatically by the afc circuit or manually by the DRIFT INDICATOR control C8, located on the front panel. The afc system corrects for carrier signal drifts up to plus or minus 2,000 cycles. For a detailed description of the afc circuits, see paragraphs 43 to 48. In channel A, the frequency is controlled either by crystal Y1 (fig. 18) or by the variable-frequency tuning circuit L1, C7, and C8. Selection is made by means of switch S1 located on the front panel. Switch S1 is a 5-position, 5-section switch marked AFC-XTAL-MARK HOLD on the converter panel. Two sections, D and E, are used in the oscillator for switching from one frequency control circuit to the other (fig. 18). In both XTAL positions, the crystal is series connected from the plate (pin 1) of V2A to the grid (pin 7) of V2B through S1E and feedback capacitor C14. Resistors R7 and R8 provide a voltage dividing network for the feedback circuit when operating with crystal control. Switch section D grounds the variable frequency tuning elements to make them inoperative on XTAL control. On MARK HOLD, the oscillator is crystal controlled and the switcs circuits of S1D and S1E are identical with those used on XTAL control.

d. In either AFC position, the variable frequency tuning circuit L1, C7, and C8 (in channel A) is connected to the oscillator tube in place of the crystal. The crystal is grounded through switch section D to make it inoperative on afc operation. When switch S1 is in the AFC position, the frequency is controlled either automatically or manually by the inductance-capacitance combination L1, C7, and C8. Under afc control conditions, tuning capacitor C8 is motor driven by a servo system to maintain correct tuning of the oscillator in the presence of drift of the input signals. The tuning combination L1, C7, and C8 has a frequency range of 400 to 460 kc. For channel B, tube V28 together with the crystal Y2, or the vfo tuning circuit L2, C59, and C60 form a similar oscillator having a frequency range of 420.7 to 480.7 kc. In all positions, the unused switch contact points are grounded to prevent coupling between the oscillator and other stages.

39. Mixer Stage

(fig. 19)

a. The mixer circuit uses a pentagrid converter. An incoming signal from a receiver having a 450–510 kc if. is mixed with an oscillator voltage 50 kc lower to form a new if. signal of 50 kc which is passed on to band-pass filter Z1. The second control grid (pin 7) is connected to the untuned secondary winding of transformer T2. The first control grid (pin 2) is coupled to the output of the oscillator V2 through C13. The oscillator output is applied across resistor R5. Resistor R6 is the cathode resistor across which the grid-bias voltage is developed. Capacitor C10 acts as a bypass for the if. signal. Resistor R11 is the screen grid dropping resistor and it is bypassed by capacitor C11 so that rf voltage is not developed across it. The plate resistor R12 serves to match the plate load impedance to that of the band-pass filter Z1. Resistor R10 and capacitor C12 form an rf decoupling network. For channel B, tube V29 and its associated components form a similar mixer stage which feeds terminals 1 and 2 of band-pass filter Z6. For example, when used with a receiver having a 455-kc if., the channel B oscillator is tuned to 425.7 kc which, when mixed with the incoming signal, produces a 29.3-kc if. output.

b. Band-pass filters Z1 and Z6 limit the bandwidth to approximately 1,500 cycles. This rejects certain noise frequencies and interference from other transmitting stations. They also suppress

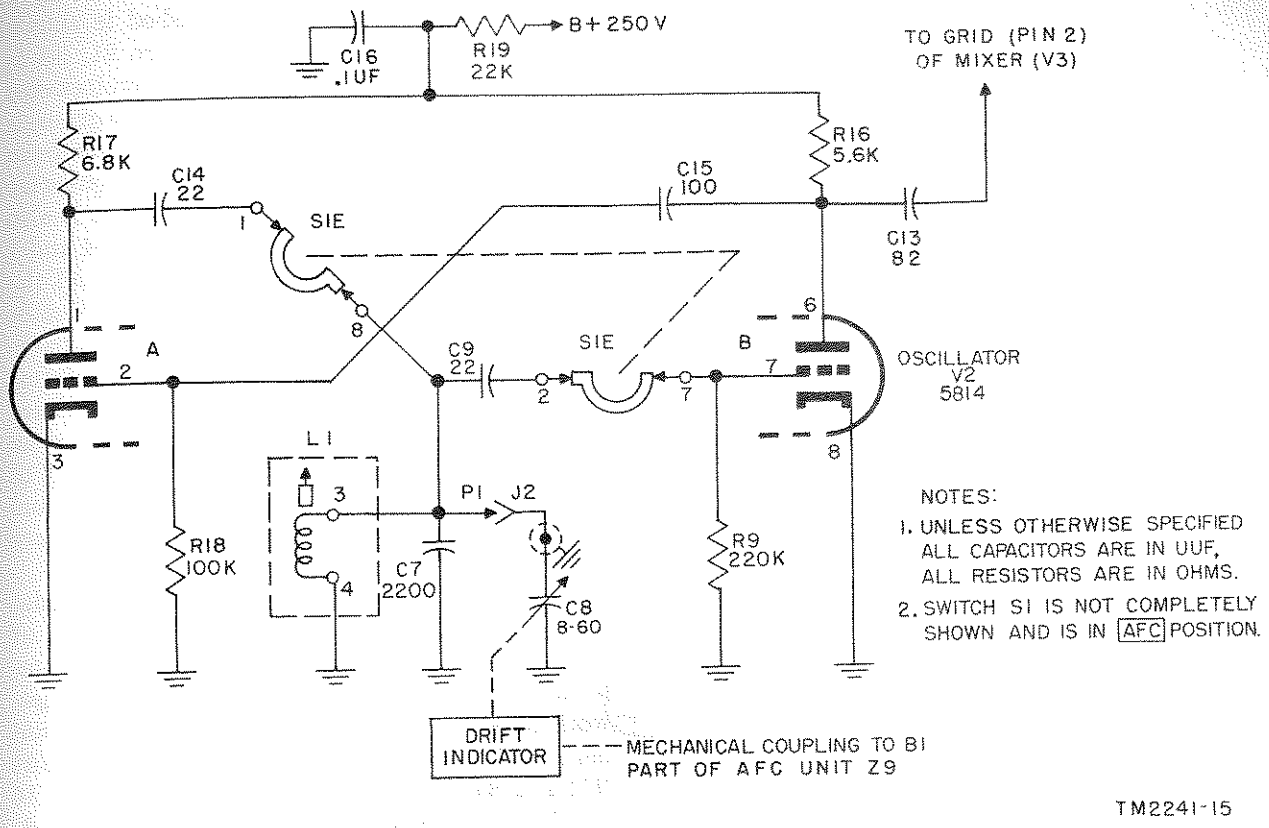

Figure 17. Channel A oscillator, schematic diagram.

the harmonics and sum frequencies produced in V3 and V29. The output of each filter works into a resistive load matching network consisting of resistors R13 and R14 across Z1 and R123 and R124 across Z6.

c. A difference exists between the circuitry of the channel A and channel B mixers. This difference occurs in the output connections of Z1 and Z6. The 50-kc signal of channel A suffers little attenuation in the matching network of Z1, while the 29.3-kc signal of channel B is attenuated nearly 6 db in the matching dividing network terminating Z6. Attenuating channels A and B by different amounts is necessary to compensate for gain inequality in other stages.

40. Diversity Limiting Amplifiers
(fig. 20 and 21)

a. Radio teletype signals, radiated from the transmitting antenna, vary in frequency in accordance with the original dc marking and spacing pulses, but are virtually constant in amplitude. In the radio link between the transmitter output and the converter input, these signals may encounter conditions which produce irregular variations in signal amplitudes. The limiting amplifiers in the diversity circuit minimize undesirable amplitude variations in the incoming signals before they are fed to the discriminators for detection.

b. The diversity limiting amplifiers, V16, V17, V18, V19 and V20, form three limiting stages and two peak-clipping circuits. There are two first limiting amplifiers, V16 for the output of channel A and V17 for the output of channel B. The outputs of V16 and V17 are coupled to the grid of the second limiting amplifier, V18. The plate of V16 is coupled to the control grid of V18 through coupling capacitor C34 and grid limiting resistor R76. For channel B signals, capacitor C41 and resistor R82 provide the necessary coupling from V17. Section B of CHANNEL SELECTOR switch S5 permits channel A, channel B, or channel A+B to drive the second limiting amplifier and, ultimately, the dc loop circuit for operating a teletypewriter printer. In position A, switch S5B grounds the plate of V17 to make channel B inoperative. Channel A is inoperative when S5B

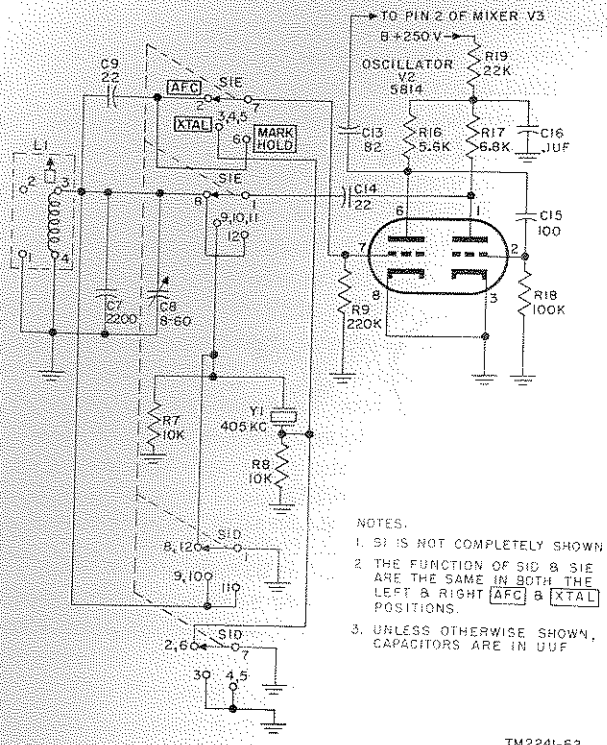

Figure 18. Switch S1 circuits for selecting variable-frequency or crystal oscillator operation.

is in position B, the plate of V16 being grounded through the switch. In position A + B, the plates of V16 and V17 are ungrounded permitting both channel A and channel B signals to feed V18.

c. Through S5, the CHANNEL SELECTOR switch on the front panel, the operator may elect to operate the converter through the channel A receiver, channel B receiver or, in diversity operation, both. How this is accomplished is shown schematically in figure 21. In figure 21, S5 is shown in the channel A, or fully counterclockwise position. In this position, section B of S5 grounds the plate of V17 and thus prevents the input from the channel B receiver from reaching the converter diversity section. In this position, section B also connects the alarm circuit (consisting of S4 and I 1) into the 115V line. Section S5A sets up the mark-hold circuit for channel A and deactivates it in channel B. This circuit is described in paragraph 42. In the channel B position, S5 performs functions similar to those performed in the channel A position. As can be seen in figure 21, when S5 is in the A + B position, the outputs from V16 and V17 are not grounded and the afc alarm and mark-hold circuits for both chanels A and B are activated.

d. Tubes V16 and V17 are sharp cutoff pentodes with the outputs combined at the control grid of V18. The input signal to each first limiting amplifier is taken from a resistive load matching network consisting of resistors R13 and R14 in channel A and R123 and R124 in channel B. Resistors R71 and R77 couple the signal to the grids of V16 and V17. Cathode resistors R72 and R78 provide the correct bias for their respective tubes and C37 and C38 act as the bypass capacitors. When the input signal to V16 becomes large enough, saturation takes place and no further increase in output voltage results. This saturation occurs over a wide range of input voltages. Actually, the gain of a limiter tube decreases as the input signal voltage increases and the result in an output signal of nearly constant amplitude. The gains

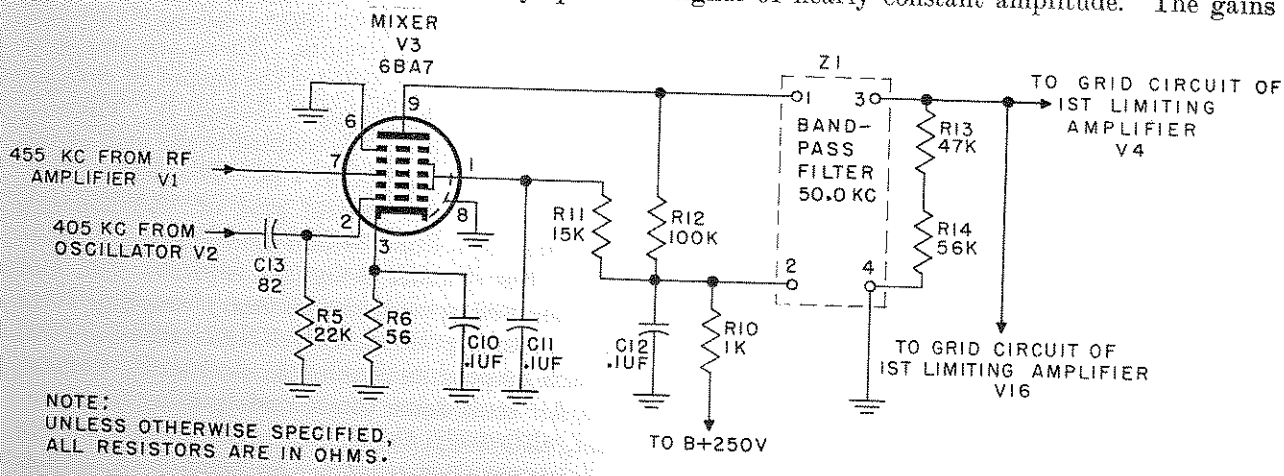

Figure 19. Channel A mixer stage, schematic diagram.

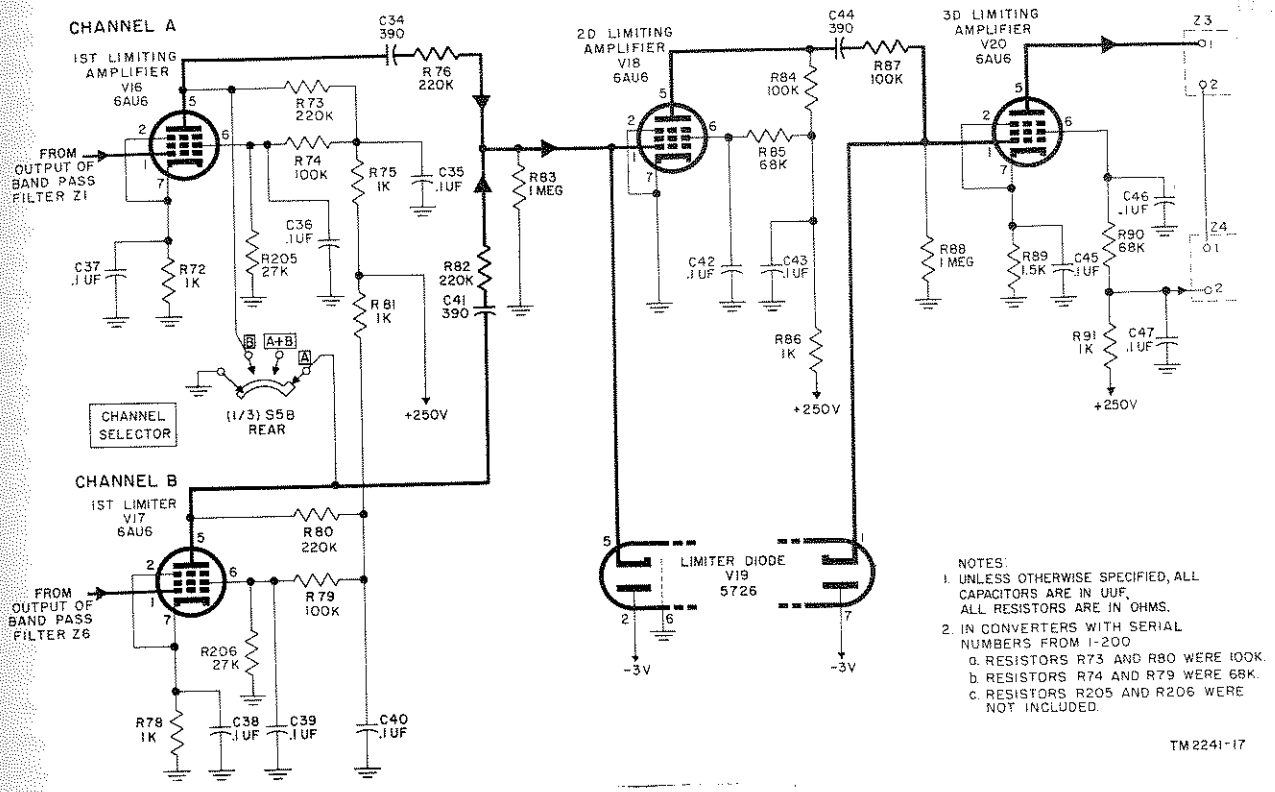

Figure 20. Diversity limiting amplifiers, schematic diagram.

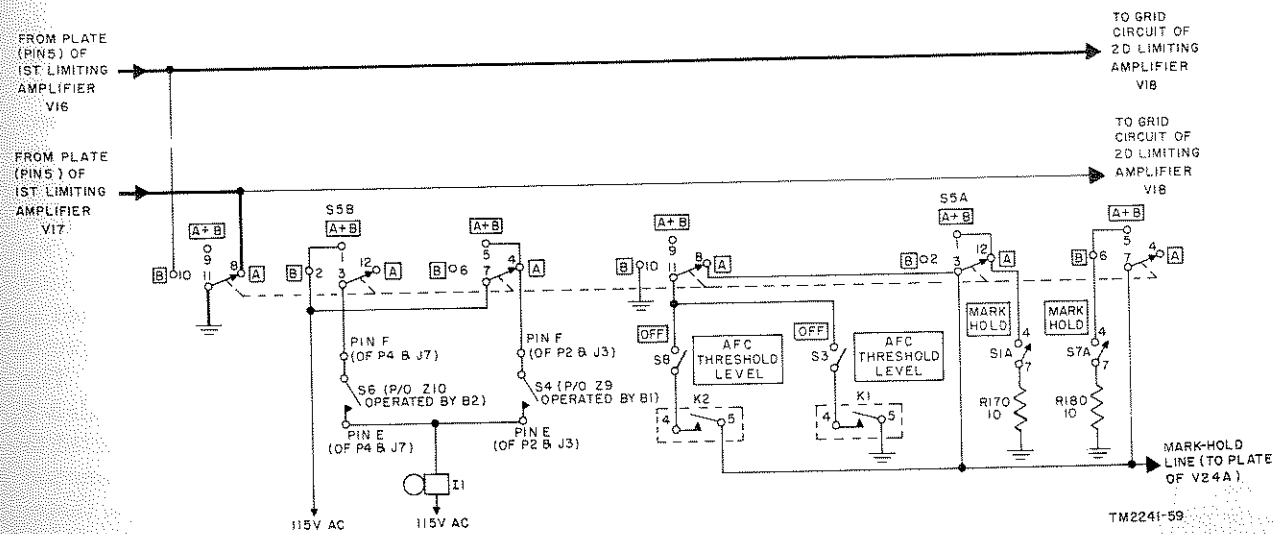

Figure 21. Switch S5, simplified schematic diagram.

of V16 and V17 are low for strong signals and high for weak signals. Resistors R73 and R80 are the plate load resistors. The voltage divider consisting of R74 and R205 fixes the screen grid voltage applied to V16, and the voltage divider consisting of R79 and R206 fixes the screen grid voltage applied to V17. Capacitors C36 and C39 bypass the screen grids of V16 and V17, respectively. The rf decoupling networks are formed by R75 and C35 and R81 and C40.

e. When the peak amplitude of a grid signal in either of the first limiting amplifier stages is small, limiting action does not take place. For this reason, additional limiter stages are required that will produce enough gain to provide sufficient signal voltage to saturate the final limiter with the smallest useful receiver signal.

f. The second limiting amplifier, V18, uses a sharp cutoff pentode in a grid-limiting type circuit. The signal input to the grid (pin 1) of V18 is through resistors R76 and R82 which serve to isolate the outputs of V16 and V17 from each other. At this point, the two signals are combined across grid resistors R83. This applied signal voltage is prevented from swinging too far in the negative direction by the action of limiter diode V19. This diode acts to prevent the grid voltage from dropping below −3 volts (*g* below). When the grid signal increases in the negative direction, the plate current of V18 decreases causing an increase in the plate voltage which continues until the grid voltage reaches −3 volts. At −3 volts, the plate voltage reaches a value which remains constant with further increase in negative signal. The screen grid voltage is applied to pin 6 through dropping resistor R85 which is bypassed by capacitor C42. Resistor-capacitor combination R86 and C43 form the decoupling network for the B+ circuits of V18. Resistor R84 is the plate load resistor.

g. Diode limiter V19 is a dual diode with each section connected in a separate peak-clipping circuit. The first section (pins 5 and 2) limits the signal on the grid of V18 to voltages more positive than −3 volts. In the same manner, the second diode section (pins 1 and 7) limits the signal on the grid of V20 to voltages more positive than −3 volts. As long as the input signal to either tube is more positive than the −3 volts on the plate, the diode limiter section is effectively an open switch. When the input to a diode section becomes more negative than −3 volts, the diode conducts heavily and effectively connects the grid of V18 or V20 to the −3 volt supply. Thus, each signal on the grids of V18 and V20 is limited to a maximum negative value of 3 volts.

h. The third limiter, V20, utilizes a sharp cutoff pentode in a combination grid-clipping and screen-gain limiting circuit. Capacitor C44 couples the signal from V18 to V20, and R87 prevents overloading tube V18 when diode V19 conducts. The input voltage to the control grid is developed across R88. Bias voltage is developed by resistor R89 which is bypassed by capacitor C45. Resistor R90 serves as a screen voltage-dropping resistor and is bypassed by capacitor C46. Plate voltage is applied through the primary windings of the discriminator transformers in Z3 and Z4 connected in series. The high voltage circuit is decoupled by means of the network composed of capacitor C47 and resistor R91.

41. Diversity Discriminators

(figs. 22 and 23)

a. The diversity discriminator diodes V21 and V22 convert frequency-shift signals from the diversity-limiting amplifiers into corresponding dc marking and spacing signals. Tube V21 converts the frequency-shifted signals received over channel A, and V22 converts the frequency-shifted signals received over channel B. These two dc voltages then are combined in the series arrangement of the discriminator output circuits. The dc output voltages at terminals 5 and 6 of the discriminator networks Z3 and Z4 will vary in polarity and magnitude in the same manner as the original mark-space signals.

b. Referring to figure 23, the T_A and T_B secondary windings of the transformer of Z3 are tuned to resonate, respectively, at approximately 1,000 cycles above and below 50 kc. The upper winding, T_A, is connected in series with the resistance across terminals 5–9 of Z3 and one section of V21. With the two diode sections connected as in A, figure 23, the currents of the two circuits flow in the direction indicated by the arrows. The polarities of the voltage drops across terminals 5–9 and 9–6 of Z3 are positive at the ends connected to the cathodes of V21, and negative at the common point, terminal 9. The two voltage drops, therefore, oppose each other, and the resultant voltage across terminals 5 and 6 of Z3 is the difference between the two voltages. The resultant polarity depends upon which of these two voltages is

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greater. If the voltages across the diode load resistances are equal, the net output voltage will be zero. At the center frequency of the discriminator, equal if. signal voltages are applied to the two diode rectifiers, the rectified output of each is the same, and the net output voltage is zero.

c. A frequency-response characteristic curve is shown in figure 23Ⓑ. It indicates general voltage levels for tuned windings T_A and T_B of Z3 for frequencies centering around 50 kc. The curves designated as MARK and SPACE represent the voltages across resistances 5–9 and 6–9, respectively. The voltage drops across these resistances are connected series-opposing. Therefore, the resultant voltage across output terminals 5 to 6 may be illustrated as shown under Z3 when terminal 6 is connected to ground and the output is taken from terminal 5. From this curve it will be noted that the resultant voltage increases gradually in a positive direction as the frequency changes from 50 kc to higher frequencies and gradually becomes more negative as the frequency changes from 50 kc to low frequencies. Throughout the frequency range involved in frequency-shift keying, there is a linear relation between the magnitude of the resultant voltage and the frequency change. Capacitor C48 permits tuning one curve over a range of ±150 cycles without changing its linearity. Capacitor C49 tunes the other curve. These discriminator tuning capacitors are adjustable from the rear of the chassis (fig. 9). Resistor R202 eliminates residual discriminator curve skirt-response to undesirable components of the 29.3-kc signal. Capacitor C92 resonates the secondary of discriminator Z3 at 50 kc.

d. A similar demodulation takes place in the channel B discriminator network Z4, which responds to frequencies centering around 29.3 kc. The total output voltage of network Z4 is the result of the sloping responses of the two individual secondary tuned circuits, with each providing output of opposite polarity because of the balanced arrangement of the diode sections of tube V22. The discriminator tuning capacitors C50 and C51 are adjustable from the rear of the chassis (fig. 9). Resistor R203 eliminates residual discriminator curve skirt-response to undesirable components of the 50-kc signal. Capacitor C93 resonates the secondary of discriminator Z4 at 29.3 kc.

e. Figure 25 shows the individual S-shaped dis-

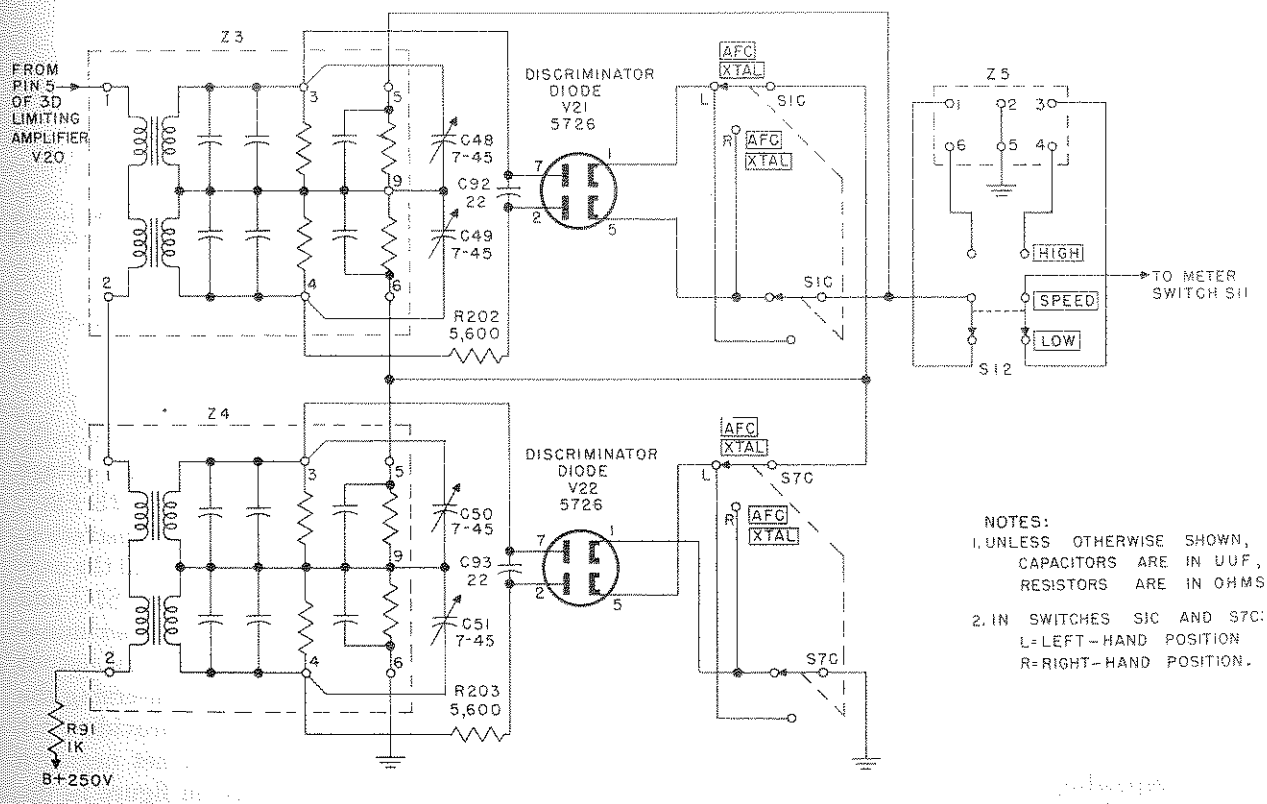


Figure 22. Diversity discriminator stage.

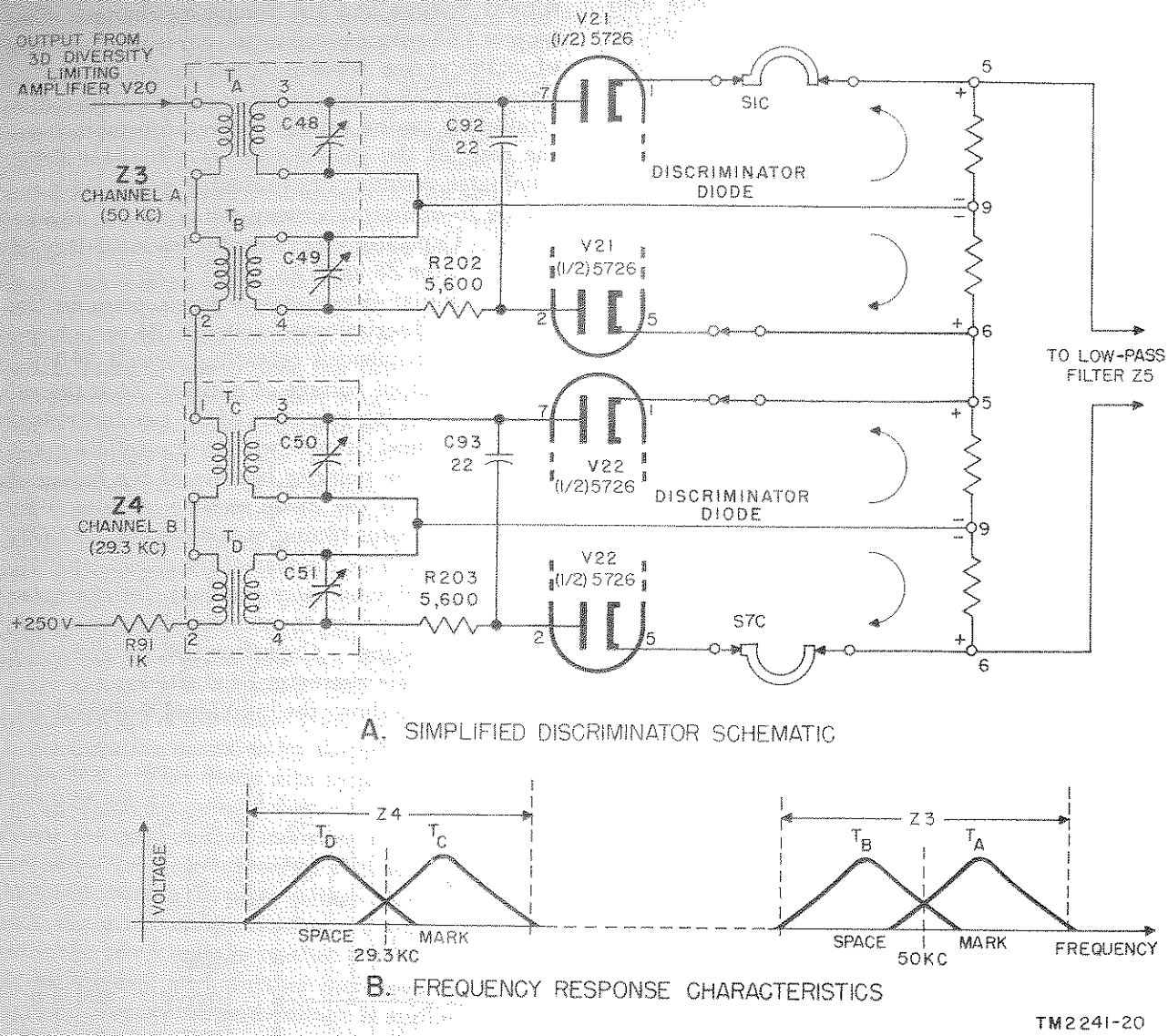
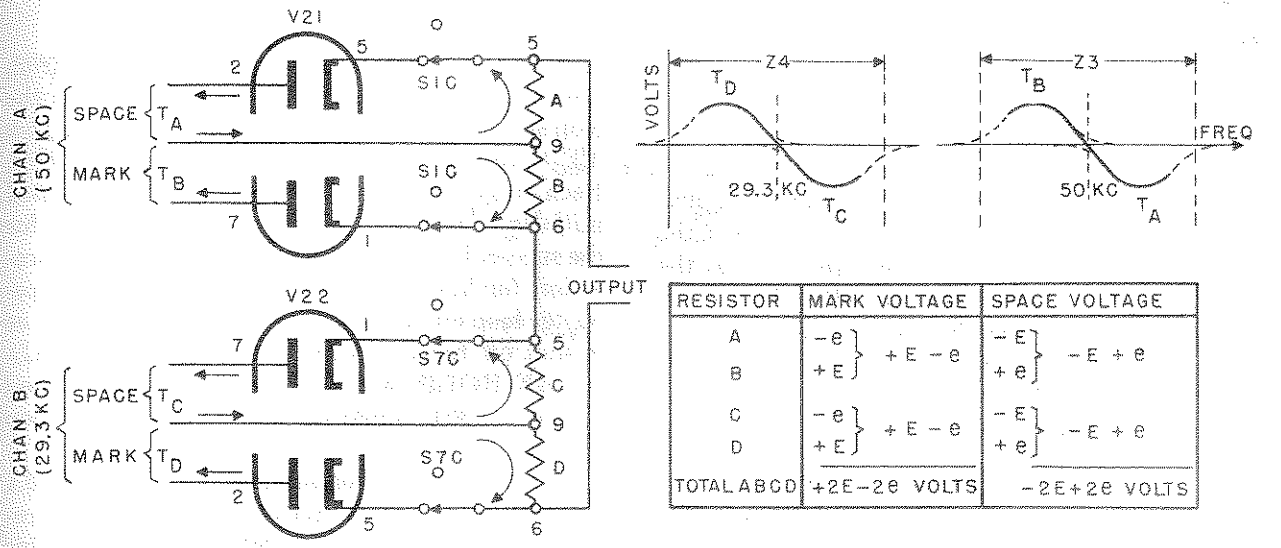


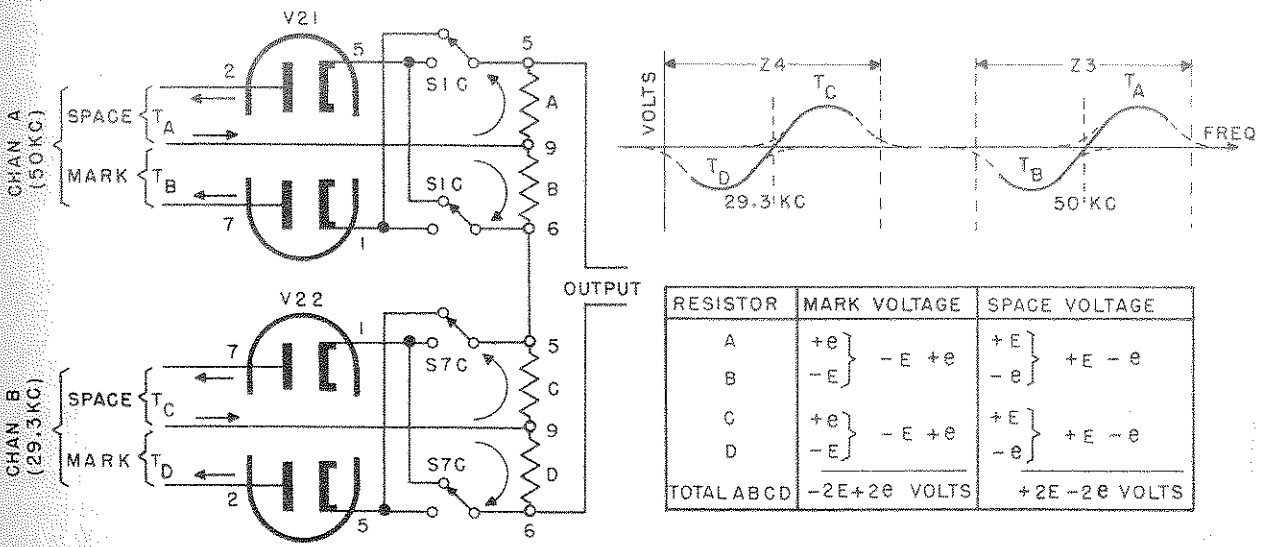
Figure 23. Discriminator operation.

criminator response curve for Z3. The curve for Z4 has the same shape but the center frequency is 29.3 kc. Positive and negative peaks on the S-curve occur at the resonant frequency for each of the two secondary tuned circuits. It should be noted from figure 23 that the output of Z3 and Z4 are connected in series, so that the dc output signals from both discriminators are added. For the purpose of illustration, it is assumed in figure 24 Ⓐ that a positive mark signal results from the higher frequencies centering around 29.3 kc and 50 kc. Depending on the relative locations of the frequencies, a larger voltage E is produced in the upper part of each discriminator and a smaller voltage is produced in the lower part. The voltages add to produce a net positive voltage (+2E−2e) or a net negative voltage (−2E+2e). Under the conditions assumed for this illustration, the positive voltage represents a mark and the negative voltage a space. Switch sections S1C and S7C, in the output circuits of the two discriminators, allow for reversing the polarity of the output signals (fig. 24 Ⓑ). The method of reversing the discriminator connections to always provide a net positive voltage for a mark and a net negative voltage for a space is illustrated in figure 24 Ⓑ. Reversal of output polarity in channel A is accomplished by section C of switch S1 which reverses



RESISTOR	MARK VOLTAGE	SPACE VOLTAGE
A	−e	−E
B	+E	+e
	+E − e	−E + e
C	−e	−E
D	+E	+e
	+E − e	−E + e
TOTAL ABCD	+2E−2e VOLTS	−2E+2e VOLTS

A. POSITIVE MARK SIGNALS (SWITCHES S1 AND S7 IN LEFT-HAND POSITIONS)



RESISTOR	MARK VOLTAGE	SPACE VOLTAGE
A	+e	+E
B	−E	−e
	−E + e	+E − e
C	+e	+E
D	−E	−e
	−E + e	+E − e
TOTAL ABCD	−2E+2e VOLTS	+2E−2e VOLTS

B. NEGATIVE MARK SIGNALS (SWITCHES S1 AND S7 IN RIGHT-HAND POSITIONS)

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Figure 24. Discriminator theory diagram.

the cathode connections to tube V21. For channel B, section C of switch 7 is used to reverse the cathode connections to tube V22.

f. The combined outputs of the diversity discriminators are applied to a low-pass filter, Z5, which filters out any remaining if. signals. Since the combined filtered outputs of Z3 (positive dc pulses) and Z4 (negative dc pulses) appear at the output of Z5, the signal delivered from Z5 to the grid of keyer amplifier V24 is polar in nature. Meter M4 may be placed across the output of the low-pass filter Z5 to observe the operation of the discriminator (par. 50*g* and fig. 39). This is accomplished by placing the metering-circuit selector switch, S11, in the A+B position, pushing PRESS TO TEST switch, and observing the channel A DISCRIMINATOR meter on the front panel.

g. HIGH-LOW-SPEED switch S12 (fig. 22) selects the section of low-pass filter Z5 to be inserted between the discriminator section output and the input to the keyer circuit. The LOW position is used for keying speeds up to 38 dot cycles per second. For keying speeds over 38 dot cycles per second, the HIGH position is required. The low speed section of Z5 is used normally.

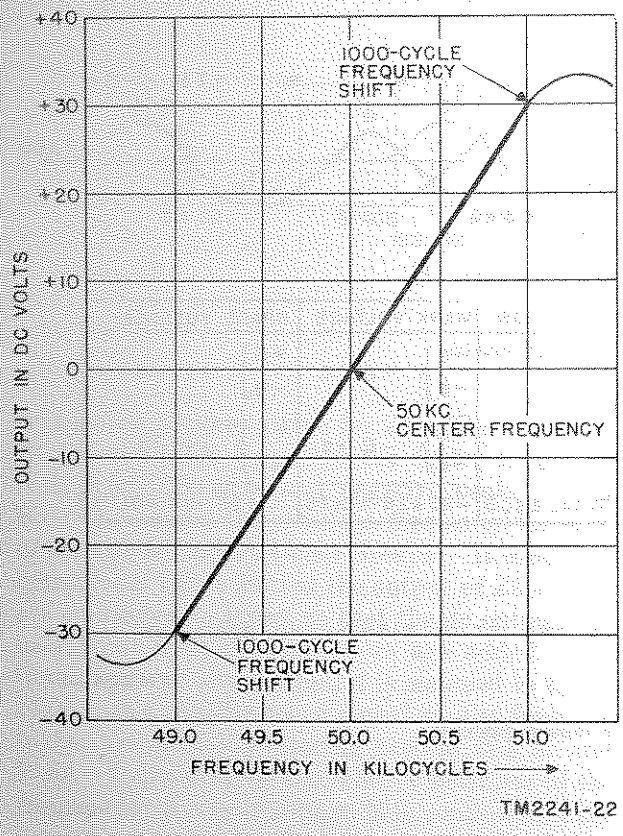

Figure 25. Discriminator response curve.

42. Keyer Circuit

(fig. 26–29)

a. The keyer circuit amplifies the dc pulses from the discriminator output. It opens or closes the loop supply which applies neutral dc pulses to jack TT J4 for operation of the teletypewriter printer. Each stage has a potentiometer which is adjusted initially to provide the correct operating bias for the succeeding stage. The keying circuit has provision for holding a mark signal on the teletypewriter loop circuit if the incoming carrier fades or is shut off for any reason. Either AFC-XTAL-MARK HOLD switch, S1 or S7, also may be used to put a mark signal on the teletypewriter loop circuit.

b. Resistor R95, potentiometer R94, and V23A (section one of a dual-triode tube) with grid resistor R92 form a cathode follower circuit. This stage serves as a buffer between Z5 and the keyer amplifier stage to prevent loading of the low-pass filter circuit. No voltage inversion or gain results from the use of the cathode follower. Dc output voltage is fed to the keyer amplifier, V24A, through grid limiting resistor R96. With the grid of V23A grounded through the meter switch S11 and the PRESS TO TEST switch S10 (fig. 39), R94 is adjusted for approximately −8 volt bias at the grid (pin 2) of keyer amplifier V24A. Correct bias will be indicated on the channel A DISCRIMINATOR meter by a zero reading. Dc signals from the cathode follower are amplified by keyer amplifier V24A. Resistor R97 serves as the plate load resistor for V24A. A voltage dividing network is formed by resistors R97, R98, and R100 and potentiometer R99. When the input to the cathode follower circuit is grounded (as outlined above), potentiometer R99 is adjusted for a bias of 0 volts on the grid (pin 7) of the space keyer V24B. Resistor R101 serves as a grid-limiting resistor for tube V24B and resistor R102 is the plate load resistor. A voltage divider network is formed by resistors R102, R103, and R105 and potentiometer R104. The slide arm of potentiometer R104 is connected to the grids of the mark-keyer tubes and is initially adjusted to −35 volts.

c. Mark-keyer tubes V25 and V26 are parallel-connected beam-power amplifier tubes. The control grids and the screen grids are isolated by resistors R107 and R108, respectively. With a bias

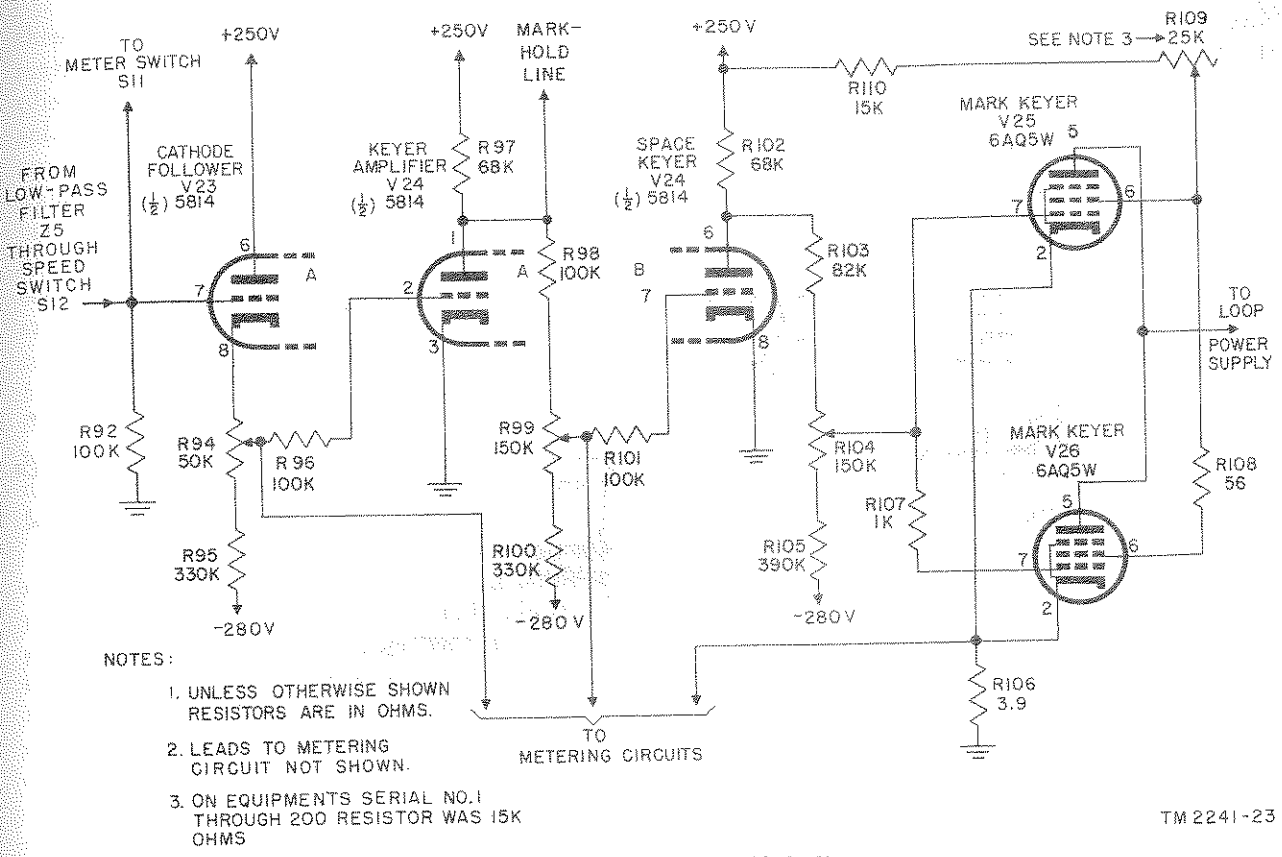

Figure 26. Keyer circuit, simplified diagram.

of −35 volts on the grids, the two mark-keyer tubes are cut off. When the grids of V25 and V26 are driven positive by a mark signal, the tubes conduct. The electron path (fig. 27) is from the negative side of the loop power supply, through the TT jack to the cathodes of V25 and V26, thence to the plates and back to the positive side of the loop supply. Effectively, this action keys the loop power supply which operates the tty selector magnet. Potentiometer R109 adjusts the screen voltages to produce a mark output current to J4 of approximately +60 ma for a given printer load. When metering this current on M4, resistor R106 serves as a meter shunt (par. 50).

d. Figure 28 shows polarity relationships for the keyer circuit. Dc mark-space pulses from the discriminator are fed through network Z5 to the cathode follower, V23A. A positive mark signal appearing at the grid of V23A will cause the tube to draw current through R96, thus causing the grid of keyer amplifier V24A to become more positive with respect to its cathode. In drawing more current, the plate of V24A becomes more negative and this change, reflected through R98, R99, and R101, makes the grid of space keyer V24B become more negative. Therefore, V24B conducts less current and the change in its plate voltage toward a more positive condition is reflected through R103 and R104 at the grid of mark-keyer V25 and

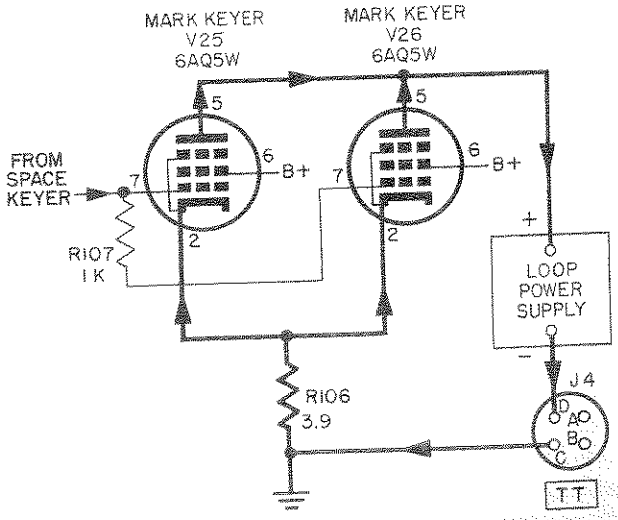

Figure 27. Simplified loop current circuit.

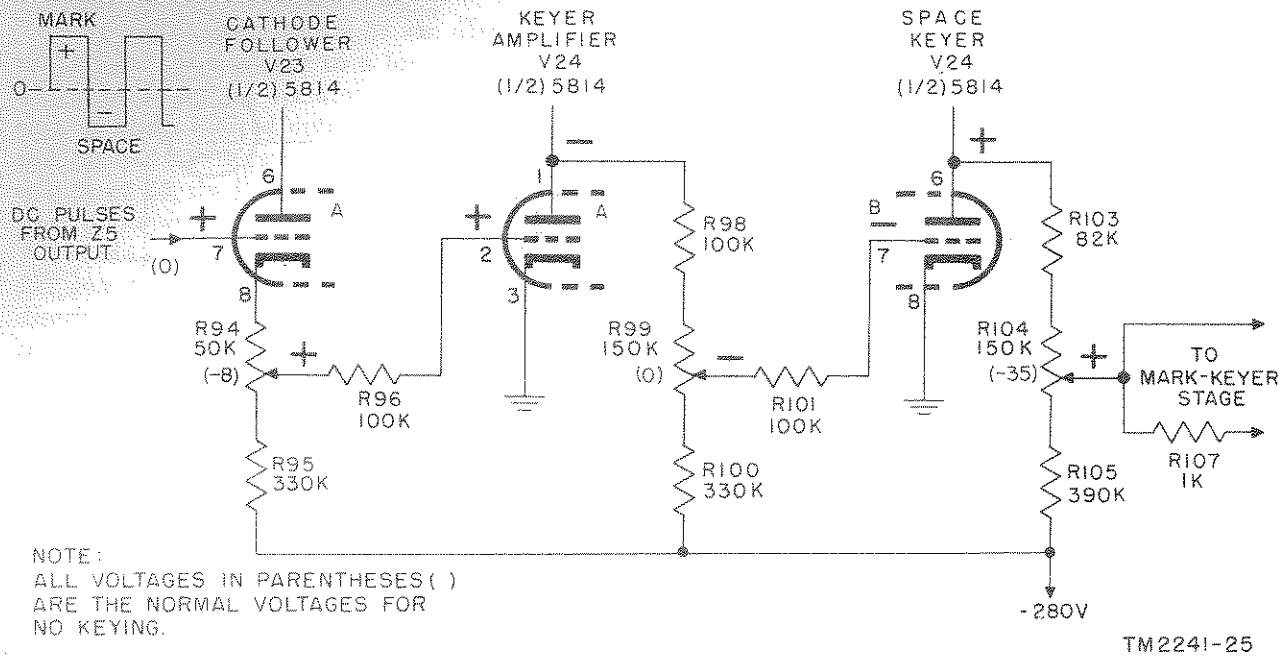

Figure 28. Keyer circuit polarity relations, theory diagram.

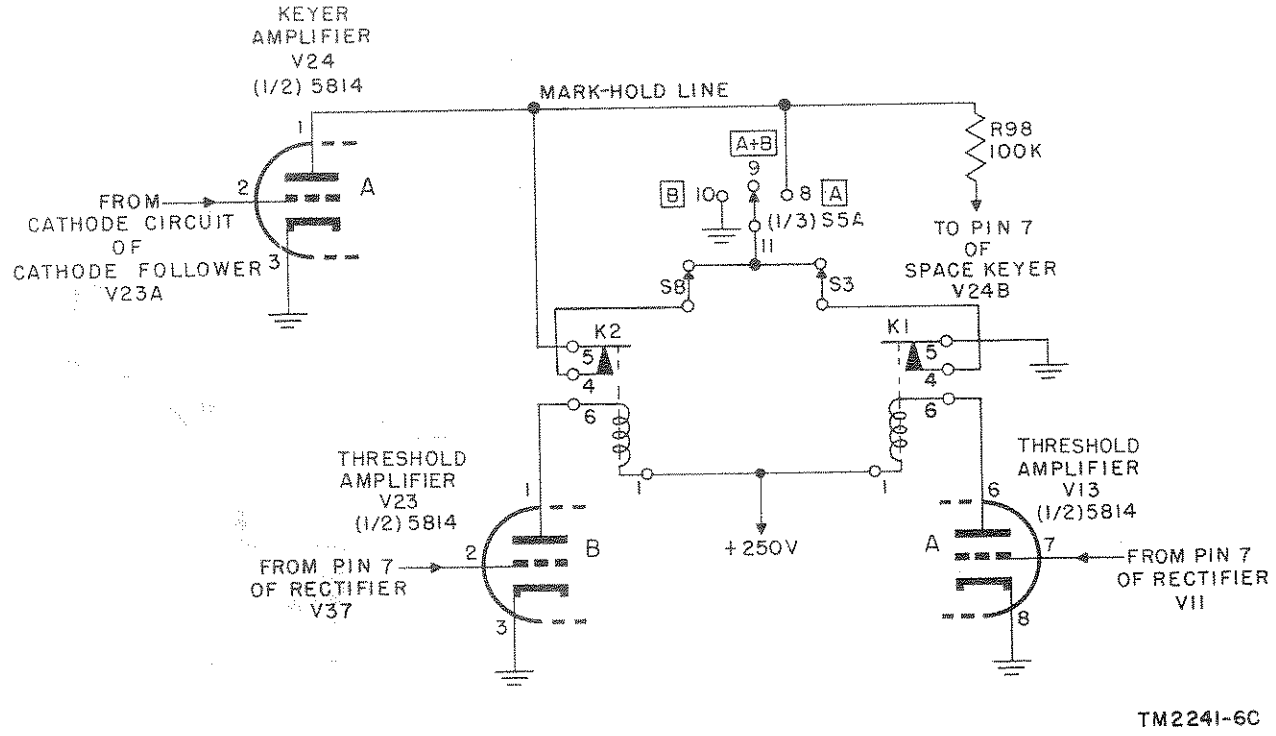

Figure 29. Mark-hold circuit, simplified schematic diagram.