DEPARTMENT OF THE ARMY TECHNICAL MANUAL TM 11-2150

DEPARTMENT OF THE AIR FORCE TECHNICAL ORDER TO 16-30TCC7-5

TELEPHONE CARRIER SYSTEMS

USING TELEPHONE TERMINAL AN/TCC-7 TELEPHONE REPEATER AN/TCC-8 (AN/TCC-21) TELEPHONE REPEATER AN/TCC-11 AND TELEPHONE TEST SET TS-712/TCC-11

DEPARTMENTS OF THE ARMY AND THE AIR FORCE

SEPTEMBER 1953

TECHNICAL MANUAL

TELEPHONE CARRIER SYSTEMS USING TERMINALS, TELEPHONE AN/TCC-7 AND AN/TCC-50, REPEATER, TELEPHONE AN/TCC-8 (AN/TCC-21), REPEATER, TELEPHONE AN/TCC-11, AND TELEPHONE TEST SET TS-712/TCC-11

TM 11-2150
CHANGES No. 3

HEADQUARTERS,
DEPARTMENT OF THE ARMY
WASHINGTON 25, D. C., *28 May 1962*

TM 11-2150, 11 September 1953, is changed as indicated so that the manual also applies to Terminal Telephone AN/TCC-50.

Change the title of the manual to: TELEPHONE CARRIER SYSTEMS USING TERMINALS, TELEPHONE AN/TCC-7 AND AN/TCC-50, REPEATER TELEPHONE AN/TCC-8 (AN/TCC-21), REPEATER, TELEPHONE AN/TCC-11, AND TELEPHONE TEST SET TS-712/TCC-11.

Note. The parenthetical reference to previous changes (example: page 6 of C 1) indicates that pertinent material was published in those changes.

Page 7. Make the following changes:

Add the following "Note" below the title of chapter 1:

Note. Terminal, Telephone AN/TCC-50 and Terminal, Telephone AN/TCC-7 are identical except that Power Supply PP-826(*)/U (600 VOLT POWER SUPPLY) is not provided as a component of the AN/TCC-50. Information in this manual that applies to the AN/TCC-7 also applies to the AN/TCC-50 except for information concerning those applications of the AN/TCC-7 which utilize the 600 VOLT POWER SUPPLY for unattended Repeaters, Telephone AN/TCC-11.

Paragraph 1*a*. Add the following after subparagraph (5):

(6) Terminal, Telephone AN/TCC-50.

Page 130, figure 54 (page 6 of C 1). Change "SIG C STOCK NO. 2Z9637.188" to: FSN 5950-569-0183.

TAGO 6996A-June 610476*-62

APPENDIX

REFERENCES

The following references are applicable to the user of this manual:

(Superseded)

DA PAM 310-4	Index of Technical Manuals, Technical Bulletins, Supply Bulletins, Lubrication Orders, and Modifications Orders.
TM 11-381	Cable Assembly CX-1065/G, Telephone Cable Assemblies CX-1606/G, and CX-1512/U, Telephone Loading Coil Assembly CU-260/G and Electrical Connector Plug U-176/G.
TM 11-687	Radio Sets AN/TRC-24, AN/GRC-75, AN/GRC-78, AN/GRC-81; Radio Terminal Sets AN/TRC-35, AN/GRC-76, AN/GRC-79, AN/GRC-82; Radio Relay Set AN/TRC-36; and Radio Repeater Sets AN/GRC-77, AN/GRC-80 and AN/GRC-83.
TM 11-900	Power Units PE-75-C, -D, -J. -K, -P. -S. -T, -U, -W, -AA, -AB, -AC, -AD, and -AE.
TM 11-900A	Power Unit PE-75-AF.
TM 11-2143	Telephone Test Set TS-712/TCC-11.
TM 11-2139-10	Operator's Manual: Terminals, Telephone AN/TCC-7 and AN/TCC-50.
TM 11-2139-20	Organizational Maintenance Manual: Terminals, Telephone AN/TCC-7 and AN/TCC-50.
TM 11-2139-35	Field and Depot Maintenance Manual: Terminals, Telephone AN/TCC-7 and AN/TCC-50.
TM 11-2140-10	Telephone Repeater AN/TCC-8 and Telephone Repeater AN/TCC-21; Operator's Manual.
TM 11-2140-20	Telephone Repeater AN/TCC-8 and Telephone Repeater AN/TCC-21; Organizational Maintenance Second Echelon.
TM 11-2140-35	Field and Depot Maintenance: Telephone Repeater AN/TCC-8 and Telephone Repeater AN/TCC-21.
TM 11-5805-240-12	Operator's and Organizational Maintenance Manual: Repeater Telephone AN/TCC-11.
TM 11-5805-240-35	Field and Depot Maintenance Manual: Repeater Telephone AN/TCC-11.
TM 11-5820-287-10	Operator's Manual: Radio Sets AN/TRC-21, AN/GRC-75, AN/GRC-78 and AN/GRC-81; Radio Terminal Sets AN/TRC-35, AN/GRC-76, AN/GRC-79, and AN/GRC-82; Radio Relay Set AN/TRC-36; Radio Repeater Sets AN/GRC-77, AN/GRC-80, and AN/GRC-83; and Radio Set Group AN/TRA-25.
TM 11-5820-287-20	Organizational Maintenance Manual: Radio Sets AN/TRC-24, AN/GRC-75, AN/GRC-78, and AN/GRC-81; Radio Terminal Sets AN/TRC-35, AN/GRC-76, AN/GRC-79, AN/GRC-82; Radio Relay Set AN/TRC-36; Radio Repeater Sets AN/GRC-77, AN/GRC-80, and AN/GRC-83; and Radio Set Group AN/TRA-25.

BY ORDER OF THE SECRETARY OF THE ARMY:

G. H. DECKER,
General, United States Army,
Chief of Staff .

Official:

J. C. LAMBERT,
Major General, United States Army,
The Adjutant General.

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USA Trans Tml Comd (1)
Army Tml (1)
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AFIP (1)
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USA Sig Msl Spt Agcy (13)
Sig Fld Maint Shops (3)
USA Corps (3)
D Log Svc Cen (1)
JBUSMC (2)
Units organized under following TOE's:

7 (2)	11-85 (2)
11-5 (2)	11-87 (2)
11-6 (2)	11-95 (2)
11-7 (2)	11-97 (2)
11-15 (2)	11-117 (2)
11-16 (2)	11-155 (2)
11-18 (2)	11-157 (2)
11-36 (2)	11-500 (AA-AE) (4)
11-38 (2)	
11-39 (2)	11-557 (2)
11-45 (2)	11-587 (2)
11-46 (2)	11-592 (2)
11-47 (2)	11-597 (2)
11-55 (2)	17 (2)
11-56 (2)	37 (2)
11-57 (2)	

NG: None.
USAR: Same as Active Army except allowance is one copy to each unit.
For explanation of abbreviations used, see AR 320-50.

GPO 895-426

DEPARTMENT OF THE ARMY TECHNICAL MANUAL **TM 11-2150**
DEPARTMENT OF THE AIR FORCE TECHNICAL ORDER **TO 31W1-2TCC-101**
C 2

TELEPHONE CARRIER SYSTEMS USING TELEPHONE TERMINAL AN/TCC-7, TELEPHONE REPEATER AN/TCC-8 (AN/TCC-21), TELEPHONE REPEATER AN/TCC-11 AND TELEPHONE TEST SET TS-712/TCC-11

TM 11-2150
TO 31W1-2TCC-101
CHANGES No. 2

DEPARTMENTS OF THE ARMY AND
THE AIR FORCE
WASHINGTON 25, D. C., *9 May 1956*

TM 11-2150/TO 31W1-2TCC-101, 11 September 1953, is changed as follows:

The following information changes TM 11-2150 so that the manual also applies to Power Supply PP-826A/U.

Page 7. Add the following note at the beginning of chapter 1.

Note. Power Supply PP-826A/U may be used interchangeably with Power Supply PP-826/U.

Add "or Power Supply PP-826A/U" after "Power Supply PP-826/U" in the following places:

Page 20, figure 12. Callout at bottom of figure.
Page 32, paragraph 25. Paragraph heading.
Page 34, figure 25. Caption.
Page 38, figure 29. Callouts at left of figure.
Page 44, paragraph 31*a*. Heading.
Page 56, figure 45 (fold out). In three blocks representing Power Supply PP-826/U.

Add "or PP-826A 600 VOLT POWER SUPPLY" after any of the identifications of the "PP-826 600 VOLT POWER SUPPLY" in the following places:

Page 18, paragraph 14*a*. Chart, contents column, item 4.
Page 18, paragraph 14*b*. Chart, contents column, item 4.
Page 32, paragraph 25*a*.. Line 2.
Page 32, paragraph *25b*. Line 1.
Page 35, figure 26. Caption.
Page 44, paragraph 31*a*.. Lines 3, 5. 7, 9, and 12.
Page 45, paragraph 34*d*. Line 3.
Page 56, paragraph 48*a*. Line 3.
Page 59, paragraph 54*c*. Line 2.
Page 59, paragraph 54*c*(3). Line 3.
Page 59, paragraph 54*c*(4). Line 2.
Page 59, paragraph 54*c*(6). Line 3.
Page 60, paragraph 58*a*. Line 3.
Page 61, paragraph 61*c*. Line 3.
Page 62, paragraph 65*a*. Line 3.
Page 72, paragraph *89b*. Heading.
Page 72, paragraph *89b* (1). Line 2.
Page 72, paragraph *89b* (3). Lines *5* and 10.
Page 72, paragraph *89b* (5). Line 3.
Page 74, paragraph *94b* . Heading.
Page 74, paragraph *94b*. Warning. Line 2.
Page 74, paragraph *94b* (1). Line 2.
Page 74, paragraph 94*b* (2). Line 2.
Page 74, paragraph *94b* (3). Line 2.
Page 74, paragraph *94b* (4). Line 5.
Page 75, paragraph *94b* (4). Next to last line.
Page 76, paragraph *99b* (2*)*. Line 4.
Page 77, paragraph *102c*. Line 3.
Page 92, paragraph 144*a* (2). Line 3.
Page 93, paragraph 144*a* (3). Line 2.
Page 92, paragraph 144*b* (2). Line 3.
Page 92, paragraph 144*b* (3). Line 2.
Page 92, paragraph 144*b* (4). Line 3.
Page 101, paragraph 157*b*. Line 1.
Page 101, paragraph 157*e*. Line 2.
Page 110, paragraph 171*c*. Line 14.
Page 111, paragraph 173*b*. Line 2.
Page 112, paragraph 177*a*. Line 1.
Page 113, paragraph 179*c*. Line 4.
Page 120, paragraph 195*d*. Line 3.
Page 120, paragraph 195*e*. Line 4.
Page 120, paragraph 195*g*. Line 3.
Page 122, paragraph 201*b*. Lines 2 and 9.
Page 135, paragraph 222*b* (2) Lines 3 and 11.

Page 35, figure 26. Add the following note to figure 26.

NOTE. IN THE PP-826A 600 VOLT POWER SUPPLY, LOW-VOLTAGE RECTIFIER AND ALARM Z2 IS PLUGGED INTO THE LEFT SIDE OF THE MAIN CHASSIS. THE OTHER COMPONENTS OF THE MAIN CHASSIS OF THE PP-826 600 VOLT POWER SUPPLY AND PP-826A 600 VOLT POWER SUPPLY ARE IDENTICAL.

Page 44, paragraph 31. Heading. After "PP-826-U", add: or PP-826A/U.

TAGO 6941A-May 360475*-56

Page 56, figure 45 (fold-out). In the two blocks designated "TELEPHONE REPEATER AN/TCC-11", nearest "TELEPHONE REPEATER AN/TCC-8", change "J1" to read J2 and "J2" to read J1,

Page 59, paragraph 54*c*. Make the following changes:

c(4) In line 3, after "lamp", add: on the PP-826 600 VOLT POWER SUPPLY. Add the following after the last line: When the PP-826A 600 VOLT POWER SUPPLY is used in place of the PP-826 600 VOLT POWER SUPPLY, both the LOAD ALARM and LOW VOLTAGE lamps will light and the buzzer will sound.

c(5) In line 8. after "indicated", add: on the PP-826 600 VOLT POWER SUPPLY.

(5.1) (Added) On the PP 826A 600 VOLT POWER SUPPLY, when the LOW VOLTAGE and LOAD ALARM lamps light and the buzzer sounds, the CURRENT meter should indicate approximately 110 ma. The meter on the TS-760 TEST PANEL ((5) above) should indicate approximately 0 db. Adjust the 600V ADJ control to make the meter or. the TS-760 TEST PANEL read exactly 0 db. After approximately 20 seconds, the LOW VOLTAGE and LOAD ALARM lamps should extinguish and the buzzer should stop sounding. If the LOW VOLTAGE and LOAD ALARM lamps remain lighted, check the adjustment of the LOW-VOLT ALARM control. If the LOW VOLTAGE lamp extinguishes and the HIGH VOLTAGE lamp lights, check the adjustment of the HIGH-VOLT ALARM control. If the LOW VOLTAGE and LOAD ALARM lamps light and do not extinguish follow the instructions in *(a)* below. If the HIGH VOLTAGE and LOAD ALARM lamps light and do not extinguish, follow the instructions in (*b*) below.

(*a*) When the LOW VOLTAGE and LOAD ALARM lamps do not extinguish operate and hold the RESTORE switch and check the reading on the CURRENT meter. A CURRENT meter indication of more than 10 ma indicates an incorrect line condition or an incorrect setting of the REPEATER switch. A CURRENT meter indication of less than 10 ma probably indicates an equipment trouble: an incorrect adjustment of the LOW-VOLT ALARM control or the failure of a tube in the PP-826A 600 VOLT POWER SUPPLY.

(*b*) When the HIGH VOLTAGE and LOAD ALARM lamps light but do not extinguish, operate and hold the RESTORE switch and check the reading on the CURRENT meter. A CURRENT meter indication of less than 10 ma indicates an incorrect line condition or an incorrect setting of the REPEATER switch.

Page 73, paragraph 89*b*(7). Line 9. After "indicated", add: on the PP-826 600 VOLT POWER SUPPLY.

(7.1) (Added) When the PP 826A 600 VOLT POWER SUPPLY is being used, follow the instructions given in paragraph 54*c*(5.1) when the LOW VOLTAGE and LOAD ALARM lamps or HIGH VOLTAGE; and LOAD ALARM lamps light.

Page 79, paragraph 110*a*. In the last line, change "AN/TCC-9" to read: AN/TCC-8.

Page 85, paragraph 129.1 (C 1). In the notes of the chart, delete note 8 and substitute the following:

8. When Power Supply PP-826/U is used turn the 600V ADJ clockwise and operate the RESTORE switch momentarily when the LOW VOLTAGE and LOAD ALARM lamps light. When Power Supply PP-826A/U is used, output power is not interrupted when the LOW VOLTAGE alarm lamp lights and the RESTORE switch need not be operated. When either of the two power supplies are used, if HIGH VOLTAGE and LOAD ALARM lamps light, turn the 600V ADJ control counterclockwise and operate the RESTORE switch momentarily.

Page 103 paragraph 159*b*(2). In next to last line, change "AP" to read: AB.

Page 112. paragraph 177. Make the following changes:

c. At the end of the last line, add: when a PP-826 600 VOLT POWER SUPPLY is used. When a PP-826A 600 VOLT POWER SUPPLY is used, current is not removed from the power loop if the LOW VOLTAGE and LOAD ALARM lamps light.

d. In line 1, before "Operate" insert: If the LOW VOLTAGE lamp of a PP-826 600 VOLT POWER SUPPLY lights.

d. 1. (Added) If the LOW VOLTAGE and LOAD ALARM lamps of a PP-826A 600 VOLT POWER SUPPLY light (the output voltage will not be interrupted), operate and hold the RESTORE lever switch and observe the CURRENT meter.

(1) If the meter indicates a current less than 10 ma, the line conditions can be considered to be correct. The reason for the alarm condition is probably in incorrect adjustment of the 600V ADJ or LOW-VOLT ALARM controls, or the failure of a tube in the control circuit of the power supply.

(2) If the current indication exceeds 10 ma, the alarm is probably due to an incorrect line condition. After the RESTORE switch is released, the lamps will light and extinguish after 20 seconds, if the line resistance has increased to the correct value.

f(1) and (2). At the beginning of (1) and (2), add: When the PP-826 600 VOLT POWER SUPPLY is used.

(3) (Added) When Power Supply PP-826A/U is used, the momentary operation of the RESTORE lever switch will restore power *only* if the power loop resistance is not open. If the power is not restored, *only* the LOAD ALARM lamp will light and the buzzer will sound approximately 1 second after the release of the RESTORE switch; if power is restored, the LOW VOLTAGE and LOAD ALARM lamps will light. After approximately 20 seconds, the lamps will either extinguish or only the LOW VOLTAGE lamp will extinguish and the HIGH VOLTAGE lamp will light, to indicate that the output voltage has been removed. This indicates an abnormally high power loop resistance. Check the setting of the REPEATER switch, adjustment of the 600V ADJ control, adjustment of the HIGH-VOLT ALARM control, and the repeater tubes.

Page 113, paragraph 179. Add the following note after *a*.

Note. When Power Supply PP-826A/U is used in place of Power Supply PP-826/U, the CURRENT meter will indicate the power loop resistance. While holding the RESTORE switch operated, the CURRENT meter reading is proportional to the resistance of the power loop. Therefore, if the meter reading is 0 ma, the loop may be open or the power supply may be defective. To locate the open circuit, follow the procedure in *c* and *d* below.

[AG 413.42 (4 May 56)]

BY ORDER OF THE SECRETARIES OF THE ARMY AND THE AIR FORCE:

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

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

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Gen Depots (2) except Atlanta Gen Depot (None)
Sig Sec, Gen Depots (10)
Sig Depots (20)
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OS Sup Agencies (2)
Sig Fld Maint Shops (8)
Sig Lab (5)
Mil Dist (1)
Units organized under following TOE's:
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11-16C, Hq & Hq Co, Sig Bn, Corps or Abn Corps (2)
11-75C, Armd Sig Co (2)
11-127R, Sig Rep Co (2)
11-128R, Sig Depot Co (2)
11-500R (AA-AE), 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 per unit.
USAR: None.
For explanation of abbreviations used, see SR 320-50-1.

TAGO 6941A

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DEPARTMENT OF THE ARMY TECHNICAL MANUAL

TELEPHONE CARRIER SYSTEMS USING TELEPHONE TERMINAL AN/TCC-7, TELEPHONE REPEATER AN/TCC-8 (AN/TCC-21), TELEPHONE REPEATER AN/TCC-11, AND TELEPHONE TEST SET TS-712/TCC-11

CHANGES No. 1

DEPARTMENT OF THE ARMY
WASHINGTON 25 D. C., *4 March 1954*

TM 11-2150/TO 16-30TCC-7-5, 11 September 1953, is changed as follows:

110. Line-up of Radio Section, General

a. The line-up is accomplished by sending 68 kc from one end of the section, measuring it, and making the necessary gain adjustments at the radio transmitters and at the AN/TCC-7 or AN/TCC-8 point at the other end of the section.

* * * * *

113. General

a. (Superseded) This section describes the overall lineup for the system. Two separate procedures are possible: a rapid initial lineup procedure ((1) below) and a complete lineup procedure ((2) below).

(1) If it is necessary to place the system in operation rapidly, follow the procedure given in paragraph 129.1. This procedure assumes that there is no trouble in the system, omits several adjustments that may improve the quality, and approximates certain other adjustments. After this procedure has been completed, the system should be realigned as soon as is practicable in accordance with instructions in paragraphs 114 through 129.

(2) The procedure given in paragraphs 114 through 129 provides a complete lineup of the system. Before this procedure may be used as an initial lineup, the procedure given in paragraphs 97 through 112 must be completed.

* * * * *

115. Transmitting Adjustment at AN/TCC-7 Terminal for System Line-up of Order Wire Circuit

* * * * *

b. Perform the order wire adjustments given in paragraph 75 or 79 (whichever is applicable) to complete the transmitting adjustments at the AN/TCC-7 terminal. It is assumed that the *AB* direction of transmission will be lined up first

* * * * *

129.1 Initial System Lineup, Rapid Method (Added)

a. *Rapid System Lineup, General.* The chart below is an outline of preliminary adjustments and an initial overall lineup procedure for an AN/TCC-7 system. Use this procedure when it is necessary to place the system in operation rapidly. This procedure assumes that there is no trouble in the system, omits several adjustments that may improve the quality, and approximates certain other adjustments. After this procedure has been completed, the system should be realigned as soon as is practicable in accordance with the instructions in paragraphs 114 through 129.

b. *Rapid System Lineup Chart.* Perform steps 1 through 16 in the chart below in sequence at each AN/TCC-7 as soon as the terminal power loop is installed. Perform steps 17 through 28 at each AN/TCC-8 as soon as the power loops associated with the AN/TCC-8 are installed. Perform steps 29 through 63 in sequence after steps 1 through 28 in sequence after steps 1 through 28 have been completed for all equipments in the systems. Unless otherwise specified in the chart, restore all *lever* switches to their (vertical) positions at the completion of each step.

TAGO 4262A-Feb. 270472*-54

Operate TEST PANEL switches to positions shown				Connect TEST PANEL measure cord to		Operate switch to position shown			Adjust control to obtain indicated reading on TEST PANEL meter		
Step	MEASURE	MEASURE SELECTIVE	MEASURE NON-SELECTIVE	Panel	Jack	Panel containing switch	Switch	Position	Panel containing control	Control	Meter reading
	Perform steps 1 through 16 at each AN/TCC-7 terminal as soon as the power loop for the terminal is installed.										
1	200 VOLTS	OFF	OFF			200 VOLT POWER SUPPLY.	AC POWER	On	200 VOLT POWER SUPPLY	200 V ADJ	0 db.
2	TRANSMIS-SION	OFF	CHECK 1KC CHECK HF	TEST	CHECK 1KC	TEST	SEND	CHECK GAIN CHECK HF	TEST	1KC (See note 1)	0 db.
3	TRANSMIS-SION	OFF	CHECK 1KC CHECK GAIN	TEST	CHECK HF	TEST	SEND	CHECK GAIN CHECK HF	TEST	HF	0 db.
4	TRANSMIS-SION	CHECK GAIN	OFF	TEST	CHECK HF	TEST	SEND	CHECK GAIN CHECK HF	TEST	GAIN (See note 2).	0 db
5						ORDER WIRE	CABLE REELS TO NEXT AN/TCC-7 OR AN/TCC-8	See note 3			
6	TRANSMIS-SION	OFF	OW TR AMP OUT	ORDER WIRE	TR AMP OUT	ORDER WIRE	SEND OW	ON	ORDER WIRE	TR GAIN (See note 1).	See note 4.
7						GROUP	CABLE REELS TO FIRST AN/TCC-11 TR (See note 1).	See note 5			
8						GROUP	CABLE REELS TO FIRST AN/TCC-11 TR (See note 1).	See note 11			
9						GROUP	FLAT ADJ 68 KC (See note 1).	0			
10	TRANSMIS-SION	68 KC	OFF	GROUP	TR AMP OUT	CARRIER SUPPLY	CARR SYNC	LOCAL at A terminal, REMOTE at B terminal	CARRIER SUPPLY	68 KC (See notes 1 and 2).	0 db.
11	TRANSMIS-SION	12 KC	OFF	GROUP	TR AMP OUT	CARRIER SUPPLY	12 & 28 KC	ON	CARRIER SUPPLY	12 KC (See note 2).	0 db.
12	TRANSMIS-SION	28 KC	OFF	GROUP	TR AMP OUT	CARRIER SUPPLY	12 & 28 KC	ON	CARRIER SUPPLY	28 KC (See note 2).	0 db.
13	TRANSMIS-SION	37 KC	OFF	GROUP	TR AMP OUT	CHAN MODEM 2, CHAN 2	SEND MEAS	SEND	SUBGROUP	TR AMP GAIN (See notes 1 and 2).	0 db.
14						600 VOLT POWER SUPPLY	REPEATER (See note 1).	See notes 6 and 7.			
15	600 VOLTS	OFF	OFF			600 VOLT POWER SUPPLY	AC POWER	ON	600 VOLT POWER SUPPLY.	600 V ADJ (See note 8).	0 db.
16									600 VOLT POWER SUPPLY	LOAD CURRENT (See note 1).	None (See note 9).
	Perform steps 17 through 28 at each AN/TCC-8 as soon as the power loop associated with the repeater are installed.										
17	200 VOLTS	OFF	OFF			200 VOLT POWER SUPPLY	AC POWER	ON	200 VOLT POWER SUPPLY	200 V ADJ	0 db.
18	TRANSMIS-SION.	OFF	CHECK OSC.	TEST	CHECK OSC.	TEST	SEND FREQUENCY	68 KC OR CHECK.	TEST	OSC	0 db.

Operate TEST PANEL switches to positions shown				Connect TEST PANEL measure cord to		Operate switch to position shown			Adjust control to obtain indicated reading on TEST PANEL meter		
Step	MEASURE	MEASURE SELECTIVE	MEASURE NON-SELECTIVE	Panel	Jack	Panel containing switch	Switch	Position	Panel containing control	Control	Meter reading
19	TRANSMIS-SION	CHECK GAIN	OFF----------	TEST ----------	CHECK OSC.	TEST----------	SEND FREQUENCY	68 KC OR CHECK.	TEST ----------	GAIN (See note 2).	0 db.
20	----------	----------	----------	----------	----------	ORDER WIRE ----	AB CABLE REELS TO NEXT AN/TCC-7 OR AN/TCC-8.	See note 3--------	----------	----------	
21	TRANS-MISSION	OFF ----------	OW TR AMP OUT	ORDER WIRE	AB TR AMP OUT.	ORDER WIRE ----	RING----------	ON ----------	ORDER WIRE ---	AB TR GAIN (See note 1).	See Note 4.
22	----------	----------	----------	----------	----------	REPEATER --------	CABLE REELS TO FIRST AN/TCC-11 TOWARD A TERM (AB IN) (See note 1).	See note 11------	----------	----------	
23	----------	----------	----------	----------	----------	REPEATER --------	CABLE REELS TO FIRST AN/TCC-11 TOWARD B TERM (AB OUT) (See note 1)	See note 5--------	----------	----------	
24	----------	----------	----------	----------	----------	REPEATER --------	AB FLAT ADJ 68 KC	0 ----------	----------	----------	
	Perform steps 25 through 27 at the 600 VOLT POWER SUPPLY connected to REPEATER PANEL connector designated POWER TOWARD B TERM. If connected directly to a radio section or to an attended point (no AN/TCC-11 repeater in the section), disconnect the 600 VOLT POWER SUPPLY, and omit steps 25 through 27.										
25	----------	----------	----------	----------	----------	600 VOLT POWER SUPPLY.	REPEATER ----------	See notes 6 and 7.	----------	----------	
26	600 VOLTS TOWARD B	OFF ----------	OFF----------	----------	----------	600 VOLT POWER SUPPLY.	AC POWER----------	ON ----------	600 VOLT POWER SUPPLY	600 V ADJ (See note 8).	0 db.
27	----------	----------	----------	----------	----------	----------	----------	----------	600 VOLT POWER SUPPLY	LOAD CURRENT (See note 8)	See note 9.
28	Repeat steps 20 through 27. Substitute BA for AB in the switch and control settings for steps 20 through 24, and A for B in the introductory statement to step 25 and in step 26.										
	Perform step 29 at terminal A only and leave the switch in this position until step 31 is completed.										
29	----------	----------	----------	----------	----------	ORDER WIRE	SEND OW----------	ON ----------	----------	----------	
	Perform step 30 at each AN/TCC-8. Perform the procedure first at the AN/TCC-8 nearest terminal A, and then at each successive AN/TCC-8 toward terminal B. Each AN/TCC-8 attendant will report completion to terminal A.										
30	TRANS-MISSION	OFF ----------	OW REG AMP	ORDER WIRE	AB REG AMP OUT	----------	----------	----------	ORDER WIRE ---	AB REG GAIN------	0 db.
	Perform step 31 at terminal B after all AN/TCC-8 repeaters have reported completion of step 30 to terminal A.										
31	TRANS-MISSION	OFF ----------	OW REG AMP	ORDER WIRE	REC AMP OUT	----------	----------	----------	ORDER WIRE ---	REC GAIN	0 db.
32	Perform step 29 at terminal B and leave the switch in this position until step 34 is completed.										
	Perform step 33 at each AN/TCC-8. Perform the procedure first at the AN/TCC-8 nearest terminal B, and then at each successive AN/TCC-8 toward terminal A. Each AN/TCC-8 will report completion to terminal A.										
33	TRANS-MISSION	OFF ----------	OW REG AMP	ORDER WIRE	BA REG AMP OUT	----------	----------	----------	ORDER WIRE ---	BA REG GAIN------	0 db.
	Perform step 34 at terminal A after all AN/TCC-8 repeaters have reported completion of step 33 to terminal A.										
34	TRANS-MISSION	OFF ----------	OW REG AMP	ORDER WIRE	REC AMP OUT	----------	----------	----------	ORDER WIRE ---	REC GAIN ----------	0 db.

Operate TEST PANEL switches to positions shown				Connect TEST PANEL measure cord to		Operate switch to position shown			Adjust control to obtain indicated reading on TEST PANEL meter		
Step	MEASURE	MEASURE SELECTIVE	MEASURE NON-SELECTIVE	Panel	Jack	Panel containing switch	Switch	Position	Panel containing control	Control	Meter reading
	Perform step 35 at terminal A and leave the switch in this position until step 49 has been completed.										
35	----------	----------	----------	----------	----------	CARRIER SUPPLY	12 &28 KC ----------	ON ----------	----------	----------	
	Perform steps 36 through 42 at each AN/TCC-8. Perform the procedure first at the AN/TCC-8 nearest terminal A, and then at each successive AN/TCC-8 toward terminal B. Each AN/TCC-8 will report completion to terminal A.										
36	TRANS-MISSION	68 KC ----------	OFF----------	REPEATER	AB AMP 1 OUT	----------	----------	----------	REPEATER-------	AB FLAT ADJ 68 KC (See notes 1 and 2).	0 db.
37	TRANS-MISSION	68 KC ----------	OFF----------	REPEATER	AB AMP 2 OUT	REPEATER	AB REGULATOR (See note 1).	MAN ----------	REPEATER-------	AB MAN REG OUTPUT (See notes 1 and 2).	0 db.
38	----------	----------	----------	----------	----------	REPEATER --------	ALARM TEST (See note 1).	1 HIGH ----------	REPEATER-------	ADJ HIGH (See note 1).	See note 10
39	----------	----------	----------	----------	----------	REPEATER --------	ALARM TEST (See note 1.)	2 LOW ----------	REPEATER-------	ADJ LOW (See note 1).	See note 10
40	TRANS-MISSION	68 KC ----------	OFF----------	REPEATER	AB AMP 2 OUT	REPEATER --------	AB REGULATOR--	AUTO----------	REPEATER-------	AB AUTO REG OUTPUT (See note 1).	0 db.
41	TRANS-MISSION	12 KC ----------	OFF----------	REPEATER	AB AMP 2 OUT	----------	----------	----------	REPEATER-------	AB SLOPE ADJ 12 KC (See notes 1 and 2).	0 ± .8 db.
42	TRANS-MISSION	28 KC ----------	OFF----------	REPEATER	AB AMP 2 OUT	----------	----------	----------	REPEATER-------	AB BULGE ADJ 28 KC (See notes 1 and 2).	0 ± .8 db.
	Perform steps 43 through 49 at terminal B after all AN/TCC-8 repeaters have reported completion of step 42 to terminal A. Terminal B will report completion of step 49 to terminal A.										
43	TRANS-MISSION	68 KC ----------	OFF----------	GROUP --------	REC AMP 1 OUT	----------	----------	----------	GROUP ----------	FLAT ADJ 68 KC (See note 1 and 2).	0 db.
44	TRANS-MISSION	68 KC ----------	OFF----------	GROUP --------	REC AMP 2 OUT	GROUP----------	REGULATOR -------	MAN ----------	GROUP ----------	MAN REG OUT-PUT (See note 1).	0 db.
45	----------	----------	----------	----------	----------	GROUP----------	ALARM TEST ------	1 HIGH ----------	GROUP ----------	ADJ HIGH (See note 1).	See note 10.
46	----------	----------	----------	----------	----------	GROUP----------	ALARM TEST ------	2 LOW ----------	GROUP ----------	ADJ LOW ----------	See note 10.
47	TRANS-MISSION	68 KC ----------	OFF----------	GROUP --------	REC AMP 2 OUT	GROUP----------	REGULATOR -------	AUTO----------	GROUP ----------	AUTO REG OUT-PUT (See notes 1 and 2).	
48	TRANS-MISSION	12 KC ----------	OFF----------	GROUP --------	REC AMP 2 OUT	----------	----------	----------	GROUP ----------	SLOPE ADJ 12 KC (See notes 1 and 2)	0 ± .8 db.
49	TRANS-MISSION	28 KC ----------	OFF----------	GROUP --------	REC AMP 2 OUT	----------	----------	----------	GROUP ----------	BULGE ADJ 28 KC (See notes 1 and 2).	0 ± .4 db.
	Perform step 50 at terminal A and leave the switch in this position until step 51 has been completed.										
50	----------	----------	----------	----------	----------	CHAN MODEM 2, CHAN 2	SEND-MEAS --------	SEND ----------	----------	----------	
	Perform step 51 at terminal B and report completion to terminal A.										
51	TRANS-MISSION	OFF ----------	GRP DEM OUT	GROUP --------	DEM OUT --	----------	----------	----------	GROUP ----------	DEM GAIN (See note 1).	0 db.

Operate TEST PANEL switches to positions shown				Connect TEST PANEL measure cord to		Operate switch to position shown			Adjust control to obtain indicated reading on TEST PANEL meter		
Step	MEASURE	MEASURE SELECTIVE	MEASURE NON-SELECTIVE	Panel	Jack	Panel containing switch	Switch	Position	Panel containing control	Control	Meter reading
	Perform steps 52 through 54 at terminal A and leave switches operated until step 57 is completed.										
52	----------	----------	----------	----------	----------	CHAN MODEM 1 CHAN 2	SEND-MEAS --------	SEND ----------	----------	----------	
53	----------	----------	----------	----------	----------	CHAN MODEM 2 CHAN 2	SEND-MEAS --------	SEND ----------	----------	----------	
54	----------	----------	----------	----------	----------	CHAN MODEM 3 CHAN 2	SEND-MEAS --------	SEND ----------	----------	----------	
	Perform steps 55 through 57 at terminal B. Report completion to terminal A.										
55	TRANS-MISSION	OFF ----------	SUBGRP DEM OUT	SUBGROUP	DEM 1 OUT	----------	----------	----------	SUBGROUP ------	DEM 1 GAIN --------	0 db.
56	TRANS-MISSION	OFF ----------	SUBGRP DEM OUT	SUBGROUP	DEM 2 OUT	----------	----------	----------	SUBGROUP ------	DEM 2 GAIN --------	0 db.
57	TRANS-MISSION	OFF ----------	SUBGRP DEM OUT	SUBGROUP	DEM 3 OUT	----------	----------	----------	SUBGROUP ------	DEM 3 GAIN --------	0 db.
	Perform step 58 at terminal A and leave switch in this position until step 59 is completed.										
58	----------	----------	----------	----------	----------	CHAN MODEM 1 CHAN 1	SEND-MEAS --------	SEND ----------	----------	----------	
	Perform step 59 at terminal B and report completion to terminal A.										
59	TRANS-MISSION	OFF ----------	CHANNEL OUT	TEST ----------	CHANNEL OUT	CHAN MODEM 1 CHAN 1	SEND-MEAS --------	MEAS ----------	CHAN MODEM 1 CHAN 1	GAIN ----------	0 db.
60	Repeat steps 58 and 59 for each of the remaining 11 channels.										
61	Repeat steps 35 through 60 substituting terminal B for terminal A and terminal A for terminal B in the directions. Substitute AB for BA in AN/TCC-8 switch, jack and control designations.										
	Perform step 62 at both terminal A and terminal B simultaneously. Conduct a talking test.										
62	----------	----------	----------	----------	----------	CHAN MODEM 1 CHAN 1	TALK-MON ---------	TALK ----------	----------	----------	
63	Repeat step 62 for each of the remaining 11 channels.										

NOTES:

1. Located on top of chassis. For steps 38, 39, 45, and 46, open drawer as far as possible.
2. Slowly adjust FINE TUNE control on TEST PANEL for maximum meter reading before making final control adjustment specified under Meter reading.
3. Adjust for number of reels to next AN/TCC-7 or AN/TCC-8. If control is set from 104 to 160, turn clockwise one step for each 20° F increase in average daily temperature above 45° F or one step counterclockwise for each 20° F decrease. If control is set from 58 to 103, turn one step clockwise for each 50F. above 45° F., or counterclockwise if below.
4. Push ATTENUATOR push buttons specified on OW TR AMP OUT ADJ table on ORDER WIRE PANEL and adjust TR GAIN (on AN/TCC-7) or AB OR BA TR GAIN (on AN/TCC-8). If singing occurs, turn associated REC GAIN control on ORDER WIRE PANEL counterclockwise until singing ceases.
5. If connected directly to a radio section, operate switch to RADIO. Otherwise, operate switch to the position corresponding to the number of cable reels to next AN/TCC-11.
6. CAUTION: Do not turn 600 VOLT POWER SUPPLY on until all AN/TCC-11 repeaters in adjacent section have been installed.
7. Adjust for number of AN/TCC-11 repeaters in the power loop. If connected directly to a radio section or to an attended point (no AN/TCC-11 repeaters in section) disconnect the 600 VOLT POWER SUPPLY, and do not perform steps 14, 15, 16, 25, 26, and 27.
8. If LOW VOLTAGE alarm lamp lights, turn 600 V ADJ control clockwise and operate RESTORE lever switch. If HIGH VOLTAGE alarm lamp lights, turn 600 V ADJ control counterclockwise and operate RESTORE lever switch.
9. Adjust for 100 ma on 600 VOLT POWER SUPPLY meter. Recheck previous step.
10. Adjust clockwise until alarm first operates.
11. If connected directly to a radio section, operate switch to RADIO. If connected to a section *without* an AN/TCC-11, operate switch to 23. Otherwise, operate switch to the position corresponding to the number of cable reels to next AN/TCC-11.

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212. Repeater Limitation When Open Wire Lines Are Used

* * * * *

e. The following table * * * numbers of repeaters.

Maximum distance between repeaters or several types of open wire line and various numbers of repeaters					
Dia-meter n mils	Materials	68 kc loss in db per mile (Note 1)	No. repeaters (1 span) Open wire line		Max dist. (mi) with entrance cable (Note 2)
			68 kc gain (db)	Max. dist. (mi.)	
080 104 *	Copper .... *	0.36 .32 *	(Note 4) 26 73 *	..... 72 72 *	(Note 4) 64 64 *

Figure 54. SIG C STOCK NO. 3Z9637.188 is changed to read: SIG C STOCK NO. 2Z9637.188.

[AG 413.42 (16 Feb 54)]

214. Emergency Order Wire Line-up When Open Wires Lines Are Used

The lineup of * * * the following exceptions:

a. Operate all CABLE REELS TO NEXT AN/TCC-7 or AN/TCC-8 switches on the ORDER WIRE PANELS to the position marked 0-11.

* * * * *

250. Order Wire Performance in System

The order wire circuit performance for a 200-mile cable system, is as follows:

* * * * *

b. Temperature Range.

(1) The values of circuit loss given in paragraph 240 may be obtained over a temperature range from -55° F. to +130° F.

* * * *

BY ORDER OF THE SECRETARY OF THE ARMY:

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General, United States Army,
Chief of Staff.

OFFICIAL:

WM. E. BERGIN,
Major General, United States Army,
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TECHNICAL MANUAL
No. 11-2150
TECHNICAL ORDER
No. 16-30TCC7-5

DEPARTMENTS OF THE ARMY AND
THE AIR FORCE
Washington 25, D. C., *11 September 1953*

TELEPHONE CARRIER SYSTEMS USING TELEPHONE TERMINAL AN/TCC-7, TELEPHONE REPEATER AN/TCC-8 (AN/TCC-21), TELEPHONE REPEATER AN/TCC-11, AND TELEPHONE TEST SET TS-712/TCC-11

WARNING

Heavy currents at moderate potentials are carried in the wiring of this equipment. These currents are dangerous to life.

All operating adjustments of this equipment are made with the power on. Be careful when examining the wiring of the equipment.

When repairing or replacing parts on a particular circuit, remove the power cord to avoid possible electrocution.

The spiral-four cable used in this system normally carries 100 milliamperes at high voltage. Do not disconnect or handle cable connectors unless power has been removed from the cable.

ARTIFICIAL RESPIRATION

GENERAL PRINCIPLES

1. Seconds count! Begin at once! Don't take time to move the victim unless you must. Don't loosen clothes, apply stimulants or try to warm the victim. Start resuscitation! Get air in the lungs! You may save a life!

2. Place the victim's body in a prone position, so that any fluids will drain from the respiratory passages. The head should be extended and turned sideward *never flexed forward;* the chin shouldn't sag, since obstruction of the respiratory passages may occur.

3. Remove any froth or debris from the mouth with your fingers. Draw the victim's tongue forward.

4. Begin artificial respiration. Continue it rhythmically and without any interruption until natural breathing starts or the victim is pronounced dead. Try to keep the rhythm smooth. Split second timing is not absolutely essential.

5. When the victim starts breathing, or when additional help is available loosen the clothing; remove it, if it's wet; keep the victim warm. Shock should receive adequate attention. Don't interrupt the rhythmical artificial technique for these measures. Do them only when you have help or when natural breathing has started.

6. When the victim is breathing, adjust your timing to assist him. Don't fight his efforts to breathe. Synchronize your efforts with his. After resuscitation, keep him lying down until seen by a physician or until recovery seems certain.

7. Don't wait for mechanical resuscitation! If an approved model is available, use it, but, since mechanical resuscitators are only slightly more effective than properly performed "push-pull" manual technique, *never* delay manual resuscitation for it.

BACK-PRESSURE ARM LIFT METHOD

1. *Position of Victim.* Place the victim in the prone (face down) position. Bend his elbows; place one hand upon the other. Turn his face to one side, placing his cheek upon his hands.

2. *Position of Operator.* Kneel on your left or right knee, at the victim's head, facing him. Your knee should be at the side of the victim's head close to his forearm, your foot should be near his elbow. Kneel on both knees if you find it more comfortable, with one knee on each side of the head. Place your hands on the flat of the victim's back so that their heels are just below the lower tip of his shoulder blades. With the tip of your thumbs touching spread your fingers downward and outward. (See A)

3. *Compression Phase.* Rock forward until your arms are approximately vertical and allow the weight of the upper part of your body to exert a slow, steady, even, downward pressure upon your hands. This forces air out of the lungs. Keep your elbows straight and press almost directly downward on the back. (See B)

4. *Expansion Phase.* Release the pressure, avoid any finish thrust, and commence to rock backward slowly. Place your arms upon the victim's arms just above the elbows, and draw his arms upward and toward you. Apply just enough lift to feel resistance and tension at the victim's shoulders.

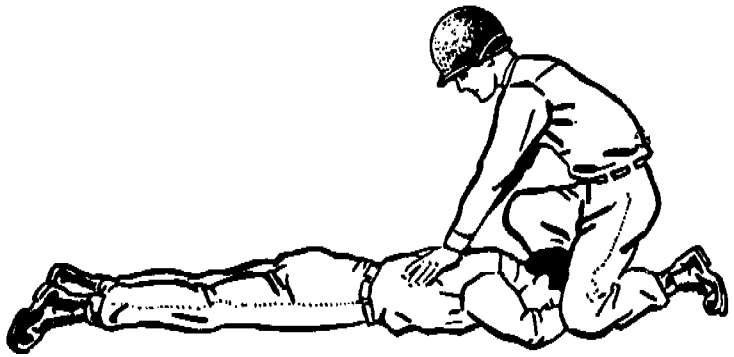
Don't bend your elbows. As you rock backward, the victim's arms will be drawn toward you. (The arm lift expands the chest by pulling on the chest muscles, arching the back and relieving the weight on the chest.) Drop the arms gently to the ground or floor. This completes the cycle. (See C and D). Now, repeat the cycle.

5. *Cycle Timing and Rhythm.* Repeat the cycle 10 to 12 times per minute Use a steady uniform rate of Press, Release, Lift, Release. Longer counts of about equal length should be given to the "Press" and "Lift" steps of the compression and expansion phases. Make the "Release" periods of minimum duration.

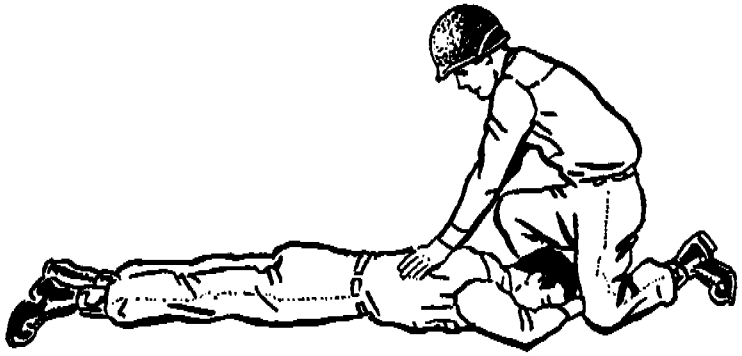
6. *Changing Position or Operator.*

(*a*) Remember that you can use either or both knees or can shift knees during the procedure, provided you don't break the rhythm. Observe how you rock forward with the back-pressure and backward with the arm-lift. The rocking motion helps to sustain the rhythm and adds to the ease of operation.

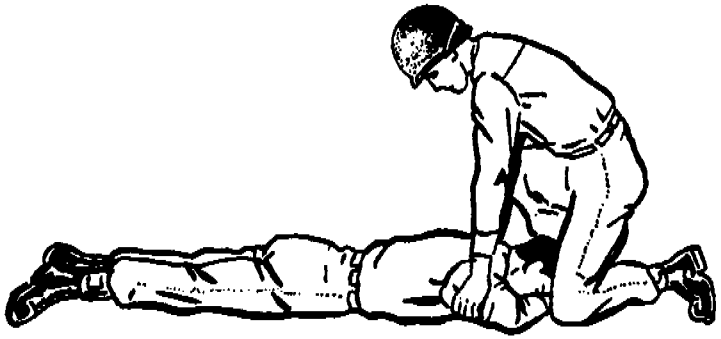
(*b*) If you tire and another person is available, you can "take turns." Be careful not to break the rhythm in changing. Move to one side and let your replacement come in from the other side. Your replacement begins the "Press-Release" after one of the "Lift-Release" phases, as you move away.



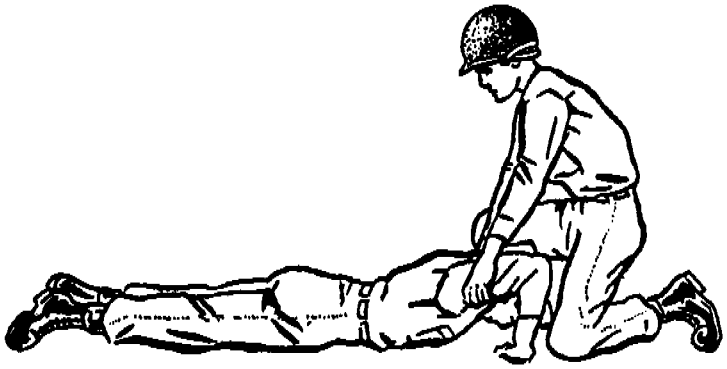
A Position of operator and victim



B Compression phase



C Expansion phase (arm lift)



D Expansion phase (arm release)

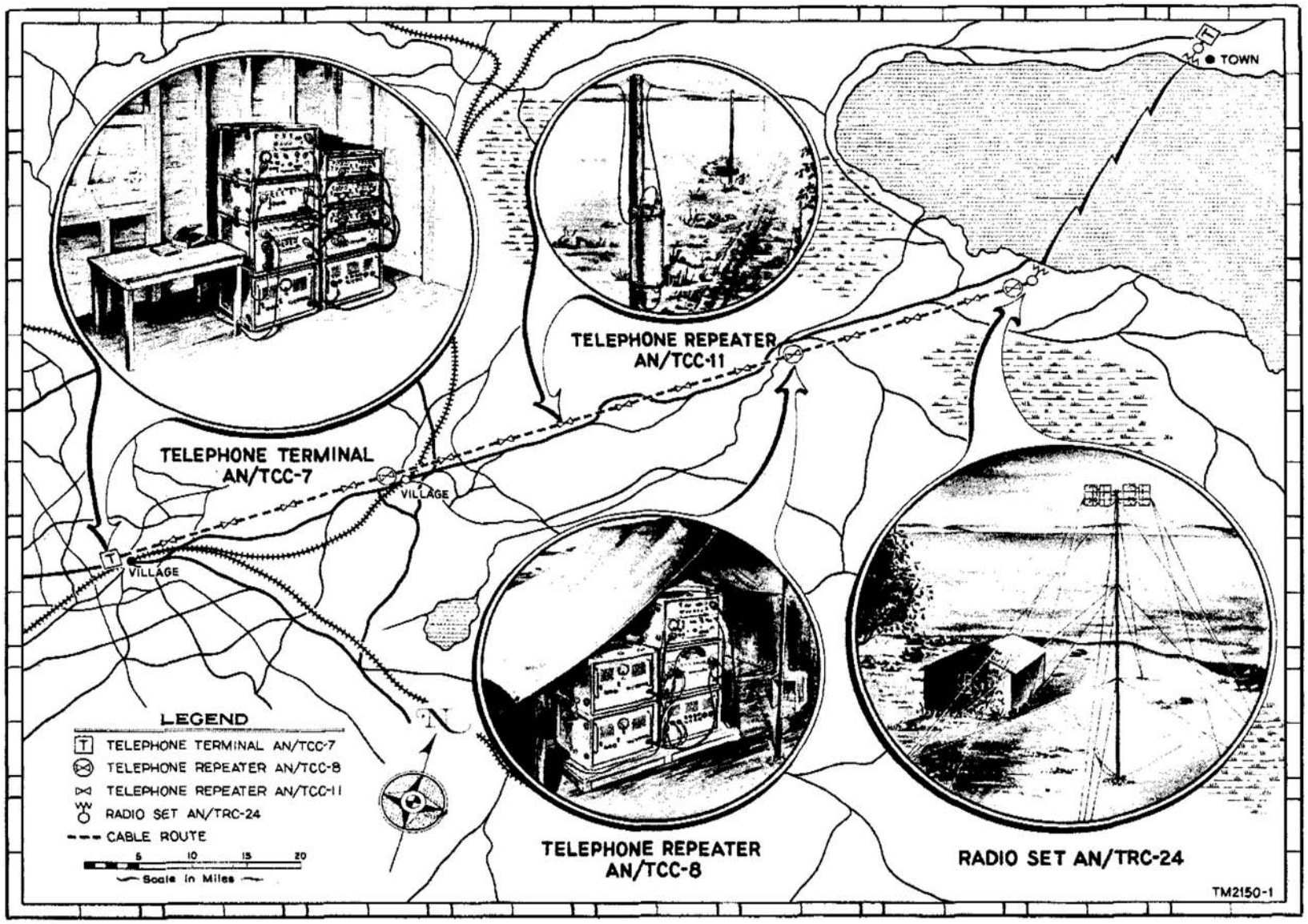


Figure 1. Typical telephone carrier system using Telephone Terminal AN/TCC-7, Telephone Repeater AN/TCC-8, and Telephone Repeater AN/TCC-11

CHAPTER 1
INTRODUCTION

Section I. GENERAL

1. Scope

a. This technical manual contains information concerning 12-channel carrier telephone systems that use combinations of the equipment listed below. These systems use nonloaded spiral-four cable (Cable Assembly CX-1065/G) or radio links as transmission media.

(1) Telephone Terminal AN/TCC-7.
(2) Telephone Repeater AN/TCC-8.
(3) Telephone Repeater AN/TCC-21. (This is a Telephone Repeater AN/TCC-8 plus its own power unit and grounding accessories.)
(4) Telephone Repeater AN/TCC-11.
(5) Telephone Test Set TS-712/TCC-11.

b. These instructions are published for the information and guidance of personnel who plan or use the systems**.** They contain information for system planning, installation, line-up, operation, maintenance testing, and trouble location.

c. In general, the subject matter pertains to the system as a whole rather than the individual equipments, which are covered by other technical manuals. Also included in this manual is information that applies to the equipments after connection to a transmission medium to form a system. Information that applies to the equipments before connection in the system is given in the associated equipment technical manuals.

2. Forms and Records

The trouble locating procedures and routine tests included in this technical manual are applicable to the system as a whole rather than individual equipments. Refer to the applicable equipment technical manual for the forms and records to be used when reporting trouble and performing preventive maintenance on individual equipments used in the system.

Section II. SYSTEM APPLICATION

3. Purpose and Use

a. *Purpose.*

(1) The AN/TCC-7 system provides 12 carrier telephone channels over a single nonloaded spiral-four cable and/or radio links for distances up to 200 miles. Facilities are provided for replacement of all or a portion of the 12 telephone carrier channels by broad-band special service circuits in 3 frequency ranges. The communication channels available for simultaneous use are listed in the table opposite.

Number of telephone message channels	Number of special service channels		
300 to 3,500 cps	4 to 20 kc	12 to 60 kc	60 to 108 kc
12	0	0	0
8	1	0	0
4	2	0	0
0	3	0	0
0	0	1	0
0	0	0	1

(2) An order wire circuit is provided in addition to the above listed communication circuits.

(3) The message channels (or the special service channels used in their place) are translated to a band of 12 to 60 kc (kilocycles) for transmission over the cable or radio links. The order wire circuit operates in the v-f (voice-frequency) range.

b. Use.

(1) The AN/TCC-7 system is used to make up trunks from switchboard to switchboard wherever there is need for the facilities which the system provides. The trunks may use a single AN/TCC-7 system, a number of AN/ TCC-7 systems in tandem, or combinations of AN/TCC-7 systems in tandem with other systems.

(2) The order wire circuit is used only for system maintenance and administration.

(3) The AN/TCC-7 system may be used as a direct connection between special service terminal equipment locations.

4. Description of General Types of AN/TCC-7 Systems

Notes.-1. Throughout this technical manual, the term "system" or "AN/TCC-7 system" will refer to any arrangement of Telephone Terminal AN/TCC-7, Telephone Repeater AN/TCC-8, Telephone Repeater AN/TCC-11, and the interconnecting facilities arranged to form a telephone carrier communication system.

2. Throughout this technical manual, descriptive names will be substituted for standard nomenclature of equipment and equipment components used in the system. A complete list of standard nomenclature and the descriptive names used for each unit appears in paragraph 13.

3. Throughout this technical manual, the terms "nonloaded spiral-four cable" and "spiral-four cable" are used to indicate cable comprised of sections of Cable Assembly CX-1065/G. *Note that Telephone Loading Coil Assembly CU-260/G is not used in this system.* An AN/TCC-7 system may contain the following: Telephone Terminal AN/TCC-7, Telephone Repeater AN/TCC-8 (or AN/TCC-21), Telephone Repeater AN/TCC-11, spiral-four cable, and radio links.

a. Use of Cable in AN/TCC-7 Systems. Spiral-four cable may be used as the transmission medium for an AN/TCC-7 system. When spiral-four cable is used, AN/TCC-8 repeaters must be placed along the cable route at intervals not exceeding 40 miles. In addition, AN/TCC-11 repeaters must be spaced at 5 3/4 mile intervals between the attended points. Figure 2 shows a typical AN/ TCC-7 system layout using spiral-four cable.

b. Use of Radio links in AN/TCC-7 Systems. An AN/TCC-7 system may consist of AN/TCC-7 terminals connected by radio links or by a combination of radio links and cable sections.

(1) Figure 3 illustrates an AN/TCC-7 system in which the AN/TCC-7 terminals are connected by a radio section. The radio section may consist of one or more radio links in tandem.

(2) Figure 4 illustrates an AN/TCC-7 system in which both radio and cable sections are used. When one or more radio sections are used in a system which also contains cable sections, the radio link terminal equipment must be placed adjacent to either an AN/TCC-7 terminal or an AN/TCC-8 repeater. An AN/TCC-11 repeater may not be placed adjacent to a radio link terminal.

5. Telephone Terminal AN/TCC-7, Functional Description

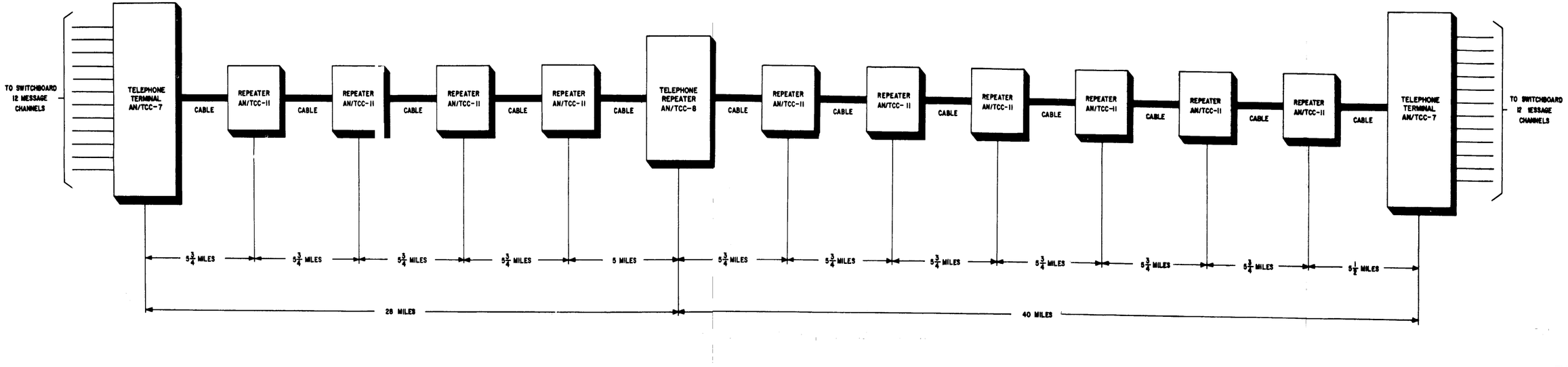
Telephone Terminal AN/TCC-7 comprises the terminal equipment for the system. This equipment should be located in a shelter at an attended point at which an a-c (alternating-current) power source is available. The features discussed in *a* through *f* below are provided by the AN/TCC-7 terminal.

a. Modulator circuits and carrier frequencies are provided to translate the message channels in three steps to a 12- to 60-kc frequency band. Demodulator circuits are provided to perform the reverse frequency translation process.

b. Special service circuits are provided that permit special service broad-band signals to be transmitted through the AN/TCC-7 terminal. The AN/TCC-7 terminal may be arranged to accept 16-kc bandwidth special service signals in the 4- to 20-kc band, 48-kc bandwidth signals in the 12- to 60-kc band, or 48-kc bandwidth signals in the 60- to 108-kc band. When 48-kc bandwidth special service signals are transmitted through the AN/TCC-7 terminal, all message channels are replaced by the special service signals. When 16-kc bandwidth signals are transmitted through the AN/TCC-7 terminal, each 16-kc bandwidth signal replaces four message channels.

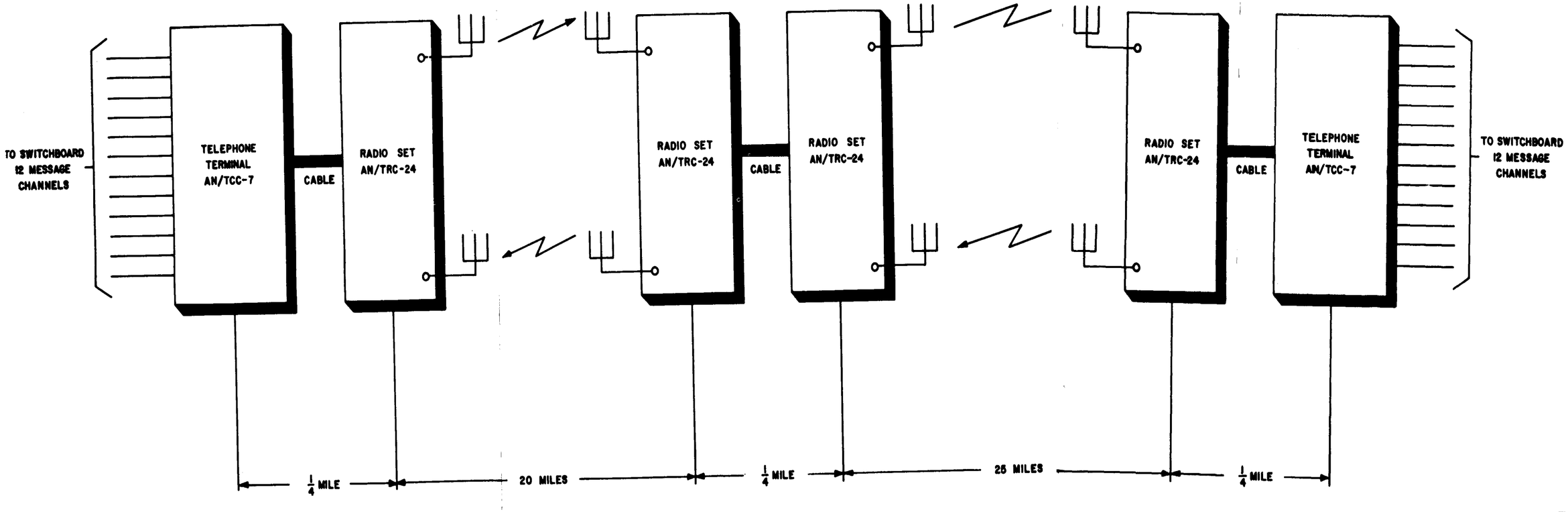
c. Amplifiers, regulator circuits, and equalizers are provided to compensate for the cable loss and for loss variations that occur with frequency and temperature variations.

d. An order wire circuit with talking and ringing



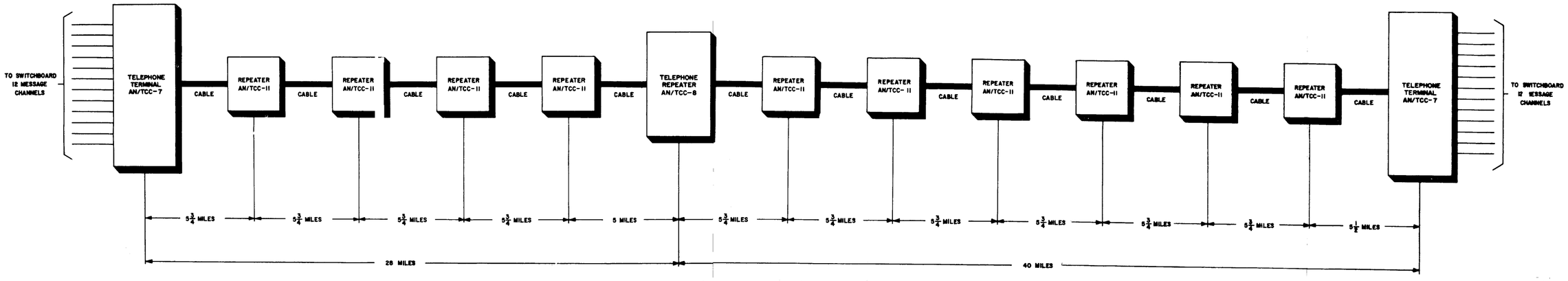
TM 2150-2
(Face p. 8) No. 1

Figure 2. -Typical AN/TCC-7 system layout using spiral-four cable, block diagram.



TM 2150-3
(Face p. 8) No. 2

Figure 3. -Typical AN/TCC-7 system layout using radio links, block diagram.



TM 2150-4
(Face p. 8) No. 3

Figure 4. Typical AN/TCC-7 system layout wiring spiral-four cable and radio links, block diagram.

facilities is provided for system maintenance and administration.

e. D-c (direct-current) power supplies are provided to supply power over the spiral-four cable phantom circuit for a maximum of three AN/TCC-11 repeaters. The power supplies operate from a 115- or 230-volt, 50- to 60-cps (cycles per second) power source.

f. Alarm circuits and testing facilities are provided.

6. Telephone Repeater AN/TCC-8 (or AN/TCC-21), Functional Description

The AN/TCC-8 repeater (or AN/TCC-21 repeater) provides amplification in two directions for the entire band of frequencies transmitted over the cable or radio links. These repeaters are spaced at intervals not exceeding 40 miles and should be located in shelters at normally attended points at which a-c power sources are available. The features discussed in *a* through *d* below are provided by the AN/TCC-8 repeater.

a. Amplification, equalization, and regulation are provided for the carrier frequency band and for the v-f order wire circuit for both directions of transmission.

b. Circuits- are provided to permit talking and ringing over the order wire.

c. D-c power supplies are provided to supply power over a spiral-four cable phantom circuit for a maximum of three AN/TCC-11 repeaters in each direction of transmission. The power supplies operate from a 115- or 230-volt, 50- to 60-cps power source.

d. Alarm circuits and testing facilities are provided.

7. Telephone Repeater AN/TCC-11, Functional Description

The AN/TCC-11 repeater provides amplification for the carrier frequency band in two directions of transmission. These repeaters are spaced at 5 3/4-mile intervals and may be located at unsheltered, unattended points. The features discussed in *a* through *c* below are provided by the AN/TCC-11 repeater.

a. Amplification, equalization, and regulation are provided for the carrier frequency band in both directions of transmission.

b. Filter sets are provided to separate the carrier frequency band and the order wire band. The order wire circuit is bypassed around the carrier amplifiers.

c. Circuits are provided to utilize the d-c power received over the cable from power supplies included in AN/TCC-7 and AN/TCC-8 equipments.

8. Cable and Radio Circuits, Functional Description

The AN/TCC-7 and AN/TCC-8 equipments are designed to operate in communication systems in which the various equipments are interconnected by cable or by radio links. The interconnecting links for a system may be either cable, radio, or a combination of cable and radio (figs. 2, 3, and 4). Some of the more pertinent aspects of each type of interconnecting facility are discussed in *a* and *b* below.

a. *Cable*.

(1) The system is designed for use with a single nonloaded spiral-four cable. The cable contains four polyethylene-insulated, stranded-copper conductors wound as a spiral quad. Diametrically opposite conductors are used to form a pair; each pair is used for a different direction of transmission of the v-f order wire and carrier frequency bands. Further information concerning the use and handling of the cable may be found in TB SIG 233.

(2) Cable Assembly CX-1065/G (fig. 5) consists of a reel of approximately 1/4 mile of spiral-four cable having a watertight connector at each end. The cable links that interconnect AN/TCC-7, AN/TCC-8, and AN/TCC-11 equipments are built up by connecting together the required number of 1/4-mile cable sections. The cable sections are connected by engaging the cable connectors. The AN/TCC-7, AN/TCC-8, and AN/TCC-11 equipments are provided with cable connectors to join with the cable.

(3) Telephone Cable Assembly CX-1606/G consists of a reel of spiral-four cable approximately 100 feet long having a connector at each end. This spiral-four cable assembly may be used to build up cable sections of intermediate lengths.

b. *Radio*

(1) Radio links may be used to interconnect two AN/TCC-7 terminals, an AN/TCC-7 terminal and an AN/TCC-8 repeater, or two AN/TCC-8 repeaters. Radio Set

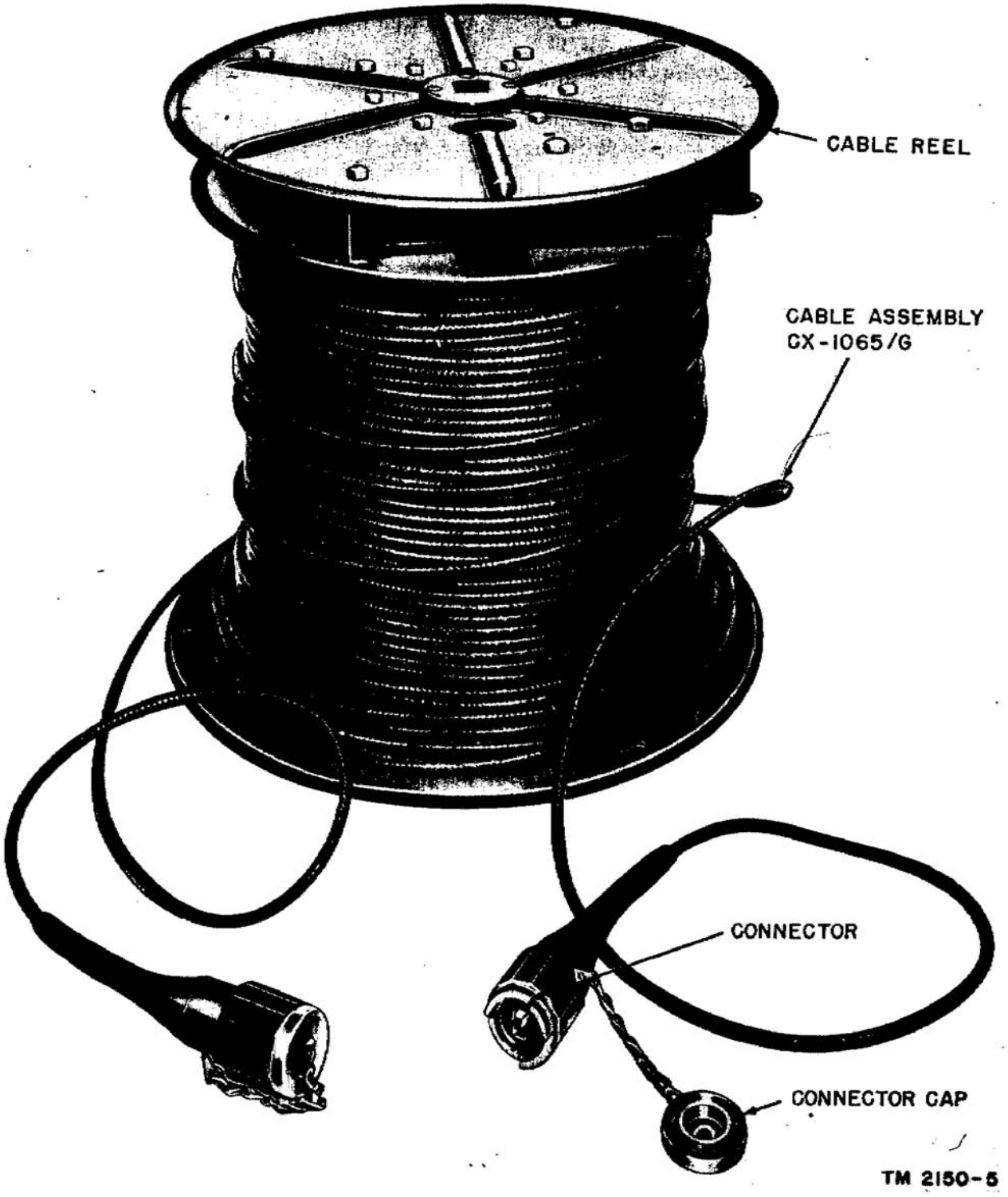


Figure 5. Cable Assembly CX-1065/G.

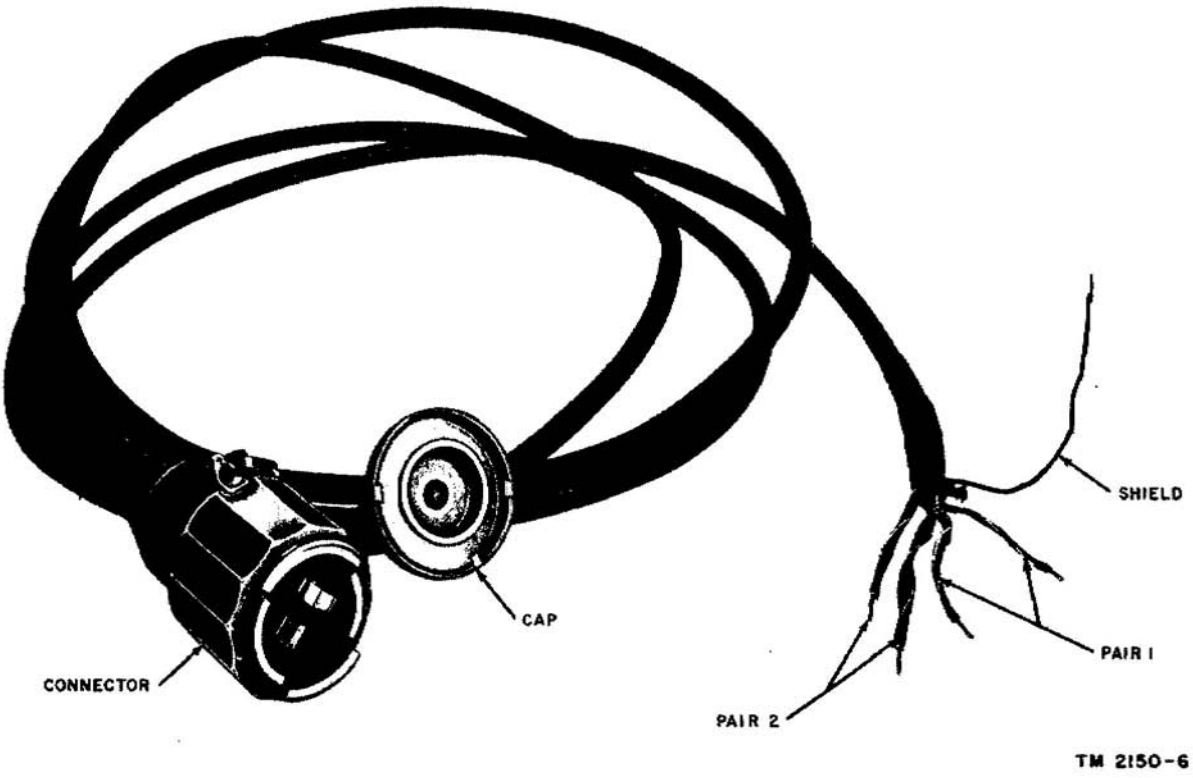


Figure 6. Telephone Cable Assembly CX-1512/U.

AN/TRC-24 is a typical example of a radio set that may be used for this purpose.

(2) Connections to a radio link may not be made from an AN/TCC-11 repeater.

(3) Radio links should provide a net loss of approximately 0 db (decibel) over a frequency band from 0.3 to 68 kc for both directions of transmission.

(4) Connections are made to the radio equipment by means of Telephone Cable Assembly CX-1512/U (fig. 6). This assembly (known as a cable stub) consists of approximately 12 feet of spiral-four cable with a watertight connector at one end and bared tinned copper conductors at the other end. The AN/TCC-7 or AN/TCC-8 equipment may be connected to the radio equipment by adding the necessary 1/4-mile lengths or 100-foot lengths to the cable stub. The length of the spiral-four cable used between a radio station and the adjacent AN/TCC-7 or AN/TCC-8 point is subject to the limitations given in paragraph 42.

9. System Application-Message Channels

a. Talking Circuits. A typical application of a message channel of the system would be to provide a trunk from a switchboard at one point to a switchboard at some distant point. The message channel may be terminated in a switchboard. The switchboard may be connected to loops leading to telephone stations or to other trunks (fig. 7).

b. Other Terminating Equipment. The message channels of the system may terminate in a switchboard or in other terminating equipment that meets the technical requirements of the message channels. These technical characteristics are listed in paragraph 12.

c. Signaling. The AN/TCC-7 terminal does not provide means for signaling over a message channel. V-f ringing signals must be provided externally. In the typical loop arrangement shown in figure 7, signaling is provided by Telegraph-Telephone Signal Converter TA-182/U, which receives 20-cps signals from the switchboard and delivers 1,225-cps or 1,600-cps signals to the AN/TCC-7 message channel.

d. Levels.

(1) The level at any point in a system is

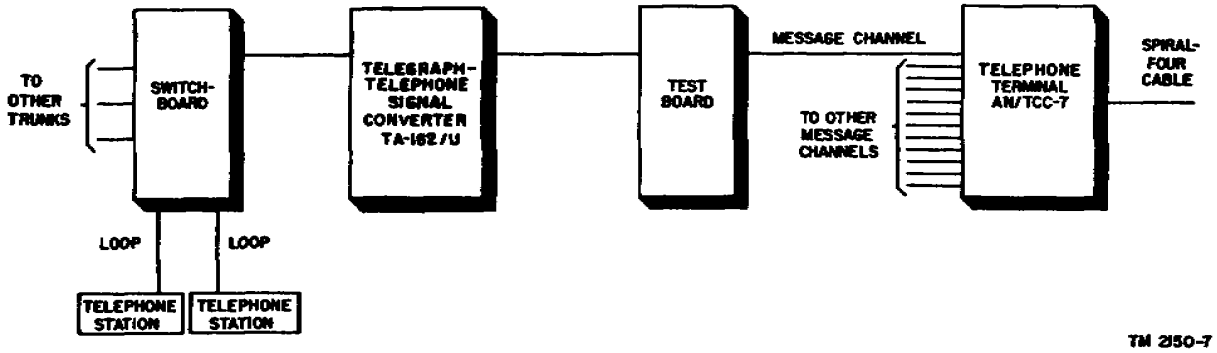


Figure 7. Typical loop arrangement of an AN/TCC-7 system terminated at a switchboard

defined as the gain (or loss) in db from some reference point to the point under consideration. In the AN/TCC-7 system, the two-wire message channel transmitting input is the reference point (0 db level). For example, if -3 dbm (decibels relative to 1 milliwatt) is delivered to the 0 db level point, -6 dbm will be delivered to a -3 db level point, -2 dbm will be delivered to a +1 db level point.

(2) The message channel connections in an AN/TCC-7 system may be made on a 2-wire or 4-wire basis. With the 2-wire connection, the same pair of wires is used by both the channel transmitting and the channel receiving circuits. The levels for the 2-wire connection are 0 db for transmitting and -3 db for receiving, which provide a net loss of 3 db for the channel. With a 4-wire connection, separate pairs are used for the channel transmitting and the channel receiving circuits. The levels at a 4-wire connection are -4 db for the transmitting circuit and +1 db for the receiving circuit, which provides a net gain of 5 db for the channel.

e. Circuit Extensions. The message channels of the system may be extended through switchboards or connected directly to a wide variety of other communication systems.

(1) The AN/TCC-7 system may be interconnected to systems that meet the technical characteristics of the message channel circuits as listed in paragraph 12.

(2) Interconnections of two different systems may be made by the use of loss pads or amplifiers to match the technical requirements of the two different carrier systems. For example, a message channel of an AN/TCC-7 system may be terminated in an AN/TCC-3 system on a 4-wire basis (fig. 8). In this case, 5-db pads are required in the transmitting and receiving circuits of the AN/TCC-7 terminal.

10. System Application-Special Service Channels

The special service circuits of an AN/TCC-7 system may be connected directly to special service terminating equipments or may be extended over other telephone systems arranged in tandem. Any terminating equipment or telephone system that meets the technical requirements (par. 12) of

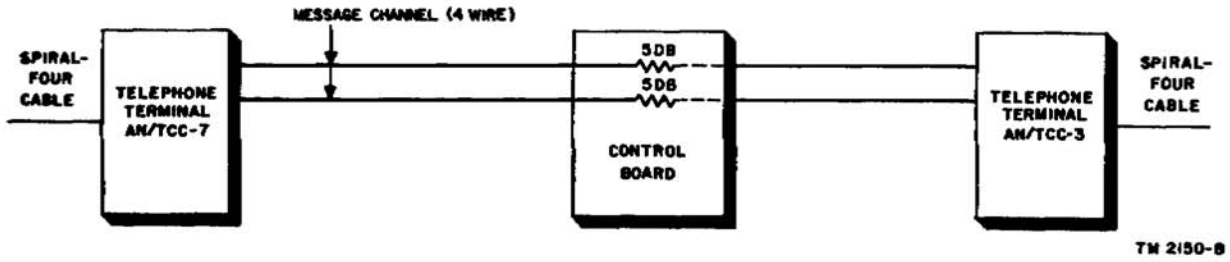


Figure 8. Extension of message channel from AN/TCC-7 system to AN/TCC-3 system, block diagram.

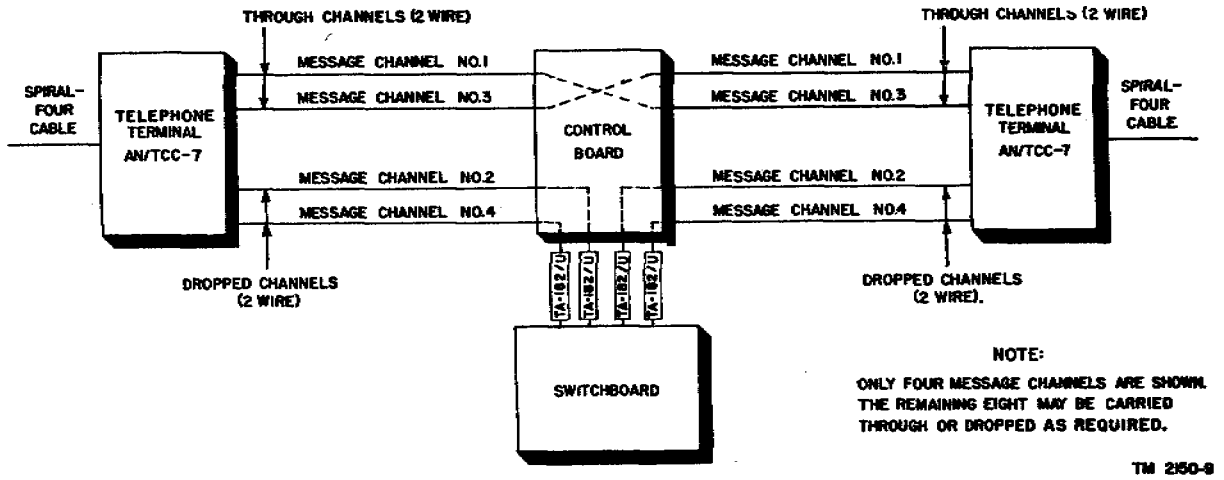


Figure 9. Systems in tandem, 2-wire connection, block diagram.

the special service circuits may be used. Special service channels may be used to replace a limited number or all of the telephone channels (par. 3*a*). Switching arrangements in the AN/TCC-7 terminal provide for rapid switch-over from telephone message channel operation to special service operation.

11. Systems in Tandem

a. Interconnections. The interconnections between systems arranged in tandem may be made on a 2-wire basis (fig. 9) or on a 4-wire basis (fig. 10).

(1) With a 2-wire interconnection between systems arranged in tandem, the circuit loss of the over-all communication system increases at the rate of 3 db for each system added to the circuit. For example, a loss of 15 db will result from a communication system consisting of an arrangement of five systems connected in tandem on a 2-wire basis.

(2) With 4-wire interconnections between systems arranged in tandem, the total loss of the over-all communication system may be limited to 3 db, regardless of the number of systems connected in tandem for use in the circuit. This is due to the fact that hybrid coil arrangements in the AN/TCC-7 terminal used for a 2-wire inter-connection are not used for a 4-wire inter-connection. When 4-wire interconnections are used between AN/TCC-7 systems arranged in tandem, the signal levels between systems must

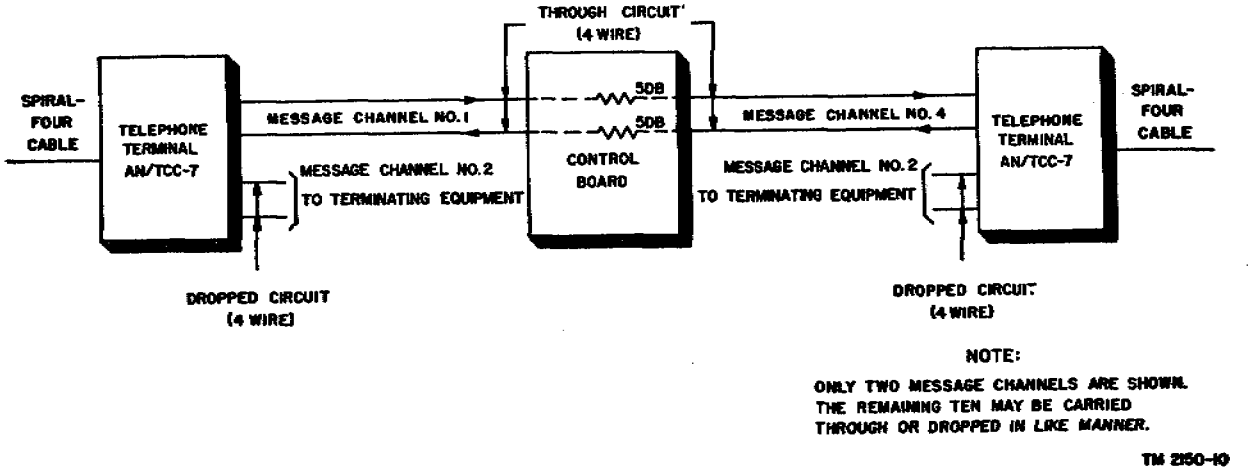


Figure 10. Systems in tandem, 4-wire connection, block diagram.

be adjusted to the input requirements of the AN/TCC-7 terminals. The v-f output level of a message channel of the AN/TCC-7 terminal is +1 db, and the v-f input level to a message channel is -4 db (par. 9*d*). These levels require that a 5-db pad be inserted in the inter-connections between terminals arranged in tandem. Figures 8 and 10 show this 5-db pad located in a control board. Four-wire inter-connections may be made between systems arranged in tandem without the use of 5-db pads by reducing the output level of the interconnected channels by 5 db.

b. Performance.

(1) Satisfactory talking circuits may be obtained from five systems in tandem, but the performance will be considerably poorer than that of a single system. In such a case, the effective bandwidth of a message channel becomes narrower, the variation in loss over the band increases, and the delay distortion becomes poorer. Considerable caution should be exercised in the use of several systems in tandem when the message channels are used to transmit services which are more critical in their transmission requirements than talking circuits.

(2) Some improvement in performance may be obtained *by frogging* channels at the inter-connection between systems. Figure 9 shows an example of *frogging* of message channels at the interconnection between AN/TCC-7 terminals of two systems in tandem. In figure 9, channels 1 and 3 of one AN/TCC-7 terminal are shown connected to channels 3 and 1, respectively, of another AN/TCC-7 terminal. Figure 10 shows *frogging* of channels 1 and 4 at the interconnection between AN/TCC-7 terminals of two systems.

(3) When more than two systems are connected in tandem on a 4-wire basis, the nominal net loss of the over-all system may have to be increased to prevent singing in the circuit. With the systems connected on a 4-wire basis, regulation in the system may prove to be inadequate to hold the net loss high enough to prevent singing.

c. Dropping of Channels. Message channels or special service channels may be dropped at a junction of any two systems in tandem, for termination or extension to other systems (figs. 9 and 10). There is no provision for drop-ping channels at any other point within an AN/TCC-7 system.

Section III. DESCRIPTION AND DATA

12. Technical Characteristics

a. Distances Covered.

System..... 200 miles max.
Attended repeater section ..... 40 miles max.
Unattended repeater section..... 5 3/4 miles.

b. Message Channels.

Number ..... 12.
Frequency band ..... 300 to 3,500 cps.
Impedance..... 600 ohms.
Levels:

Type of operation:	Input to AN/TCC-7 terminal	Output from AN/TCC-7 terminal	System net loss or gain
2-wire operation.	0 db	-3 db	3 db loss
4-wire operation.	-4 db	+1 db	5 db gain

Note. The level at any point in a system is defined as the gain (or loss) in db from some reference point to a point under consideration. In the AN/TCC-7 system, the 2-wire message channel transmitting input is the reference point (0 db level).

c. Special Service Channels.

Frequency band (kc)	No. of channels	Levels		Impedance (ohms)
		Input to AN/TCC-7 terminal (db)	Output from AN/TCC-7 terminal (db)	
4 to 20	3	0	0	600
12 to 60	1	0	-2	135
60 to 108	1	0	-5	135

d. Transmission Over Cable.

Type of cable..... Cable Assembly CX-1065/G.
Cable impedance..... 135 ohms nom (above 12 kc).
Message channels (or special service):
Frequency band ..... 12 to 60 kc.
Level at input to cable... 0 db.

Frequencies to cable from individual message channels:

Channel	*TA-219 CHAN MODEM*	*Cable frequency (kc)*
1.....	1	56-60
2.....	1	52-56
3.....	1	48-52
4.....	1	44-48
1.....	2	40-44
2.....	2	36-40
3.....	2	32-36
4.....	2	28-32
1.....	3	24-28
2.....	3	20-24
3.....	3	16-20
4.....	3	12-16

Pilot frequency:

Frequency	*Power at input to cable*	*Use*
68 kc	0 dbm	Automatic regulation to compensate for variation of loss due to temperature variation. This pilot frequency is always transmitted.

Test frequencies:

Frequency (kc)	*Power at input to cable (dbm)*	*Use*
12	-10	Adjustment of equalization of slope characteristic of cable. This frequency is transmitted only during line-up.
28	-10	Adjustment of equalization of bulge characteristic of cable. This frequency is transmitted only during line-up.
83	0	Location of trouble in transmission loops to AN/TCC-11 repeaters.
91	0	
99	0	

e. Transmissions Over Radio.

Radio set impedance (transmit and receive).	135 ohms.
Frequencies transmitted to radio set.	0.3 to 68 kc.
Level l (at input to cable leading to radio set):	
300 to 1,700 cps (order wire).	+10 db.
12 to 60 kc (message channels or special service).	0 db.
68 kc (pilot).....	0 dbm.
Net loss (transmitting radio set input to receiving radio set output).	0 db.

f. *Order Wire.*

Frequency range.....	300 to 1,700 cps.
Signaling frequency	1,600 cps.
Transmitting level to cable.....	+20 db max.
Transmitting level to radio.....	+10 db.
2-wire extension to control board:	
Impedance.....	600 ohms.
Transmitting level	0 db.
Receiving level	-12 db.

g. Power Requirements

Telephone Terminal AN/TCC-7.	115 or 230 v, ac, 50-60 cps, single phase, 750 watts.
Telephone Repeater AN/TCC-8.	115 or 230 v, ac, 50-60 cps, single phase, 900 watts.
Telephone Repeater AN/TCC-11.	150 v regulated dc, .1 ampere, supplied over spiral-four cable from an AN/TCC-7 terminal or an AN/TCC-7 8 repeater.

13. Tables of Components

The tables that follow list the components of the equipments used in the system. The tables list the standard nomenclature of each unit and the descriptive name used for each unit. In this technical manual, the descriptive names will be used for simplicity and clarity. The dimensions**,** weight, and volume are listed for each component.

a. Telephone Terminal AN/TCC-7 (AN/TCC-7 Terminal).

Nomenclature	Name used in text	No. req	Height (in.)	Depth (in.)	Width (in.)	Volume (cu ft)	Wt (lb)	Other items incl.
Telephone Modem TA-219/U.	TA-219 CHAN MODEM.	3	9 1/8	18 1/16	20 5/8	1.97	73	One copy of TA-219 CHAN MODEM circuit label book.
Telephone Modem TA-227/U.	TA-227 SUB-GROUP PANEL.	1	9 1/8	18 1/16	20 5/8	1.97	63	One copy of TA-227 SUB-GROUP circuit label book.
Amplifier-Pilot Regulator AM-707/ TCC-7.	AM-707 group and junction panels.	1	17 1/16	18 1/16	20 5/8	3.68	108	One copy of AM-707 group and junction panels circuit label book.
Group panel	GROUP PANEL							
Junction panel	JUNCTION PANEL							
Telephone Carrier Frequency Supply TA-228/TCC-7.	TA-228 CARRIER SUPPLY PANEL.	1	12 3/16	18 1/16	20 5/8	2.63	70	One copy of TA-228 CARRIER SUPPLY PANEL circuit label book, one copy of the over-all AN/ TCC-7 terminal circuit label book, one copy of AN/TCC-11 repeater circuit label book, one extension cable, and one measure cord adapter.
Receiver-Transmitter Test Set Group OA-443/TCC-7.	OA-443 order wire and test set.	1	17 1/16	18 1/16	20 5/8	3.68	83	One copy of OA-443 order wire and test set circuit label book and one extension cable.
Order Wire Receiver-Transmitter RT-280/TCC-7.	RT-280 ORDER WIRE PANEL.							
Telephone Test Set TS-760/TCC-7.	TS-760 TEST PANEL.							
Power Supply PP-826/U.	PP-826 600 VOLT POWER SUPPLY.	1	17 1/16	18 1/16	20 5/8	3.68	103	One copy of PP-826 600 VOLT POWER SUPPLY PANEL circuit label book.
Power Supply PP-827/U.	PP-827 200 VOLT POWER SUPPLY.	1	17 1/16	18 1/16	20 5/8	3.68	100	One copy of PP-827 200 VOLT POWER SUPPLY PANEL circuit label book.

b. Telephone Repeater AN/TCC-8 (AN/TCC-8 Repeater).

Nomenclature	Name used in text	No. req	Height (in.)	Depth (in.)	Width (in.)	Volume (cu ft)	Wt (lb)	Other items incl.
Amplifier-Pilot Regulator AM-708/TCC-8.	AM-708 REPEATER PANEL.	1	17 1/16	18 1/16	20 5/8	3.68	118	One copy of AM-708 REPEATER PANEL circuit label book, one copy of the overall AN/TCC-8 repeater circuit label book assembly, one copy of AN/TCC-11 repeater circuit label book, one extension cable, and one measure cord adapter.
Receiver-Transmitter Test Set Group OA-446/TCC-8.	OA-446 order wire and test set.	1	17 1/16	18 1/16	20 5/8	3.68	87	One copy of OA-446 order wire and test set circuit label book, and one extension cable.

b. Telephone Repeater AN/TCC-8 (AN/TCC-8 Repeater)-Continued

Nomenclature	Name used in text	No. req	Height (in.)	Depth (in.)	Width (in.)	Volume (cu ft)	Wt (lb)	Other items incl.
Receiver-Transmitter Order Wire RT-281/TCC-8.	RT-281 ORDER WIRE PANEL.	.....	.....	.....	.....	.....	.....	
Telephone Test Set TS-761/TCC-8.	TS-761 TEST PANEL.	.....	.....	.....	.....	.....	.....	
Power Supply PP-826/U.	PP-826 600 VOLT POWER SUPPLY	2	17 1/16	18 1/16	20 5/8	3.68	103	One copy of PP-826 600 VOLT POWER SUPPLY circuit label book.
Power Supply PP-827/U.	PP-827 200 VOLT POWER SUPPLY.	1	17 1/16	18 1/16	20 5/8	3.68	100	One copy of PP-827 200 VOLT POWER SUPPLY circuit label book.

c. Telephone Repeater AN/TCC-21 (AN/TCC-21 Repeater).

Nomenclature	Name used in text	No. req	Height (in.)	Depth (in.)	Length (in.)	Volume (cu ft)	Wt (lb)
Repeater, Telephone AN/TCC-8	AN/TCC-8 repeater	1	([1])	.....	.....	.....	.....
Power Unit PE-75-( )*	Power Unit PE-75-( )	2	26½	19	36	10.489	330
Ground Rod MX-148/G	Ground Rod MX-148/G	1	.....	.....	72	.....	.....
Junction Box J-85/G	Junction Box J-85/G	1	4 1/16	5½	5½	.0648	.....
Junction Box JB-110	Junction Box JB-110	1	2¼	4½	12¼	.0718	8½
Clamp TM-106	Clamp TM-106	1	.....	.....	.....	.....	.....
Cord CO-711	Cord CO-711	1	.....	.....	.....	.....	.....

*PE-75-( ) refers to all models of Power Unit PE-75.

[1] See *b* above.

d. Other Equipment.

Nomenclature	Name used in text	No. req	Height (in.)	Depth (in.)	Width or length	Volume (cu ft)	Wt (lb)	Other items incl.
Telephone Repeater AN/TCC-11.	AN/TCC-11 repeater.	1	*10-inch diameter*		28¼	1.79	70	AN/TCC-11 circuit label books are stored in TA-228 CARRIER SUPPLY PANEL at the AN/TCC-7 terminal and in the AM/708 REPEATER PANEL at the AN/TCC-8 repeater.
Telephone Test Set TS-712/TCC-11.	TS-712 test set	1	7½	9 7/8	13 3/8	.573	19	One copy of TS-712 test set circuit label book.
Artificial cable	Artificial cable	1	13½	2	7½	.03	5	Artificial cable is a component of TS-712 test set but is completely detached from it. Attached to the artificial cable is a 2-foot length of spiral-four cable with a cable connector at the end.
Telephone EE-8-( )*	EE-8 telephone	1	10	4	8 in.	.185	10	
Cable Assembly CX-1065/G.	Nonloaded spiral- four cable (or spiral-four cable).	.....	.....	.....	¼ mi.	.....	.....	
Telephone Cable Assembly CX-1512/U.	Cable stub	.....	.....	.....	12 ft	.....	.....	
Telephone Cable Assembly CX-1606/G.	100-ft reels or 100-ft lengths.	.....	.....	.....	100 ft	.....	.....	

*EE-8-( ) refers to all models Telephone EE-8.

14. Packaging Data

The components of the system are packed for shipment in wooden boxes. The following tables list the dimensions, weight, volume, and contents of each box.

a. AN/TCC-7 Terminal Equipment.

No. of boxes	Height (in.)	Depth (in.)	Width (in.)	Volume (cu ft)	Weight (lb)	Contents
1	22	25	26	8.3	147	OA-443 order wire and test set.
1	22	25	26	8.3	174	AM-707 group and junction panels.
1	22	25	26	8.3	164	PP-827 200 VOLT POWER SUPPLY.
1	22	25	26	8.3	167	PP-826 600 VOLT POWER SUPPLY.
1	18	25	26	6.77	130	TA-228 CARRIER SUPPLY PANEL.
3	15	25	26	5.63	122	TA-219 CHAN MODEM.
1	15	25	26	5.63	112	TA-227 SUBGROUP PANEL.
Total				62.5	1260	

b. AN/TCC-8 Repeater Equipment.

No. of boxes	Height (in.)	Depth (in.)	Width (in.)	Volume (cu ft)	Weight (lb)	Contents
1	22	25	26	8.3	182	AM-708 REPEATER PANEL.
1	22	25	26	8.3	151	OA-446 order wire and test set.
1	22	25	26	8.3	164	PP-827 200 VOLT POWER SUPPLY.
2	22	25	26	8.3	167	PP-826 600 VOLT POWER SUPPLY.
Total				41.5	831	

c. AN/TCC-11 Repeater.

No. of boxes	Height (in.)	Depth (in.)	Width (in.)	Volume (cu ft)	Weight (lb)	Contents
1	16	34	14	4.4	130	AN/TCC-11 repeater.

d. TS-712 Test Set and Additional Equipment.

No. of boxes	Height (in.)	Depth (in.)	Width (in.)	Volume (cu ft)	Weight (lb)	Contents
1	14	27	15	3.3	72	TS-712 test set (including artificial cable), EE-8 telephone.

15. Physical Description of Components

All the components of equipments used in the system with the exception of the TS-712 test set, the artificial cable, the EE-8 telephone, and the AN/TCC-11 repeater, are similar in mechanical structure. The mechanical features of the similar panels are described in *a* through *f* below. More complete details are given in the technical manuals for the individual equipment.

a. General. Each component consists of panel and chassis assemblies of the drawer type, flush-mounted in a relay rack-type frame. The frame is mounted in an olive drab aluminum carrying case complete with weatherproof cover.

b. Case. The case (fig. 11), with front cover attached, provides a weatherproof assembly for transit or storage. Snap catches on the front edges of the case serve to hold the cover in place. Nesting cleats on the top and bottom of the case are used to facilitate stacking of components.

Carrying straps are provided on the sides of the case.

c. Rack Frame. The rack frame (fig. 11) is mechanically secured within the case. It provides shock mounting for the panel and chassis assemblies and slide channels for the roller slides on the chassis.

d. Panel and Chassis Assemblies. Each panel and chassis assembly consists of a panel with etched aluminum markings and an attached chassis. The assembly slides into the proper compartment

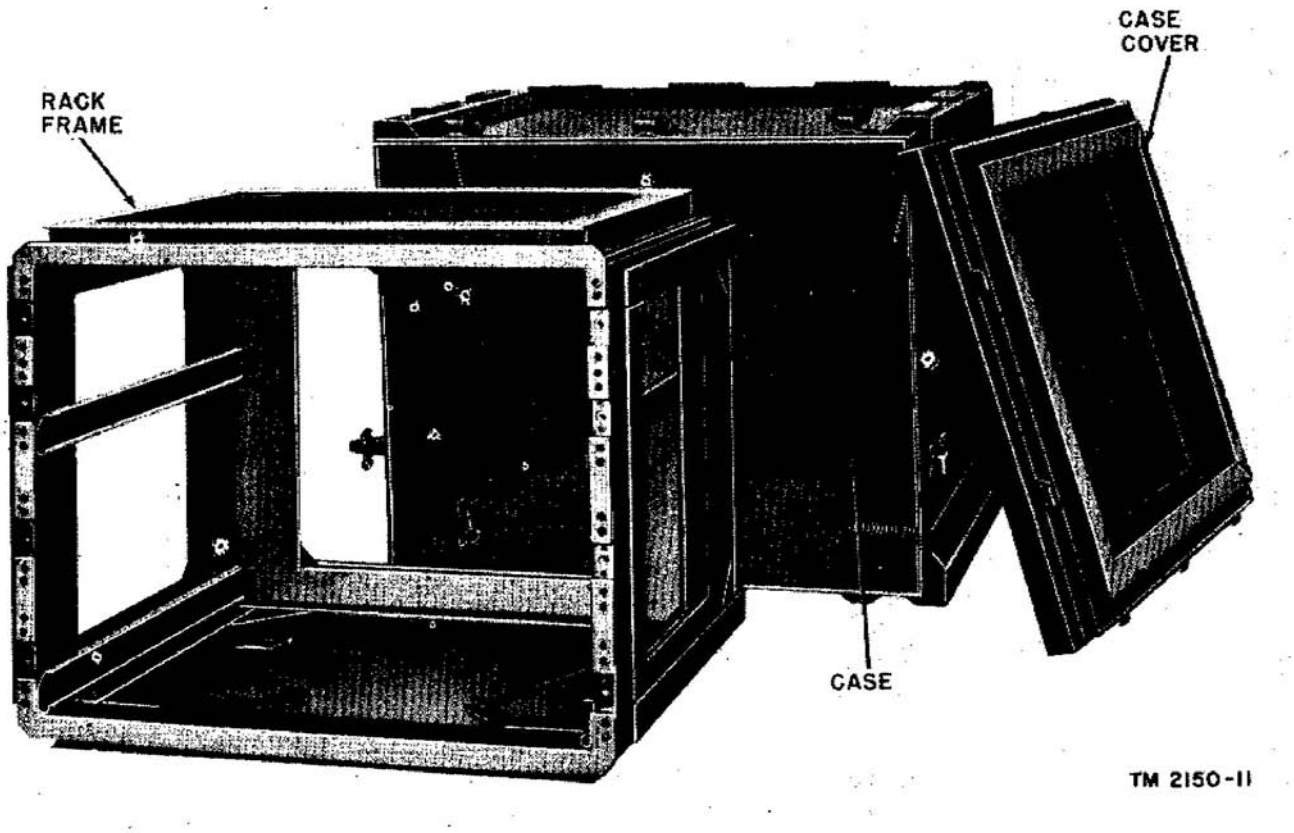


Figure 11. Case and rack frame, cover removed

of the rack frame on roller slides. These slides are attached to the sides of the chassis.

e. Cables. All electrical connections between the components are made by means of captive cables and panel-mounted cable connectors. Space is provided within each panel and chassis assembly to store the cables which are connected permanently to circuits within that assembly.

f. Spares. Running spares for use in the replacement of tubes, fuses, lamps, and lightning arresters are stored in sockets distributed throughout the various components of the equipments.

16. Description of Telephone Terminal AN/TCC-7, General

Paragraphs 17 through 26 briefly describe the components of the AN/TCC-7 terminal. The descriptions include the controls, test jacks, and other parts used in test procedures described in later chapters in this technical manual. Photographs of each component are included as an aid in locating the controls. More complete descriptions are given in the technical manual for the AN/TCC-7 terminal equipment. Figure 12 shows a typical arrangement of all the components of an AN/TCC-7 terminal.

17. Description of Telephone Modem TA-219/U (CHAN MODEM)

a. The AN/TCC-7 equipment includes three TA-219 CHAN MODEM panel which will be referred to as the No. 1, No. 2, and No. 3 TA-219 CHAN MODEM panels. These three panels are stacked in the arrangement of the AN/TCC-7 equipment with No. 1 at the top of the assembly of three, No. 2 in the middle, and No. 3 at the bottom (fig. 12).

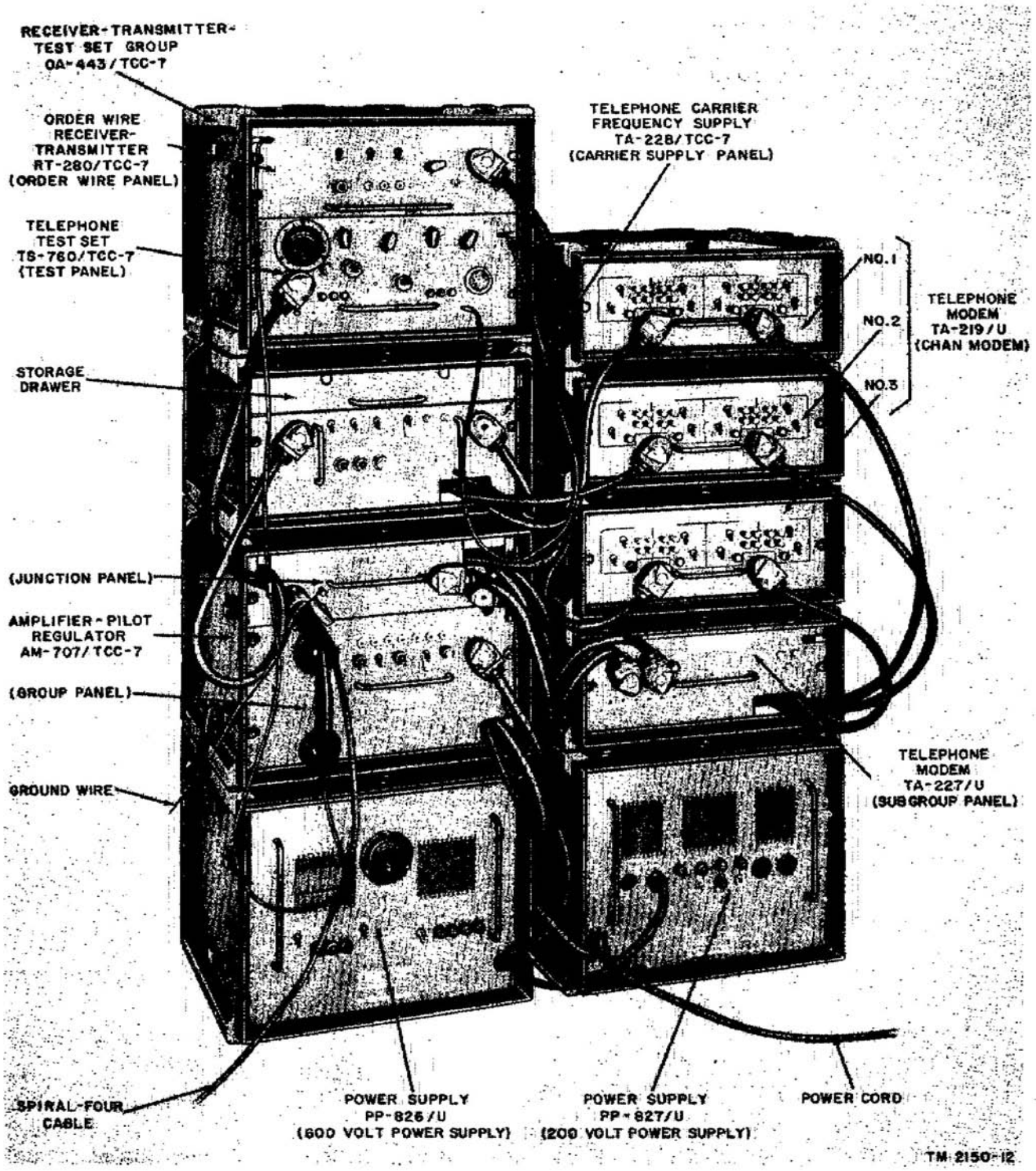


Figure 12. Telephone Terminal AN/TCC-7.

b. The front panel of the TA-219 CHAN MODEM (fig. 13) contains lever switches, controls, and binding posts for each of four message channels. Additional lever switches are mounted on brackets in back of the front panel (fig. 14) and may be reached by sliding the panel a few inches out of its case.

c. Each TA-219 CHAN MODEM panel contains circuits to modulate four message channels to a band of 4 to 20 kc in the transmitting direction. It also contains circuits to separate and demodulate the received message channels from a 4- to 20-kc band to four bands of 300 to 3,500 each. Each message channel is equipped with a v-f output amplifier.

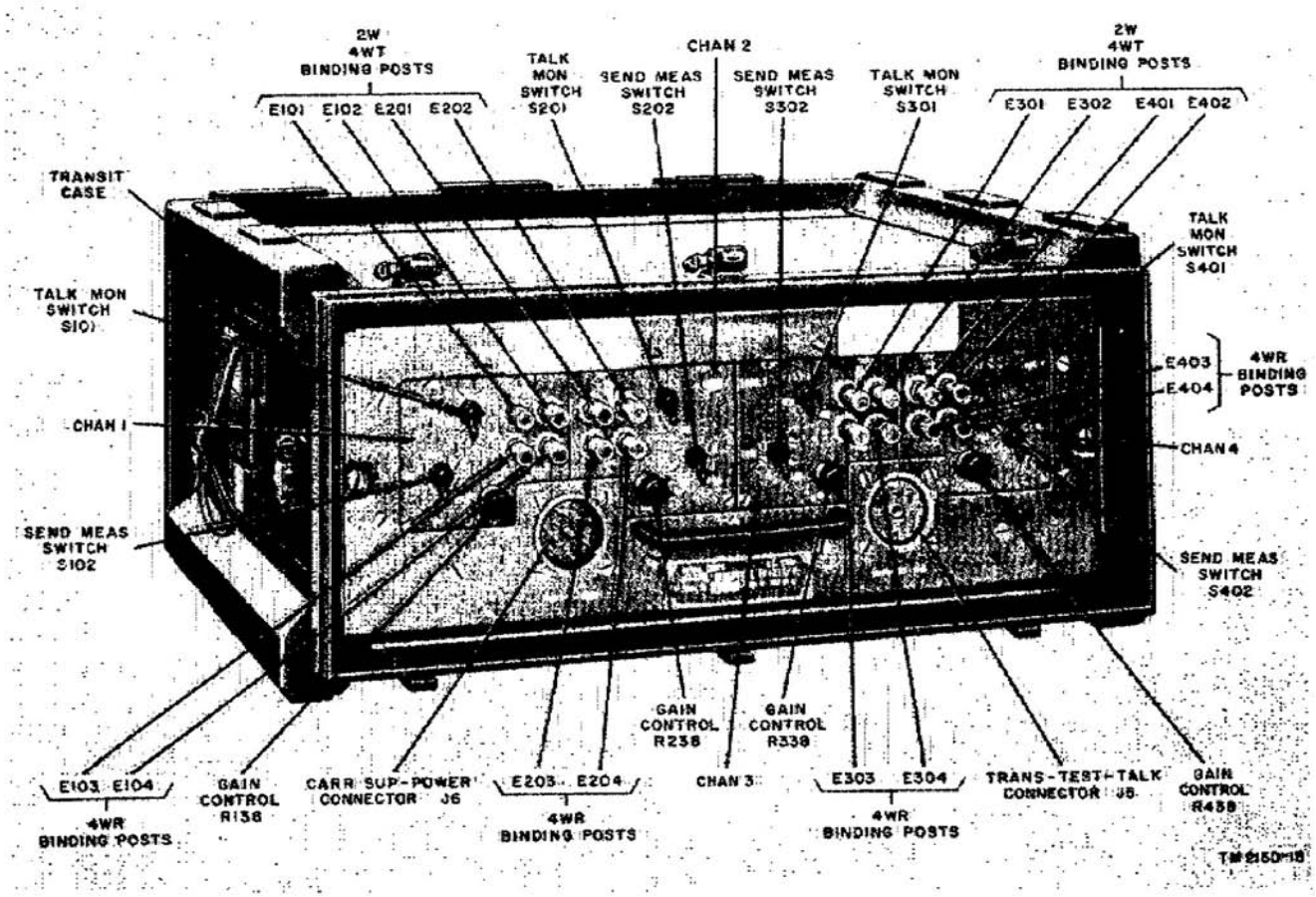


Figure 13. Telephone Modem TA-219/U (CHAN MODEM), front view.

18. Description Telephone Modem TA-227/U (SUBGROUP PANEL)

a. The front panel (fig. 15) of the TA-227 SUBGROUP PANEL contains a number of test jacks and controls and one lamp. Additional binding posts, lever switches, and one control are mounted in back of the front panel (fig. 16) and may be reached by sliding the panel a few inches out of its case.

b. In the transmitting direction, the TA-227 SUBGROUP provides circuits which modulate with a different carrier frequency each of the three 4- to 20-kc bands received from the panels. These bands are combined to from a single band in the 60 to 108 kc range. In the receiving direction, the 60- to 108-kc band is separated into three bands which are demodulated into three 4- to 20-kc bands; these bands then are delivered to the TA-219 CHAN MODEM panels.

19. Description of Amplifier-Pilot Regulator AM-707/TCC-7 (GROUP PANEL and JUNCTION PANEL)

Amplifier-Pilot Regulator AM-707/TCC-7 consists of two panels, a group panel and a junction panel. These panels are described in *a* and *b*, below.

a. Group Panel.

(1) The front panel of the GROUP PANEL

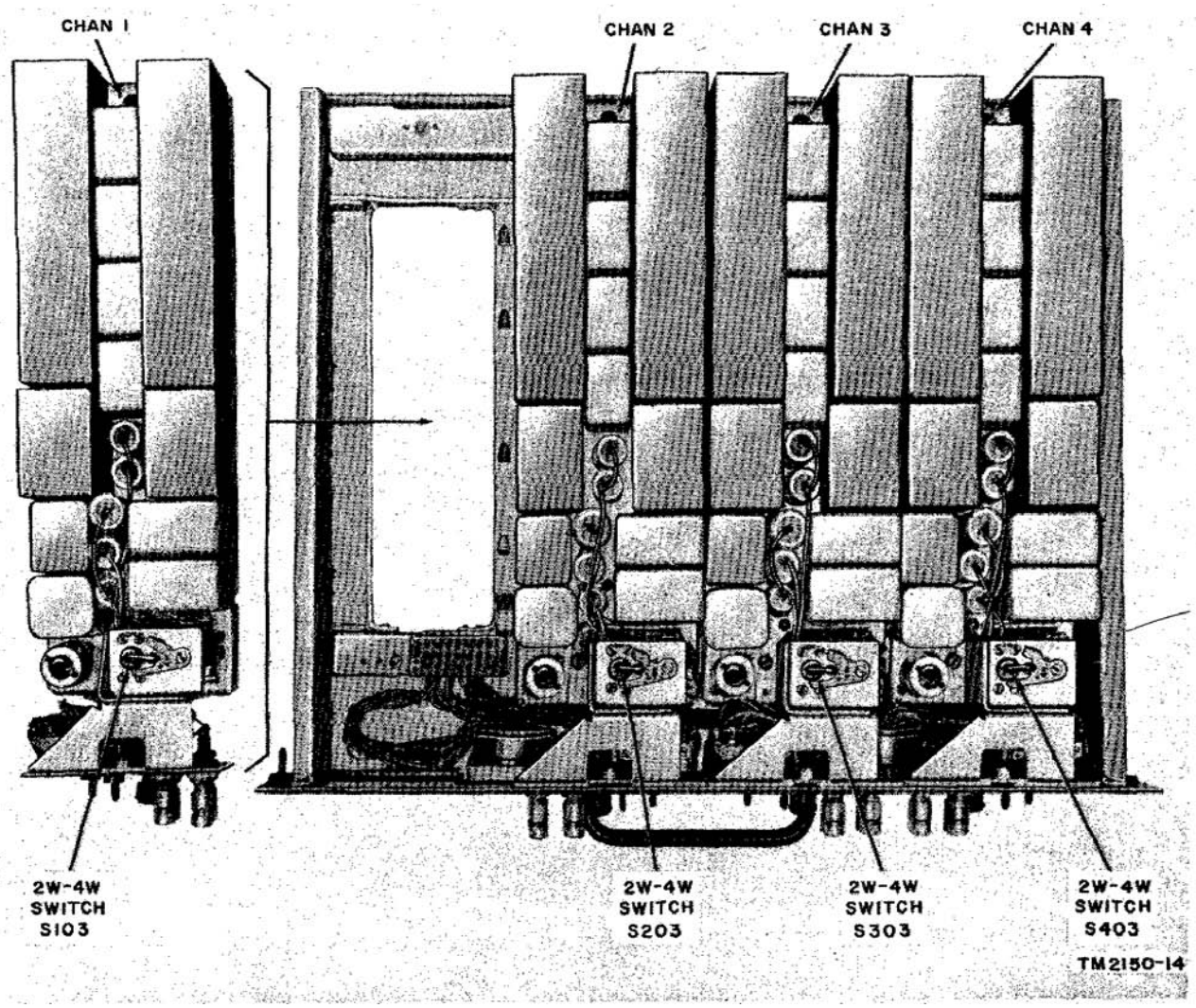


Figure 14. TA-219 CHAN MODEM, top view of chassis.

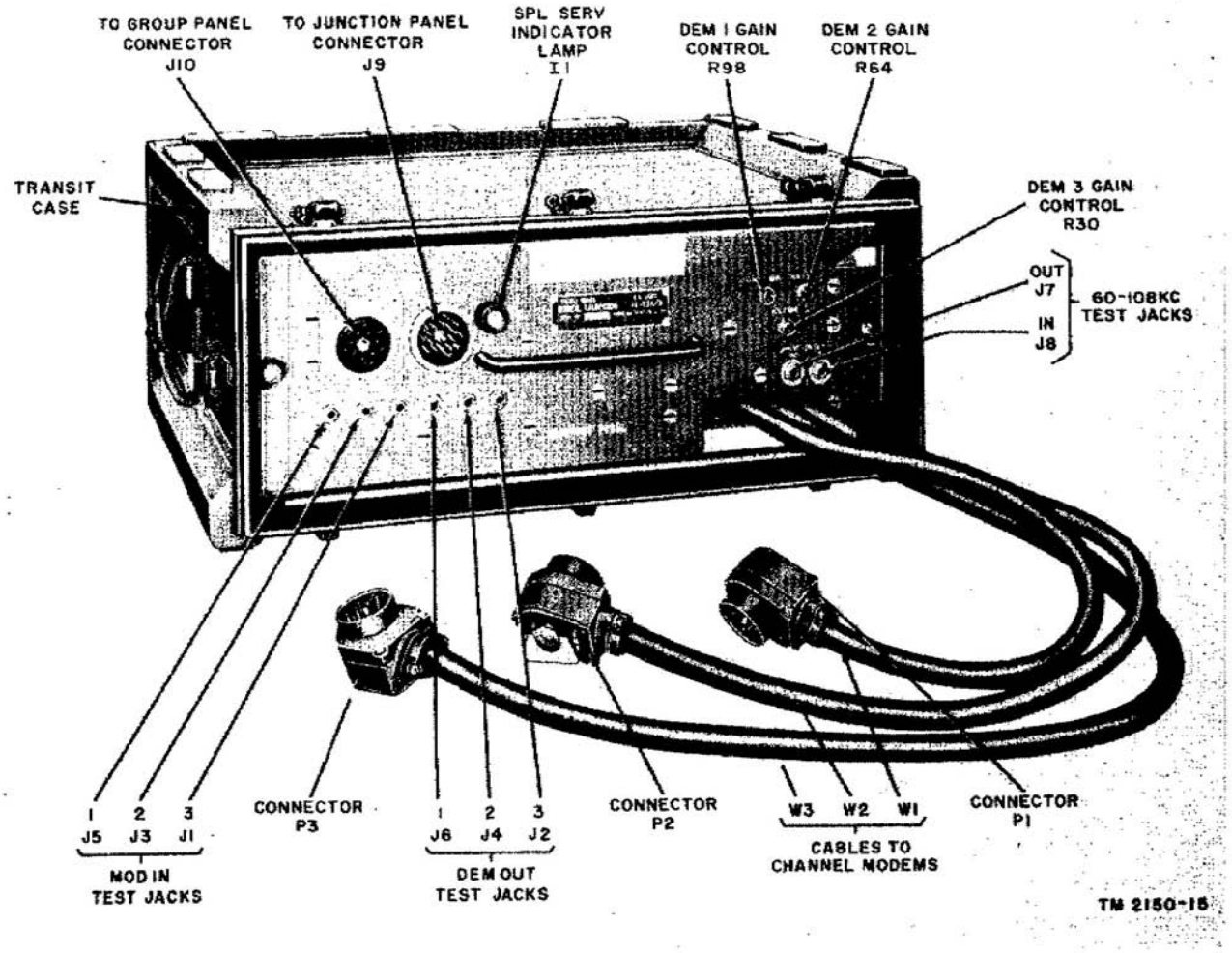


Figure 15. Telephone Modem TA-227/U (SUBGROUP PANEL), front view.

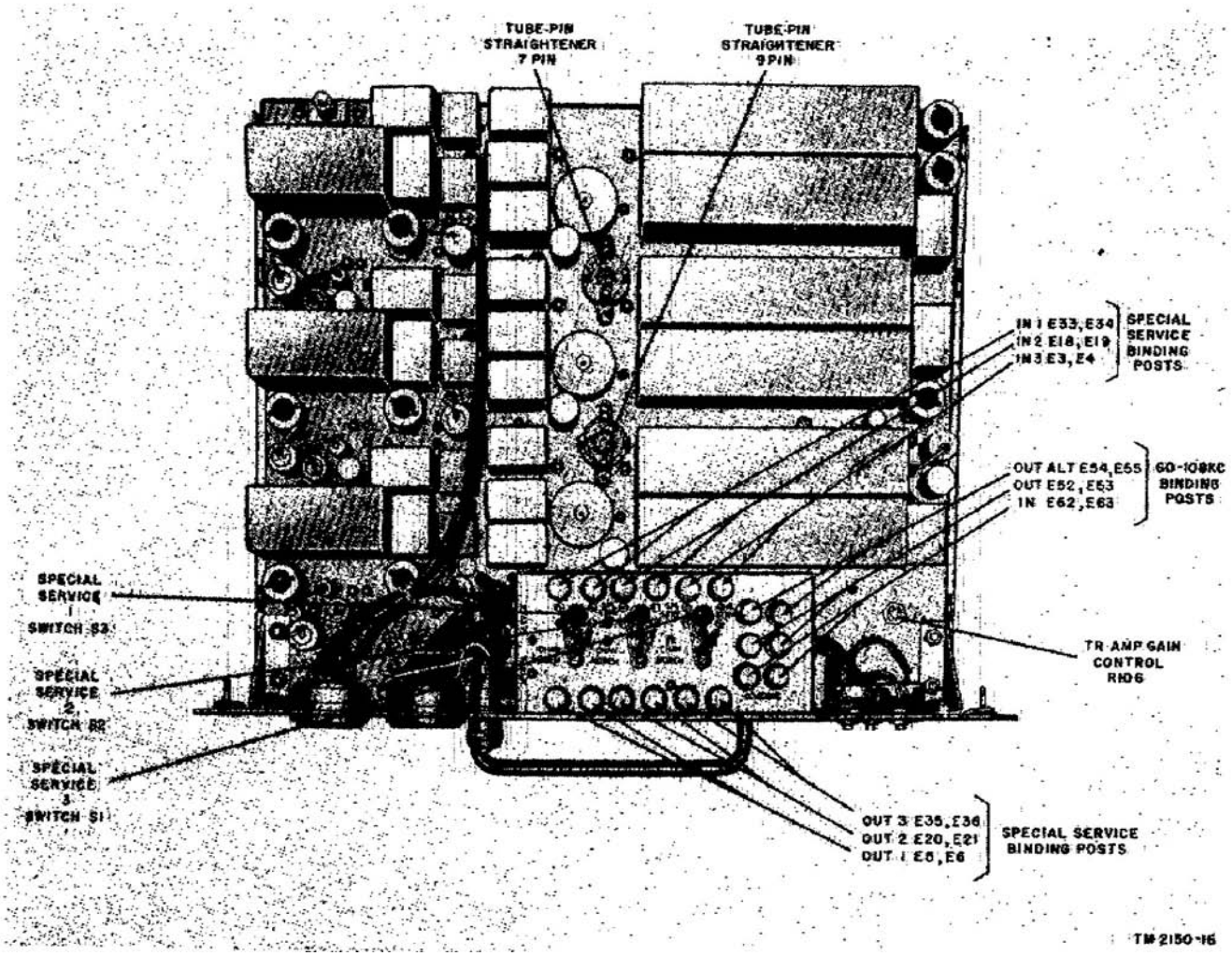


Figure 16. TA-227 SUBGROUP PANEL, top view of chassis.

(fig. 17) contains a number of test jacks, lever switches, and lamps. A telephone handset cradle is also provided to accommodate the telephone handset which is connected to the RT-280 ORDER WIRE PANEL (par. 22). Additional binding posts, controls, pin jacks, and lever switches are mounted on shelves and brackets on the back of the front panel (fig. 18) and may be reached by sliding the panel a few inches out of its case.

(2) In the transmitting direction, the GROUP PANEL provides circuits which modulate the 60- to 108-kc band received from the TA-227 SUBGROUP PANEL to a band of 12 to 60 kc. This band, along with a 68-kc pilot frequency, then is amplified and sent out over the spiral-four cable. In the receiving direction, the incoming 12- to 60-kc band is equalized, amplified, automatically regulated, and demodulated to a 60- to 108-kc band which is delivered to the TA-227 SUBGROUP PANEL.

b. JUNCTION PANEL.

(1) The front panel of the JUNCTION PANEL (fig. 17) contains a ground binding post (GND). A number of lightning arresters are mounted on a bracket on the back of the front panel (fig 19).

(2) The JUNCTION PANEL contains terminal boards connected to cable and connector arrangements which interconnect some of the components of the AN/TCC-7 terminal equipment. The JUNCTION PANEL also contains filter sets to separate the 12- to 60-kc band from the v-f order wire band, and line repeat coils for connection to the spiral-four cable.

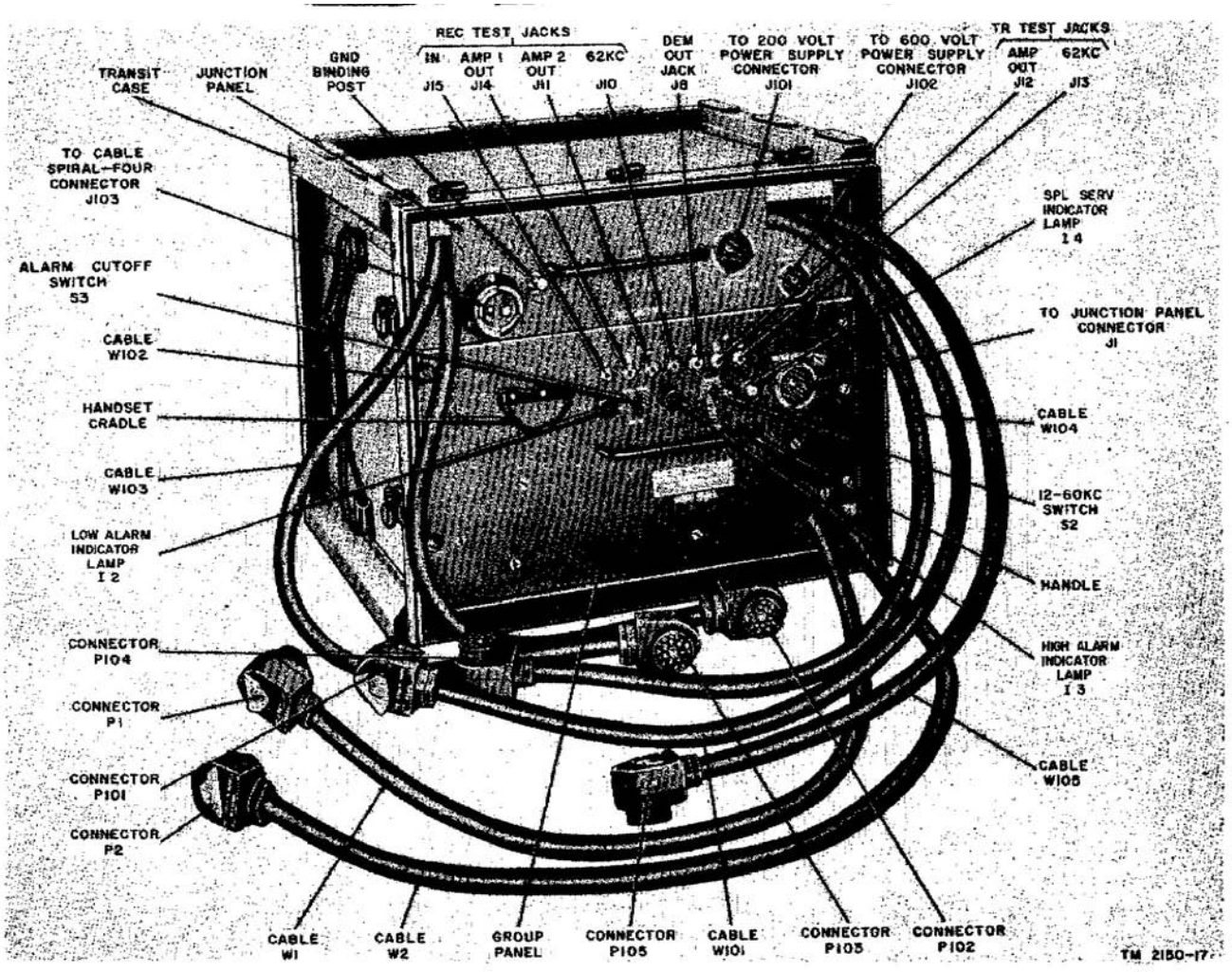


Figure 17. Amplifier-Pilot Regulator AM-707/TCC-7 (GROUP PANEL and JUNCTION PANEL), front view.

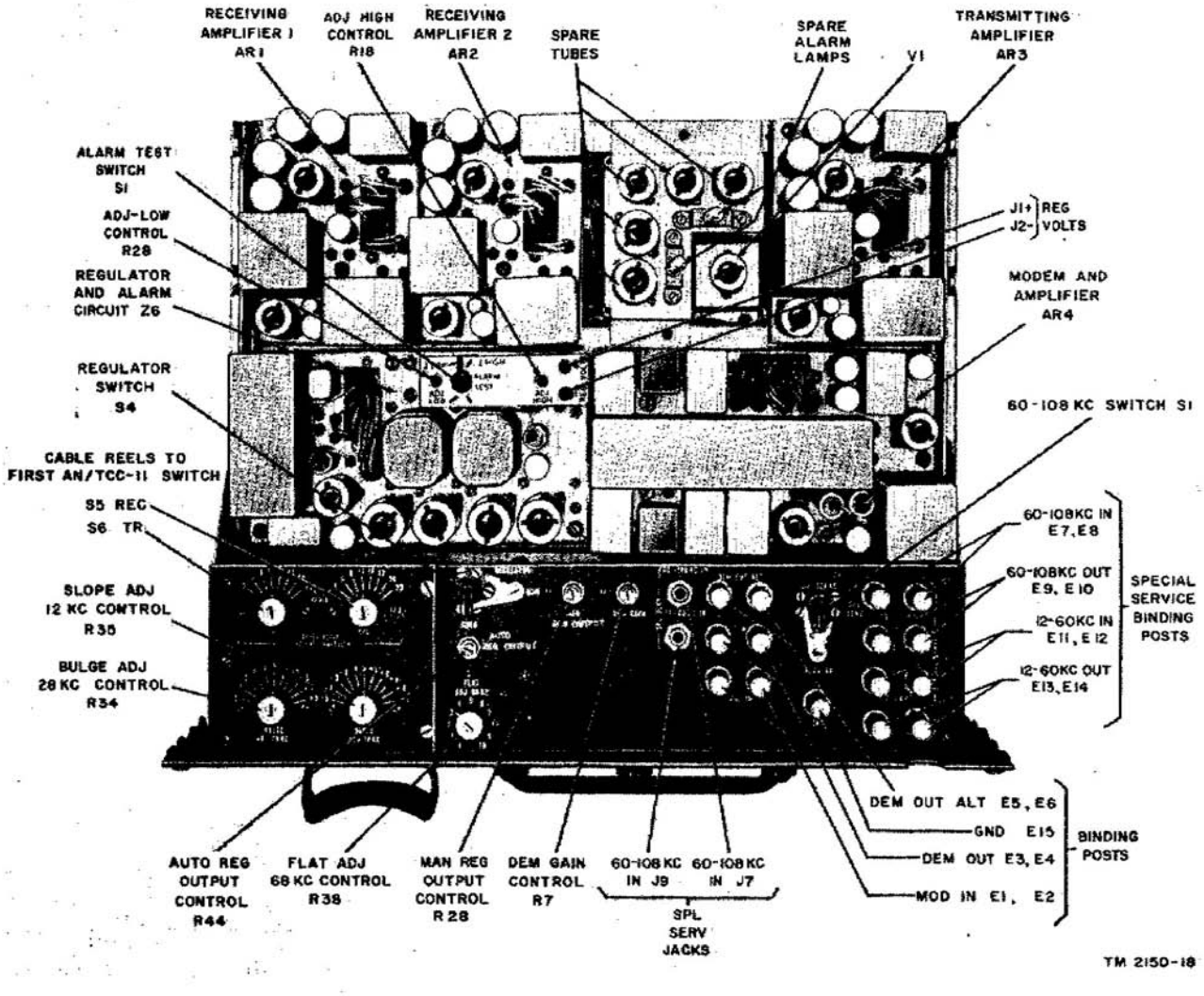


Figure 18. GROUP PANEL, top view of chassis

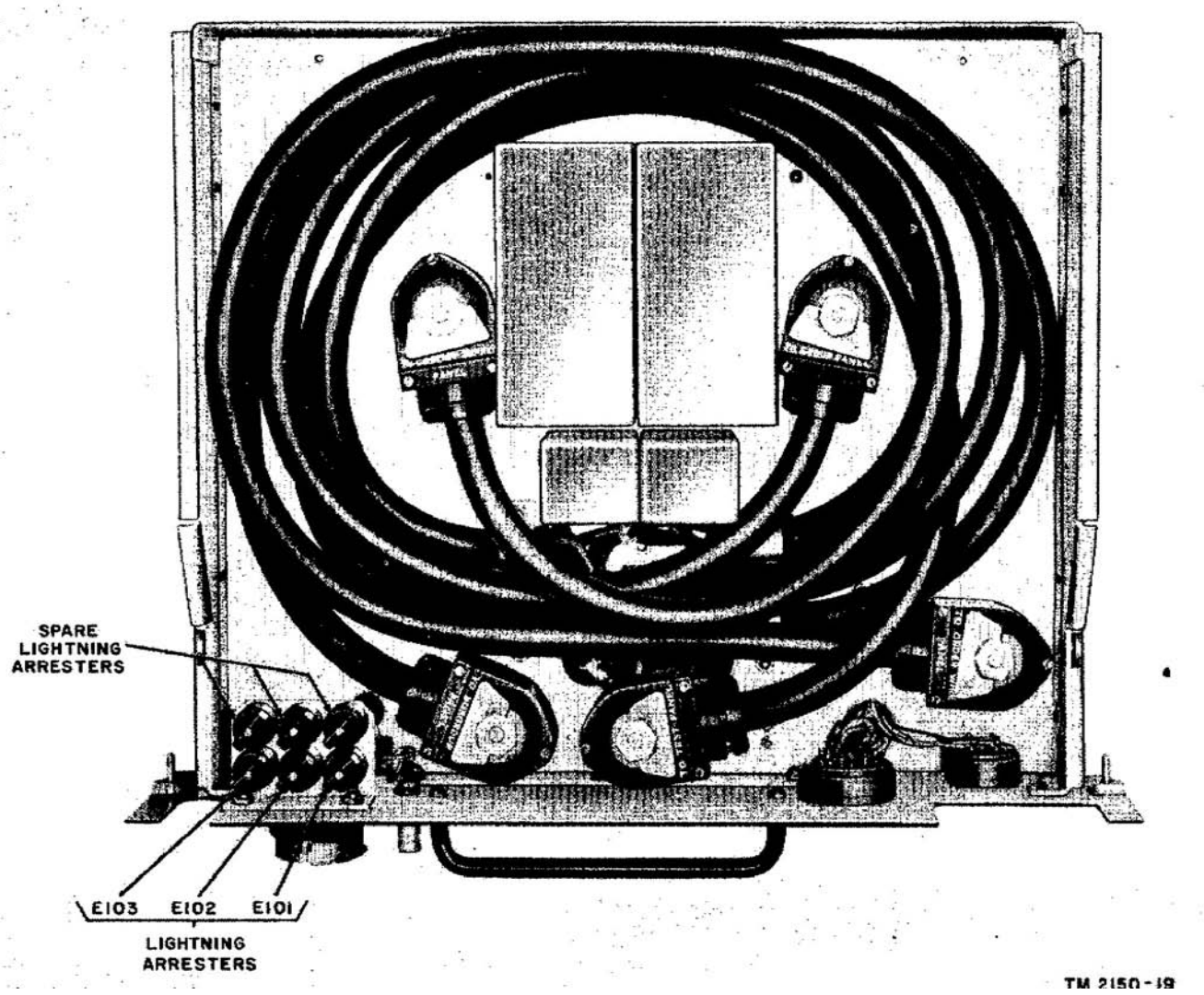


Figure 19. JUNCTION PANEL, top view of chassis.

20. Description of Telephone Carrier Frequency Supply TA-228/TCC-7 (CARRIER SUPPLY PANEL)

a. The front panel of the TA-228 CARRIER SUPPLY PANEL (fig. 20) contains a number of lever switches, controls, and lamps. A drawer is located above the TA-228 CARRIER SUPPLY PANEL to storage circuit label book assemblies. A number of test jacks are mounted on a bracket directly behind the front panel of the TA-228 CARRIER SUPPLY PANEL (fig. 21). A control is mounted on the chassis near the front panel. Other test jacks are mounted on a bracket half way to the rear of the chassis. All test jacks and the control are made accessible by sliding the panel out of its case.

b. The TA-228 CARRIER SUPPLY PANEL contains sources for the carrier frequencies for the modulator and demodulator circuits in the GROUP PANEL, the TA-227 SUBGROUP PANEL, and each of the TA-219 CHAN MODEM panels. The TA-228 CARRIER SUPPLY PANEL also provides sources of 68 kc, 12 kc, and 28 kc frequencies which are used in conjunction with the regulating and equalizing circuits.

21. Description of Receiver-Transmitter Test Set Group OA-443/TCC-7 (ORDER WIRE PANEL and TEST PANEL)

The OA-443 order wire and test set contains two panels. Individual nomenclature is assigned to each of the panels. The upper panel bears the nomenclature Receiver-Transmitter, Order Wire RT-280/TCC-7, and is designated ORDER WIRE PANEL. The RT-280 ORDER WIRE PANEL is described in paragraphs 22 and 23. The lower panel bears the nomenclature Telephone Test Set TS-760/TCC-7, and is designated

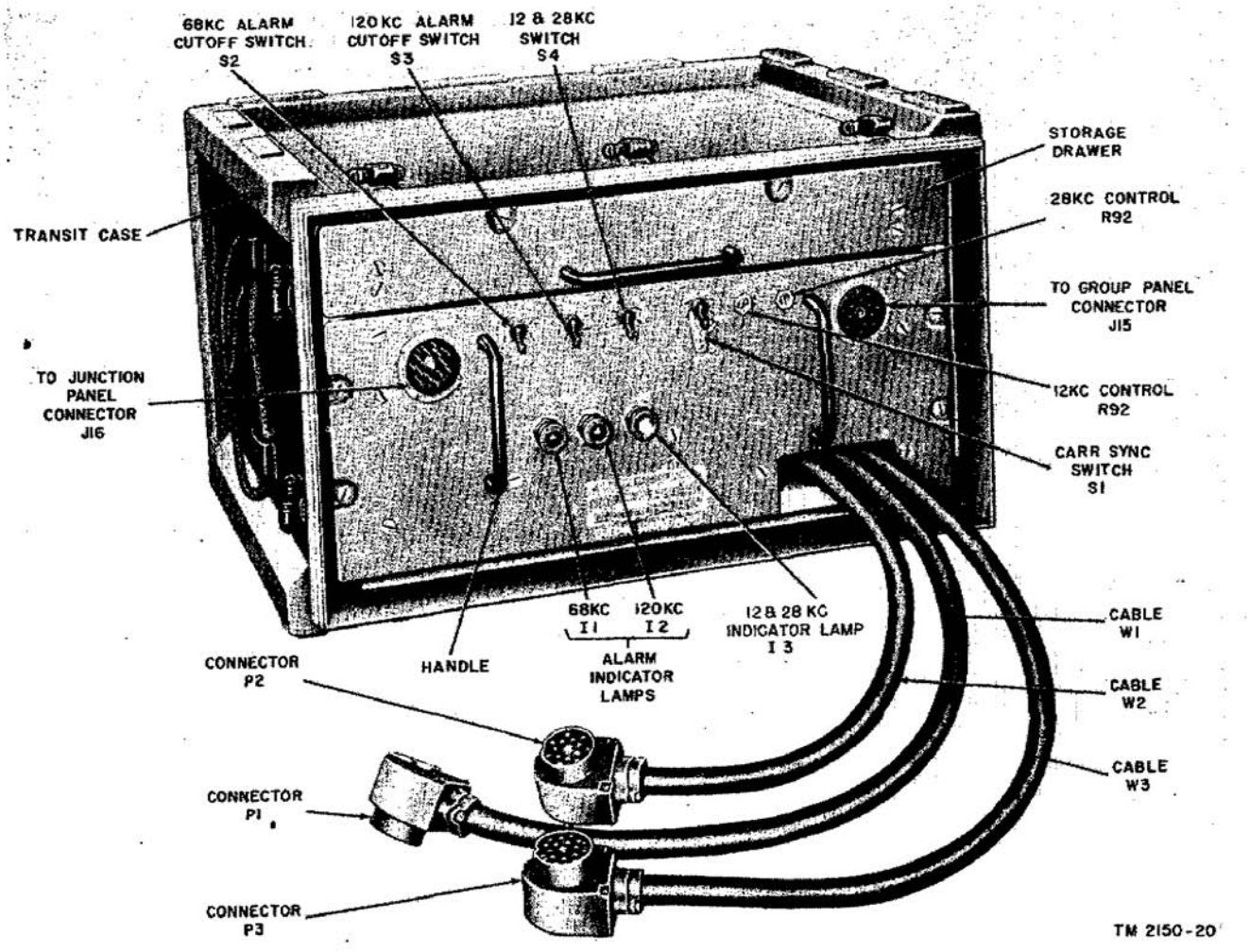


Figure 20. Telephone Carrier Frequency Supply TA-228/TCC-7 (CARRIER SUPPLY PANEL), front view.

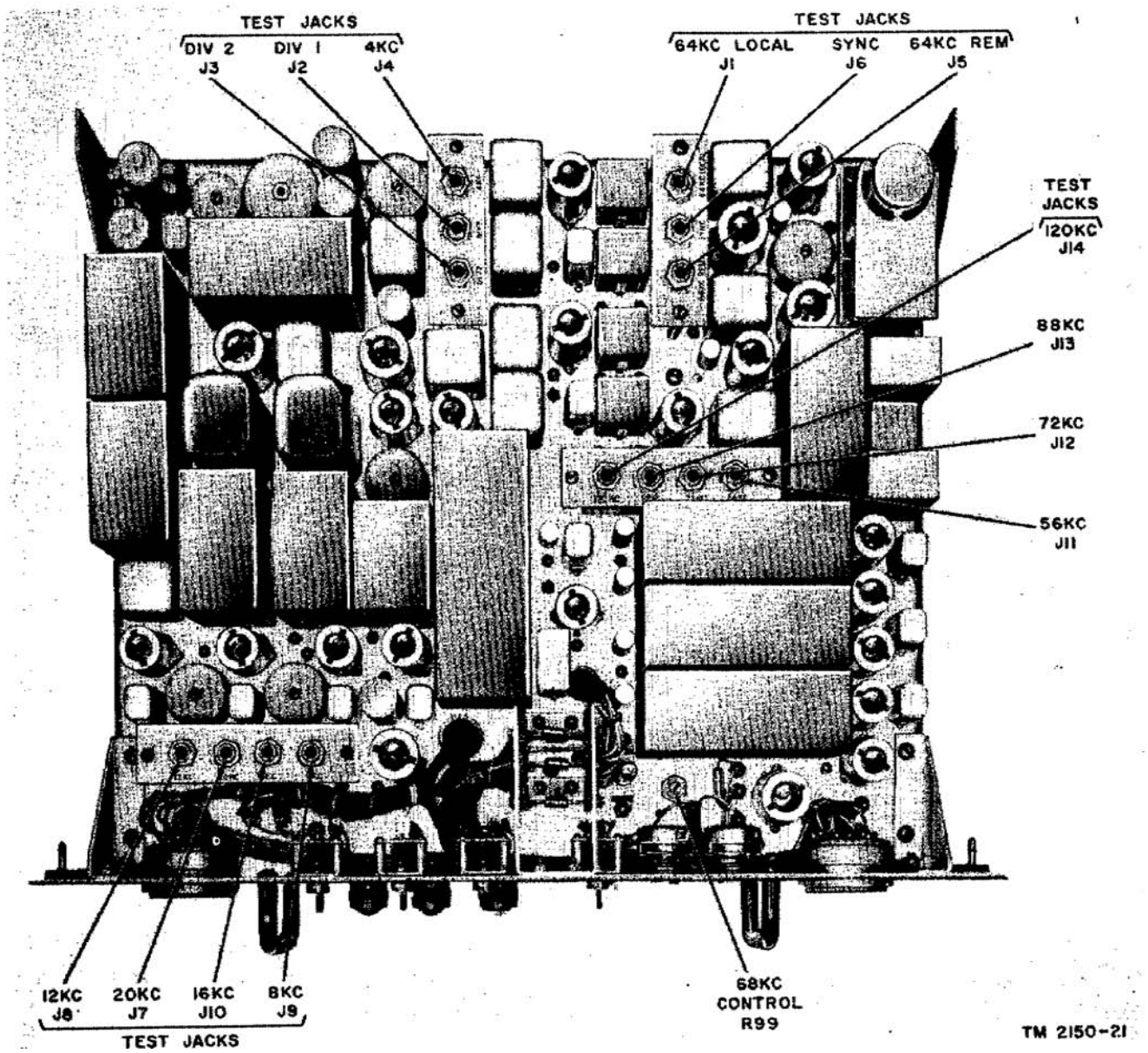


Figure 21. TA-228 CARRIER SUPPLY PANEL, top view of chassis.

TEST PANEL. The TS-760 TEST PANEL is described in paragraph 24.

22. Description of Receiver-Transmitter, Order Wire RT-280/TCC-7 (ORDER WIRE PANEL)

a. The front panel of the RT-280 ORDER WIRE PANEL (fig. 22) contains a number of lever switches and test jacks, one lamp, one rotary switch, one gain control, and a table for use in the adjustment of the order wire transmitting amplifier output level (par. 23). The gain control is bracket-mounted on the chassis in back of the front panel (fig. 23). The TR GAIN control and other parts may be reached by sliding the panel out of its case a few inches. Two binding posts are mounted on the chassis behind the front panel. A telephone handset is stored on the rear portion of the chassis. During normal use, this telephone handset is removed from its storage place and is hung on the cradle located on the GROUP PANEL (par. 19*a*).

b. The RT-280 ORDER WIRE PANEL provides facilities for transmitting and receiving a limited v-f band for use as an order wire circuit. The telephone handset is provided for talking

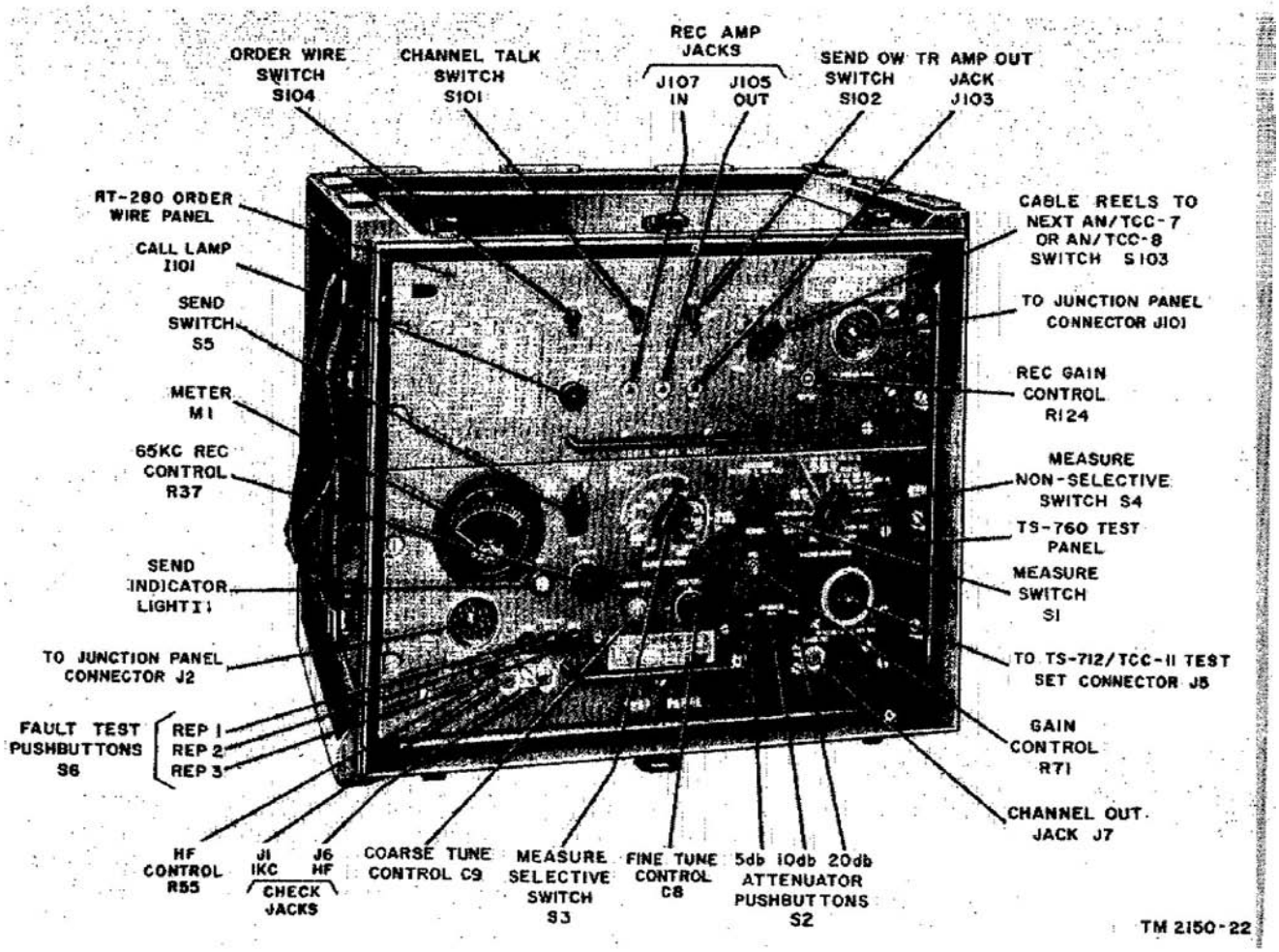


Figure 22. Receiver- Transmitter Test Set Group OA-443/ TCC-7 (ORDER WIRE PANEL and TEST PANEL), front view

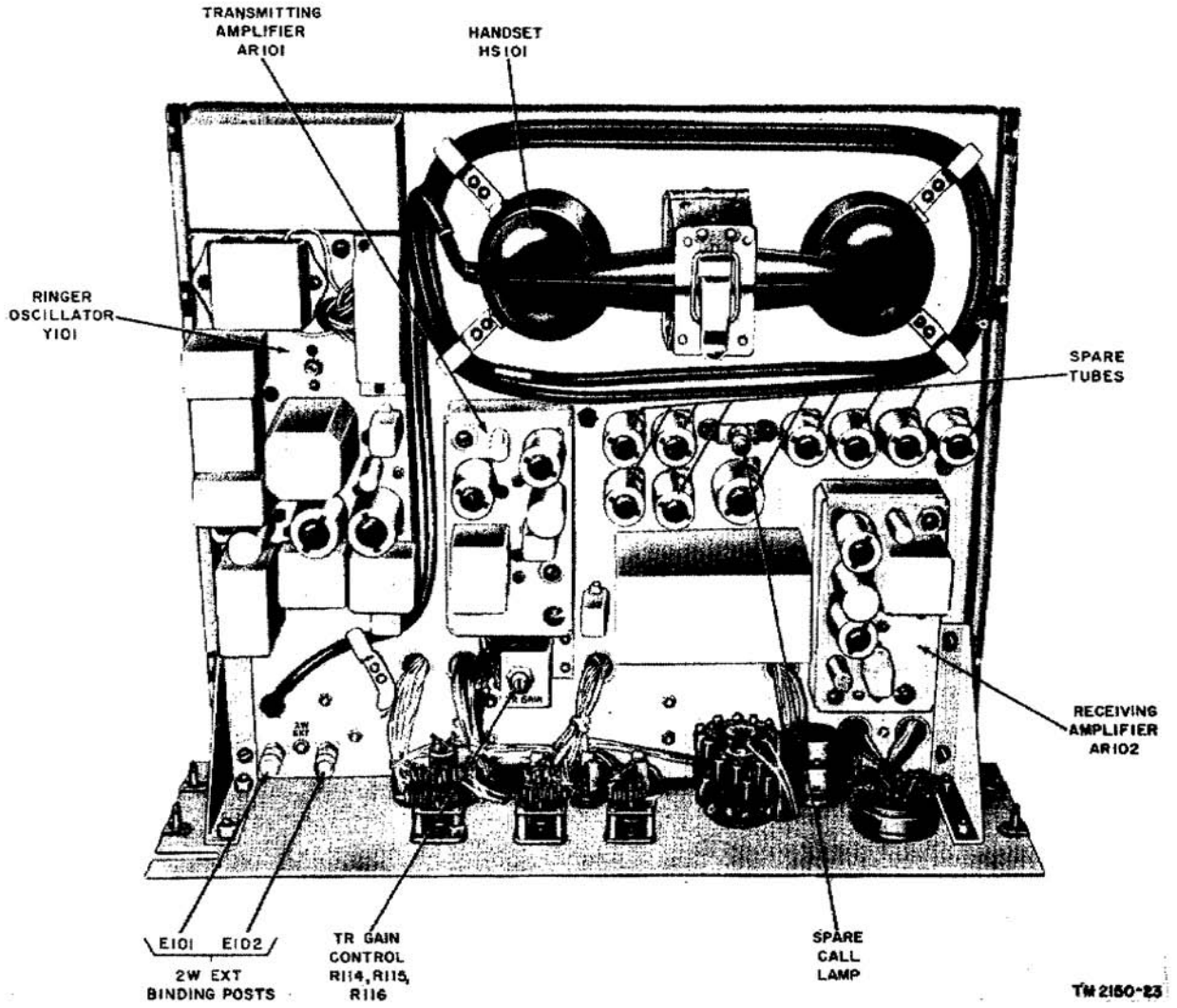


Figure 23. RT-280 ORDER WIRE PANEL, top view of chassis.

over the order wire circuit or the message channels. The signals are passed through an equalizer circuit and are amplified for transmission to the cable. Received signals are amplified and delivered to the telephone receiver. A ringer-oscillator circuit is included for signaling over the order wire circuit.

23. Table of Order Wire Circuit Transmitting Amplifier Output Adjustments

The following table is used in adjusting the transmitting amplifier output of the order wire circuit. The table is etched on the front panel of the RT-280 ORDER WIRE PANEL of the AN/TCC-7 terminal and on the RT-281 ORDER WIRE PANEL of the AN/TCC-8 repeater.

OW TR AMP OUT ADJ			
		Test panel	
Repeaters in power loop	Cable reels to first AN/TCC-11	Attenuator	Meter reading
0	2-9	0 db	+2.5 db
0	10-16	5 db	0 db
0	17-23	10 db	-2.0 db
1	2-9	10 db	+1.5 db
1	10-16	5, 10 db	-0.5 db
1	17-23	5, 10 db	+2.0 db
2	2-9	20 db	+0.5 db
2	10-16	5, 20 db	-1.5 db
2	17-23	5, 20 db	+1.0 db
3	2-9	10, 20 db	-0.5 db
3	10-16	10, 20 db	+2.5 db
3	17-23	5, 10, 20 db	0 db
Radio connection		10, 20 db	+0.5 db

24. Description of Telephone Test Set TS-760/TCC-7 (TEST PANEL)

a. The front panel of the TS-760 TEST PANEL contains several rotary switches, controls, push buttons, test jacks, a meter, and a lamp. One control is located on a plug-in unit at the rear of the chassis and two controls are located near the front of the chassis (fig. 24). A cable and plug assembly (MEASURE cord) is stored on the chassis. The MEASURE cord is provided to permit transmission measurements at test jacks located on this and other panels of the AN/TCC-7 terminal.

b. The TS-760 TEST PANEL contains circuits for selective and nonselective measurements at a number of test jacks at various points in the circuits of the other panels of the AN/TCC-7 terminal (figs. 66 and 70). The panel contains a number of rotary switches for setting up the measuring circuits, which include filters, amplifiers, rectifiers, and a meter. The TEST PANEL also provides frequency sources which are used for system line-up, system modulation tests, and trouble location.

25. Description of Power Supply PP-826/U (600 VOLT POWER SUPPLY) at AN/TCC-7 Terminal

a. The front panel of the PP-826 600 VOLT POWER SUPPLY (fig. 25) contains a number of fuses, lamps, lever switches, a toggle switch, a control, and a meter. A number of controls and test jacks are located behind the front panel (fig. 26).

b. The PP-826 600 VOLT POWER SUPPLY is a regulated power supply which furnishes a constant dc of 100 milliamperes, over interconnecting spiral-four cable, to as many as three unattended AN/TCC-11 repeaters. It contains relay circuits which allow application of power to the cable only when the load is normal.

26. Description of Power Supply PP-827/U (200 VOLT POWER SUPPLY) at AN/TCC-7 Terminal

a. The front panel of the PP-827 200 VOLT POWER SUPPLY (fig. 27) contains several fuses, two 115-volt a-c convenience outlets, a lamp, a toggle switch, and a control. A number of test jacks and a toggle switch are mounted on the chassis behind the front panel (fig. 28).

b. The PP-827 200 VOLT POWER SUPPLY is a regulated power supply which provides a constant d-c voltage to each of the other panels of the AN/TCC-7 terminal. It also contains transformers to provide a number of 6.3-volt a-c supplies for each of the other terminal panels and a nonregulated negative bias supply for the RT-280 ORDER WIRE PANEL.

27. Additional Equipment Required for Installation of the AN/TCC-7 Terminal

The following material is not supplied as part of the AN/TCC-7 terminal, but is required for its installation and operation.

a. Ground Rod MX-148/G. Ground Rod MX-148/G is a 6 foot ground rod which may be required to connect the AN/TCC-7 terminal to an earth ground for protection against lightning.

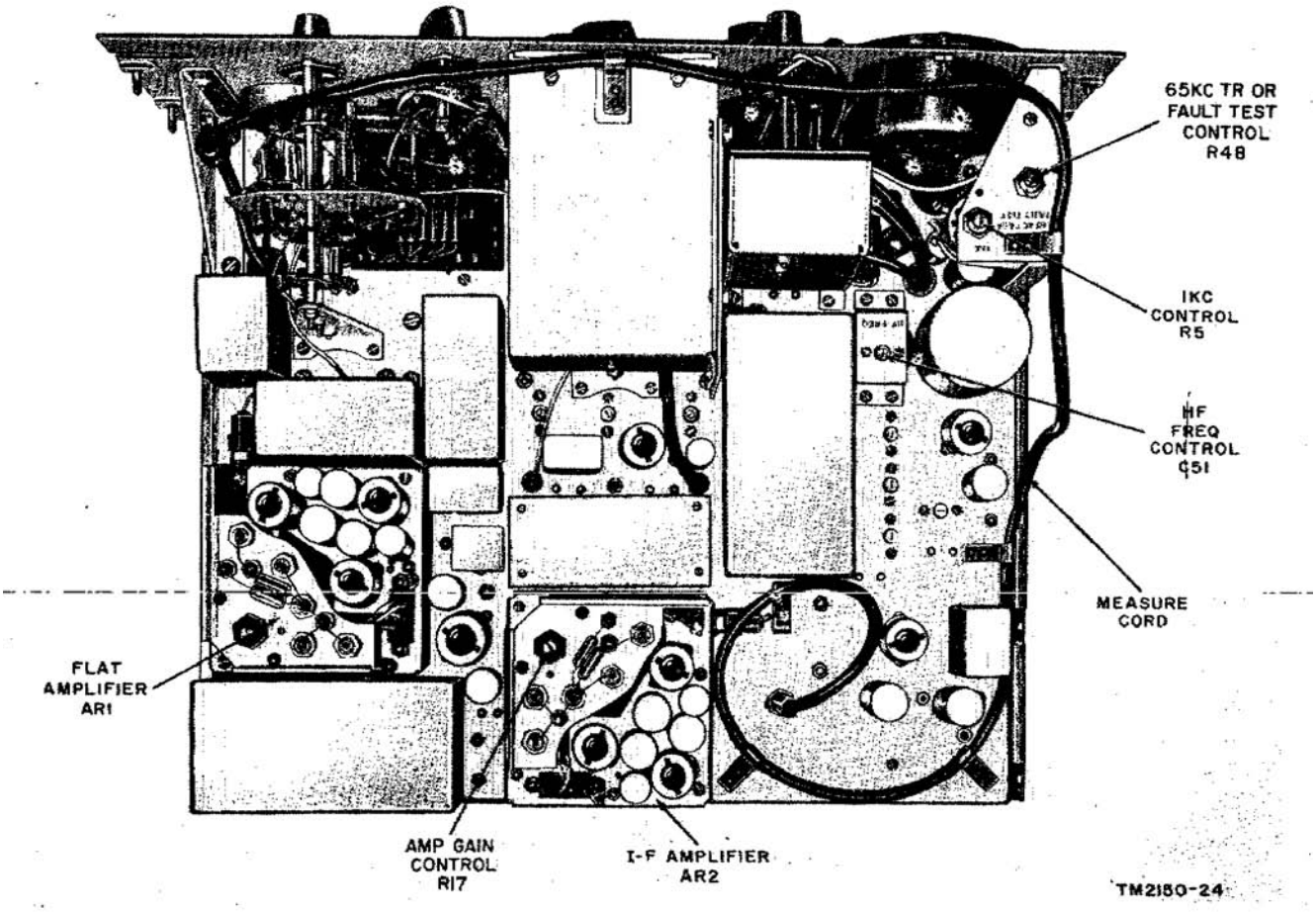


Figure 24. TS-760 TEST PANEL, top view of chassis.

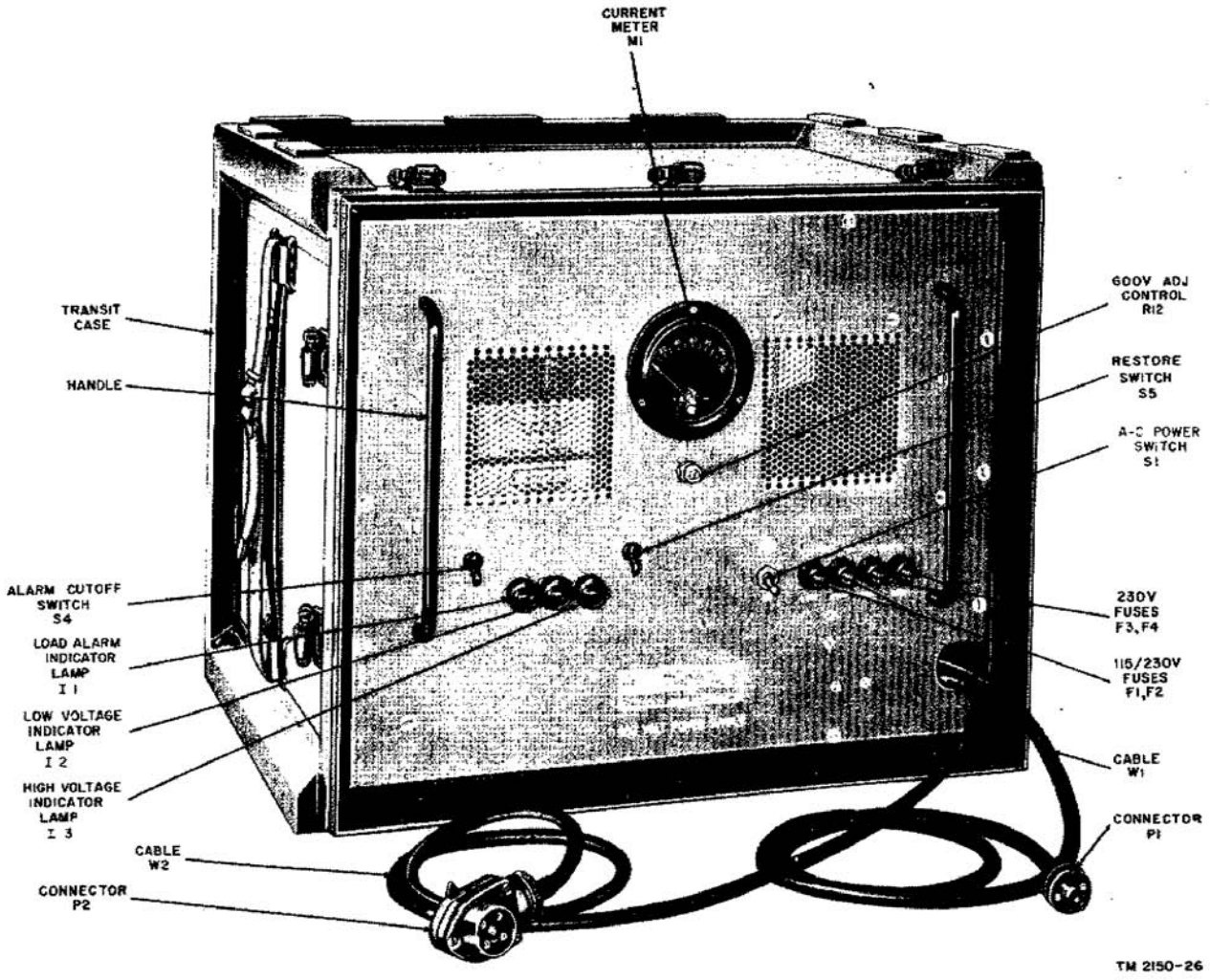


Figure 25. Power Supply PP-826/U (600 VOLT POWER SUPPLY), front view.

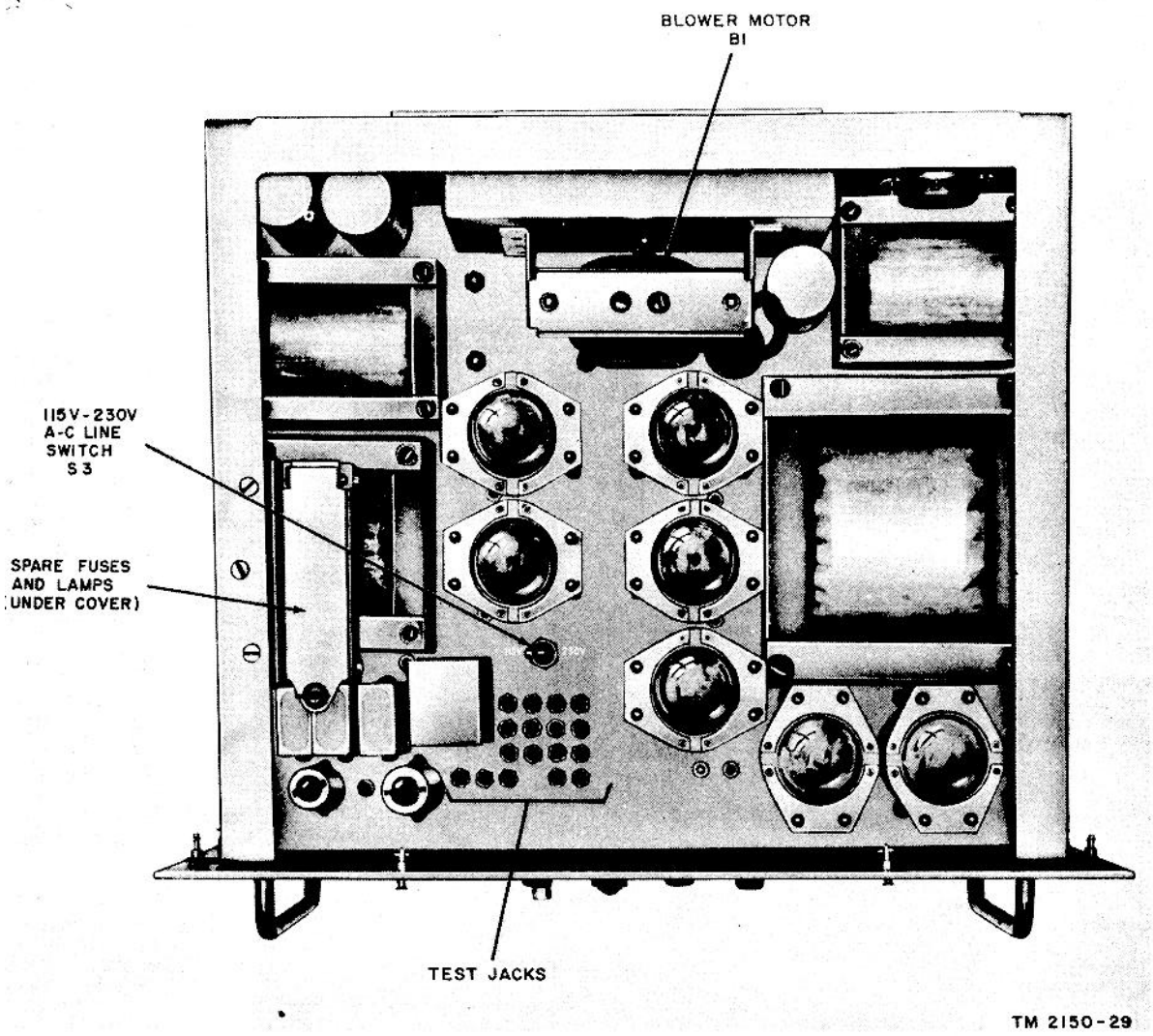


Figure 26. PP-826 600 VOLT POWER SUPPLY, top view of chassis.

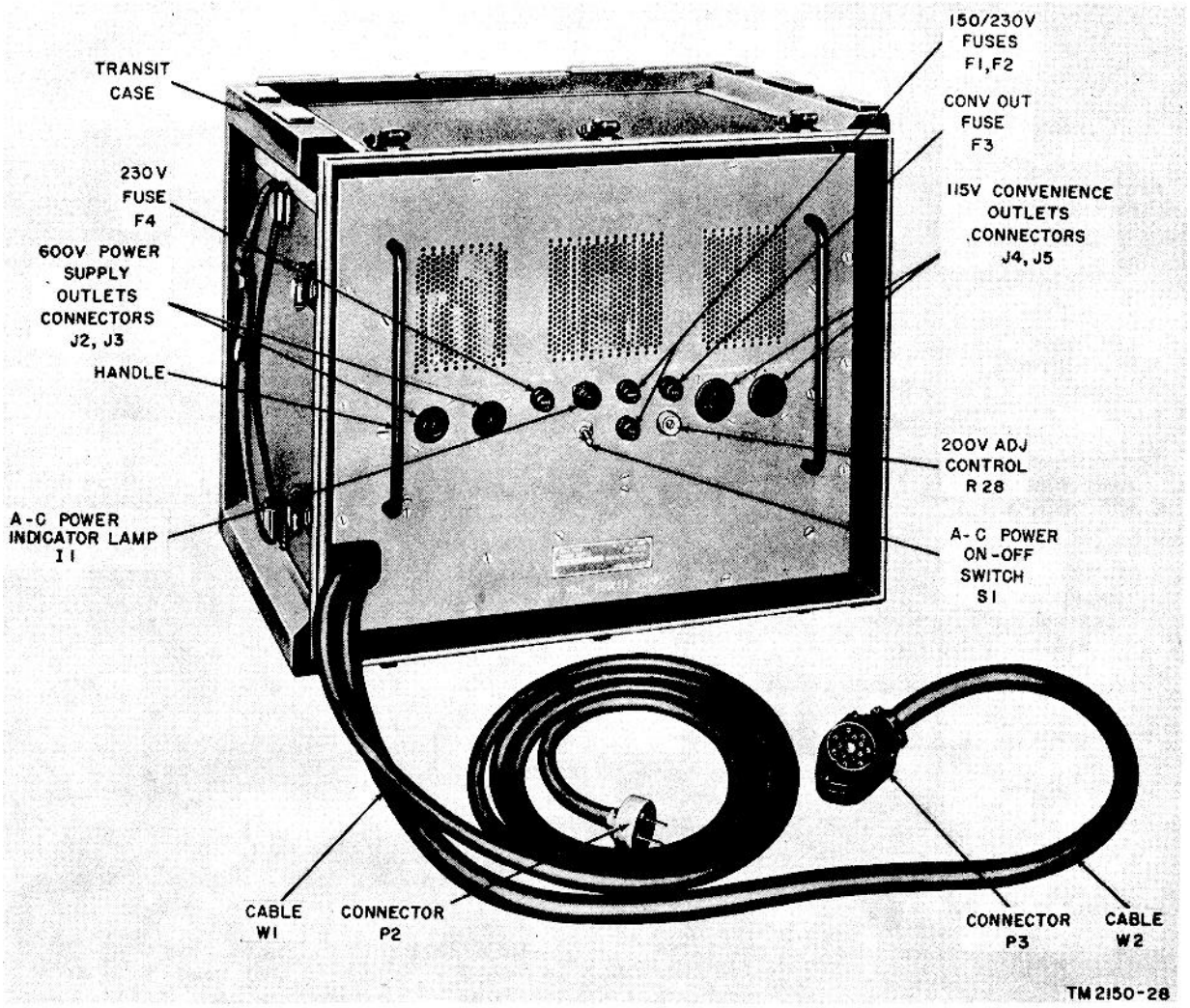


Figure 27. Power Supply PP-827/U (200 VOLT POWER SUPPLY), front view.

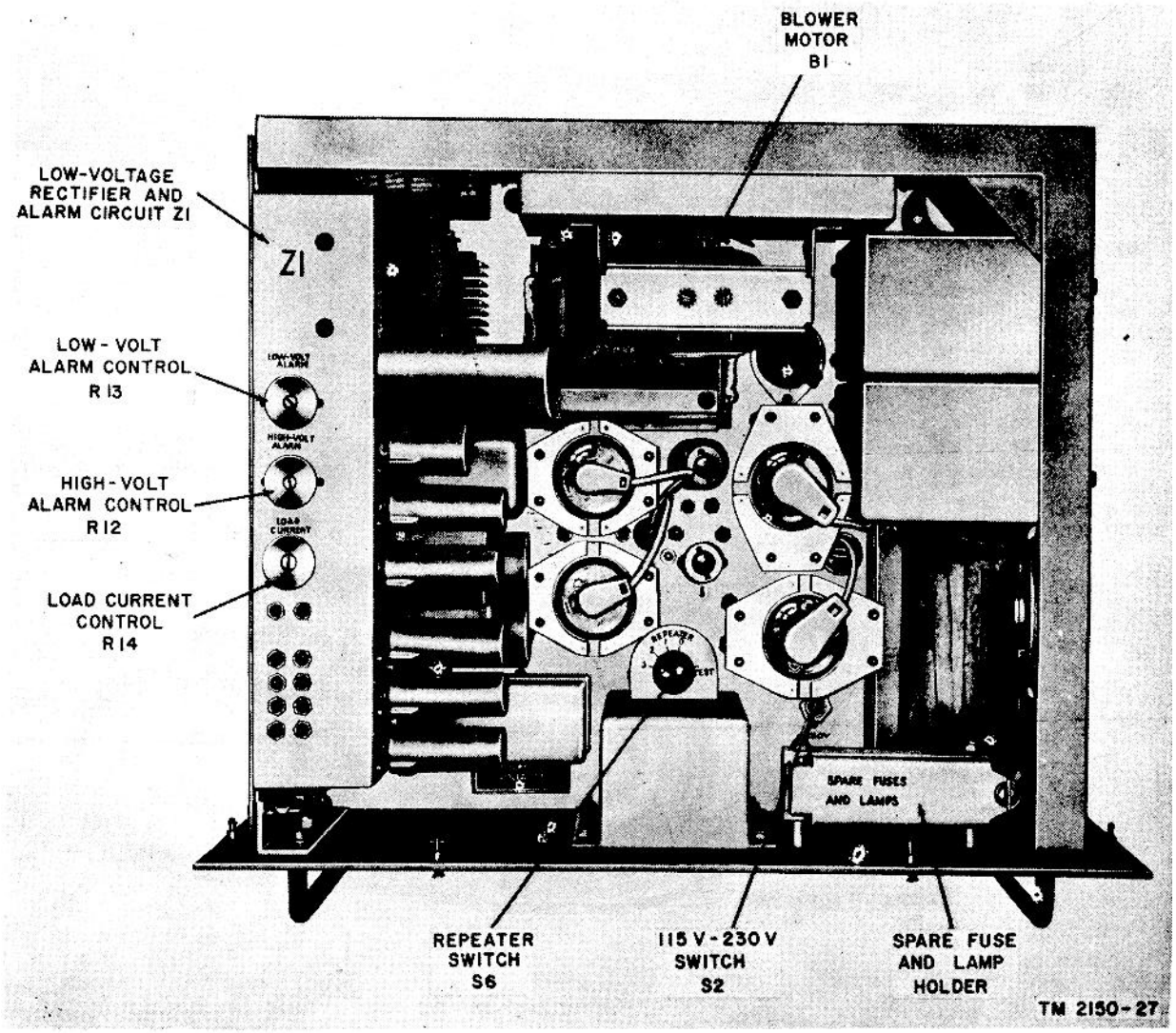


Figure 28. PP-827 200 VOLT POWER SUPPLY, top view of chassis.

b. Clamp TM-106. Clamp TM-106 may be required to connect the AN/TCC-7 terminal to earth ground through a water pipe. The clamp is a soft copper ground clamp used to provide connection from the ground lead of the terminal equipment to ½- to 1 ¼-inch pipe.

c. Cable Stub. A cable stub (Telephone Cable Assembly CX-1512/U,(fig. 6))is required for testing at the AN/TCC-7 terminal. The cable stub is described in paragraph 8*b* (4).

d. Telephone Test Set TS-712/TCC-11. A TS-712 test set is required at an AN/TCC-7 point when the PP-826 600 VOLT POWER SUPPLY at the AN/TCC-7 terminal is used to supply power to one or more AN/TCC-11 repeaters. The TS-712 test set is described in paragraph 35.

e. Telephone EE-8 ( ). Telephone EE-8 ( ) is required at an AN/TCC-7 terminal whenever a TS-712 test set is supplied. Telephone EE-8 ( ) is described in paragraph 36.

28. Description of Telephone Repeater AN/ TCC-8, General

Paragraphs 29 through 31 describe briefly the components of the AN/TCC-8 repeater. The description includes the controls, test jacks, and other parts that are used in the test procedures described in later chapters in this technical manual. Photographs of each component are included as an aid in locating, the controls. More complete descriptions are given in the technical manual for the AN/TCC-8 repeater equipment.

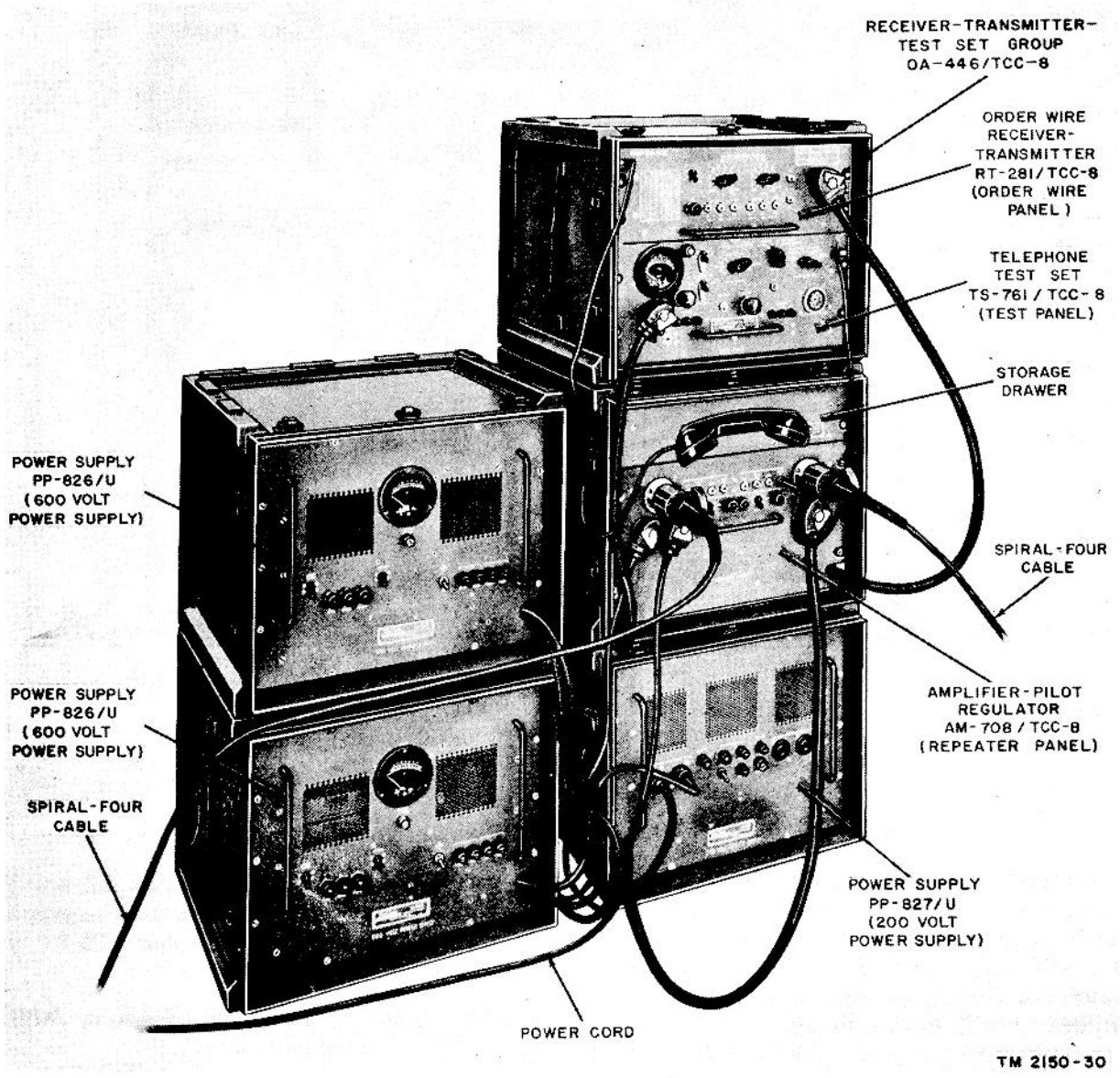


Figure 29. Telephone Repeater AN/TCC-8

Figure 29 shows a typical arrangement of the components of an AN/TCC-8 repeater.

29. Description of Amplifier-Pilot Regulator AM-708/TCC-8-(REPEATER PANEL)

a. The front panel (fig. 30) of the AM-708 REPEATER PANEL, contains a number of test jacks, lamps, and lever switches. A number of controls, lightning arresters, lever switches, and pin jacks are mounted on shelves and brackets behind the front panel (fig. 31). They may be reached by sliding the panel out of its case. A drawer is located above the REPEATER PANEL for the storage of a circuit label book.

b. The AM-708 REPEATER PANEL, contains the circuits which provide amplification equalization, and automatic regulation of the 12 to 60-kc carrier frequency bands in both directions of transmission. The panel also includes filter sets to separate the 12- to 60-kc band from the v-f order wire band.

30. Description of Receiver-Transmitter Test Set Group OA-446/TCC-8 (ORDER WIRE PANEL and TEST PANEL)

The OA-446 order wire and test set contains two panels. Individual nomenclature is assigned to each of the panels. The upper panel bears the nomenclature Receiver-Transmitter, Order Wire RT-281/TCC-8, and is designated ORDER WIRE PANEL. The RT-281 ORDER WIRE PANEL is discussed in a below. The lower panel bears the nomenclature Telephone Test Set TS-761/TCC-8, and is designated TEST PANEL. The TS-761 TEST PANEL is discussed in *b* below.

a. Receiver-Transmitter, Order Wire RT-281/TCC-8 (ORDER WIRE PANEL).

(1) The front panel of the RT-281 ORDER

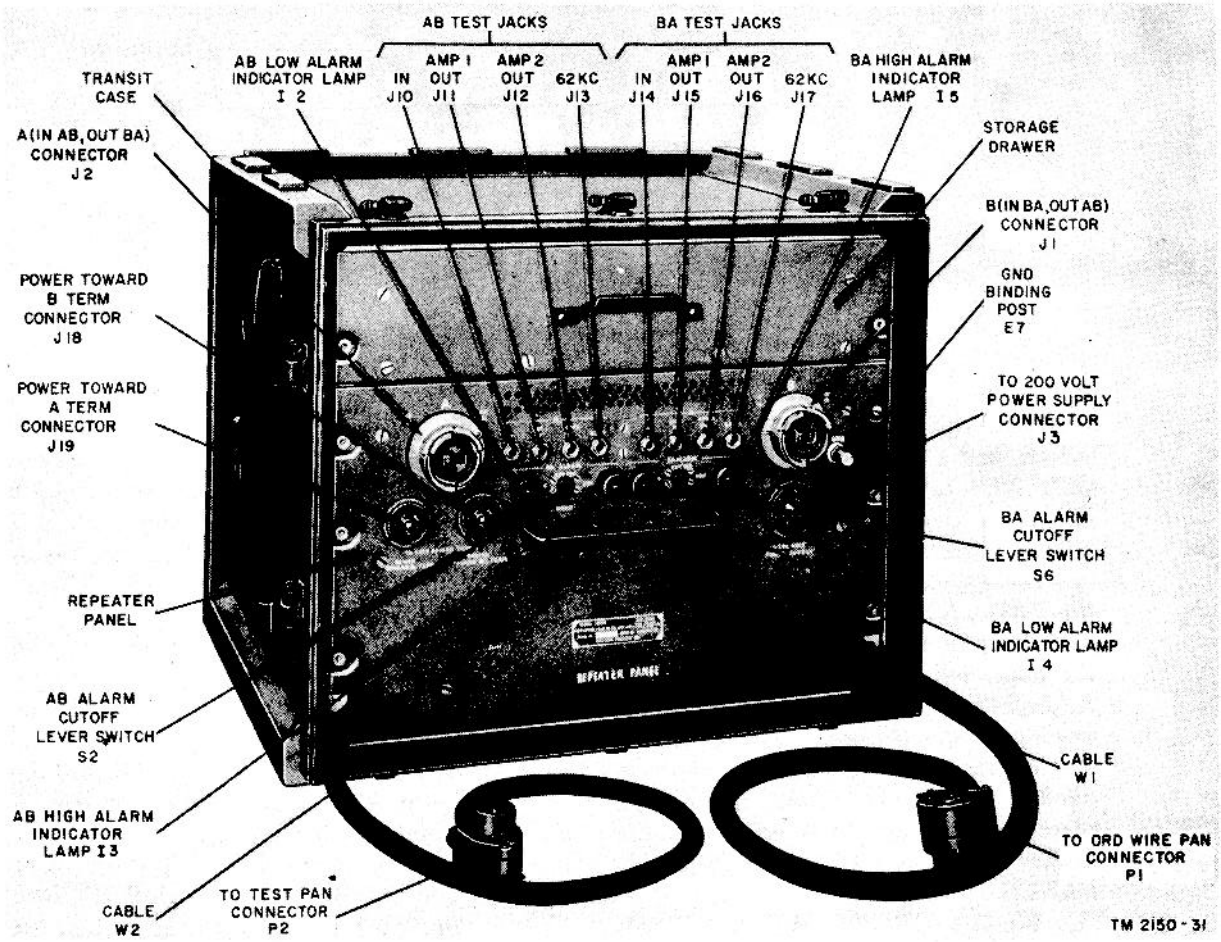


Figure 30. Amplifier-Pilot Regulator AM-708/TCC-8 (REPEATER PANEL), front view.

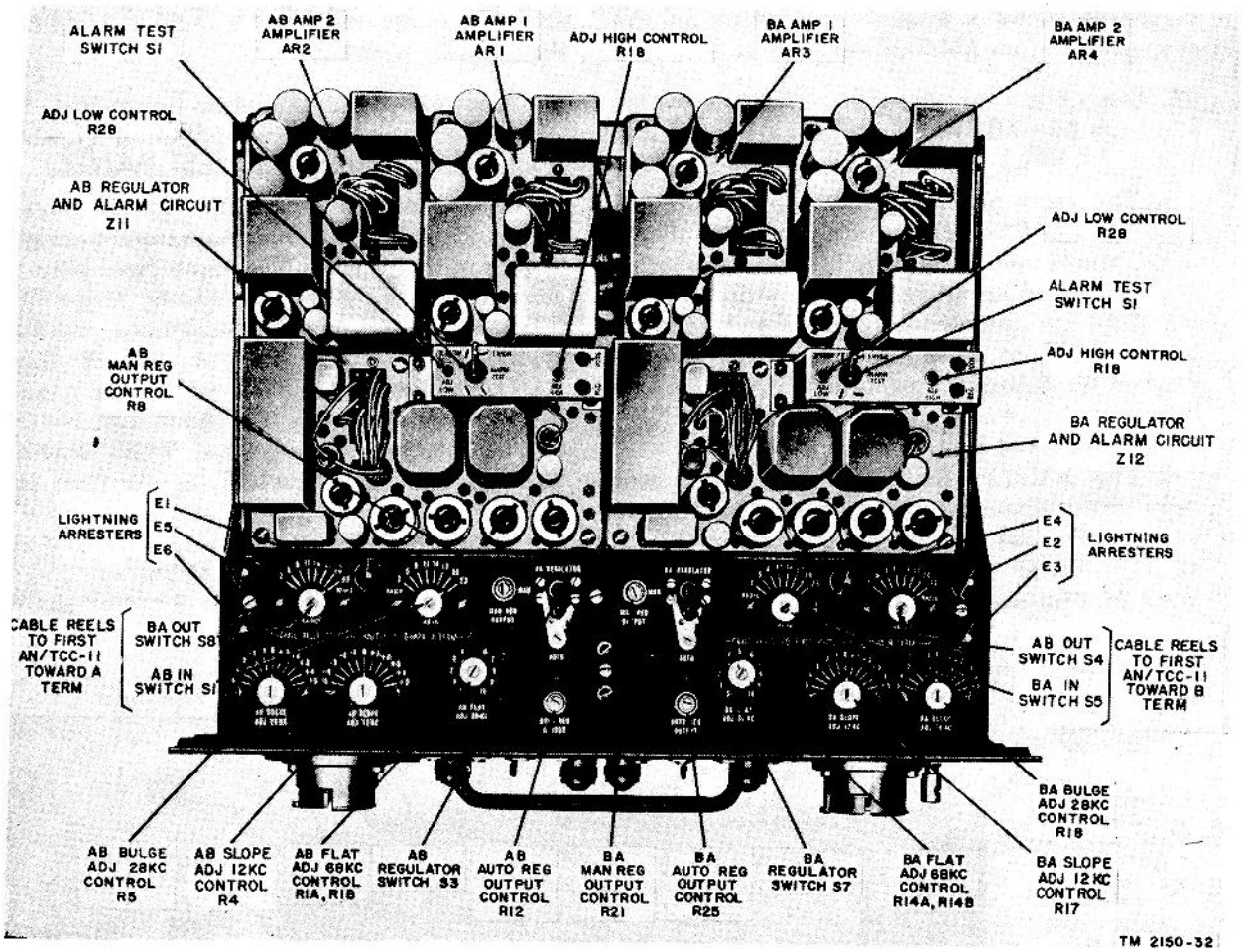


Figure 31. AM-708 REPEATER PANEL, top view of chassis.

WIRE PANEL (fig. 32) contains rotary switches, test jacks, controls, a lever switch, and a lamp. An OW TR AMP OUT ADJ table, identical to the table shown in paragraph 23, is provided. Other controls are bracket-mounted to the chassis in back of the front panel (fig. 33). These controls and other parts may be made accessible by sliding the panel out of the case a few inches. A telephone handset is stored on the rear portion of the chassis. During normal use of the equipment, the telephone handset is removed from its storage place and is hung on a cradle on the drawer above the AM-708 REPEATER PANEL.

(2) The RT-281 ORDER WIRE PANEL provides amplification and equalization for the v-f order wire circuit in both directions of transmission. It also includes a telephone circuit and a handset that provide facilities for talking over the order wire circuit from the AN/TCC-8 repeater. A ringer-oscillator circuit provides a means of signaling over the order wire circuit from the AN/TCC-8 repeater.

b. Telephone Test Set TS-761/TCC-8 (TEST PANEL).

(1) The front panel of the TS-761 TEST PANEL (fig. 32) contains rotary switches controls, lever switches, push buttons, a lamp, a test jack, and a meter. One control is located on a plug-in unit at the rear of the chassis (fig. 34). A cable and plug assembly (MEASURE cord) is provided to permit transmission measurements at test jacks on other panels of the AN/TCC-8 repeater.

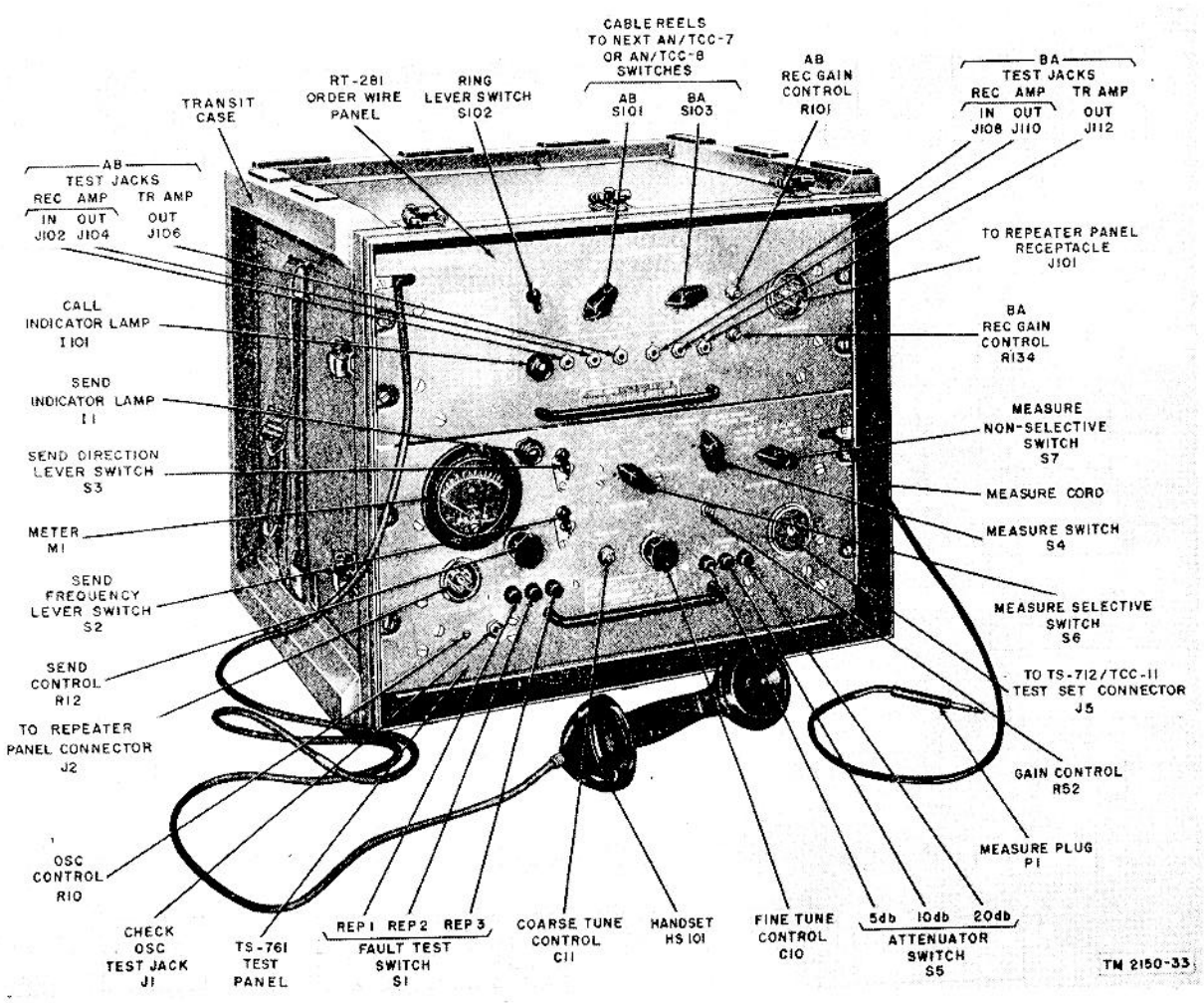


Figure 32. Receiver-Transmitter Test Set Group OA-446/TCC-8 (ORDER WIRE PANEL and TEST PANEL), front view.

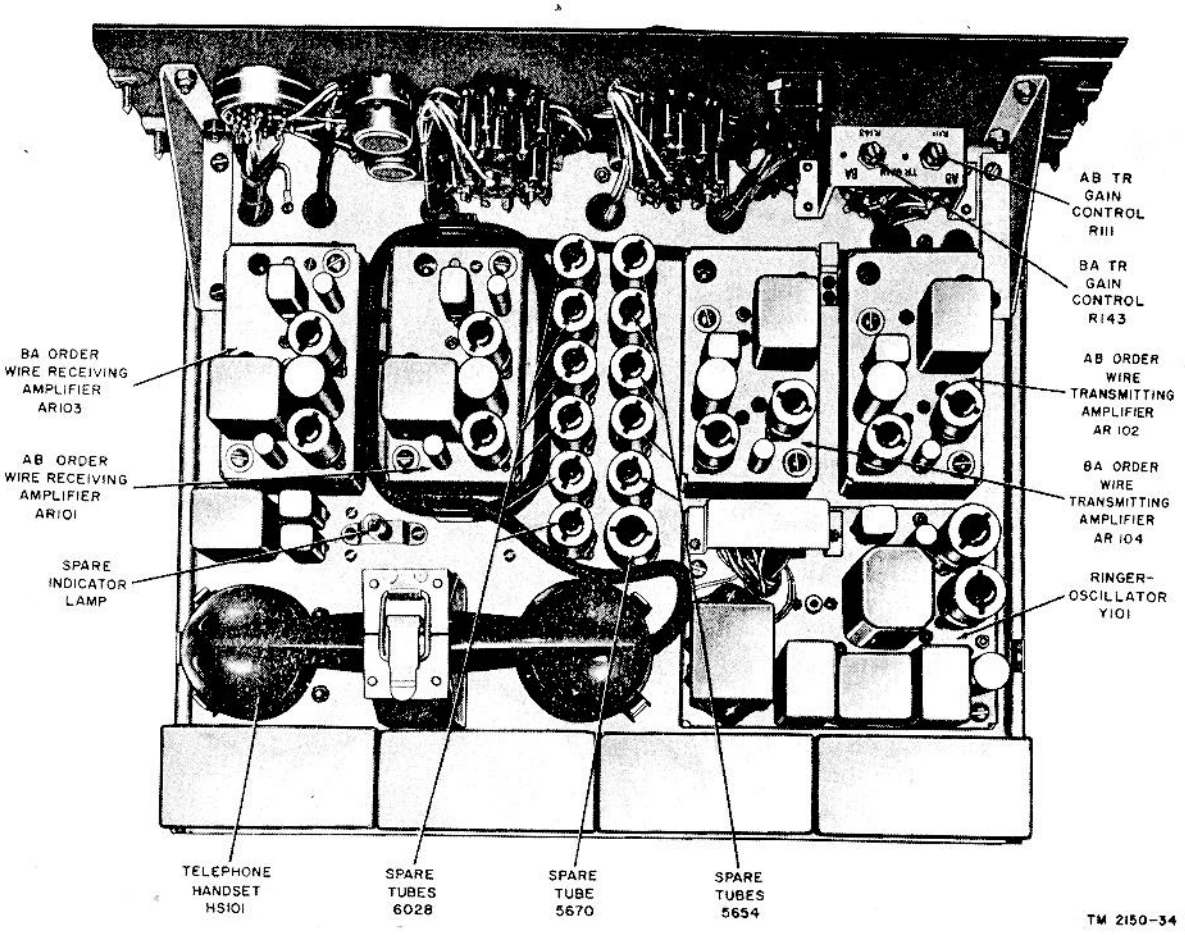


Figure 33. RT-281 ORDER WIRE PANEL, top view of chassis.

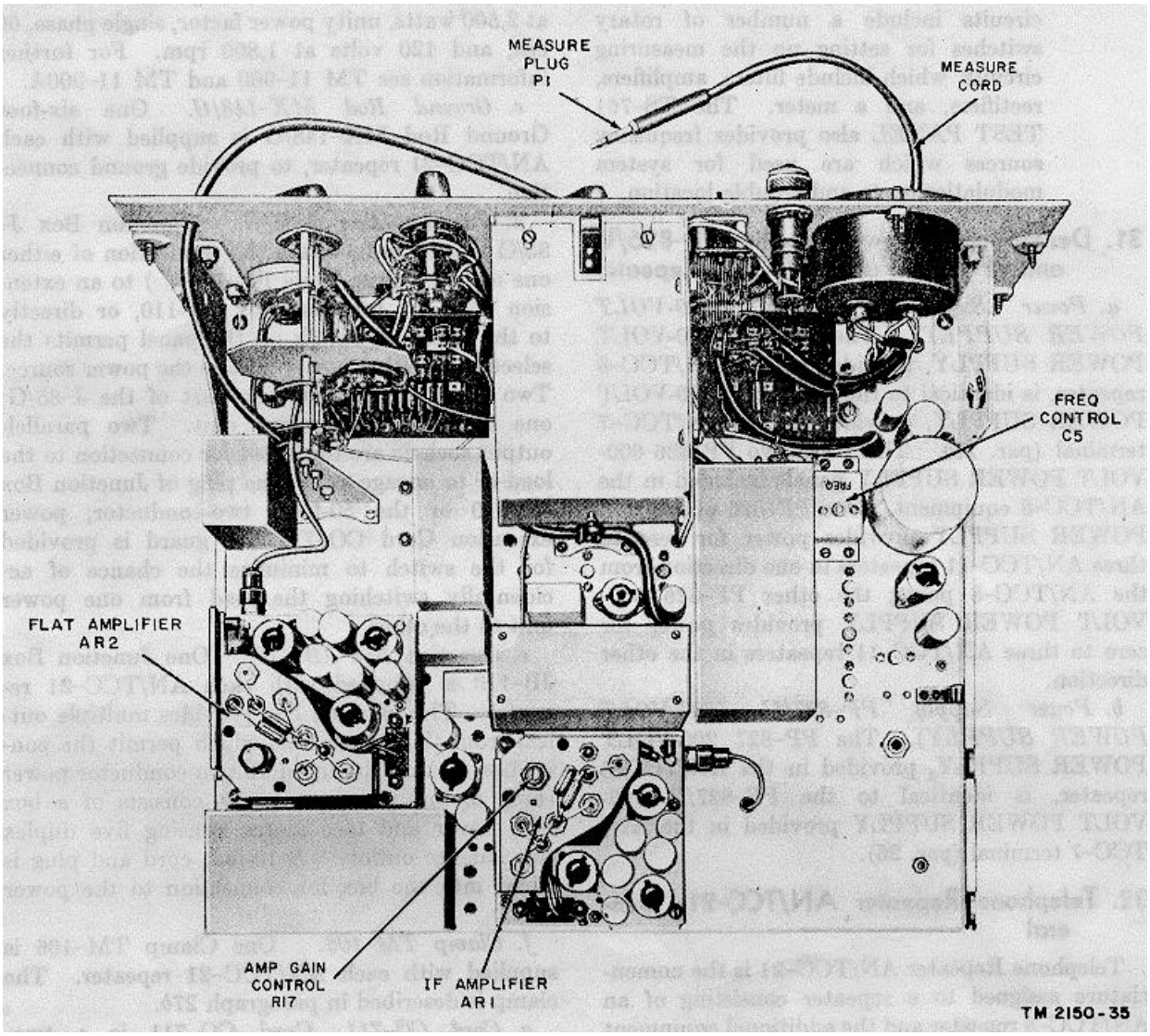


Figure 34. TS-761 TEST PANEL, top view of chassis.

(2) The TS-761 TEST PANEL contains circuits which provide for selective and non selective measurements at test jacks located at various points in the circuits of the other panels of the repeater (fig. 71). The TS-761 TEST PANEL circuits include a number of rotary switches for setting up the measuring circuits, which include filters, amplifiers, rectifiers, and a meter. The TS-761 TEST PANEL also provides frequency sources which are used for system modulation tests and trouble location.

31. Description of Power Supplies PP-826/U and PP-827/U at AN/TCC-8 Repeater

a. Power Supply PP-826/U (600-VOLT POWER SUPPLY). The PP-826 600-VOLT POWER SUPPLY, provided at the AN/TCC-8 repeater, is identical to the PP-826 U 600-VOLT POWER SUPPLY, provided in the 1 terminal (par. 25). There are two PP-826 600 VOLT POWER SUPPLY panels included in the AN/TCC-8 equipment. One PP-826 600-VOLT POWER SUPPLY provides power for zero to three AN TCC-11 repeaters in one direction from the AN/TCC-8 point; the other 600 VOLT POWER SUPPLY provides power for zero to three AN/TCC-11 repeaters in the other direction.

b. Power Supply ' PP-82Y/U (200-VOLT POWER SUPPLY). The PP-827 200-VOLT POWER SUPPLY, provided in the AN TCC-8 repeater, is identical to the PP-827/U 200 VOLT POWER SUPPLY provided in the AN/ TCC-7 terminal (par. 26).

32. Telephone Repeater AN/TCC-21, General

Telephone Repeater AN/TCC-21 is the nomenclature assigned to a repeater consisting of an AN/TCC-8 repeater and the additional equipment discussed in paragraph 33b through g Telephone Repeater AN TCC-21 is used when the location planned for a repeater does not have a-e power available to meet the requirements of the AN/ TCC-8 repeater equipment (par. 12*g*).

33. Description of Component of the AN/ TCC-21 Repeater

This paragraph describes the components of the AN/TCC-21 equipment.

a. Telephone Repeater AN/TCC 8. The AN/TCC-8 repeater is described in paragraphs 28 through 31.

b. Power Unit PE-75-( ). The PE 75-( ) power unit (fig. 35) is a gasoline engine-driven a-e generator. The engine is a single-cylinder, air-cooled gasoline engine. The generator is rated at 2,500 watts, unity power factor, single phase, 60 cps, and 120 volts at 1,800 rpm. For further information see TM 11-900 and TM 11-900A.

c. Ground Rod MX-148/G. One six-foot Ground Rod MX-148/G is supplied with each AN/TCC-21 repeater, to provide ground connection.

d. Junction Box J-85/G. Junction Box J-/G is used to facilitate the connection of either one or two Power Units PE-75-( ) to an extension cord, to Junction Box JB-110, or directly to the load. A switch on the panel permits the selection of either power unit as the power source. Two cords are provided as part of the J-85/G; one fits into each power unit. Two parallel output sockets are furnished for connection to the load or to engage either the plug of Junction Box JB-110 or the 50-foot, two-conductor, power extension Cord CO-711. A guard is provided for the so itch to minimize the chance of accidentally switching the load from one power unit to the other.

e. Junction Box JB-110. One Junction Box JB-I 10 is supplied with each AN/TCC-21 repeater. The junction box provides multiple outlets from the power unit which permit the connection of a maximum of 10 two-conductor power cords to one power unit. It consists of a box with cover and face plates housing five duplex convenience outlets. A 10-foot cord and plug is wired into the box for connection to the power unit.

f. Clamp TM-106. One Clamp TM-106 is supplied with each AN/TCC-21 repeater. The clamp is described in paragraph 27b.

g. Cord CO-711. Cord CO 711 is a two conductor, 14 gage, 50-foot cord with a plug cap at one end and a connector at the other. It is used for making a connection between Power Unit PE-75-( ) and Junction Box JB-110.

34. Additional Equipment Required for Installation of the AN/TCC-8 Repeater

The following equipment is not supplied as part of the AN/TCC-8 repeater but is required for its installation and operation.

a. Ground Rod MX-148/G. Ground Rod MX

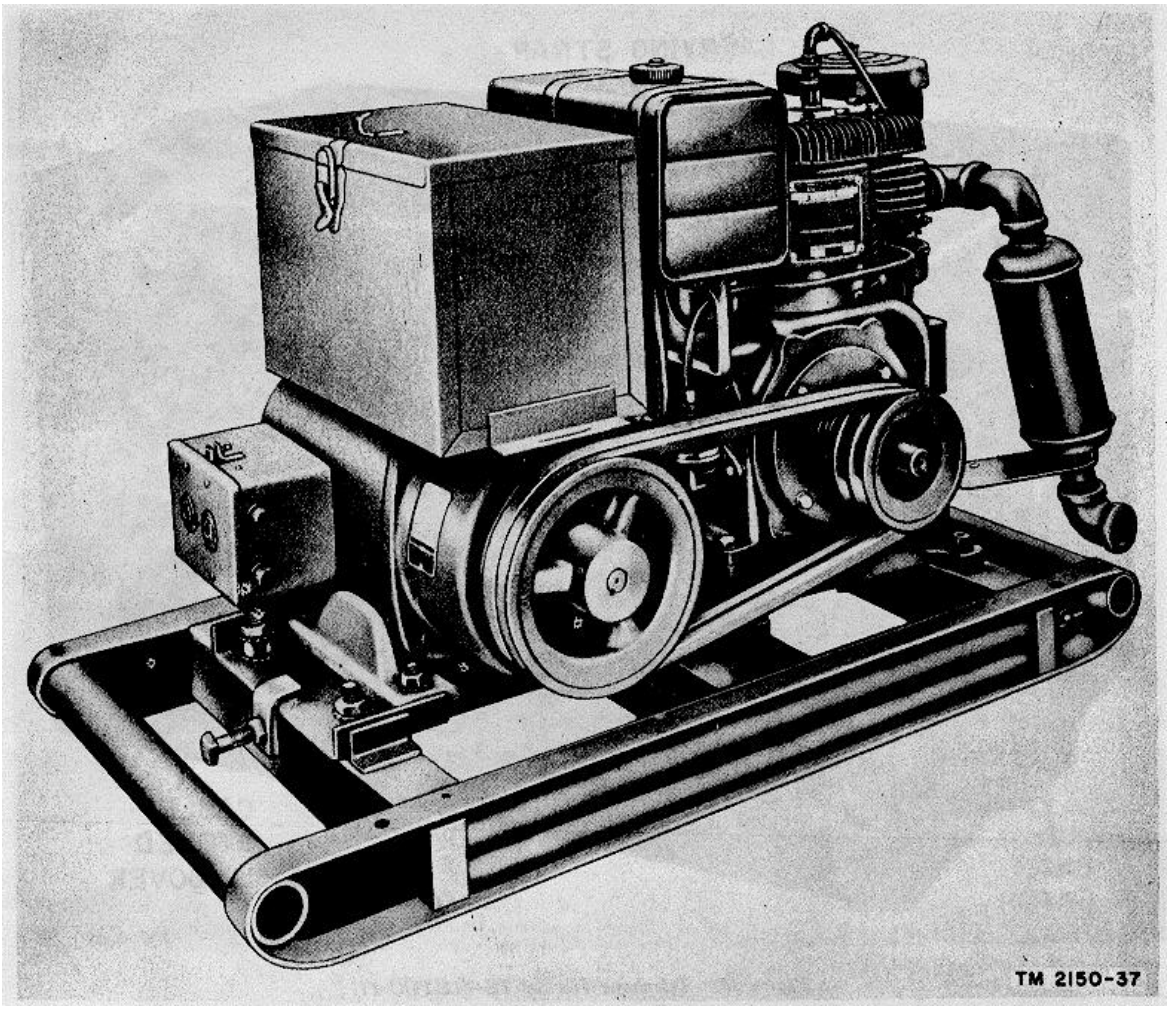


Figure 35. Power Unit PE-75-AF.

148/G may be required to connect the AN/TCC-8 repeater to an earth ground for protection against lightning. This ground rod is a component of Telephone Repeater AN/TCC-21 and therefore is not required as additional equipment when the AN/TCC-8 repeater is provided as part of the AN/TCC-21 repeater.

b. Clamp TM-106. Clamp TM-106 may be required to connect the AN/TCC-8 repeater to earth ground through a water pipe. The clamp is described in paragraph 27b. This clamp is a component of the Telephone Repeater AN/ TCC-21 and is not required as additional equipment when the AN/TCC-8 repeater is provided as part of the AN/TCC-21 repeater.

c. Cable Stub. A cable stub (Telephone Cable Assembly CX-1612/U (fig- 6)) is required for testing the AN/TCC-8 repeater. The cable stub is described in paragraph 8b.

d. TS-718 Test Set. One TS 712 test set is required at an AN/TCC-8 point for each PP-826 600-VOLT' POWER SUPPLY which supplies power to one or more AN/TCC-11 repeaters. A maximum of two TS 712 test sets may he required. The TS 712 test set is described in paragraph 35

e. Telephone EE-8. One Telephone ED 8 is required at an AN/TCC 8 point for each TS-712 test set supplied. A maximum of two Telephones EE 8 may be required. Telephone EE-8 is described in paragraph 36.

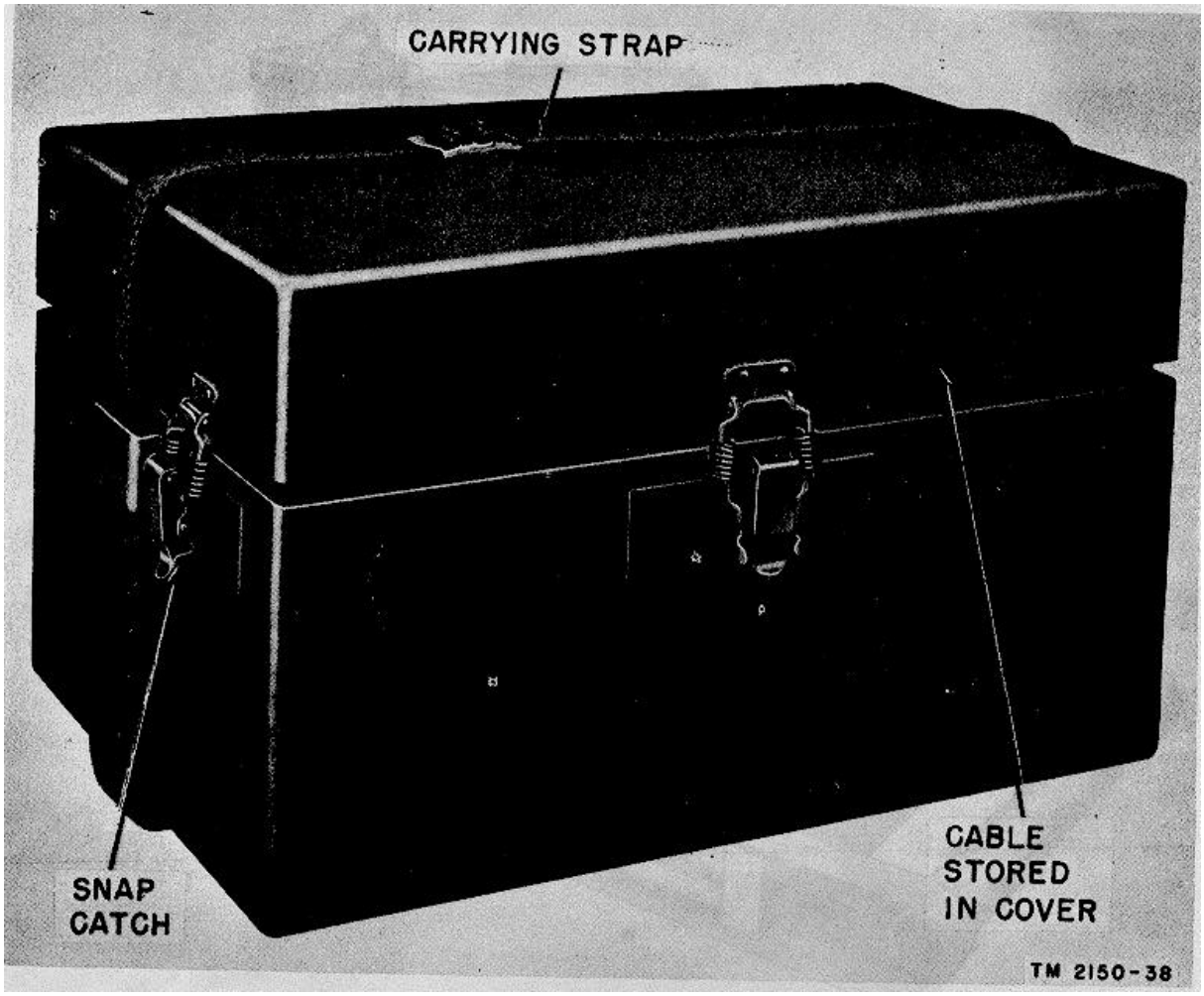


Figure 36. Telephone Test Set TS-712/TCC-11.

35. Telephone Test Set TS-712/TCC-11, Description

a. The TS 712 test set (fig. 36) is a portable, battery-powered unit which is carried to an AN/TCC-11 repeater location and is used there.

b. I he apparatus is mounted on a frame which is m an olive drab aluminum carrying case with a removable cover held in place by snap catches. A carrying strap is fastened to the case A panel (fig. 37) at the top of the frame may be exposed by removing the cover of the ease.

c. The panel contains controls, lever switches, rotary switches, and binding posts which may be arranged to make tests on an AN/TCC-11 repeater. Connection is made to the AN/TCC-11 repeater through a cable attached to the TS 712 test set (par. 262). One control (GAIN is located on the chassis below the front panel (fig 38).

d. The TS-712 test set contains circuits which may be used to measure direct current and signal voltages at various points in the AN/TCC-11 repeater (par. 263). The TS-712 test set, when used with Telephone EE-8 also provides circuits for talking and signaling on the order wire circuit from the AN- TCC-11 repeater.

e. The TS-712 test set includes an artificial cable which is completely detached from the TS-712 test set but is packed in the same crate for delivery. The artificial cable (fig. 39) consists of an assembly of apparatus and a short length of spiral-four cable equipped with a cable connector. The artificial cable is used to test AN/TCC-11 repeaters. When the artificial cable

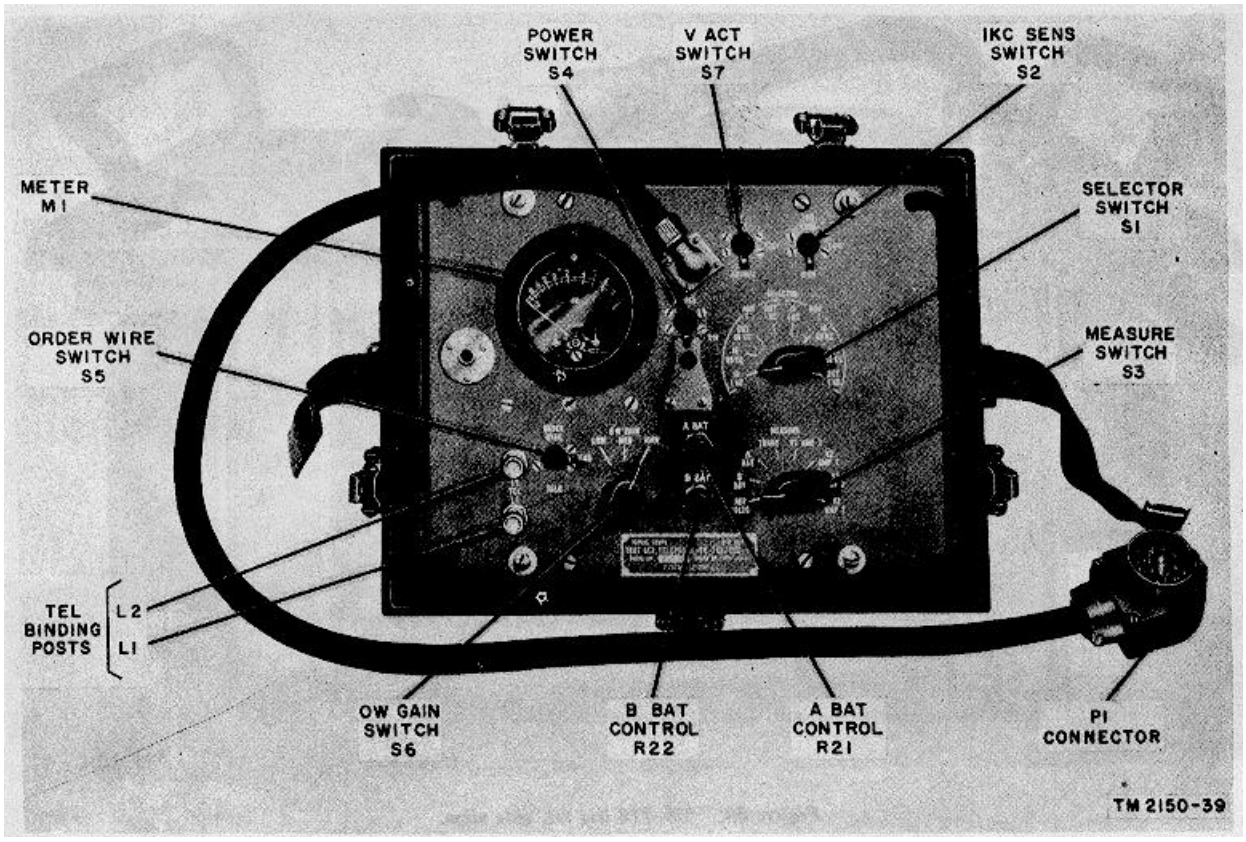


Figure 37. TS-712 test set, top view.

assembly is connected to an AN/TCC- 11 repeater, the assembly provides a transmission path from the output of one amplifier in the repeater to the input of the other amplifier. The loss of this path is approximately the same as that of 5 3/4 miles of spiral-four cable for a frequency band of 12 to 68 kc.

36. Description of Telephone EM)

The EE 8 telephone (fig. 40), when used with the TS-712 test set, provides means of talking and signaling on the order wire circuit from an AN/TCC-11 repeater. Telephone EE 8-( ) may be arranged as a local battery telephone for use with the AN/TCC-11 repeater. For detailed information on Telephone EE-8 ( ), refer to TM 11-333.

37. Telephone Repeater AN/TCC-11, Description

a. The AN/TCC-11 repeater (fig. 41) is enclosed in a cylindrical aluminum case and is effectively waterproofed so that it may be located at unsheltered areas. A strap is provided to aid in transporting the repeater and in mounting it on poles.

b. The two ends of the case are designated J1 and J2 and are identified by raised characters on the casting.

(1) The J1 end of the case (fig. 42) has two removable covers which cover a cable connector and a circular panel (CONTROLS), respectively. The panel contains a number of lightning arresters and a GAIN control for repeater amplifier No. 1.

(2) The J2 end of the case (fig. 43) has three removable covers which cover a cable connector, a connector for the TS-712 test set cable (TEST) and a circular panel (CONTROLS), respectively. The panel contains a number of lightening arresters and controls.

c. The AN/TCC-11 repeater contains the circuits which provide amplification, equalization,

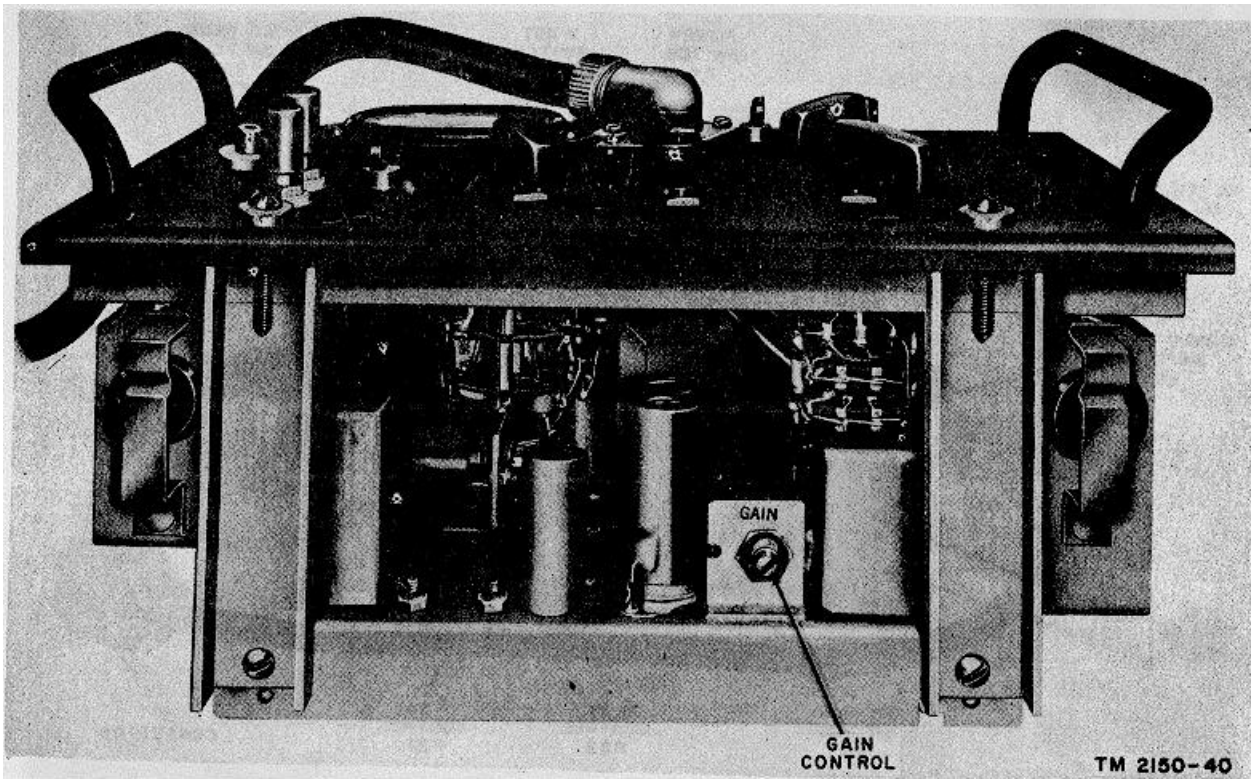


Figure 38. TS-712 test set, side view.

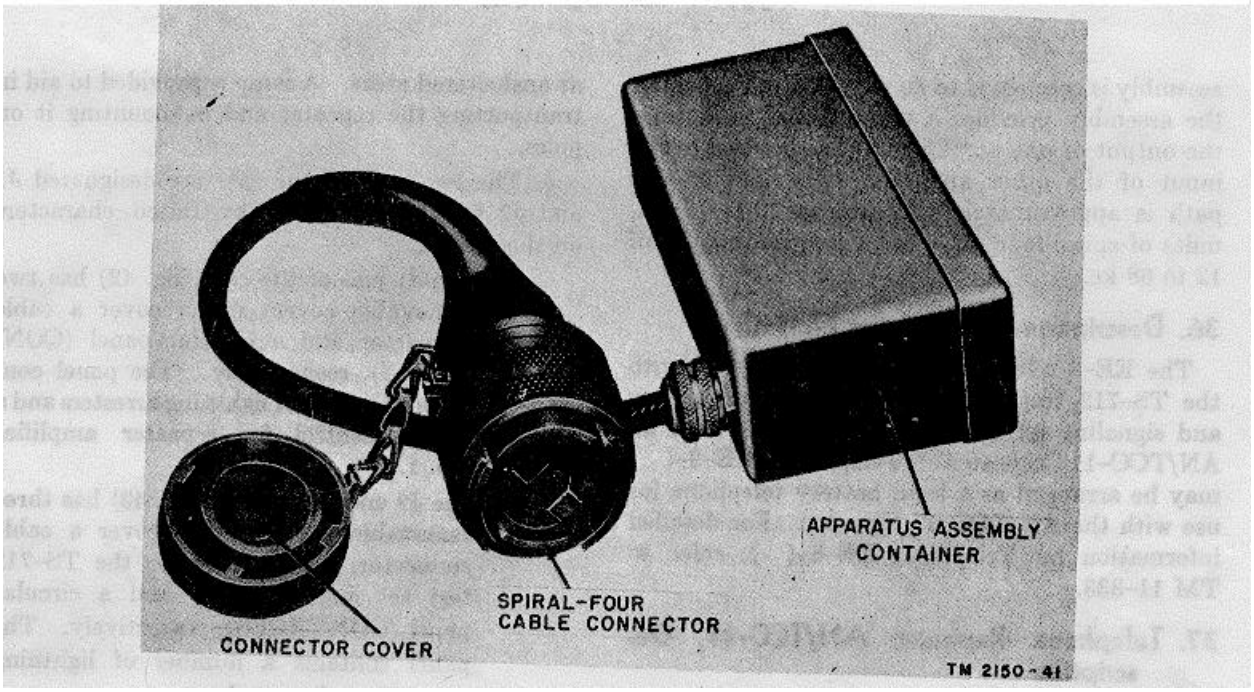


Figure 39. Artificial cable assembly.

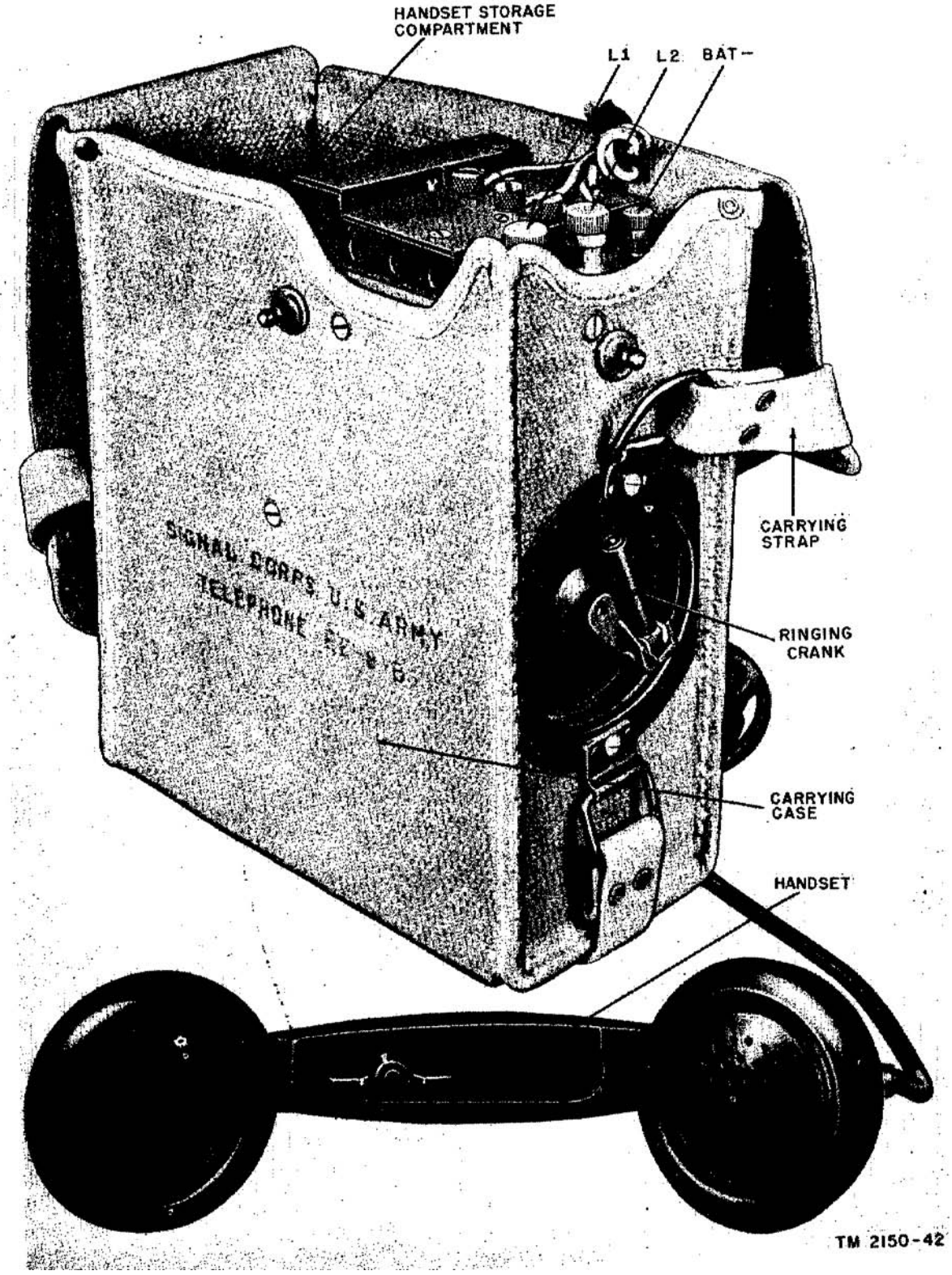


Figure 40. Telephone EE-8-B.

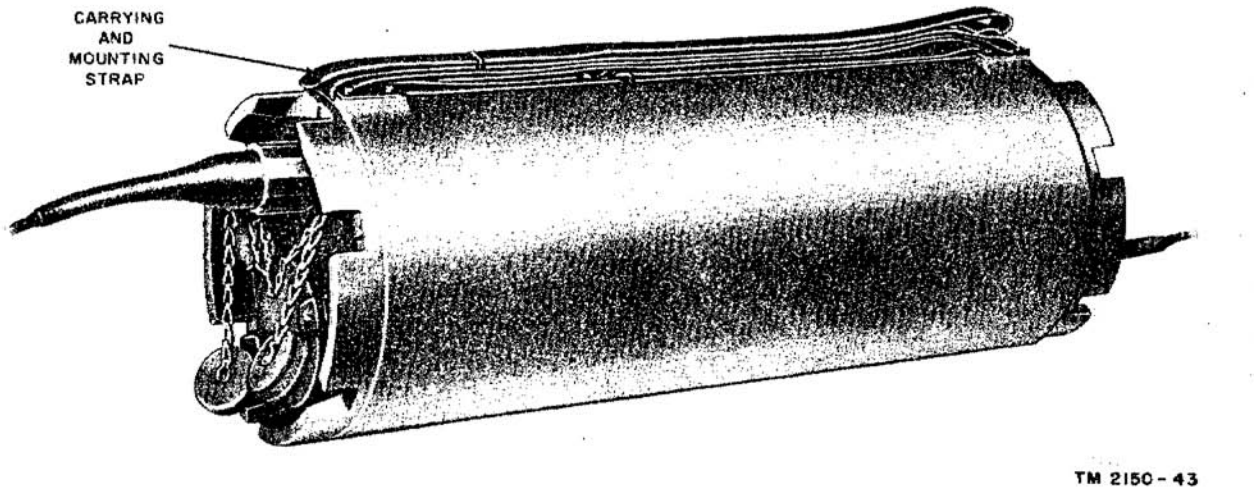


Figure 41. Telephone Repeater AN/TCC-11.

and automatic regulation for the 12- to 60-kc carrier-frequency bands in both directions of transmission. The v-f order wire circuits are separated from the carrier-frequency circuits by filter sets and are bypassed around the carrier-frequency amplifiers. The AN/TCC-11 repeater also includes relay and filter circuits used in trouble location procedures.

d. Ground Rod MX-148/G is required to connect the frame of the AN/TCC-11 repeater securely to an earth ground for protection against lightning.

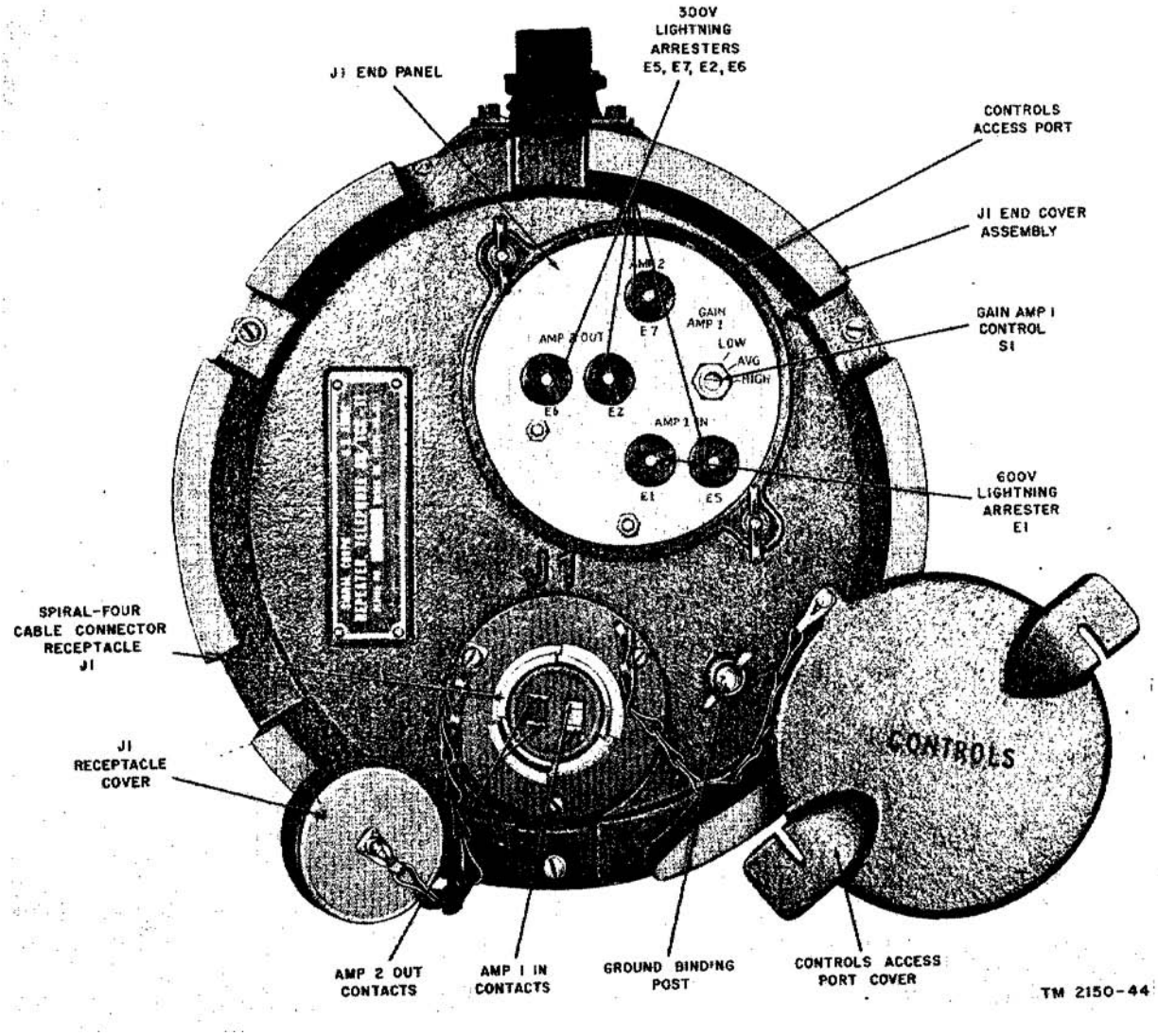


Figure 42. Telephone Repeater AN/TCC-11, J1 end view.

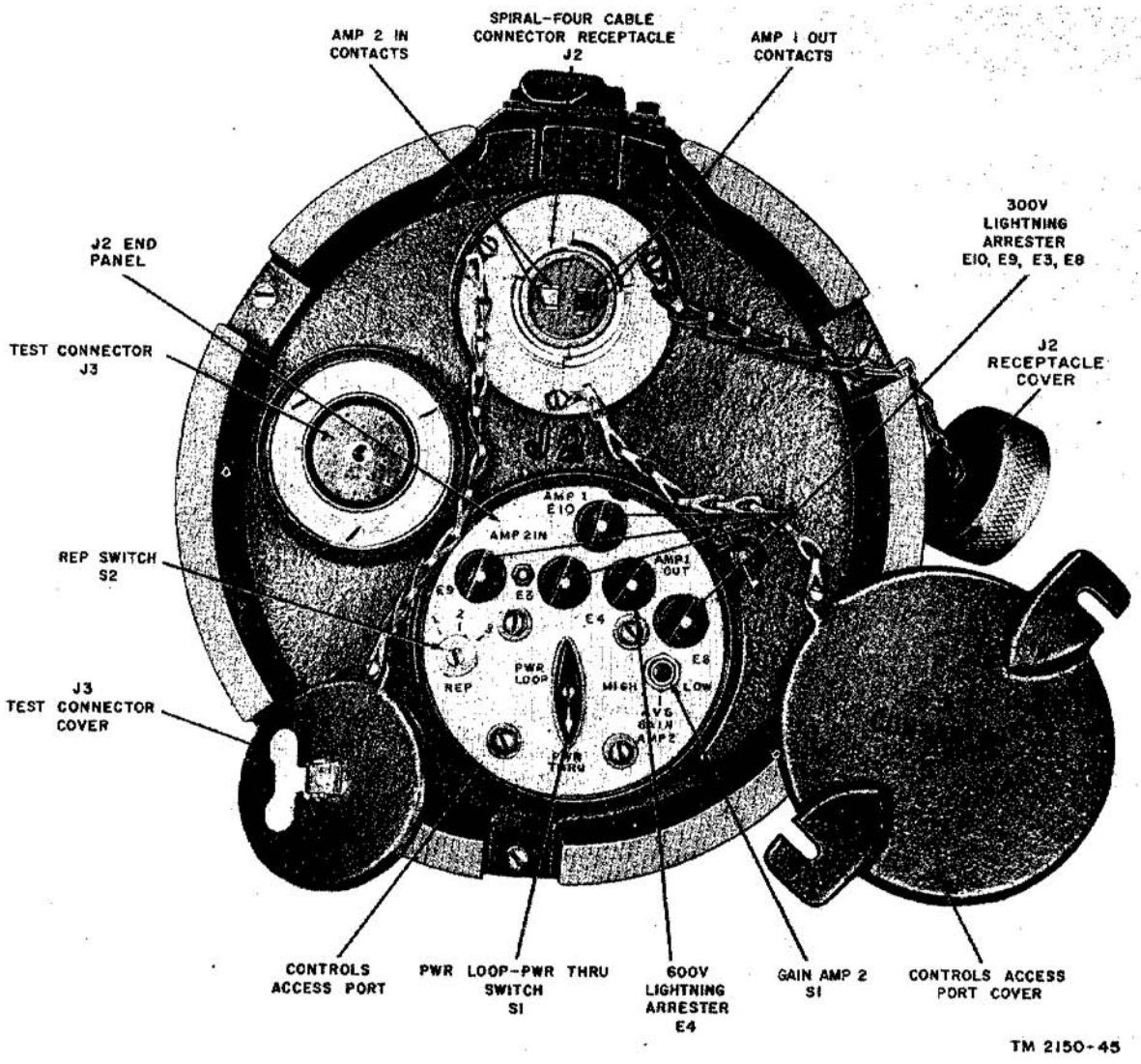


Figure 43. Telephone Repeater AN/TCC-11, J2 end view.

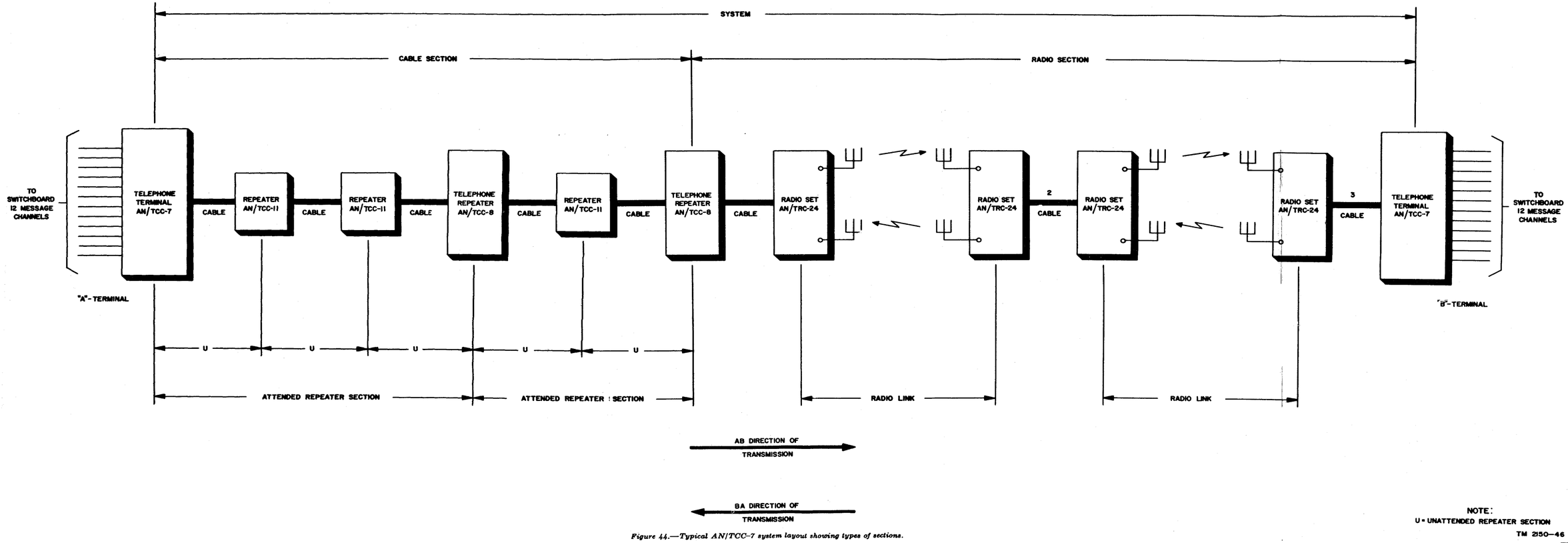


Figure 44.—Typical AN/TCC-7 system layout showing types of sections.

(Face p. 53)

Figure 44. Typical AN/TCC-7 system layout showing types of sections.

CHAPTER 2

SYSTEM PLANNING AND ENGINEERING

Section I. SYSTEM PLANNING

38. General

Before the installation of an AN/TCC-7 system can be initiated, the route of the system and the spacing of equipments along the route must be fixed. Paragraphs 39 through 48 define terminology used in planning an AN/TCC-7 system, describe the location of system equipments, and discuss considerations which influence the system layout.

39. System Layout, General

a. Typical Layout. A typical AN/TCC-7 system is composed of AN/TCC-7 terminals, AN/TCC-8 repeaters, and AN/TCC-11 repeaters. The transmission media may be either spiral-four cable or radio links on combinations of both types. Figure 44 shows a typical system layout.

b. Terminal Designations. The AN/TCC-7 terminal at the higher echelon end of the system is designated terminal *A*. The AN/TCC-7 terminal at the lower echelon end of the system is designated terminal *B*. These designations also serve to identify the two directions of transmission. The *AB* direction of transmission is from terminal *A* toward terminal *B*. The *BA* direction of transmission is from terminal *B* toward terminal *A* (fig. 44).

c. Definitions of Sections. To facilitate discussion of the arrangement of a system, names have been assigned to various portions of the system (fig. 44). The names are defined in (1) through (5) below.

(1) A *cable section* is a portion of an AN/TCC-7 system from. an AN/TCC-7 terminal (or an AN/TCC-8 repeater connected to a radio set) to the most distant attended point to which the connection is made entirely by cable. A cable section may comprise an entire system (fig. 2), or a portion of a system which also contains a radio-section (fig. 4).

(2) An *attended repeater section* is a section from one attended point to the attended point with a cable connection.

(3) An *unattended repeater section* is a section from one AN/TCC-11 repeater to next AN/TCC-11 repeater, or from an AN/TCC-11 repeater to an adjacent attended point.

(4) A *radio section* is a section from attended point through a radio link the next attended point. A radio section includes the cable used to connect radio terminals to the attended points and to interconnect radio terminals when the section contains more than one radio link.

(5) A *radio link* is a section from a radio terminal to an adjacent radio terminal through a radio connection. Spiral-four cable may be used to connect two or more radio links in tandem as part of a radio section.

d. *Overlapping of Sections.* A section as defined in *c* above includes the equipments at both of the section. Thus there is an overlapping of sections because two adjacent sections will contain an equipment in common.

40. Limitations of Attended Repeater Section

One attended repeater section or several sections in tandem comprise a cable section. Typical limiting factors of an attended repeater section outlined in *a* through *d* below. The reason for these limitations are explained in paragraph 222. Distances between repeater locations are given in cable miles. Geographical distances; point to point, always will be shorter.

a. An attended repeater section may contain maximum of six AN/TCC-11 repeaters; therefore the number of unattended repeater sections contained

within an attended repeater section may vary from zero to seven.

b. The maximum length of an attended repeater section is 40 miles (160 ¼-mile cable reels).

c. The minimum length of an attended repeater section is ½ mile (two ¼-mile cable reels).

d. In general, the length of attended repeater sections should be made as near to 40 miles as possible. When three or more attended repeater sections are connected in tandem, the average length per section should not be less than 25 miles, unless there is some decided advantage to be gained (such as convenience of attended point locations). Failure to observe this limitation will result in improper equalization (par. 227*c*).

41. Limitations of Unattended Repeater Section

Typical limiting factors of an unattended repeater section are outlined in a and *b* below. The reasons for these limitations are explained in paragraph 222.

a. An unattended repeater section adjacent to an attended point may vary in length from ½ mile to six miles (two to twenty-four ¼-mile cable reels).

Note. Normal reel length is 1,320 ± 40 feet (¼ mile ± 3 percent). Reel lots contain random lengths within these limits. Individual reels are tagged to show actual lengths. Random installation is recommended.

b. All other unattended repeater sections should be approximately 5¾ miles long (twenty-three ¼-mile cable reels). A variation of ±¼ mile (one ¼-mile cable reel or thirteen 100-foot cable reels) may be tolerated, but should be avoided. In general, the length of the section should be within ±500 feet of 23 reels. This limitation should not be violated more than once in an attended repeater section, unless some compensation is arranged; that is, an attended repeater section of 24 reels may be compensated by another unattended repeater section of 22 reels in the same attended repeater section. The length of an unattended repeater section must always consist of not less than 22 or not more than 24 quarter-mile reels.

42. Limitations of Radio Section

This paragraph discusses typical limiting factors of a radio section.

a. The limitations on the length of the radio path of a radio section are determined by radio transmission considerations.

b. The total length of cable used within a radio section to connect the radio terminals to the adjacent attended points (AN/TCC-7 or AN/TCC-8) and to interconnect radio links within the radio section is subject to the following limitations:

(1) In any radio section the total length of cable from attended points to radio transmitters should not exceed 1 mile for each direction of transmission.

(2) For example, in figure 44, cables 1 and 2 connect attended points to radio transmitters in the *AB* direction. Cable 3 connects a radio receiver to an attended point in the *AB* direction and is not considered. Therefore, the sum of the lengths of cables 1 and 2 should not exceed 1 mile. Likewise, cables 3 and 2 connect attended points to radio transmitters in the *BA* direction, and this total length should not exceed 1 mile.

(3) This limitation is necessary to prevent the accumulation of excessive slope (68 kc-12 kc loss) in the circuit to the radio transmitter input.

43. System Planning, General Considerations

a. General. It is assumed that the desired locations of the terminals of the system are known. The AN/TCC-7 terminal equipments should be located at readily accessible points with adequate shelter and power. These locations should be as near as practical to the equipment in which the message or special service channels are to be terminated or through which the channels are to be extended. The distance between the two points which constitute the ends of the system and the nature of the terrain to be covered must be known.

b. Control. The terminal located at the higher echelon end of the two ends of the system is designated as the control terminal. The installation, operation, and maintenance of the system is supervised at this terminal.

c. Order of Planning. The system planning should proceed in the following order:

(1) Location of AN/TCC-7 terminals.

(2) Decision regarding need for radio sections, and location of radio stations.

(3) Location of AN/TCC-8 repeater equipments.

(4) Choice of cable route.

(5) Location of unattended points (AN/TCC-11 repeaters).

(6) Division of unattended repeater sections into power loops.

44. Considerations Governing Use of Radio Sections

a. The following factors should be considered in determining the advisability of using radio sections in the system.

(1) *Terrain.* Where bodies of water are to be spanned or mountainous country is to be traversed, radio sections should be considered.

(2) *Damage to cable.* If the system crosses a region in which cable is susceptible to damage, the use of a radio section should be considered.

(3) *Security.* The relative security of radio and cable sections must be weighed when considering any radio section.

b. A more complete discussion of factors to be considered in determining the use of radio sections appears in the technical manuals for Radio Set AN/TCC-24 and other suitable radio systems.

c. When the radio terminal adjacent to an AN/TCC-7 terminal is some distance from the local switchboard, it is preferable to favor the local switchboard point rather than the radio terminal, provided the limitations outlined in paragraph 42 are met. Location of the AN/TCC-7 terminal within .5 db (1,000-cps loss) of the local switchboard is preferred. This reduces the loss of the system contributed by the 2-wire portions of the message circuits and enables the more stable realization of the 3.0 db net transmission loss without unnecessary sacrifice of singing margin.

45. Planning Attended Repeater Sections

An attended point must be located within a short distance of each radio terminal (par. 42). When this has been accomplished, the system has been divided into cable sections and radio sections. Each cable section then must be divided into attended repeater sections.

a. The cable sections may be divided into attended repeater sections by locating AN/TCC-8 points within the cable sections. Cable sections longer than 40 miles require AN/TCC-8 repeaters at intermediate points. Locations of these AN/TCC-8 points should observe the limitations on length of attended repeater sections given in paragraph 40. Allowance should be made for errors in estimating distances.

b. Attended repeater sections of lengths less than 5 miles should be avoided if possible. The sections should be planned to be as long as possible without exceeding the 40-mile limit. An attempt also should be made to make all the attended sections in the system approximately equal in length.

c. AN/TCC-8 points should be chosen to be readily accessible by road. The location should furnish adequate shelter. A permanent building is desirable. Availability of adequate power is an advantage. If adequate power is not available at the chosen location, an AN/TCC-21 repeater (par. 32) must be used instead of an AN/TCC-8 repeater.

d. The locations should be chosen so that the system follows a reasonably direct route.

46. Choice of Cable Route

a. The cable route should be chosen to follow as direct a path (from one attended point to the next) as possible, consistent with other considerations.

b. There is considerable advantage in having the cable follow a road or trail, or any route which is easily accessible. Routes to which access is unusually difficult should be avoided.

c. If the cable route follows a road, the cable should be located in such a manner as to avoid damage from vehicles using the road.

d. Routes should be avoided which subject the cable to possible pick-up of electrical fields. For example, the route should not follow close to and parallel to a power transmission line.

e. Routes should be avoided which require submersion of the cable for any appreciable length. In particular, it is undesirable to submerge a cable connector.

f. Routes should be avoided along which the cable is unduly susceptible to damage from humans or animals.

47. Planning Unattended Repeater Sections

When the locations of all attended points are determined, the cable sections have been divided into attended repeater sections. Each attended repeater section then must be divided into unattended repeater sections by locating AN/TCC-11 points within each attended repeater section.

a. The limitations on lengths of unattended repeater sections should be observed (par. 41).

b. The AN/TCC-11 points should be chosen to lie on a reasonably direct line from one attended point to the next.

c. Whenever possible, the AN/TCC-11 repeaters should be located at points readily accessible by road. The lengths of the unattended

repeater sections adjacent to attended points may be adjusted (within the limits of paragraph 41) to make this possible. The use of 100-foot cable reels should facilitate the location of AN/TCC-11 repeaters at the desired points.

d. Locations unusually difficult to reach should be avoided if possible. For example, the AN/TCC-11 repeaters should not be located in a swamp, in a thickly overgrown area, or in mountainous country where access may be extremely difficult.

e. If accurate information as to a preferred route of the cable is lacking, the exact location of the AN/TCC-11 repeaters may be deferred until the actual installation of the cable. However, it should be possible to determine the number of AN/TCC-11 repeaters required for any attended repeater section before installation of the cable.

48. Power Loop Planning Considerations

a. In an attended repeater section, the AN/TCC-11 repeaters receive power over the cable from PP-826 600-VOLT POWER SUPPLY panels which are parts of the AN/TCC-7 or AN/TCC-8 equipments at the ends of the attended repeater section. A power loop is defined as the cable over which the power is fed and the AN/TCC-11 repeaters to which power is fed.

b. Figure 45 shows the power plan of an attended repeater section. Each AN/TCC-11 repeater is equipped with a PWR LOOP-PWR THRU switch (S1). The position of the switch controls the configuration of the phantom circuit. At one AN/TCC-11 repeater in the attended repeater section, the PWR LOOP-PWR THRU switch is set at PWR LOOP position; at all other AN/TCC-11 repeaters, the switch is operated to the PWR THRU position. The phantom circuit is divided into the two power loops at the AN/TCC-11 repeater in which the PWR LOOP-PWR THRU switch is set at the PWR LOOP position.

(1) One power loop consists of the power leaving the AN/TCC-7 terminal by way of the phantom of the spiral-four cable, entering the first AN/TCC-11 repeater at connector J1, picking up the d-c distribution circuit of the repeater, leaving the first AN/TCC-11 repeater by way of the connector J2, entering the second AN/TCC-11 repeater at the connector J1, picking up the d-c distribution circuit of the repeater, and looping back toward the AN/TCC-7 terminal.

(2) The second power loop is formed in the same manner except that the point of loop-back is at the second AN/TCC-11 repeater of the AN/TCC-7 terminal power loop and at this point does not provide power to any part of this AN/TCC-11 repeater.

(3) Inspection of figure 45 will show that d-c power is present in all portions of the spiral-four cable of the attended repeater section. This not only powers all AN/TCC-11 repeaters but maintains conditioning current on all spiral-four cable connector contacts. This conditioning current is desirable since it helps maintain good contact in the cable connector (keeping the contacts clean) by having a d-c current present at all times.

c. A power loop may contain up to three AN/TCC-11 repeaters.

d. The AN/TCC-11 repeaters in an attended repeater section should be divided approximately equally between the power loops from the attended points at the two ends of the section, unless there are other considerations. A division such as three repeaters in one power loop and none in the next should be avoided, but may be used in a specific instance if it offers some advantage.

e. In general, the division of an attended repeater section into two power loops determines the allocation of the AN/TCC-11 repeaters for purposes of maintenance. The AN/TCC-11 repeaters in a power loop usually will be maintained by the attended point from which they receive power.

f. The accessibility of an AN/TCC-11 point should be considered. If the location of an AN/TCC-11 repeater is reached more easily from one end of the attended repeater section than the other, the AN/TCC-11 repeater should be placed in a power loop fed from the more accessible attended point. This procedure should be followed if possible regardless of the relative distances along the cable to the two ends of the attended repeater section.

g. Figure 46 shows an example of a power loop division of three repeaters to none. A swamp adjacent to the AN/TCC-8 point shown at the left side of the figure makes it advisable to maintain all three AN/TCC-11 repeaters from the AN/TCC-8 point shown at the right side of the figure. Therefore the power is looped back at the

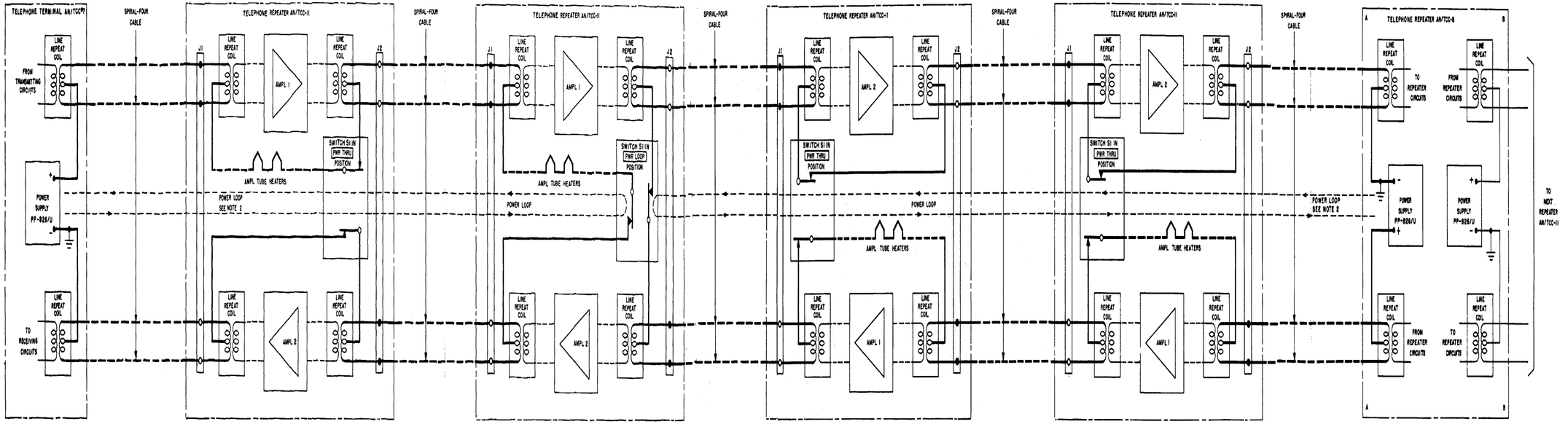


Figure 45. Attended repeater section showing typical power loops, functional diagram.

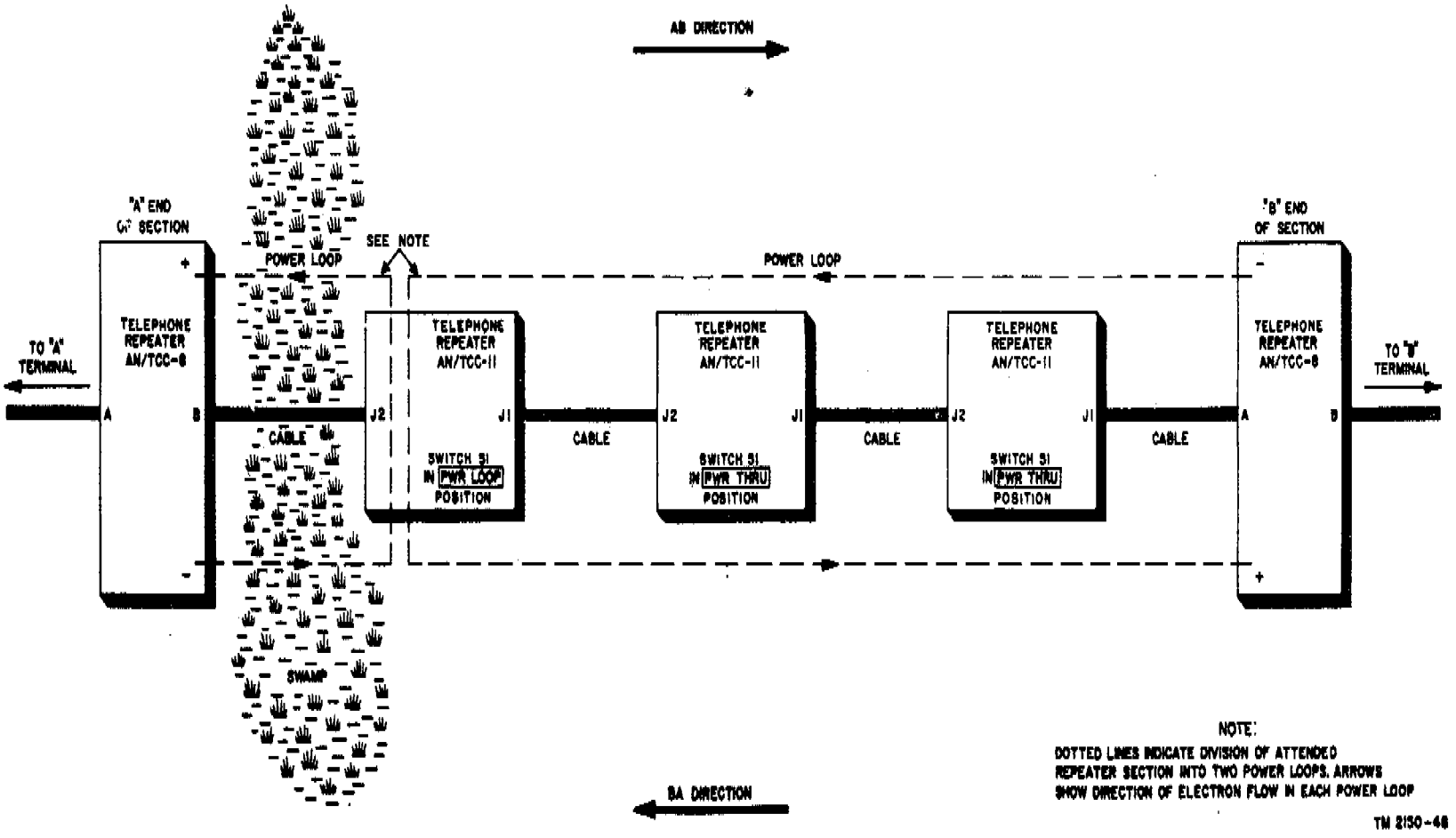


Figure 46. Attended repeater section showing special case of power loop division, block diagram.

first AN/TCC-11 repeater beyond the swamp in such a manner that all three repeaters are fed power from the AN/TCC-8 point at the right. The AN/TCC-8 point on the left feeds power only through the cable to tile adjacent AN/TCC 11 repeater. This is desirable to help maintain good contact in tile cable connectors by maintaining a flow of current through them.

Section II. EQUIPMENT INSTALLATION

49. General

This section describes the installation and preliminary adjustments of AN/TCC-7 and AN/TCC-8 equipments at attended points. It also describes the testing of AN/TCC-11 repeaters at attended points prior to the installation of the repeaters at their final locations. Installation instructions for the AN/TCC-11 repeater appears in paragraphs 66 through 82.

50. Planning Delivery of Equipment to Site, General

a. The AN/TCC-7 and AN/TCC-8 equipments should be delivered to their planned locations and set up in their final positions. Siting information appears in the respective equipment technical manuals.

b. A sufficient number of AN/TCC-11 repeaters should be delivered to each attended point to provide for the repeaters in the attended repeater section starting from that attended point in the direction planned for building up the system. It is recommended, if circumstances permit, that an extra AN/TCC-11 repeater be delivered to each attended point for storage as a spare.

c. Sufficient cable should be available to interconnect the system completely. This cable should be delivered to attended points from which the attended repeater sections will be built up and to other convenient points along the route that the system will follow.

51. Installation of Equipment at Attended Points, General

a. At an AN/TCC-7 point, the equipment should be installed and tested as described in the technical manual for Telephone Terminal AN/TCC-7.

b. At an AN/TCC-8 point, the equipment should be installed and tested as described in the technical manual for Telephone Repeater AN/TCC-8.

52. Test of AN/TCC-11 Repeater at Attended Points, General

The AN/TCC-11 repeaters should be tested before being transported to their final locations along the cable route. These tests may be performed at an attended point with the use of AN/TCC-7 or AN/TCC-8 equipment. Paragraphs 53 through 58 describe the test procedure at an AN/TCC-7 point. Paragraphs 60 through 65 describe the test procedures at an AN/TCC-8 point.

53. Adjustments of AN/TCC-11 Repeater Prior to Tests at AN/TCC-7 Terminal

a. Use a 100-foot cable reel to connect from the cable connector on the JUNCTION PANEL of the AN/TCC-7 terminal to the J1 cable connector at one end of the AN/TCC-11 repeater.

b. Connect the artificial cable to the AN/TCC-11 repeater by connecting the short cable from the artificial cable to the J2 cable connector of the AN/TCC-11 repeater.

c. Remove the two covers marked CONTROLS and the cover marked TEST at the ends of the repeater (figs. 42 and 43).

d. At the J1 end of the repeater, operate the GAIN AMP 1 switch to the AVG position.

e. At the J2 end of the repeater, operate the GAIN AMP 2 switch to the AVG position. Operate the REP switch to 1. Operate the PWR LOOP-PWR THRU switch to the PWR THRU position.

54. Adjustment of AN/TCC-7 Terminal Prior To Test of AN/TCC-11 Repeater at AN/TCC-7 Terminal

After performing the installation procedures and the initial adjustments required for installation of the AN/TCC-7 terminal as described in the technical manual for Telephone Terminal AN/TCC-7, the following readjustments should be made to prepare the AN/TCC-7 for testing AN/TCC-11 repeaters.

a. Operate the CABLE REELS TO FIRST AN/TCC-11 switches (REC and TR) to the positions marked 2.

b. Operate the AC POWER switch of the PP-827 200 VOLT POWER SUPPLY to the ON position.

c. Make the following adjustments on the PP-826 600-VOLT POWER SUPPLY.

(1) Operate the REPEATER switch to 1.

(2) The 600 V ADJ LOAD CURRENT HIGH-VOLT ALARM and LOW-VOLT ALARM controls should remain as adjusted in the installation test procedure DESCRIBED in the equipment technical manual.

(3) Arrange the TS-760 TEST PANEL to measure the PP-826 600-VOLT POWER SUPPLY output voltage (par. 253, item 2).

(4) Operate the AC POWER switch on the PP-826 600-volt power supply panel to on. The LOAD ALARM lamp will light and the buzzer will sound.

(5) Observe the reading of the TS-760 TEST PANEL meter. After several seconds it should rise to a value near 0 db and stop. Adjust the 600 V ADJ control to obtain a reading of 0 db on the meter. If the 600 V ADJ control is considerably out of adjustment, a power alarm may be received, indicated by lighting of the HIGH VOLTAGE lamp or the LOW VOLTAGE lamp, and the TEST PANEL meter reading will fall (output voltage removed). If this happens, operate the RESTORE lever switch momentarily to restore power. When the TEST PANEL meter reading has again risen and stops climbing, quickly adjust the 600 V ADJ control to obtain a reading of 0 db. (There is a delay of several seconds before the alarm is received.) The LOAD ALARM lamp will be extinguished and the buzzer will be silenced when the 600 V ADJ control is correctly adjusted.

(6) Observe the reading on the CURRENT meter on the PP-826 600-VOLT POWER SUPPLY. Adjust the LOAD CURRENT control, if necessary, to obtain a reading of 100 milliamperes. Then readjust the 600 V ADJ control, if necessary, to obtain a reading of 0 db on the TEST PANEL meter.

(7) Operate the PWR LOOP-PWR THRU switch on the AN/TCC-11 repeater to PWR LOOP. The reading on the TEST PANEL meter should reduce slightly (less than .5 db).

55. Test of AN/TCC-11 Repeater Order Wire Circuit at AN/TCC-7 Terminal

a. Adjust controls on the RT-280 ORDER WIRE PANEL as follows:

(1) Operate the TR GAIN and REC GAIN controls to their maximum clockwise positions.

(2) Operate the CABLE REELS TO NEXT AN/TCC-7 OR AN/TCC-8 switch to the 0-11 position.

b. Operate the ORDER WIRE lever switch to the TALK position. Listen to the receiver of the telephone handset provided with the AN/TCC-7 terminal. No singing tone should be heard.

c. Operate the SEND OW lever switch to the ON position.

d. Use the TS-760 TEST PANEL to measure the signal at the REC AMP OUT jack of the RT-280 ORDER WIRE PANEL (par. 253, item 39). The TEST PANEL meter should read between 0 and +7 db.

e. Connect a TS-712 test set to the AN/TCC-11 repeater (par. 262). Connect the L1 and L2 terminals of an EE-8 telephone to the L1 and L2 (TEL) binding posts of the TS-712 test set. Use the TS-712 test set to measure the 1-kc output of amplifier 1 in the AN/TCC-11 repeater (par. 263, item 11). The test set meter should read between +2 and +8 db with the 1 KC SENS switch at LOW. Restore the SEND OW lever switch on the RT-280 ORDER WIRE PANEL to its nonoperated position.

f. Arrange the TS-712 test set as follows:

(1) Operate the ORDER WIRE switch to the TALK position.

(2) Operate the OW GAIN switch to the LOW position.

g. Use the EE-8 telephone to talk to an attendant using the telephone set supplied with the AN/TCC-7 terminal. Check to see that the volume and intelligibility of speech are satisfactory.

h. Restore the ORDER WIRE lever switch on the RT-280 ORDER WIRE PANEL to its nonoperated position.

56. Carrier-Frequency Measurements of AN/TCC-11 Repeater at AN/TCC-7 Terminal

The following measurements check the transmission of the AN/TCC-11 at 68 kc.

a. Measure the d-c voltage across the AN/TCC-11 repeater with the TS-712 test set (par. 263, item 1). The TS-712 test set meter should read within .5 db of the BAT mark, which represents 150 volts ±10 volts.

b. Use the TS-712 test set to measure the 68-kc output of amplifier 1 in the AN/TCC-11 repeater (par. 263, item 10). The test set meter should read between +3 and +7 db.

c. Use the TS-760 TEST PANEL to measure the 68-kc output at the REC IN jack on the GROUP PANEL (par. 253, item 24). The reading on the TEST PANEL, meter shall be between +2 db and +7 db with the 10-db ATTENUATOR push button depressed.

d. Operate the GAIN AMP 1 switch on the AN/TCC-11 repeater to the HIGH position. The meter on the TS-760 TEST PANEL should read 2.5 db higher than the reading obtained in the procedure of *c* above. Operate the GAIN AMP 1 switch to the LOW position. The meter on the TS-760 TEST PANEL should read 2.5 db lower than the reading obtained in the procedure of *c* above.

e. Restore the GAIN AMP 1 switch to the AVG position. Repeat the procedure of *d* above, substituting the GAIN AMP 2 switch for the GAIN AMP 1 switch.

57. Checks of AN/TCC-11 Repeater Fault-Location Filters at AN/TCC-7 Terminal

The following tests check the band-pass filters in the AN/TCC-11 repeater. These band-pass filters are used in a repeater fault location test procedure.

a. Disconnect the artificial cable from the AN/TCC-11 repeater.

b. Arrange the TS-760 TEST PANEL, to send 99 kc (par. 255, item 5). Operate the FAULT TEST REP 1 push button. Adjust the output to read 0 db at the TR AMP OUT jack on the GROUP PANEL (par. 253, item 22).

c. Measure the signal at the REC IN jack on the GROUP PANEL (par. 253, item 27). Depress the 20-db ATTENUATOR push button. The TS-760 TEST PANEL meter should read between-3 db and +7 db.

d. Operate the REP switch on the AN/TCC-11 repeater to 2. Arrange the TS-760 TEST PANEL to send 91 kc (par. 255, item 6). Release the FAULT TEST REP 1 push button and operate the FAULT TEST REP 2 push button. Measure the signal at the REC IN jack on the GROUP PANEL (par. 253, item 27). Depress the 20-db ATTENUATOR push button. The TS-760 TEST PANEL meter should read between-3 db and +7 db.

e. Operate the REP switch on the AN/TCC-11 repeater to the 3 position. Arrange the TS-760 TEST PANEL equipment to send 83 kc (par. 255, item 7). Release the FAULT TEST REP 2 push button and depress the FAULT TEST REP 3 push button. Measure the signal at the REC IN jack on the GROUP PANEL (par. 253, item 27). Depress the 20-db ATTENUATOR push button. The TS-760 TEST PANEL meter should read between-3 db and +7 db.

58. Completion of AN/TCC-11 Repeater Test at AN/TCC-7 Terminal

a. After completion of the above tests, remove power from the PP-826 600-VOLT POWER SUPPLY by operating the AC POWER switch to the OFF position.

b. Disconnect the equipment used in the test.

c. Restore the two CONTROLS covers and the TEST cover to the ends of the AN/TCC-11 repeater (figs 42 and 43).

59. Test of AN/TCC-11 Repeater at AN/TCC-8 Repeater, General

The AN/TCC-11 repeaters that are delivered to an AN/TCC-8 point should be tested with the use of the AN/TCC-8 repeater before being transported to their final locations along the cable route. Paragraphs 60 through 65 describe the test procedure at an AN/TCC-8 point.

60. Adjustment of AN/TCC-11 Repeater Prior to Test at AN/TCC-8 Repeater

a. Use a 100-foot cable reel to connect from the B cable connector on the AM-708 REPEATER PANEL of the AN/TCC-8 repeater to the J1 cable connector at one end of the AN/TCC-11 repeater.

b. Follow the procedure outlined in paragraph 53*b* through *e*.

61. Adjustment of AN/TCC-8 Repeater Prior to Test of AN/TCC-11 Repeater at AN/TCC-8 Point

After performing the installation procedure and the initial adjustments, and after installation of an AN/TCC-8 repeater as described in the technical manual for Telephone Repeater AN/TCC-8, the readjustments listed in *a* through *c* below should be made to prepare the AN/TCC-8 repeater for testing AN/TCC-11 repeaters.

a. Operate the CABLE REELS TO FIRST AN/TCC-11 TOWARD B TERM switches (BA IN) and (AB OUT) to the positions marked 2.

b. Operate the AC POWER switch of the PP-827 200-VOLT POWER SUPPLY to the ON position.

c. Follow the procedures outlined in paragraph 54*c* to make adjustments on the PP-826 VOLT POWER SUPPLY that feeds power to the cable in the AB direction (connected to POWER TOWARD B connector on the AM-708 REPEATER PANEL).

62. Test of AN/TCC-11 Repeater Order Wire Circuit at AN/TCC-8 Repeater

a. Adjust controls on the RT-281 ORDER WIRE PANEL as follows:

(1) Operate the AB TR GAIN and BA REC GAIN controls to their maximum clockwise position.

(2) Operate the AB CABLE REELS TO NEXT AN/TCC-7 OR AN/TCC-8 switch to the O-11 position.

b. Operate the ORDER WIRE lever switch to the TALK position. Listen to the receiver of the telephone handset provided with the AN/TCC-8 repeater. No singing tone should be heard.

c. Connect a TS-712 test set to the AN/TCC-11 repeater (par. 262). Connect the L1 and L2 terminals of the EE-8 telephone to the L1 and L2 (TEL) binding posts of the TS-712 test set. Set the OW GAIN switch to LOW. Operate the RING lever switch on the ORDER WIRE PANEL, to ON. Use the TS-712 test set to measure the 1,600-cps output of amplifier 1 in the AN/TCC-11 repeater (par. 263, item 11). The test set meter should read between +3 db and off-scale high with the 1 KC SENS switch at LOW. Release the RING lever switch.

d. Operate the ORDER WIRE switch on the TS-712 test set to the TALK position.

e. Use the EE-8 telephone to talk to an attendant using the telephone handset supplied with the AN/TCC-8 repeater. Check to see that the volume and intelligibility of speech are satisfactory.

63. Carrier-Frequency Measurement of AN/TCC-11 Repeater at AN/TCC-8 Repeater

The following measurements check the transmission of the AN/TCC-11 repeater at 68 kc.

a. Measure the d-c voltage across the AN/TCC-11 repeater with the TS-712 test set (par. 263, item 1). The TS-712 test set meter should read within .5 db of the BAT mark, which represents 150 volts $\pm$ 10 volts.

b. Arrange the TS-761 TEST PANEL to send 68 kc in the AB direction (par. 260, item 1). Measure the 68-kc output at the AB AMP 1 OUT jack on the AM-708 REPEATER PANEL (par. 258, item 8). Adjust the SEND control to obtain a reading of 0 db on the TS-761 TEST PANEL meter.

c. Measure the 68-kc output at the AB AMP 2 OUT jack (par. 258, item 15). Operate the AB REGULATOR lever switch on the chassis of the AM-708 REPEATER PANEL to MAN. Adjust the AB MAN REG OUTPUT control to obtain a reading of 0 db on the TEST PANEL meter.

d. Use the TS-712 test set to measure the 68-kc output of amplifier 1 in the AN/TCC-11 repeater (par. 263, item 10). The test set meter should read between +3 and +7 db.

e. Use the TS-761 TEST PANEL to measure the 68-kc output at the BA IN jack on the AM-708 REPEATER PANEL (par. 258, item 18). Depress the 10-db ATTENUATOR push button. The reading on the TEST PANEL meter should be between +2 db and +7 db.

f. Operate the GAIN AMP 1 switch on the AN/TCC-11 repeater to the following positions and check that the TS-761 TEST PANEL meter reads within the indicated limits.

(1) GAIN AMP 1 switch at HIGH: 2.5 db greater than the reading obtained as described in *e* above, within ±.5 db.

(2) GAIN AMP 1 switch at LOW: 2.5 db less than the reading obtained as described in *e* above, within ±.5 db.

g. Restore the GAIN AMP 1 switch to AVG. Set the GAIN AMP 2 switch to the following positions and check that the TS-761 test set meter reads within the indicated limits.

(1) GAIN AMP 2 switch at HIGH: 2.5 db greater than the readings obtained as described in subparagraph *e* above within ±.5 db.

(2) GAIN AMP 2 switch at LOW: 2.5 db less than the reading obtained as described in subparagraph *e* above, within ±.5 db.

h. Restore the GAIN AMP 2 switch to AVG.

64. Checks of AN/TCC-11 Repeater Fault-Location Filters at AN/TCC-8 Repeater

The following tests check the band-pass filters in the AN/TCC-11 repeater that are used in a repeater fault location test procedure.

a. Disconnect the artificial cable from the AN/TCC-11 repeater.

b. Arrange the TS-761 TEST PANEL to send 99 kc in the AB direction (par. 260, item 5). Operate the FAULT TEST REP 1 push button. Adjust the output to read 0 db at the AB AMP 2 OUT jack on the AM-708 REPEATER PANEL (par. 258, item 16).

c. Measure the signal at the BA IN jack on the AM-708 REPEATER PANEL (par. 258, item 21). Depress the 20-db ATTENUATOR push button. The TS-761 TEST PANEL meter should read between-3 db and +7 db.

d. Operate the REP switch on the AN/TCC-11 repeater to 2. Arrange the TS-761 TEST PANEL to send 91 kc in the AB direction (par. 260, item 7). Release the FAULT TEST REP 1 push button and operate the FAULT TEST REP 2 push button. Measure the signal at the BA IN jack on the AM-708 REPEATER PANEL (par. 258, item 21). Depress the 20-db ATTENUATOR push button. The TS-761 TEST PANEL meter should read between -3 db and +7 db.

e. Operate the REP switch on the AN/TCC-11 repeater to 3. Arrange the TS-761 TEST PANEL to send 83 kc in the AB direction (par. 260, item 9). Release the FAULT TEST REP 2 push button and operate the FAULT TEST REP 3 push button. Measure the signal at the BA IN jack on the AM-708 REPEATER PANEL (par. 258, item 21). Depress the 20-db ATTENUATOR push button. The TS-761 TEST PANEL meter should read between-3 db and +7 db.

65. Completion of AN/TCC-11 Repeater Test of AN/TCC-8 Repeater

a. After completion of the tests in paragraphs 60 through 64 remove power from the PP-826 600-VOLT POWER SUPPLY by operating the AC POWER switch to OFF.

b. Disconnect the equipment used in the test.

c. Restore the two CONTROLS covers and the TEST cover to the ends of the AN/TCC-11 repeater (figs. 42 and 43).

Section III. SYSTEM INSTALLATION

66. General

a. The information contained in this section describes the installation of spiral-four cable to interconnect equipments at attended locations and the installation of AN/TCC 11 repeaters at their final locations. Paragraphs 78 through 82 describe the installation of radio sections.

b. The planning of the system, as described in paragraphs 38 through 48, should be complete before the cable and AN/TCC-11 repeater installation is started.

c. A typical system consists of a number of attended repeater sections and radio sections in tandem. These sections may be individually built up and then combined to form the entire system. The order in which the separate attended repeater sections and radio sections are installed is not significant. The system installation is complete when all these sections have been installed.

d. The control point should keep a detailed record of the system layout. The following information should be recorded:

(1) Exact locations of all AN/TCC-7, AN/TCC-8, AN/TCC-11 points and radio sets.

(2) Layouts of all attended repeater sections, including number of AN/TCC-11 repeaters and the division of repeater sections into power loops.

(3) Numbers and types of cable reels in each unattended repeater section and radio section.

(4) Settings of GAIN AMP and REP controls and PWR LOOP-PWR THRU switch on all AN/TCC-11 repeaters.

e. The ends of an attended repeater section or a radio section will be referred to as the *A* and *B* ends. The *A* end of a section is defined as the end which transmits into the section in the *AB*

direction whereas the *B* end transmits into the section in the *BA* direction. This is illustrated for an attended repeater section in figure 47.

f. The AN/TCC-7 or AN/TCC-8 equipments at the two ends of an attended repeater section should be installed and tested before installing the AN/TCC-11 repeaters. The AN/TCC-11 repeaters that are to be installed in an attended repeater section should be completely tested (as described in pars. 55 through 65) at an AN/TCC-7 or AN/TCC-8 point before being transported to their final locations.

67. General Planning Considerations in Building an Attended Repeater Section

An attended repeater section, when completed, provides a cable connection from one end of the section to the other with AN/TCC-11 repeaters installed at intervals of nominally 5¾ miles (twenty-three ¼-mile reels). The precise limitations on spacing of AN/TCC-11 repeaters are given in paragraph 41. The build-up of the section may be accomplished in a number of ways. Three of the methods are briefly outlined in *a* through *c* below.

a. Start from the attended point at one end of the attended repeater section and install spiral-four cable until a desirable location is reached for the first AN/TCC-11 repeater, at a distance of twenty-three ¼ mile reels or the equivalent. Install the first repeater at a desirable location near this point. Lay out another span of twenty-three ¼-mile reels and install the second repeater at a desirable location near the end of this span. Continue in this manner, installing successive repeaters at intervals of twenty-three ¼-mile reels. Install the final repeater at a distance of two to twenty-four ¼-mile reels from the distant end of the attended repeater section.

b. Locate an AN/TCC-11 repeater at a desirable point between the ends of the attended repeater section.

(1) Install a span of twenty-three ¼-mile reels toward one end of the section. Install another AN/TCC-11 repeater at a desirable location near the end of this span. Continue in this manner, installing successive repeaters at intervals of twenty-three ¼-mile reels, leaving the final span to the attended point with a length of two to twenty-four ¼-mile reels.

(2) Follow the procedure outlined in (1) above. Start from the AN/TCC-11 repeater initially installed and progress toward the other end of the attended repeater section.

c. Install the spiral-four cable from the attended point at one end to the attended point at the other end before installing any AN/TCC-11 repeaters. Use ¼-mile reels connected end to end. After the cable installation is completed, install the AN/TCC-11 repeaters by following the procedures in (1) or (2) below.

(1) Start from one end of the attended repeater section and install an AN/TCC-11 repeater at the end of each section of twenty-three ¼-mile reels. If a more desirable repeater location is available within a few hundred feet of this point, install the repeater at the more desirable location using 100-foot cable reels and rearranging the laid cable (taking up slack or looping back) to reach the new location. This procedure will establish a length of approximately 23 reels for each unattended repeater section except the last one which may vary from 2 to 24 reels.

(2) Install an AN/TCC-11 repeater at some point between the two ends of the attended repeater section. Start at this point and install other AN/TCC-11 repeaters in both directions at intervals of 23 reels (or within a few hundred feet of these intervals), leaving the spans from the final repeaters to the ends of the section not longer than 24 reels nor shorter than 2 reels.

68. Typical Attended Repeater Section, General

a. The choice of the exact procedure to follow in building up an attended repeater section will depend on circumstances encountered in each individual installation problem. However, the procedure described in paragraph 67*a*, may offer some advantages. This procedure provides some latitude in the choice of AN/TCC-11 repeater locations and therefore increases the possibility of choosing desirable locations. The procedure also permits checking of the installation to some extent by use of the order wire circuit for talking at each successive repeater as each one is installed. The procedure also provides a rapid means of installing a system; each attended repeater section is complete and ready to use as soon as the installation

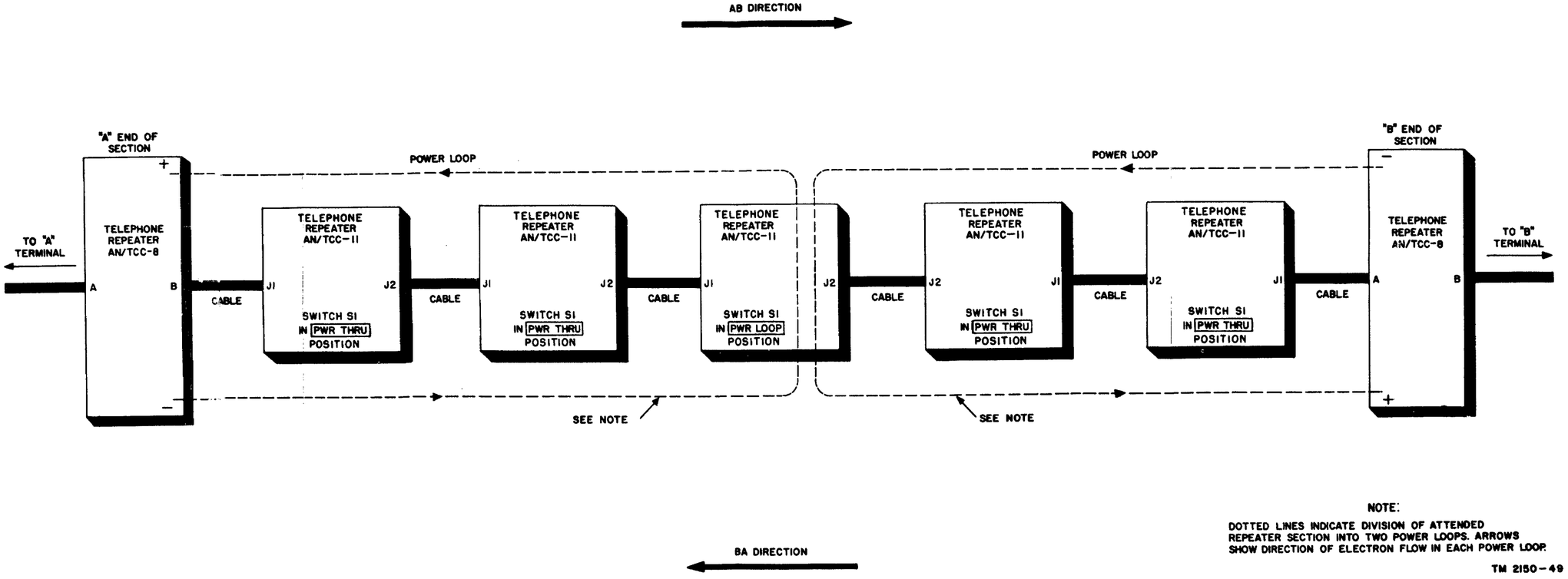


Figure 47. Attended repeater section showing cable connection to AN/TCC-11 repeaters, block diagram.

team has completed one trip along the cable route.

b. Paragraph 69 through 77 describe the procedure of paragraph 67*a* in detail. The procedures in paragraphs 69 through 77 are intended to serve as an example of a typical installation procedure rather than a procedure that should be followed in all cases. The details concerning the installation of an AN/TCC-11 repeater are applicable to any procedure for building up an attended repeater section and should be followed in all cases.

69. Procedure at Starting Point for Installation of Typical Attended Repeater Section

The installation should start at the attended point at one end of the attended repeater section The procedures at the starting point are outlined in *a* through *d* below. Select the applicable procedure from those listed in *b* and *c* below, depending on whether the starting point is an AN/TCC-7 terminal or an AN/TCC 8 repeater.

a. Determine the direction in which the system is built up (*AB* or *BA*).

b. Adjust the order wire controls according to the instructions in (1) below if the starting point is an AN/TCC-7 terminal, or according to the instructions in (2) below if the starting point is an AN/TCC-8 repeater.

(1) When starting from an AN/TCC-7 point operate the TR GAIN and REC GAIN controls on the RT-280 ORDER WIRE PANEL, to their extreme clockwise positions. Operate the CABLE REELS TO NEXT AN/TCC-7 OR AN/TCC-8 switch to the 150-160 position.

(2) When starting from an AN/TCC-8 point, deter-mine the transmission direction and operate the appropriate TR GAIN and REC GAIN controls on the RT-281 ORDER WIRE PANEL, to their extreme clockwise positions. Operate the appropriate CABLE REELS TO NEXT AN/TCC-7 OR AN/TCC-8 switch to the 150-160 position.

c. Connect a ¼-mile reel of cable to the equipment at the starting point by engaging the cable connector at one end of the reel with a cable connector on the equipment according to the applicable procedure in (1) or (2) below.

(1) At an AN/TCC-7 point engage the connector on the JUNCTION PANEL.

(2) At an AN/TCC-8 point engage the B connector on the AM-708 REPEATER PANEL, if proceeding in the *AB* direction, or the *A* connector if proceeding in the *BA* direction.

d. At the starting point, provide the installation team with the equipment listed in (1) through (5) below:

(1) A plan of the attended repeater section, showing the locations of the AN/TCC-11 repeaters (if they have been determined) and the settings of the controls for each repeater.

(2) A sufficient number of AN/TCC-11 repeaters required to reach the next attended point.

(3) A sufficient supply of spiral-four cable.

(4) A TS-712 test set.

(5) An EE-8 telephone.

70. Installation of Cable for a Typical Unattended Repeater Section

a. Laying of Cable. The installation team should proceed along the route chosen for the system (par. 46), installing successive ¼-mile reels of cable and joining ends of the reels by engaging the cable connectors. Reels of 100-foot length should be used when required to reach desirable repeater locations that fall between quarter-mile points. The use of 100-foot cable lengths prevents the necessity of leaving a large quantity of cable stored in the vicinity of the repeater. At times circumstances may require the cable to be stored on a reel or looped back and forth in the vicinity of the repeater. Detailed procedures for handling of the spiral-four cable are covered in TB SIG 233.

b. Location of AN/TCC-11 Repeaters. The locations chosen for the AN/TCC-11 repeaters must meet the requirements as to limitations of length of unattended repeater sections (par. 41) and other considerations as to repeater location (par. 47). If a desirable site is found within a distance of 1/8 mile or less beyond the end of a ¼-mile reel, the remaining cable to the chosen site should be made up of 100-foot reels. If a desirable site is found within a distance of between 1/8 mile and ¼ mile beyond the end of a ¼-mile reel, an additional ¼-mile reel should be used to reach the site. In this case, store the excess cable on a reel or loop it back and forth in the vicinity of the AN/TCC-11 repeater site.

c. Continuity Check. After completion of the cable installation to the site of the AN/TCC-11 repeater, check the continuity of the cable by measuring the d-c resistance of each pair of conductors

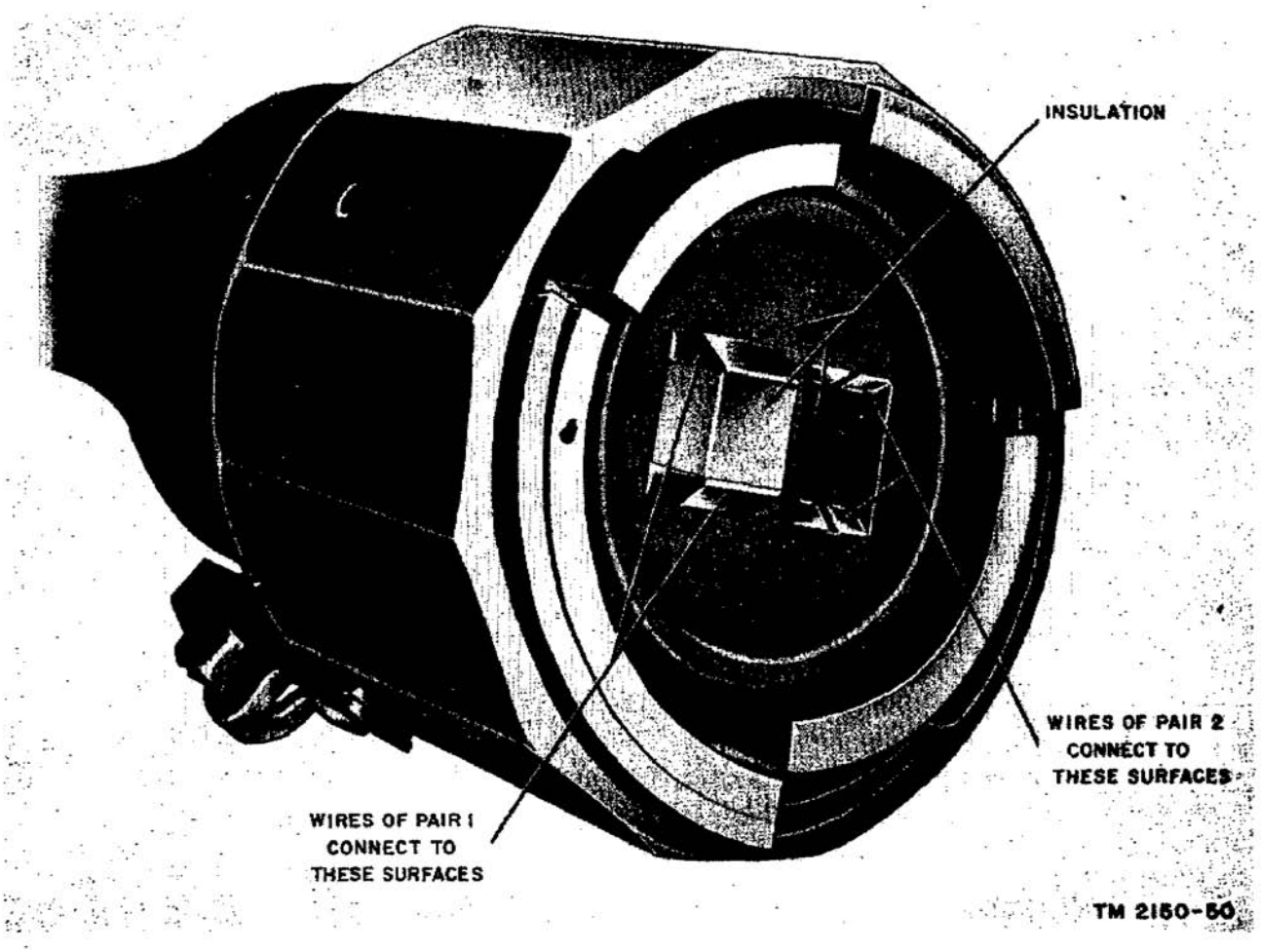


Figure 48. Spiral-four cable connector.

with an ohmmeter. Make d-c resistance measurements by making contact with the terminals in the final cable connector (fig. 48). The loop resistance of one pair of wires in twenty-three ¼-mile reels is approximately 500 ohms.

71. Installation of AN/TCC-11 Repeaters in a Typical Attended Repeater Section

a. The mounting arrangements of the AN/TCC-11 repeater depend on the manner in which the spiral-four cable is installed in both directions from the repeater. The repeater should be mounted in a location that is subject to the same temperature factors as the cable. For example, if a large part of the cable is suspended from poles, the repeater should be mounted on a pole. If the cable runs along the ground, the repeater should be placed on the ground. If the cable is buried, the repeater should be placed on the ground, but should be protected from the elements and from direct exposure to the sun. If the cable is exposed to direct sunlight, the repeater should be similarly exposed. Caution must be observed when installing the repeater. It must not be hidden in a place that is difficult to find. The repeater should never be placed in water or in a spot that might collect water. Detailed mounting arrangements are given in the technical manual for Telephone Repeater AN/TCC-11.

b. Figures 42 and 43 show the location of switches, connectors, and lightning arresters under removable covers on the end faces of the repeater.

c. After the repeater is located in its final position, connect the incoming cable as outlined in (1) through (3) below.

(1) If the repeater is to receive power from the attended point from which the installation started, connect the cable to the J1 cable connector (fig. 47).

(2) If the repeater is to receive power from the attended point toward which the installation is progressing, connect the cable to the J2 cable connector (fig. 46).

(3) The following rule should always be observed: The J1 connector should connect to the cable leading toward the attended point from which the repeater receives power.

d. Connect one end of a ¼-mile reel of cable to the remaining cable connector (at the other end of the repeater). This is the first reel of cable in the section to the next AN/TCC-11 repeater (or attended point).

e. Ground the case of the AN/TCC-11 repeater by connecting a wire from the ground binding post at the J1 end of the repeater to a ground rod driven into a good earth ground near the repeater.

f. Be sure that the cable is not arranged in a manner that places mechanical strain on the AN/TCC-11 repeater cable connectors. A detailed procedure for securing the cable at unattended points is discussed in the technical manual for Telephone Repeater AN/TCC-11.

72. Adjustment of AN/TCC-11 Repeaters in a Typical Attended Repeater Section

a. Remove the CONTROLS cover from the J2 end of the repeater (fig. 43). Operate the PWR LOOP-PWR THRU switch as outlined in (1) or (2) below.

(1) If the planning of power loops for the attended repeater section (par. 48) calls for splitting of the section into two power loops at this location, operate the switch to the PWR LOOP position (fig. 46).

(2) If the planning calls for power to be extended beyond the AN/TCC-11 repeater, operate the switch to the PWR THRU position (fig. 47).

Caution: Precautions must be taken to prevent moisture and dirt from entering the openings when the covers are removed, especially during rain or snowstorms.

b. Operate the GAIN AMP 2 switch to the AVG position.

c. Operate the REP switch to the position number corresponding to the location of the repeater relative to the attended point from which it receives power; that is, its position in a power loop. If the repeater is in the first position in a power loop (nearest the attended point), operate the REP switch to position 1, if second, to position 2, and if third, to position 3.

d. Remove the CONTROLS cover from the J1 end of the repeater (fig. 42). Operate the GAIN AMP 1 switch to the AVG position.

73. Talking from an AN/TCC-11 Repeater After Installation in a Typical Attended Repeater Section

After completion of the installation and adjustment of an AN/TCC-11 repeater (pars 71 and 72), use the order wire circuit to talk to the attended point from which the installation started. This serves to check the continuity of the circuit to that point, and to inform the attended point of the progress of the installation. The use of the order wire circuit at an AN/TCC-11 point is described in detail in paragraph 134. The steps given in *a* through *h* below repeat the essential part of the procedure.

a. Connect a TS-712 test set to the AN/TCC-11 repeater according to directions in paragraph 262.

b. Arrange the TS-712 test set as follows:

(1) Connect the L1 and L2 terminals of an EE-8 telephone to the L1 and L2 (TEL) binding posts of the TS-712 test set.

(2) Set the OW GAIN switch in accordance with the position of the AN/TCC-11 repeater relative to the starting attended point, as follows:

Position of AN/TCC-11 repeater	*Setting of OW GAIN switch*
First	LOW
Second	MED
Third or beyond	HIGH

c. Monitor the order wire circuit; if the circuit is not in use, signal to the attended point as follows:

(1) Operate the ORDER WIRE lever switch to RING.

(2) Turn the ringing handle on the EE-8 telephone rapidly for several seconds.

d. Talk on the order wire circuit by operating the ORDER WIRE lever switch to TALK and using the EE-8 telephone. Check to ascertain that the volume and intelligibility of speech is satisfactory. Inform the attendant at the attended point that the installation of the AN/TCC-11 repeater at that point has been completed and report the number of cable reels installed to that point.

e. The use of the order wire circuit at the attended point is described in paragraphs 132 and 133.

f. At AN/TCC-11 repeater points beyond the third, the talking circuit to the attended point will become progressively weaker because of the increasing loss of the circuit. Talking from the fifth and sixth repeaters may not be possible.

g. Notify the attended point, by use of the order wire, when the last AN/TCC-11 repeater in the attended repeater section has been installed. The order wire circuits at the attended point then should be readjusted as described in paragraphs 75 and 76. If talking on the order wire from the last repeater is not possible (for example, from the fifth or sixth repeater), the order wire circuits at the attended point will not be readjusted; their preliminary adjustments will suffice.

h. Upon completing the conversation over the order wire, disconnect the TS-712 test set from the AN/TCC-11 repeater. Replace all covers over the openings to the repeater. This completes the installation of the repeater.

74. Completion of Installation of Attended Repeater Section

a. Successive unattended repeater sections should be built up by installing the spiral-four cable as described in paragraph 70 and AN/TCC-11 repeaters as described in paragraphs 71 and 72, until the attended point at the end of the attended repeater section is reached.

b. If the attended point is an AN/TCC-7 point, connect the final cable reel to the cable connector on the JUNCTION PANEL. If the attended point is an AN/TCC-8 point, connect the cable to the A connector on the AM-708 REPEATER PANEL if proceeding in the *AB* direction, or the B connector if proceeding in the *BA* direction.

c. This completes the installation of the attended repeater section. Adjust the order wire circuits at the attended point at the end of the section (pars. 75 and 76). Use the order wire circuit (par. 132 or 133) to notify the attendant at the point from which this installation began. At this time the attended repeater section is ready for the line-up procedure described in paragraphs 97 through 108.

75. Readjustment of AN/TCC-7 Order Wire Circuit

The readjustments of the order wire circuit at an AN/TCC-7 point at one end of an attended repeater section that is being installed are described in *a* through c below. When the AN/TCC-7 point is the starting point for the installation, the procedure below should be followed when notice is received from the installation team that the final AN/TCC-11 repeater has been installed. When the AN/TCC-7 point is at the end of the attended repeater section toward which the installation is progressing, the procedure below should be followed when the installation has been completed to the end point. These readjustments are necessary to permit use of the order wire circuit within the attended repeater section being installed. Incorrect adjustment may result in excessive gain which will cause the circuit to oscillate, or insufficient gain which may result in unintelligible communication.

a. Cable Reels Switch.-Operate the CABLE REELS TO NEXT AN/TCC-7 OR AN/TCC-8 switch on the RT-280 ORDER WIRE PANEL to the position marked with numbers that include the number of cable reels to the next attended point. This number will be four times the approximate distance in miles.

b. Transmitting Gain. Adjust the transmitting gain as follows:

(1) Arrange the TS-760 TEST PANEL to measure the 1 kc output at the TR AMP OUT jack (par. 253, item 37).

(2) Note the number of AN/TCC-11 repeaters in the loop that will be fed power from the AN/TCC-7 point, and the number of reels to the first AN/TCC-11 point (assume 23 if the number is not known). Refer to the appropriate line of the OW TR AMP OUT ADJ table on the front panel of the RT-280 ORDER WIRE PANEL (par. 23).

(3) Operate the ATTENUATOR push buttons on the TS-760 TEST PANEL as specified in the table (par. 23):

(4) Operate the SEND OW lever switch on the RT-280 ORDER WIRE PANEL to ON. Adjust the TR GAIN control to obtain a reading on the T-760 TEST PANEL meter as specified in the table (par. 23).

(5) Restore the SEND OW lever switch to its nonoperated position.

c. Receiving Gain. Set the REC GAIN control to the approximate position indicated below in accordance with the number of AN/TCC-11 repeaters in the power loop.

(1) No repeaters: 75° from the extreme counterclock-wise position.
(2) One repeater: midposition.
(3) Two repeaters: 75° from extreme clockwise position.
(4) Three repeaters: extreme clockwise position.

76. Readjustment of AN/TCC-8 Order Wire Circuit

The readjustments of the order wire circuit at an AN/TCC-8 point at one end of an attended repeater section that is being installed are described in *a* through *d* below. When the AN/TCC-8 point is the starting point for the installation, the procedure below should be followed when notice is received from the installation team that the final AN/TCC-11 repeater has been installed. When the AN/TCC-8 point is at the end of the attended repeater section toward which the installation is progressing, the procedure below should be followed when the installation has been completed to the end point. These readjustments are necessary to permit use of the order wire circuit within the attended repeater section being installed. Incorrect adjustment may result in excessive gain which may cause the circuit to oscillate, or insufficient gain which may result in unintelligible communication.

a. Selection of Circuit Controls to be Adjusted. Make adjustments only on the order wire circuits that transmit into or receive from the attended repeater section being installed. Select the controls to be adjusted in accordance with the location of the AN/TCC-8 repeater. The controls to be adjusted at each end of an attended repeater section are listed in (1) and (2) below.

(1) *AN/TCC-8 Repeater at A end of attended repeater section.* Adjust the AB CABLE REELS TO NEXT AN/TCC-7 OR AN/TCC-8 switch, the AB TR GAIN control, and the BA REC GAIN control.
(2) *AN/TCC-7 Repeater at B end of attended repeater section.* Adjust the BA CABLE REELS TO NEXT AN/TCC-7 OR AN/TCC-8 switch, the BA TR GAIN control, and the AB REC GAIN control.

b. Cable Reels Switch. Operate the appropriate CABLE REELS TO NEXT AN/TCC-7 OR AN/TCC-8 switch on the RT-281 ORDER WIRE PANEL to the position that includes the number of cable reels to the next attended point. This number will be four times the approximate distance in miles.

c. Transmitting Gain. Adjust the transmitting gain as follows:

(1) Arrange the TS-761 TEST PANEL to measure the output at the appropriate TR AMP OUT jack (par. 258, item 34).
(2) Note the number of AN/TCC-11 repeaters in the attended repeater section being installed in the loop that will be fed power from the AN/TCC-8 point, and the number of reels to the first AN/TCC-11 point (assume 23 if the number is not known). Refer to the appropriate line of the OW TR AMP OUT ADJ table on the front panel of the RT-281 ORDER WIRE PANEL (par. 23).
(3) Operate the ATTENUATOR push buttons on the TS-761 TEST PANEL as specified in the table (par. 23).
(4) Operate the RING lever switch on the RT-281 ORDER WIRE PANEL to ON. Adjust the appropriate TR GAIN control to obtain a reading on the TS-761 TEST PANEL meter as specified in the table (par. 23).
(5) Release the RING lever switch.

d. Receiving Gain. Operate the appropriate REC GAIN control to the approximate position indicated in (1) through (4) below in accordance with the number of AN/TCC-11 repeaters in the power loop.

(1) No repeaters: 75° from the extreme counterclockwise position.
(2) One repeater: midposition.
(3) Two repeaters: 75° from extreme clockwise position.
(4) Three repeaters: extreme clockwise position.

77. Building Additional Attended Repeater Sections

a. All other attended repeater sections should be built up according to the procedure described in paragraphs 69 through 74. The order in which the various attended repeater sections are installed is not significant.

b. If the installation of an attended repeater section is completed well in advance of the expected completion of the entire system, it should be

lined up and tested according to the procedure of paragraphs 97 through 108.

78. Installation of a Radio Section, General

a. The installation of a radio section is described in paragraphs 79 through 82. The procedure consists of adjustment of the order wire circuits at the attended points at both ends of the section and installation of cable from these points to the adjacent radio stations.

b. The AN/TCC-7 or AN/TCC-8 equipments at the two ends of the radio section should be installed and tested before connecting to the adjacent radio stations.

c. The installation of that portion of a radio section, between radio terminals is discussed in the technical manual for the particular radio equipment being used.

79. Order Wire Adjustments at AN/TCC-7 Terminal in a Radio Section

When the attended point at one end of the radio section being installed is an AN/TCC-7 point, operate the controls on the RT-280 ORDER WIRE PANEL as outlined in *a* through *c* below.

a. Cable Reels Switch Operate the CABLE REELS TO NEXT AN/TCC-7 OR AN/TCC-8 switch to RADIO.

b. Transmitting Gain. Adjust the transmitting gain as follows:

(1) Arrange the TS-760 TEST PANEL to measure the 1-kc output at the TR AMP OUT jack (par. 253, item 37).

(2) Refer to the line marked RADIO CONNECTION on the OW TR AMP OUT ADJ table on the front panel of the TS-760 ORDER WIRE PANEL (par. 23).

(3) Operate the ATTENUATOR PUSH BUTTONS on the TS-760 TEST PANEL as specified in the table (par. 23).

(4) Operate the SEND OW lever switch on the TS-760 ORDER WIRE PANEL to ON. Adjust the TR GAIN control to obtain a reading en the TS-760 TEST PANEL meter as specified in the table (par. 23).

(5) Restore the SEND OW lever switch to its nonoperated position.

c. Receiving Gain. Operate the REC GAIN control to a position approximately 45° from the extreme counterclockwise position.

80. Order Wire Adjustments at AN/TCC-8 Repeater in a Radio Section

When the attended point at one end of the radio section being installed is an AN/TCC-8 point, operate the controls on the RT-281 ORDER WIRE PANEL as outlined in *a* through *c* below. Make adjustments only on the order wire circuits that transmit into or receive from the radio section being installed.

a. Cable Reels Switch. Set the appropriate CABLE REELS TO NEXT AN/TCC-7 OR AN/TCC-8 switch to RADIO.

b. Transmitting Gain. Adjust the transmitting gain as follows:

(1) Arrange the TS-761 TEST PANEL to measure the output at the appropriate TR AMP OUT jack (par. 258, item 34).

(2) Refer to the line marked RADIO CONNECTION on the OW TR AMP OUT ADJ table on the front panel of the RT-281 ORDER WIRE PANEL (par. 23).

(3) Operate the ATTENUATOR push buttons on the TS-761 TEST PANEL as specified in the table (par. 23).

(4) Operate the RING lever switch on the RT-281 ORDER WIRE PANEL to ON. Adjust the appropriate TR GAIN control to obtain a reading on the TS-761 TEST PANEL meter as specified in the table (par. 23).

(5) Release the RING lever switch.

c. Receiving Gain. Operate the appropriate REC GAIN control to a position approximately 45° from the extreme counterclockwise position.

81. Installation of Cable in a Radio Section

a. Connection at Attended Point. Connect a reel of cable to the equipment at the attended point by engaging the cable connector at one end of the reel with a cable connector on the equipment as follows:

(1) At an AN/TCC-7 point, engage the connector on the JUNCTION PANEL.

(2) At an AN/TCC-8 point, engage the B connector on the AM-708 REPEATER PANEL if proceeding in the *AB* direction

or the A connector if proceeding in the BA direction.

b. Installation of Cable to Radio Station. Install spiral-four cable from the attended point at one end of a radio section to the adjacent radio station by using ¼-mile reels and 100-foot reels as required to reach the radio station, in the same manner as described in paragraph 70*b*. Use a cable stub (Telephone Cable Assembly CX-1512/U) to connect from the final cable reel to the appropriate binding posts of the radio terminal. The total length of cable that may be used in a radio section is subject to the limitations of paragraph 42.

82. Completion of Radio Section Installation

a. The installation of the radio section is complete when the spiral-four cable from the attended points at both ends of the radio section to the adjacent radio stations has been completely installed.

b. Use the order wire circuit to talk from the attended point at one end of the radio section to the attended point at the other end to assure continuity of the circuit and to notify both points of the completion-of the installation. At this time, the radio section is ready for the line-up procedure discussed in paragraphs 109 through 112.

Section IV. CONNECTIONS TO MESSAGE CHANNELS, SPECIAL SERVICE CHANNELS, AND ORDER WIRE CIRCUIT

83. General

This section describes the connections between the AN/TCC-7 terminal and the equipment on the local side of the AN/TCC-7 terminal. Connections of message channels, special service channels, and the order wire circuit are included.

84. Message Channel Connections

a. General.

(1) The system provides facilities for transmitting 12 message channels each having a frequency band of approximately 300 to 3,500 cps.

(2) Each message channel may be connected on a 2-wire or 4-wire basis.

(3) V-f signaling equipment must be used on all message channels.

(4) Each message channel may be used to transmit a single voice signal which utilizes the entire band of 300 to 3,500 cps or a number of simultaneous voice frequency telegraph signals.

b. 2-Wire Connection. When a message channel is to be connected on a 2-wire basis, the wires from the local circuit to the 2W posts on the desired channel of any one TA-219 CHAN MODEM panels.

c. 4-Wire Connection. When a message channel is to be connected on a 4-wire basis, connect the transmitting pair, which transmits the signal toward the AN/TCC-7 terminal, to the 4W-T binding posts on the desired channel of any one of the TA-219 CHAN MODEM panels. Connect the receiving pair, which receives signals from the AN/TCC-7 terminal, to the 4W-R binding posts of the same channel.

d. Circuit Extensions Between Systems in Tandem. A message channel may be extended from one system to a message channel of another system. This connection may be made on a 2-wire or 4-wire basis (par. 11).

(1) *2-wire extension* (fig. 9). Connect a pair of wires from the 2W binding posts of a message channel on one terminal to the 2W binding posts of a message channel, preferably a different channel number, on the terminal of the system over which the channel is to be extended. This connection is made normally through a control board.

(2) *4-wire extension* (fig. 10). The receiving gain of each channel connected on a 4-wire basis must be set 5 db below the normal setting or, as shown in figure 10, a 5 db pad must be inserted in each direction of transmission at a local control board. Make connections between the 4W-T binding posts of a message channel on one terminal and the 4W-R binding posts of a message channel, preferably a different channel number, on the other terminal. Make a similar connection for the other direction of transmission. This connection is made normally through a control board. Pads for this purpose usually are provided as part of the control board.

85. Special Service Connections

The AN/TCC-7 system provides means of transmitting special service channels of bandwidths wider than 4 kc. Switches are provided in the AN/TCC-7 terminals to provide for switch over from message channel operation to special service operation. The procedure for connecting the special service channels is given in *a* through *c* below.

a. Transmission of 4- to 20-kc Channels.

(1) The equipment may be arranged to transmit as many as three channels, of 4- to 20-kc band-width.

(2) One, two, or three, 4- to 20-kc channels may be operated simultaneously. Each 4- to 20-kc channel replaces a group of four message channels within the same TA-219 CHAN MODEM.

(3) Connect the 4- to 20-kc special service local circuit output to the SPECIAL SERVICE 1 (2 or 3) IN binding posts in the TA-227 SUBGROUP PANEL. Connect the SPECIAL SERVICE 1 (2 or 3) OUT binding posts to the local circuit input.

Note. The 4- to 20-kc special service input to the AN/TCC-7 terminal should be limited to frequencies within this band. Extraneous frequencies outside this band may cause cross-talk into other channels transmitted by the AN/TCC-7 system.

b. Transmission of 60- to 108-kc Channels.

(1) The AN/TCC-7 terminal may be arranged to transmit one channel of 60 to 108 kc bandwidth.

(2) Connect the SPECIAL SERVICE 60-108 KC IN and OUT binding posts on the GROUP PANEL to the local circuit output and input respectively.

c. Transmission of 12- to 60-kc Channels.

(1) The AN/TCC-7 terminal may be arranged to transmit one channel of 12- to 60-kc bandwidth.

(2) Connect the SPECIAL SERVICE 12-60 KC IN and OUT binding posts on the GROUP PANEL to the local circuit output and input respectively.

86. Order Wire Circuit Extension

The order wire circuit may be extended on a 2-wire basis from an AN/TCC-7 terminal to a control board or other administrative point. Connect the order wire loop to the 2W EXT binding posts on the RT-280 ORDER WIRE PANEL. Telegraph-Telephone Signal Converter TA-182/U is required to provide v-f signaling from the order wire extension.

CHAPTER 3

INITIAL OPERATION

Section I. INITIAL ADJUSTMENTS

87. General

This section covers initial adjustments which must be made at AN/TCC-7 and AN/TCC-8 points as soon as an attended repeater section or radio section is completely installed. The attended repeater section line-up and the over-all system line-up may be performed after completion of the adjustments outlined in paragraphs 88 through 96. Each section layout must be known in detail, with complete information regarding the number of reels of cable between all points and the arrangement of AN/TCC-11 repeaters in the power loops. Steps in this initial adjustment procedure that have been performed during the installation test need not be repeated.

88. Initial Adjustment of AN/TCC-7 Terminal, General

a. A number of initial adjustments must be made at the AN/TCC-7 terminal prior to line-up of an attended repeater or radio section that contains an AN/TCC-7 terminal at one end. The initial adjustment procedure is described in paragraphs 89, 90, and 91.

b. All lever switches on the front panels of all components of the AN/TCC-7 terminal should be left in the vertical position unless the instructions state otherwise. Operate the three SPECIAL SERVICE lever switches inside the TA-227 SUBGROUP PANEL to the CHAN MODEM position. Operate the 60-108 KC lever switch inside the GROUP PANEL to the REGULAR position.

89. Initial Adjustment of Power Supplies at AN/TCC-7 Terminal

a. PP-827 200 VOLT POWER SUPPLY.

(1) Operate the AC POWER switch of the PP-827 200-VOLT POWER SUPPLY to the ON position. The green AC POWER lamp should light.

(2) Measure the output voltage with the TS-760 TEST PANEL (par. 253, item 1). Adjust the 200 V ADJ control to obtain a reading of 0 db on the TEST PANEL meter.

b. PP-826 600 VOLT POWER SUPPLY.

(1) The preliminary adjustments of the PP-826 600-VOLT POWER SUPPLY should be made as described in the technical manual for Telephone Terminal AN/TCC-7.

(2) Operate the REPEATER switch to the position with a designation equal to the number of AN/TCC-11 repeaters to which power is fed.

(3) If the AN/TCC-7 terminal is connected to a radio section, or if there are no AN/TCC-11 repeaters before the next attended point, the PP-826 600-VOLT POWER SUPPLY must not be turned on. Operate the AC POWER switch to OFF. Disconnect the cable from the PP-827 200 VOLT POWER SUPPLY to the PP-826 600 VOLT POWER SUPPLY to avoid accidental turning on of power. If the AN/TCC-7 terminal is connected to a radio section or to an attended repeater section without unattended repeaters, omit the steps outlined in (4) through (7) below.

(4) The 600 V ADJ, LOAD CURRENT, HIGH-VOLT ALARM, and LOW VOLT ALARM controls should remain as adjusted in the installation test procedure described in the technical manual for Telephone Terminal AN/TCC-7.

(5) Arrange the TS-760 TEST PANEL to measure the PP-826 600-VOLT POWER SUPPLY output voltage (par. 253, item 2).

(6) Operate the AC POWER switch of the 600-VOLT POWER SUPPLY to ON. The LOAD ALARM lamp will light and the buzzer will sound.

(7) Observe the reading on the TS-760 TEST PANEL meter. After several seconds it should rise to a value near 0 db and stop. Adjust the 600 V ADJ control to obtain a reading of 0 db on the meter. If the 600 V ADJ control is considerably off from its correct adjustment, a power alarm may be received. This condition will be indicated by lighting of the HIGH VOLTAGE or LOW VOLTAGE lamp, and will cause the TEST PANEL meter reading to fall (output voltage removed). If this happens, operate the RESTORE lever switch momentarily to restore power. When the TEST PANEL meter reading has risen again and stops climbing, quickly adjust the 600 V ADJ control to obtain a reading of 0 db. There is a delay of several seconds before the alarm is received. The LOAD ALARM lamp will be extinguished and the buzzer will be silenced when the 600 V ADJ control is adjusted correctly.

(8) Observe the reading on the CURRENT meter on the 600-VOLT POWER SUPPLY. Adjust the LOAD CURRENT control if necessary, to obtain a reading of 100 milliamperes. Then readjust the 600 V ADJ control, if necessary, to obtain a reading of 0 db on the TEST PANEL meter.

90. Initial Adjustment of Order Wire Circuit at AN/TCC-7 Terminal

The use of the order wire circuit is essential for the line-up of the system. It is, therefore, important that communication on this circuit be established as soon as possible. Completion of the adjustments referred to in *a* through *c* below will permit use of the order wire circuit to make a more complete line-up of the order wire circuit and the message channels.

a. When the AN/TCC-7 terminal is at one end of a radio section repeat the adjustments described in paragraph 79.

b. When the AN/TCC-7 equipment is at one end of an attended repeater section, repeat the adjustments described in paragraph 75.

c. Detailed instructions for use of the order wire circuit are given in paragraph 132.

91. Initial Adjustment of Carrier Transmitting Circuits at AN/TCC-7 Terminal

The adjustments of the carrier frequency circuits in the transmitting direction at the AN/TCC-7 terminal are described in *a* through *c* below.

a. Cable Reels Switch. Operate the CABLE REELS TO FIRST AN/TCC-11 (TR) switch on the GROUP PANEL as described in (1) or (2), below.

(1) When the AN/TCC-7 equipment is at one end of a radio section, operate the switch to the position marked RADIO.

(2) When the AN/TCC-7 terminal is at one end of an attended repeater section, operate the switch to the position showing the number of cable reels to the next AN/TCC-11 repeater (or attended point), if there is no intervening AN/TCC-11 point.

b. Adjustment of 12, 28 and 68 Kc.

(1) Use the TS-760 TEST PANEL to measure the 68 kc output at the TR AMP OUT jack on the GROUP PANEL (par. 253, item 19). Adjust the 68 KC control on the TA-228 CARRIER SUPPLY PANEL to obtain a reading of 0 db on the TEST PANEL meter.

(2) Operate the 12 & 28 KC lever switch in the TA-228 CARRIER SUPPLY PANEL to ON.

(3) Use the TS-760 TEST PANEL to measure the 12 kc output at the TR AMP OUT jack on the GROUP PANEL (par. 253, item 17). Adjust the 12 kc control on the TA-228 CARRIER SUPPLY PANEL to obtain a reading of 0 db on the TEST PANEL meter.

(4) Repeat the procedure in (3) above for the 28 kc test frequency (par. 253, item 18).

(5) Restore the 12 & 28 KC lever switch to its nonoperated position.

c. Transmitting Gain Adjustments.

(1) Operate the SEND-MEAS lever switches to SEND on CHAN 2 of the three TA-219 CHAN MODEM panels.

(2) Use the TS-760 TEST PANEL to measure the 37-kc output at the TR AMP OUT jack of the GROUP PANEL (par. 253, item 21).

Adjust the TR AMP GAIN control on the TA-227 SUBGROUP PANEL to obtain a reading of 0 db on the TEST PANEL meter.

(3) Measure the 83-kc output at the 60-108 KC OUT jack on the TA-227 SUBGROUP PANEL (par. 253, item 11). The reading on the TEST PANEL meter should be from -2 db to +2 db.

(4) Measure the 67-kc and 99-kc output at the 60-108 KC OUT jack (par. 253, items 10 and 12, respectively). The readings should be within ±1 db of the reading obtained in step (3) above.

(5) Restore the SEND-MEAS lever switches to their nonoperated positions.

92. Initial Adjustment of Carrier Receiving Circuits at AN/TCC-7 Terminal

a. Operate the CABLE REELS TO FIRST AN/TCC-11 (REC) switch on the GROUP PANEL as described in (1), (2), or (3) below.

(1) When the AN/TCC-7 terminal is at one end of a radio section, operate the switch to the position marked RADIO.

(2) When the AN/TCC-7 terminal is at one end of an attended repeater section, that contains at least one AN/TCC-11 repeater, operate the switch to the position showing the number of cable reels to the next AN/TCC-11 repeater point.

(3) When the AN/TCC-7 terminal is at one end of an attended repeater section which contains no AN/TCC-11 repeaters operate the switch to the 23 position.

b. Adjust the FLAT ADJ 68 KC control on the GROUP PANEL to the 0 (extreme counterclockwise) position.

c. Operate the ALARM CUTOFF lever switch to LOW or to the position required to silence the buzzer.

93. Initial Adjustment of AN/TCC-8 Repeater, General

a. A number of initial adjustments must be made at the AN/TCC-8 repeater prior to line-up of an attended repeater of radio section that contains an AN/TCC-8 repeater at one end. The initial adjustment procedure is described in paragraphs 94 through 96.

b. The adjustments must be made for the circuits that transmit into or receive from the section that is ready for line-up. The procedures outlined in paragraphs 94 through 96 are for an AN/TCC-8 repeater located at the *A* end of a section. To apply the procedures to an AN/TCC-8 repeater located at the *B* end of a section substitute *B* for *A*.

c. All lever switches on the front panels of all components of the AN/TCC-8 repeater must be left in the vertical position unless the instructions state otherwise.

94. Initial Adjustment of Power Supplies at AN/TCC-8 Repeater

a. PP-827 200-VOLT POWER SUPPLY. The PP-827 200-VOLT POWER SUPPLY is identical to the one used in the AN/TCC-7 terminal. The adjustment procedure for this power supply is described in paragraph 89.

b. PP-826 600-VOLT POWER SUPPLY.

Warning: Do not connect or turn on PP-826 600-VOLT POWER SUPPLY which supplies power to a repeater section under construction.

(1) There are two PP-286 600-VOLT POWER SUPPLY panels included in the AN/TCC-8 repeater (fig. 29). One supplies power to the cable and repeaters in the *AB* direction (toward the *B* end of the system). The other supplies power in the *BA* direction (toward the *A* end of the system).

(2) The preliminary adjustments of the PP-826 600-VOLT POWER SUPPLY panels should be made as described in the technical manual for Telephone Repeater AN/TCC-8.

(3) At the PP-826 600-VOLT POWER SUPPLY that feeds power toward the *B* end of the section, re-peat the procedure outlined in paragraph 89. Operate the REPEATER switch in accordance with the number of repeaters in the power loop fed by the particular power supply being adjusted. Measure the correct power supply voltage with the TS-761 TEST PANEL (par. 258, item 3).

(4) If the AN/TCC-8 repeater is connected to a radio section, or if there are no AN/TCC-11 repeaters before the next attended point, the PP-826 600-VOLT POWER SUPPLY should not be turned on. Operate the AC POWER switch to OFF. Disconnect the cable from the

PP-827 200-VOLT POWER SUPPLY to the PP-826 G00-VOLT POWER SUPPLY to avoid accidental turning on of power.

95. Initial Adjustment of Order Wire Circuit at AN/TCC-8 Repeater

The adjustments referred to in *a, b,* and *c* below make the order wire circuit available for communication to facilitate a system line-up.

a. When the AN/TCC-8 repeater is at one end of a radio section repeat the adjustments described in paragraph 80.

b. When the AN/TCC-8 repeater is at one end of an attended repeater section, repeat the adjustments described in paragraph 76.

c. Complete details describing the use of the order wire circuit are given in paragraph 133.

96. Initial Adjustment of Carrier-Frequency Circuit at AN/TCC-8 Repeater

The initial adjustments of the carrier frequency circuits in the AM-708 REPEATER PANEL of the AN/TCC-8 repeater are described in *a* through *f*, below.

a. Operate the CABLE REELS TO FIRST AN/TCC-11 TOWARD B TERM (BA IN) switch as described in (l), (2), or (3), below.

(1) When the AN/TCC-8 repeater is at the *A* end of a radio section, operate the switch to the position marked RADIO.

(2) When the AN/TCC-8 repeater is at the *A* end of an attended repeater section containing at least one AN/TCC-11 repeater, operate the switch to the position showing the number of cable reels to the next AN/TCC-11 repeater in the *AB* direction.

(3) When the AN/TCC-8 repeater is at the *A* end of an attended repeater section containing no AN/TCC-11 repeaters, operate the switch to the 23 position.

b. Operate the CABLE REELS TO FIRST AN/TCC-11 TOWARD B TERM (AB OUT) switch as described in (l) or (2), below.

(1) When the AN/TCC-8 repeater is at the *A* end of a radio section, operate the switch to the position marked RADIO.

(2) When the AN/TCC-8 repeater is at the *A* end of an attended repeater section, operate switch to the position showing the number of cable reels to the next AN/TCC-11 repeater, or attended point if there is no intervening AN/TCC-11 repeater.

c. When the AN/TCC-8 repeater is at the *B* end of an attended repeater section, perform the procedure in *a* (2), and (3), above, for the switch designated CABLE REELS TO FIRST AN/TCC-11 TOWARD A TERM (AB IN). Perform the procedures in *b* (2), above, for the switch designated CABLE REELS TO FIRST AN/TCC-11 TOWARD A TERM (BA OUT).

d. Operate the AB (and BA) FLAT ADJ 68 KC control to the 0 (extreme counterclockwise) position.

e. Operate the AB REGULATOR and BA REGULATOR lever switches to the MAN position.

f. Operate the AB (and BA) ALARM CUTOFF switch to the LOW position or to the position required to silence the alarm buzzer.

Section II. LINE-UP OF ATTENDED REPEATER SECTIONS

97. General

This section describes the procedure for lining up and testing an attended repeater section. This procedure should be carried out as soon as possible after completing the installation of an attended repeater section (pars. 68 through 76) and the initial tests at the attended points at both ends of the section (pars. 87-96). It is important that the section line-up and tests be performed at this time so that any troubles that may exist will become known and corrected while the remainder of the system installation is taking place.

98. Amended Repeater Section Line-Up, General

a. The line-up is accomplished by sending 68 kc from one end of the section, and making measurements and necessary gain adjustments at the other end (pars. 99-105).

b. The line-up procedure (par. 105) should be repeated at a time of day when the temperatures of the cable and the AN/TCC-11 repeaters are most likely to be the same. This will assure optimum system line-up with the operating range of the repeaters approximately centered with the cable characteristics.

c. It may be necessary to modify the GAIN AMP 1 (or 2) adjustments at some of the AN/TCC-11 repeaters to meet the gain requirements in the section (par. 105).

d. The line-up procedure described in paragraphs 99 through 105 is for the *AB* direction of transmission. Follow the same procedure for the line-up in the *BA* direction of transmission by substituting the references in the *BA* direction for those in the *AB* direction, as described in paragraph 103.

e. The adjustment of the order wire circuits described in paragraphs 90 and 95 provides signaling and talking facilities on the order wire circuit between the attended points at the two ends of the attended repeater section.

99. Transmitting Line-Up Adjustments at *A* End of Attended Repeater Section

The adjustments outlined in *a* and *b* below must be made on the transmitting circuits at the *A* end of the attended repeater section.

a. AN/TCC-7 Terminal Point. If the *A* end of the section is an AN/TCC-7 terminal, perform the transmitting adjustments required for the initial tests as described in paragraph 88.

b. AN/TCC-8 Repeater Point. If the *A* end of the section is an AN/TCC-8 repeater, the adjustments outlined in (1) through (4) below must be made.

(1) Arrange the TS-761 TEST PANEL to send 68 kc in the *AB* direction (par. 260, item 1).

(2) If cable has been connected to the A cable connector on the AM-708 REPEATER PANEL, turn off the PP-826 600-VOLT POWER SUPPLY which feeds this cable (operate the AC POWER switch to OFF) and remove the cable. This prevents the possibility of interference from a 68-kc voltage coming in from this cable. If the preceding attended repeater section (toward the *A* end of the system) has been completely installed, notify the attendant at the preceding attended point and obtain permission before taking this action.

(3) Use the TS-761 TEST PANEL to measure the 68-kc output at the AB AMP 1 OUT jack on the AM-708 REPEATER PANEL (par. 258, item 8). Adjust the SEND control to obtain a reading of 0 db on the TEST PANEL meter.

(4) Measure the 68-kc output at the AB AMP 2 OUT jack (par. 258, item 15). Operate the AB REGULATOR lever switch to the MAN position. Adjust the AB MAN REG OUTPUT control to obtain a reading of 0 db on the TEST PANEL meter.

100. Receiving Line-Up Adjustments at AN/TCC-7 Terminal at *B* End of Attended Repeater Section

The adjustments listed in *a* through *f* below must be made on the receiving circuits of the AN/TCC-7 terminal at the *B* end of the attended repeater section.

a. Use the TS-760 TEST PANEL to measure the 68-kc power at the REC IN jack on the GROUP PANEL (par. 253, item 24). The algebraic sum of the TEST PANEL meter reading and the numbers for the ATTENUATOR push buttons that are operated should be between 0 and +20 db. If the reading is outside of these limits, follow the procedure described in paragraph 105.

b. Measure the 68-kc output at the REC AMP 1 OUT jack (par. 253, item 28). Adjust the FLAT ADJ 68 KC control to obtain a reading of 0 db on the TEST PANEL meter.

c. Operate the REGULATOR lever switch to the MAN position.

d. Measure the 68-kc output at the REC AMP 2 OUT jack (par. 253, item 33). Adjust the MAN REG OUTPUT control to obtain a reading of 0 db on the TEST PANEL meter.

e. Adjust the transmission alarm limits as described in (1) through (7) below.

(1) Operate the ALARM CUTOFF lever switch to the NORMAL position.

(2) Adjust the ADJ HIGH and ADJ LOW controls on the chassis of the REG AND ALARM CKT plug-in unit (Z6) to their extreme counterclockwise positions.

(3) Operate the ALARM TEST lever switch in the REG AND ALARM CKT (Z6) to the 1 HIGH position.

(4) Adjust the ADJ HIGH control clockwise to the point where the alarm first operates. The alarm is indicated by the lighting of the HIGH ALARM lamp and sounding of the buzzer.

(5) Operate the ALARM TEST lever switch to the 2 LOW position.

(6) Adjust the ADJ LOW control clockwise to the point where the alarm first operates. The alarm is indicated by the lighting of the LOW ALARM lamp and sounding of the buzzer.

(7) Restore the ALARM TEST lever switch to its nonoperated position.

f. Notify the attendant at the *A* end of the attended repeater section by use of the order wire, that the line-up in the *AB* direction is completed.

101. Receiving Line-Up Adjustments at AN/TCC-8 Repeater at *B* End of Attended Repeater Section

The adjustments discussed in *a* through *e* below are made on the receiving circuits of an AN/TCC-8 repeater at the *B* end of the attended repeater section.

a. Use the TS-761 TEST PANEL to measure the 68-kc power at the AB IN jack on the AM-708 REPEATER PANEL (par. 258, item 4). The algebraic sum of the TEST PANEL meter reading and the numbers on the ATTENUATOR push buttons that are operated, should be between 0 and +20 db. If the reading is outside of these limits, follow the procedure described in paragraph 105.

b. Measure the 68-kc output at the AB AMP 1 OUT jack (par. 258, item 8). Adjust the AB FLAT ADJ 68 KC control to obtain a reading of 0 db on the TEST PANEL meter.

c. Measure the 68-kc output at the AB AMP 2 OUT jack (par. 258, item 15). Operate the AB REGULATOR lever switch to the MAN position. Adjust the AB MAN REG OUTPUT control (on the REPEATER PANEL chassis) to obtain a reading of 0 db on the TEST PANEL meter.

d. Adjust the transmission alarm limits as described in (1) through (7) below.

(1) Operate the AB ALARM CUTOFF lever switch to the NORMAL position.

(2) Adjust the ADJ HIGH and ADJ LOW controls on the chassis of the AB REG AND ALARM CKT plug-in unit (Z11) to their extreme counterclockwise positions.

(3) Adjust the ALARM TEST lever switch in the AB REG AND ALARM CKT (Z11) to the 1 HIGH position.

(4) Adjust the ADJ HIGH control clockwise to the point where the alarm first operates. The alarm is indicated by the lighting of the HIGH AB ALARM lamp and sounding of the buzzer.

(5) Operate the ALARM TEST lever switch to the 2 LOW position.

(6) Adjust the ADJ LOW control clockwise to the point where the alarm first operates. The alarm is indicated by the lighting of the LOW AB ALARM lamp and sounding of the buzzer.

(7) Restore the ALARM TEST lever switch to its nonoperated position.

e. Notify the attendant at the *A* end of the attended repeater section, by use of the order wire, that the line-up in the *AB* direction is completed.

102. Completion of Line-up of *A* End of Attended Repeater Section

If the *A* end of the attended repeater section is an AN/TCC-8 repeater, follow the steps outlined in *a* through *c* below.

a. Remove the 68 kc transmitted from the AN/TCC-8 repeater by operating the SEND FREQUENCY lever switch to FAULT TEST and the SEND DIRECTION lever switch to CHECK on the TS-761 TEST PANEL.

b. Restore the spiral-four cable (if it was removed) to the *A* cable connector on the AM-708 REPEATER PANEL.

c. Restore the AC POWER switch to the ON position on the PP-826 600 VOLT POWER SUPPLY which feeds power toward the *A* end of the system if the switch was on at the start of the line-up procedure.

103. Line-up of Attended Repeater Section in *BA* Direction, General

When the line-up of an attended repeater section is completed in the *AB* direction, the same procedure must be followed for the *BA* direction. Follow the instructions outlined in paragraphs 99 through 102 by substituting *A* for *B* and vice versa. In paragraph 101*d* adjustments for the *BA* direction are made on the BA REG AND ALARM CKT plug-in unit (Z12).

104. Check of Line-up of Amended Repeater Section

The line-up procedure should be repeated at a time of day when the temperatures of the cable and the AN/TCC-11 repeater are most likely to be -the same. An hour from 2100 to 2300 is recommended. Follow the procedure in *a*

through *d* below.

a. Repeat the procedure outlined in paragraphs 99 through 103. It should not be necessary to readjust the transmission alarm limits.

b. The measurement of 68-kc power, as described in paragraph 100*a* or 101*a*, should give a reading on the TEST PANEL meter between -6 and +6 db with the 10-db ATTENUATOR push button operated.

c. If the reading is within these limits in both directions of transmission, the line-up of the attended repeater sections is complete.

d. If the reading is outside of these limits in either direction of transmission, the procedure described in paragraph 105 must be followed.

105. Line-up of AN/TCC-11 Repeaters in an Attended Repeater Section

A check of the 68-kc power measurements at some of the AN/TCC-11 repeaters must be made when the limits outlined in paragraph 100*a*, 101*a*, or 104*b* are not met. These checks should be made at a time of day when the temperatures of the cable and AN/TCC-11 repeaters are most likely to be the same. Cloudy weather conditions with no appreciable wind are desirable. These checks may be made at less favorable times, if necessary, to avoid delay in the completion of the system. The line-up procedure for the AN/TCC-11 repeater is outlined in *a* through *f* below.

a. These instructions are for the case in which the limits are not met at the attended point at the *B* end of an attended repeater section (receiving from the *AB* direction). The procedure for the *A* end of the section may be obtained by substituting *B* for *A* in the instructions.

b. Send a repairman, equipped with a TS-712 test set and an EE-8 telephone, to the AN/TCC-11 repeater nearest a point halfway between the two ends of the attended repeater section (toward the *B* end, if there is a choice). The repairman must contact the attendant at the attended points at both ends of the section by calling on the order wire as described in paragraph 134.

c. At the *A* end of the attended repeater section, the procedure described in paragraph 99 should be followed.

d. At the AN/TCC-11 repeater, proceed as described in (1) through (7) below.

(1) Identify the amplifier in the AN/TCC-11 repeater which is transmitting in the *AB* direction according to the procedure described in paragraph 159.

(2) Use the TS-712 test set to measure the AMP IN 68 KC power for the amplifier under check (par. 263, item 9 or 13).

(3) If the reading is less than -7 db, the circuit is in trouble; follow the procedure in paragraph 172.

(4) Measure the OUT 68 KC power for the amplifier under check (par. 263, item 10 or 14). The reading should be between -5 db and +5 db.

(5) If the reading is less than -2.5 db, remove the test cover over the GAIN AMP switch corresponding to the amplifier under check (fig. 42 or 43) and operate the switch to the HIGH position; the amplifier output should increase approximately 2.5 db.

(6) If the reading is more than +2.5 db, operate the GAIN AMP switch to the LOW position; the amplifier output should increase approximately 2.5 db.

(7) This completes the check at this point. Remove the TS-712 test set and replace all test covers on the AN/TCC-11 repeater.

e. The repairman at the AN/TCC-11 repeater should proceed to the next AN/TCC-11 repeater in the *AB* direction and repeat the procedure outlined in *d*(l) through (7), above. Progress in this manner to the *B* end of the attended repeater section, checking all AN/TCC-11 repeaters along the route.

f. At the *B* end of the section, follow the procedures outlined in paragraph 100 or 101.

106. Tests of Attended Repeater Section, General

When the line-up of an attended repeater section has been completed, tests must be conducted to check its performance. The fault location circuits used to locate a faulty AN/TCC-11 repeater section should be checked as described in paragraph 107 or 108.

107. Tests of Fault-Location Circuits at AN/TCC-7 Terminal

Checks of the fault-location circuits used to locate a faulty AN/TCC-11 repeater section from an AN/TCC-7 terminal, are described in *a* through *d* below.

a. Arrange the TS-760 TEST PANEL to send

99 kc (par. 255, item 5). (Operate the FAULT TEST REP 1 push button.) Adjust the output to read 0 db at the TR AMP OUT jack on the GROUP PANEL (par. 253, item 22).

b. Measure the signal at the REC IN jack on the GROUP PANEL (par. 253, item 27). The TEST PANEL meter should read between 0 db and off scale high. This test checks the transmission out to the first AN/TCC-11 repeater and back (in the loop that is supplied power by the AN/TCC-7 terminal).

c. If there is a second AN/TCC-11 repeater in the power loop, arrange the TS-760 TEST PANEL to send 91 kc (par. 255, item 6). (Release the FAULT TEST REP 1 push button and operate the FAULT TEST REP 2 push button.) Measure the signal at the REC IN jack on the GROUP PANEL. The TEST PANEL meter should read between 0 db and off scale high. This test checks the transmission out to the second AN/TCC-11 repeater and back.

d. If there is a third AN/TCC-11 repeater in the power loop, arrange the TS-760 TEST PANEL to send 83 kc (par. 255, item 7). (Release the FAULT TEST REP 2 push button and operate the FAULT TEST REP 3 push button.) Measure the signal at the REC IN jack. The TEST PANEL meter should read between 0 db and off scale high. This test checks the transmission out to the third AN/TCC-11 repeater and back.

108. Test of Fault-Location Circuits at AN/TCC-8 Repeater

The procedure outlined in *a* through *d* below must be used to check the AN/TCC-11 repeater fault-location circuits from an AN/TCC-8 repeater point. The tests described are for an AN/TCC-8 repeater at an *A* end of an attended repeater section (transmitting into the section in the *AB* direction). If the AN/TCC-8 repeater is at the *B* end of a section, substitute *BA* for *AB* and vice versa in the instructions.

a. Ascertain that the AB REGULATOR lever switch is adjusted to the MAN position. Ascertain that the AB MAN REG OUTPUT control is adjusted as described in paragraph 99*b*(4). Arrange the TS-761 TEST PANEL to send 99 kc in the AB direction (par. 260, item 5). (Operate the FAULT TEST REP 1 push button.) Adjust the output to read 0 db at the AB AMP 2 OUT jack on the AM-708 REPEATER PANEL (par. 258, item 16).

b. Measure the signal at the BA IN jack on the AM-708 REPEATER PANEL. The TEST PANEL meter should read between 0 db and off scale high. This test checks the transmission out to the first AN/TCC-11 repeater in the *AB* direction and back (in the loop supplied power by the AN/TCC-8 repeater in the *AB* direction).

c. If there is a second AN/TCC-11 repeater in the power loop, arrange the TS-761 TEST PANEL to send 91 kc in the *AB* direction (par. 260, item 7). (Release the FAULT TEST REP 1 push button and operate the FAULT TEST REP 2 push button.) Measure the signal at the BA IN jack. The TEST PANEL, meter should read between 0 db and off scale high. This test checks the transmission out to the second AN/TCC-11 repeater and back.

d. If there is a third AN/TCC-11 repeater in the power loop, arrange the TS-761 TEST PANEL to send 83 kc in the *AB* direction (par. 260, item 9). (Release the FAULT TEST REP 2 push button and operate the FAULT TEST REP 3 push button.) Measure the signal at the BA IN jack. The TEST PANEL meter should read between 0 db and off scale high. This test checks the transmission out to the third AN/TCC-11 repeater and back.

Section III. LINE-UP OF RADIO SECTION

109. General

This section describes the procedure for lining up and testing a radio section. This procedure should be carried out as soon as possible after completing the installation of the radio section (pars. 78-82) and the initial adjustments at the attended points at both ends of the section (pars. 87-96). It is important that the radio section line-up and tests be performed at this time so that any troubles that may exist will become known and corrected while the remainder of the system installation is taking place.

110. Line-up of Radio Section, General

a. The line-up is accomplished by sending 68 kc from one end of the section, measuring it, and making the necessary gain adjustments at the radio transmitters and at the AN/TCC-7 or AN/TCC-9 point at the other end of the section.

b. The line-up of the individual radio links

within the radio section must be completed before the section line-up is undertaken.

c. The line-up and tests are described for the *AB* direction of transmission; the procedure must be repeated for the *BA* direction of transmission by substituting the procedures for those in the *AB* direction, as described in paragraph 112.

d. The adjustment of the order wire circuits, described in paragraph 90 or 95, should provide signaling and talking facilities on the order wire circuit between the attended points at the two ends of the radio section and the radio stations within the section.

111. Line-up Procedure for Radio Section

a. Adjustments at Sending End. The adjustments at the AN/TCC-7 or AN/TCC-8 point at the sending end of the radio section are the same as described in paragraph 99.

b. Adjustments at Radio Transmitters. The following instructions apply to the AN/TRC-24 radio in particular (see the technical manual for Radio Set AN/TRC-24), but similar procedures should be followed for other radio equipments.

(1) At the radio transmitter nearest the A end of the radio section, use the built-in test circuits to measure the 68-kc power at the broad-band amplifier input.

(2) Adjust the loss at the input to the radio transmitter to obtain a meter reading of 0 db at the broad-band amplifier input.

(3) Repeat the steps outlined in (1) and (2) above at successive radio transmitters in the *AB* direction.

c. Adjustments at Receiving End. The adjustments at the AN/TCC-7 or AN/TCC-8 point at the receiving end of the section are the same as described in paragraph 100 or 101 with the following exception: When the 10-db ATTENUATOR push button is operated, the TEST PANEL meter should read between -6 db and +6 db.

112. Completion of Line-up of Radio Section

a. When the line-up in the *AB* direction is completed, follow the procedure outlined in paragraph 102.

b. When the line-up of the radio section in the *AB* direction is completed the same procedure should be followed for the *BA* direction. The instructions outlined in paragraph 111 above, may be followed by substituting *A* for *B* and vice versa.

Section IV. SYSTEM LINE-UP

113. General

a. This section describes the overall line-up procedure for the system. All attended repeater sections and radio sections must be lined up and tested as described in paragraphs 97 through 112 before starting the overall line-up.

b. The overall line-up of both the order wire and carrier circuits starts at one end of the system (AN/TCC-7 terminal) and proceeds in one direction through successive AN/TCC-8 repeaters to the other end of the system. The procedure then must be repeated in the other direction.

c. The entire line-up procedure should be under the supervision of the designated control point.

d. Note the outside temperature at each attended point at the time of the line-up.

114. System Line-up of Order Wire Circuit, General

a. The order wire circuit is required as a means of communication during the line-up of the carrier circuits. Therefore, it is important to complete the overall line-up of the order wire circuit before attempting line-up of the carrier circuits.

b. The initial tests and adjustments described in paragraph 90 should be completed so that the order wire circuit is in suitable condition to be used for communication between attended points. However, in the course of the overall line-up, these adjustments will be modified to obtain optimum order wire transmission.

c. To line up the order wire circuit, send a test tone from the AN/TCC-7 terminal at one end of the system. Progressively adjust the receiving and transmitting gains at successive AN/TCC-8 repeaters located in the direction toward the AN/TCC-7 terminal at the other end of the system. The line-up must proceed in a definite sequence. No step can be undertaken until the preceding step has been completed. When the line-up in one direction is completed, the other direction is lined up in similar manner. The line-up cannot be undertaken in both directions

at the same time because of the need to use the circuit for communication.

d. The line-up of the order wire circuit is covered in paragraphs 115 through 119.

e. The use of the order wire circuit is described in detail in paragraph 131.

115. Transmitting Adjustments at AN/TCC-7 Terminal for System Line-up of Order Wire Circuit

a. Readjust the CABLE REELS TO NEXT AN/TCC-7 OR AN/TCC-8 switch on the RT-280 ORDER WIRE PANEL as described in (1) through (4) below.

(1) Determine the average daily outside temperature at the AN/TCC-7 terminal location.

(2) If the CABLE REELS TO NEXT AN/TCC-7 OR AN/TCC-8 switch is set to positions 104-126, 127-149, or 150-160, operate the switch one step clockwise for each 20° F. increase in the average daily temperature at that location relative to 45° F., or one step counterclockwise for each 20° F. decrease.

(3) If the switch is set to positions 58-80 or 81-103, operate it one step clockwise for each 50° F. increase in ambient temperature or one step counterclockwise for each 50° F. decrease.

(4) If the switch is set to positions 0-11, 12-34, 35-57, or RADIO, no adjustment is necessary.

b. Perform the order wire adjustments referred to in paragraph 90 to complete the transmitting adjustments at the AN/TCC-7 terminal. It is assumed that the AB direction of transmission will be lined up first.

c. Establish communication on the order wire to the next AN/TCC-8 repeater and alert the attendant there to continue the line-up.

d. Operate the SEND OW lever switch on the RT-280 ORDER WIRE PANEL to the ON position. This sends a 1-kc test tone over the line to permit gain adjustment at the succeeding AN/TCC-8 repeater.

e. To answer an incoming call (indicated by simultaneous lighting of the CALL lamp and sounding of the buzzer) restore the SEND OW lever switch to the nonoperated position and operate the ORDER WIRE lever switch to the TALK position.

116. Receiving Adjustments at AN/TCC-8 Repeater for System Line-up of Order Wire Circuit

a. Start the line-up at the first AN/TCC-8 repeater as soon as advised to do so by the attendant at the transmitting AN/TCC-7 terminal.

b. Make the adjustments by using the 1-kc test tone transmitted from the AN/TCC-7 terminal (which should be audible in the telephone receiver at the AN/TCC-8 repeater). There is no source of 1-kc test tone in the AN/TCC-8 repeater.

c. Arrange the TS-761 TEST PANEL to measure the 1-kc output at the AB REC AMP OUT jack on the RT-281 ORDER WIRE PANEL (par. 258, item 33). Adjust the AB REC GAIN control to obtain a reading of 0 db on the TEST PANEL meter.

117. Transmitting Adjustments at AN/TCC-8 Repeater for System Line-up of Order Wire Circuit

a. Readjust the AB CABLE REELS TO NEXT AN/TCC-7 OR AN/TCC-8 switch on the RT-281 ORDER WIRE PANEL, as described in (1) through (4) below.

(l) Determine the average daily outside temperature at the AN/TCC-8 repeater.

(2) If the CABLE REELS TO NEXT AN/TCC-7 OR AN/TCC-8 switch is set to positions 104-126, 127-149, or 150-160, operate the switch one step clockwise for each 20° F. increase in the average daily temperature at that location relative to 45° F., or one step counterclockwise for each 20° F. decrease.

(3) If the switch is set to positions 58-80 or 81-103, operate it one step clockwise for each 50° F. increase in ambient temperature or one step counterclockwise for each 50° F. decrease.

(4) If the switch is set to positions 0-11, 12-34, 35-57, or RADIO, no adjustment is necessary.

b. The remaining procedure outlined in paragraph 115 *b* through *e* must be repeated; use the test tone received from the transmitting AN/TCC-7 point instead of operating the local RING lever switch.

c. The line-up of the order wire circuit at the AN/TCC-8 repeater in the *AB* direction then is complete.

The attendant must inform the attendant at the transmitting AN/TCC-7 terminal (signal by operating the RING lever switch to the ON position) that the line-up is complete at that point.

d. The attendant at the AN/TCC-7 terminal must then establish communication with the next AN/TCC-8 repeater and alert the attendant there to continue the line-up.

e. The attendant at the transmitting AN/TCC-7 terminal must again operate the SEND OW lever switch to ON to resume transmission of the 1-kc test tone.

118. Check at Radio Transmitters for System Line-up of Order Wire Circuit

When an AN/TCC-7 or an AN/TCC-8 point is at the *A* end of a radio section the 1-kc test tone must be measured at the radio transmitter as described in *a* and *b* below.

a. Measure the 1-kc power at the input to the radio transmitter adjacent to the *A* end of the section. The power should be between +7 and +12 dbm. If this limit is not met, check the order wire adjustments at the *A* attended point and the cable connection to the radio transmitter.

b. Repeat the procedure outlines in *a* above at successive radio transmitters (if any) sending in the *AB* direction.

119. Receiving Adjustments at Distant AN/TCC-7 Terminal for System Line-up of Order Wire Circuit

When the line-up has progressed to the distant AN/TCC-7 terminal, perform the procedure outlined in *a* through *d* below.

a. Arrange the TS-760 TEST PANEL to measure the 1-kc output at the REC AMP OUT jack on the RT-280 ORDER WIRE PANEL (par. 253, item 39). Adjust the REC GAIN control to obtain a reading of 0 db on the TEST PANEL meter.

b. This completes the line-up in the *AB* direction.

c. The attendant at the transmitting AN/TCC-7 terminal should restore the SEND OW lever switch to the nonoperated position.

d. When the line-up has been completed in one direction, the entire procedure outline in paragraphs 115 through 119*c* above should be followed for the *BA* direction of transmission. When the procedure has been completed for both directions, the order wire line-up is complete.

120. Check of Line-up of Order Wire Circuit, General

When the order wire line-up has been completed, the circuit should be tested as described in *a* through *c* below.

a. The attendant at the control point should signal over the circuit to attendants at all points.

b. Talking test should be conducted so that an attendant at any point can talk to attendants at all other points with satisfactory intelligibility and volume of speech.

c. Signaling tests should be conducted so that an attendant at any point can signal to all other attended points.

121. Carrier System Line-up, General

a. The carrier system line-up procedure includes adjustments of gain and equalization of the carrier amplifiers throughout the system and adjustments of gain for the 12 message channels which the system may transmit.

b. The line-up should be conducted when the temperature along the cable is fairly constant for a period of time. The hours from 2100 to 2300 are preferable. However, the period from 1900 to 0500 is generally satisfactory. Cloudy weather conditions with no appreciable wind are ideal for the line-up.

c. The carrier frequency adjustments are made by sending 12-kc and 28-kc test frequencies and 68-kc pilot frequency from the AN/TCC-7 terminal at one end of the system. Progressively make adjustments of gain and equalization at successive AN/TCC-8 repeaters and at the receiving AN/TCC-7 terminal. The line up must proceed in a definite order; the adjustments cannot be made at any point until the line-up is completed through the preceding point.

d. The message channels are adjusted by sending a 1-kc test tone from the transmitting end of the system and adjusting the channel gain at the receiving end of the system. These adjustments cannot be made until the carrier system line-up has been completed through the receiving AN/TCC-7 terminal.

e. When the line-up is completed in one direction of transmission, the entire procedure is repeated for the other direction.

f. The carrier system line-up and test procedure is described in paragraphs 122 through 125.

122. Carrier System Line-up, Transmitting Adjustment at AN/TCC-7 Terminals, *AB* Direction

a. The adjustments described in paragraph 91 complete the transmitting adjustments. The line-up procedure is described for the *AB* direction of transmission.

b. At the AN/TCC-7 terminal at the *A* end of the system, operate the 12 & 28 KC lever switch in the TA-228 CARRIER SUPPLY PANEL, to the ON position. This operation sends 12-kc and 28-kc test frequencies over the line in addition to the 68-kc pilot which is always present. This lever switch should be left at the ON position throughout the entire line-up in the *AB* direction.

c. Call the attendant at the first AN/TCC-8 repeater (by using the order wire circuit) and instruct the attendant to continue the carrier system line-up.

123. Carrier System Line-up Adjustments at AN/TCC-8 Repeater, *AB* Direction

a. The line-up at the first AN/TCC-8 repeater should start as soon as advised by the attendant at the transmitting AN/TCC-7 terminal.

b. Measure the 68-kc pilot at the AB IN jack on the AM-708 REPEATER PANEL (par. 258, item 4). Operate the 10-db ATTENUATOR push button. The TS-761 TEST PANEL meter should read from -6 db to +6 db. If the reading is outside of these limits, follow the procedure outlined in paragraph 105.

c. Measure the 68-kc pilot at the AB AMP 1 OUT jack on the AM-708 REPEATER PANEL (par. 258, item 8). Adjust the AB FLAT ADJ 68 KC control to obtain a reading of 0 db on the TEST PANEL meter.

d. Measure the 68-kc output at the AB AMP 2 OUT jack (par. 258, item 15). The reading should be between -.5 db and +.5 db.

e. Adjust the AB AUTO REG OUTPUT control to a position approximately 90° from its extreme counter-clockwise position.

f. Operate the AB REGULATOR lever switch (on the REPEATER PANEL chassis) to AUTO. Measure the 68-kc output at the AB AMP 2 out jack (par. 258, item 15). Allow about 2 minutes for the output to stabilize. Adjust the AB AUTO REG OUTPUT control to obtain a reading of 0 db on the TEST PANEL meter. (The meter response is sluggish; be sure that the output has stabilized at the desired value.)

g. Measure the 12-kc pilot at the AB AMP 2 OUT jack (par. 258, item 12). Adjust the AB SLOPE ADJ 12 KC switch to obtain a reading between -.8 db and +.8 db on the TEST PANEL meter.

h. Measure the 28-kc pilot at the AB AMP 2 OUT jack (par. 258, item 13). Adjust the AB BULGE ADJ 28 KC switch to obtain a reading between -.4 db and +.4 db on the TEST PANEL meter.

i. This completes the line-up at the AN/TCC-8 repeater in the *AB* direction. Inform the attendant at the transmitting AN/TCC-7 terminal. that the line-up has been completed.

j. The attendant at the transmitting AN/TCC-7 terminal should then call the next AN/TCC-8 repeater and instruct the attendant there to continue the line-up.

124. Carrier System Line-up Receiving Adjustments at Distant AN/TCC-7 Terminal, *AB* Direction

When the line-up has progressed to the distant AN/TCC-7 terminal, follow the procedures in *a* through *c* below.

a. Group Panel Adjustments. Make adjustments on the GROUP PANEL as described in (1) through (8) below.

(1) Measure the 68-kc pilot at the REC IN jack on the GROUP PANEL (par. 253, item 24). Operate the 10-db ATTENUATOR push button. The TS-760 TEST PANEL meter should read from -6 db to +6 db. If the reading is outside of these limits, follow the procedure outlined in paragraph 105.

(2) Measure the 68-kc pilot at the REC AMP 1 OUT jack (par. 253, item 28). Adjust the FLAT ADJ 68 KC control to obtain a reading of 0 db on the TEST PANEL meter.

(3) Measure the 68-kc output at the REC AMP 2 OUT jack (par. 253, item 33). The reading on the TEST PANEL meter should be between -.5 db and +.5 db.

(4) Adjust the AUTO REG OUTPUT control to a position approximately 90° from its extreme counterclockwise position.

(5) Operate the REGULATOR lever switch (on the GROUP PANEL chassis) to the AUTO position. Measure the 68-kc

output at the REC AMP 2 OUT (par. 253, item 33). Allow about 2 minutes for the output to stabilize. Adjust the AUTO REG OUTPUT control to obtain a reading of 0 db on the TEST PANEL meter. (The meter response is sluggish; be sure that the output has stabilized at the desired value.)

(6) Measure the 12-kc pilot at the REC AMP 2 OUT jack (par. 253, item 31). Adjust the SLOPE ADJ 12 KC switch to obtain a reading between -.8 db and +.8 db on the TEST PANEL meter.

(7) Measure the 28-kc pilot at the REC AMP 2 OUT jack (par. 253, item 32). Adjust the BULGE ADJ 28 KC switch to obtain a reading between -.4 db and +.4 db on the TEST PANEL meter.

(8) When this adjustment is completed, inform the attendant at the transmitting AN/TCC-7 terminal.

b. Demodulator Gain Adjustments. Make demodulator gain adjustments as described in (1) through (8) below.

(1) Call the attendant at the transmitting AN/TCC-7 terminal and instruct the attendant to restore the 12 & 28 KC lever switch on the TA-228 CARRIER SUPPLY PANEL to its nonoperated position.

(2) At the transmitting AN/TCC-7 terminal, operate the SEND-MEAS lever switch of channel 2 of the TA-219 CHAN MODEM, No. 2 panel, to the SEND position.

(3) At the receiving AN/TCC-7 terminal, measure the 83-kc output at the DEM OUT jack on the GROUP PANEL (par. 253, item 15). Adjust the DEM GAIN control to obtain a reading of 0 db on the TS-760 TEST PANEL meter.

(4) At the transmitting AN/TCC-7 terminal, operate the SEND-MEAS lever switches of channel 2 of all three TA-219 CHAN MODEM panels to the SEND position.

(5) Measure the 11-kc output at the DEM 1 OUT jack on the TA-227 SUBGROUP PANEL (par. 253, item 7). Adjust the DEM 1 GAIN control to obtain a reading of 0 db on the TS-760 TEST PANEL meter.

(6) Measure the 11-kc output at the DEM 2 OUT jack on the TA-227 SUBGROUP PANEL (par. 253, item 8). Adjust the DEM 2 GAIN control to obtain a reading of 0 db on the TEST PANEL meter.

(7) Measure the 11-kc output at the DEM 3 OUT jack on the TA-227 SUBGROUP PANEL (par. 253, item 9). Adjust the DEM 3 GAIN control to obtain a reading of 0 db on the TEST PANEL meter.

(8) At the transmitting AN/TCC-7 terminal, operate all SEND-MEAS lever switches on the TA-219 CHAN MODEM panels to their nonoperated positions.

c. Channel Gain Adjustments. Make receiving channel gain adjustments as described in (1) through (7) below.

(1) Arrange the TS-760 TEST PANEL to measure the 1-kc signal at the CHANNEL OUT jack on the TEST PANEL (par. 253, item 3).

(2) At the transmitting AN/TCC-7 terminal, operate the SEND-MEAS lever switch on channel 1 on the TA-219 CHAN MODEM No. 1 panel to the SEND position.

(3) At the receiving AN/TCC-7 terminal, operate the SEND-MEAS lever switch of channel 1 on the TA-219 CHAN MODEM No. 1 panel to the MEAS position.

(4) At the receiving AN/TCC-7 terminal, adjust the GAIN control of channel 1 on the TA-219 CHAN MODEM No. 1 panel to obtain a reading of 0 db on the TEST PANEL meter.

(5) Restore the SEND-MEAS lever switches to their nonoperated positions.

(6) Repeat the steps outlined in (2) through (5) above for each of the 12 channels in turn.

(7) This completes the carrier system line-up in the *AB* direction.

125. Carrier System Line-up in *BA* Direction

a. When the line-up has been completed in one direction, follow the entire procedure outlined in paragraphs 122 through 124 for the other direction of transmission.

b. At the completion of this procedure, operate the CARR SYNC lever switch on the TA-228 CARRIER SUPPLY PANEL at the two AN/TCC-7 terminals of the system as discussed in (1) or (2) below.

(1) If this AN/TCC-7 terminal is the control terminal (as defined in paragraph 43), operate the switch to the LOCAL position.

(2) If this AN/TCC-7 terminal is not the control terminal, set the switch to REMOTE.

c. The carrier system line-up then is completed.

126. System Tests, General

The tests described in paragraphs 127 and 128 must be performed when the system line-up has been completed. At the completion of these tests the system will be in satisfactory working condition and is available for service.

127. System Test of Message Channels

Talking and listening tests should be performed on all message channels to check, their transmission qualities. Follow the procedure described in *a* through *f* below.

a. The control point attendant should call the attendant at the distant AN/TCC-7 terminal on the order wire circuit.

b. At each AN/TCC-7 terminal, operate the TALK-MON lever switch of channel 1 of the TA-219 CHAN MODEM No. 1 panel to the TALK position.

c. At each AN/TCC-7 terminal, operate the ORDER WIRE lever switch on the RT-280 ORDER WIRE PANEL to its nonoperated position and the CHANNEL TALK lever switch to the LINE position.

d. Use the telephone handset provided at the AN/TCC-7 terminal to talk over the system. Check to see that the volume and intelligibility of speech are satisfactory. Listen to the circuit with no speech present and check to see that the noise is not excessive.

e. Restore the TALK-MON lever switches to the nonoperated positions.

f. Repeat the steps outlined in *b* through *e* above for each of the 12 channels.

128. System Modulation Measurements

A modulation test must be performed on the system as described in *a* through *d* below.

a. At the AN/TCC-7 terminal at one end of the system, arrange the TS-760 TEST PANEL to send 65 kc (par. 255, item 3). Measure the 65-kc output at the TR AMP OUT jack on the GROUP PANEL (par. 253, item 20) and adjust the output to obtain a reading of 0 db on the TEST PANEL meter.

b. At the AN/TCC-7 terminal at the other end of the system, measure the 62-kc output at the REC 62 KC jack on the GROUP PANEL (par. 253, item 36). The algebraic sum of the TEST PANEL meter reading and the numbers on the ATTENUATOR push buttons that are operated, should not exceed the limits given in the chart below.

Make-up of system	Limit
All cable	20 db
Cable and one AN/TRC-24 radio link	22 db
Cable and two AN/TRC-24 radio links.....	24 db
Cable and three AN/TRC-24 radio links.....	25.5 db

Note. For each additional radio link in excess of three, the limit increases 1 db.

c. If limits shown in *b* above are not met, follow the procedure outlined in paragraphs 186 through 192. When the modulation measurement is completed, remove the 65-kc signal at the transmitting AN/TCC-7 point (par. 255, item 3).

d. Repeat the procedure outlined in *a* and *b* above for the other direction of transmission.

129. System Adjustment of Message Channels and Special Service Channels Between Extension Equipment and AN/TCC-7 Terminal

When the system line-up is completed, the system is properly adjusted to transmit message

channel service or special service. The overall line-up for each type of service requires that the circuits beyond the AN/TCC-7 system be arranged to provide the proper impedance and levels to the AN/TCC-7 terminals.

a. Message Channels. The proper impedance and levels for the message channel connection are given in the chart below.

	Levels		Impedance
	Transmit to AN/TCC-7 terminal	Receive from AN/TCC-7 terminal	
Two-wire operation	0 db	-3 db	600 ohms
Four-wire operation	-4 db	+1 db	600 ohms

b. Special Service Channels. The proper impedances and levels for the message channel connections are given in the chart below.

Frequency band	Levels		Impedance
	Transmit to AN/TCC-7 terminal	Receive from AN/TCC-7 terminal	
4 to 20 kc	0 db	0 db	600 ohms
60 to 108 kc	0 db	-5 db	135 ohms
12 to 60 kc	0 db	-2 db	135 ohms

Note. The maximum power transmitted to the AN/TCC-7 terminal should not exceed +9 dbm for a 4- to 20-kc special service band, or +14 dbm for either a 60- to 108-kc, or 12- to 60-kc band.

CHAPTER 4

ROUTINE OPERATION

Section I. NORMAL OPERATION

130. General

This section describes the normal operation of the system. The operation of the order wire circuits, message channels, and special service transmission are included.

131. Order Wire Circuit, General Description

a. Use. When the installation and line-up of the system has been completed, an order wire circuit is available for maintenance and trouble location purposes. This circuit provides complete facilities for communication between any two attended repeater points in the system and from any unattended repeater point to the attended point from which it normally receives power.

b. Independent Operation of Order Wire Circuit. To a large degree, the order wire circuit is independent of the message channels. The circuit is bypassed around the carrier amplifiers and generally will remain in working condition despite many trouble conditions which block transmission of the message channels. For example, a failure in a carrier repeater, or a failure in a PP-826 600-VOLT POWER SUPPLY will probably not affect the order wire circuit. The operation of the order wire circuit is described in paragraphs 132 through 135.

132. Operation of Order Wire Circuit at AN/TCC-7 Terminal

To use the order wire circuit at an AN/TCC-7 terminal, proceed as described in *a* through *h* below.

a. Check to see that the SEND OW lever switch on the RT-280 ORDER WIRE PANEL is in the nonoperated position.

b. The REC GAIN and the TR GAIN controls and the CABLE REELS TO NEXT AN/TCC-7 OR AN/TCC-8 switch are adjusted during the system line-up and should not be disturbed.

c. Ascertain that the order wire circuit is not in use before signaling over the circuit. Signaling on the order wire circuit will cause a loud audible tone (1,600 cps) to be heard by any attendant listening on the circuit. Operate the ORDER WIRE lever switch to TALK and listen to the receiver of the telephone handset which normally hangs from the GROUP PANEL and is connected to the RT-280 ORDER WIRE PANEL. If the circuit is not in use, signal as described in *d* below. If the circuit is in use, wait until it is free, or if the call is urgent, ask permission to use the circuit.

d. To signal on the circuit, operate the ORDER WIRE lever switch to RING. This will cause the CALL lamps to light and the buzzers in the ORDER WIRE panels to sound at both AN/TCC-7 terminals and all AN/TCC-8 repeater points. It also will give an indication at each radio station in the system.

e. When the signaling is completed, operate the ORDER WIRE lever switch to the TALK position. The telephone handset now may be used to talk to attendants at the other attended points in the system.

f. When the call is completed, operate the ORDER WIRE lever switch to the nonoperated position. The circuit is then arranged to receive calls.

g. An incoming call is indicated by the simultaneous lighting of the CALL lamp and the sounding of the buzzer in the RT-280 ORDER WIRE PANEL. To answer a call, pick up the telephone handset and operate the ORDER WIRE lever switch to the TALK position. When the call is complete operate the ORDER WIRE lever switch to the nonoperated position.

h. When the order wire circuits are used before the final line-up (par. 114) the circuit may *sing* because of improper adjustment of the controls.

This condition is made evident by a continuous tone in the telephone receiver. If this occurs turn the REC GAIN control counterclockwise until the tone ceases. If a *singing* tone is heard after the final line-up has been completed, the line-up procedure should be repeated.

133. Operation of Order Wire Circuit at AN/TCC-8 Repeater

To use the order wire circuit from an AN/TCC-8 point, proceed as described in *a* through *f* below.

a. The AB and BA REC GAIN and the TR GAIN controls and the AB and BA CABLE REELS TO NEXT AN/TCC-7 OR AN/TCC-8 switches on the RT-281 ORDER WIRE PANEL, are adjusted during the system line-up and should not be disturbed.

b. Listen to the receiver of the telephone handset which is connected to the RT-281 ORDER WIRE PANEL to ascertain that the order wire circuit is not in use before signaling.

c. To signal on the circuit, operate the RING lever switch to ON. This will cause the CALL lamps to light and the buzzers in the ORDER WIRE PANELS to sound at both AN/TCC-7 terminals and all AN/TCC-8 repeaters. It also will give an indication at all radio stations in the system.

d. When the signaling is completed and the RING lever switch is released, the telephone handset may be used to talk to attendants at other attended points in the system.

e. An incoming call is indicated by simultaneous lighting of the CALL lamp and sounding of the buzzer in the RT-281 ORDER WIRE PANEL. To answer the call, use the telephone handset.

f. When the order wire circuits are used before the final line-up (par. 114) the circuit may *sing* because of improper adjustment of the controls. This condition is made evident by a continuous tone in the telephone receiver. If this occurs, turn the AB REC GAIN (or BA, as required) control counterclockwise until the tone ceases. If a *singing* tone is heard after the final line-up has been completed, the line-up procedure should be repeated.

134. Operation of Order Wire Circuit at AN/TCC-11 Repeater

To call on the order wire circuit from an AN/TCC-11 repeater, an EE-8 telephone and a TS-712 test set are required. The procedure is as follows:

a. Remove the TEST cover from the J3 connector at the J2 end of the AN/TCC-11 repeater (fig 43.)

b. Connect the TS-712 TEST set to the repeater by engaging connector P1 on the test set cable with the J3 connector on the repeater.

c. Connect the L1 and L2 terminals of the EE-8 telephone to the L1 and L2 (TEL) binding posts of the TS-712 test set.

d. Operate the ORDER WIRE lever switch to the TALK position. The EE-8 telephone then may be used for talking and listening.

e. If the position of the AN/TCC-11 repeater in the power loop (par. 48) is known, the OW GAIN switch on the TS-712 test set should be set as described in (1) through (3) below.

(1) If the repeater is at the far end of the power loop (the most distant one from the attended point from which power is received) set the OW GAIN switch) to the HIGH position.

(2) If the repeater is one repeater removed from the far end of the power loop, set the OW GAIN switch to the MED position.

(3) If the repeater is two repeaters removed from the far end of the power loop, set the OW GAIN switch to the LOW position.

f. If the position of the AN/TCC-11 repeater in the power loop is not known, start with the OW GAIN switch at the LOW position. If unable to contact an attended point, or if communication has been established but the speech signals appear to be weak, operate the OW GAIN switch to the MED and the HIGH position, successively, until a position is found which gives satisfactory communication. Under some conditions, the circuit may *sing* if an incorrect position of the OW GAIN switch is used. The *singing* will be heard as a continuous tone in the telephone receiver when the ORDER WIRE lever switch is operated to the TALK position. If this occurs, set the OW GAIN switch to the next position counterclockwise.

g. Make sure that the circuit is not in use, by listening to the receiver of the EE-8 telephone, before signaling on the order wire. If the circuit is in use, interrupt the conversation at a convenient time and either ask permission to signal, or request an attendant to signal to the desired point.

h. To signal on the circuit, proceed as outlined in (1) through (3) below.

(1) Operate the ORDER WIRE level switch to the RING position.

(2) Operate the ringing handle on the EE-8 tele-phone rapidly for several seconds.

(3) Restore the ORDER WIRE lever switch to the TALK position.

i. Signaling from an AN/TCC-11 repeater causes the CALL lamp to light and the order wire buzzer to sound at the attended point from which the AN/TCC-11 repeater receives power and at all other attended points in that direction. The signal is also transmitted to all radio stations in that direction. Signal indications sometimes may be received at attended points and radio stations in the other direction.

135. Coded Signaling Over AN/TCC-7 System

Signaling from any attended point will cause the CALL lamps to light and the order wire buzzers to sound at all attended points in the system. A plan of coded signaling whereby each attended point is assigned a definite code (consisting of a combination of long and short signals) may be used to permit signaling to a specific point and to avoid the necessity of all points answering all calls. Suggestions and limitations for coded signaling are offered in *a* through *d* below.

a. The duration of any signal pulse, as determined by the length of time that the appropriate lever switch is held operated, should not be less than one-half second. This is necessary because of the delay in the response of the signal receiving circuit.

b. The interval between pulses should not be less than .5 second to assure recognition of individual pulses.

c. Relatively simple codes should be used for signaling from an AN/TCC-11 point. A possible arrangement is to restrict a code of two long signals to calls from an AN/TCC-11 repeater. These signals will be received at a number of attended points, but any point answering them could then signal to the desired point by the usual code.

d. A simple code (for example, one very long signal) should be restricted for use as a general alarm which requires all points to answer.

136. Use of Order Wire Circuit Extension

a. Provision is made to extend the order wire circuit on a 2-wire basis from the AN/TCC-7 terminals to control boards or other administrative points. This is accomplished by connecting the extension circuit to the 2W EXT binding posts on the chassis of the RT-280 ORDER WIRE PANEL. Thus, a circuit is available for system administration. Telegraph-Telegraph Signal Converter TA-182/U is required on each extension to provide circuit signaling. The TA-182/U may be set for 1,225 cps or 1,600 cps signaling over the order wire circuit. With 1,225 cps operation, signaling over the entire order wire circuit will not bring in the attended points of the system. With 1,600 cps operation, signaling will bring in attended points in addition to the distant extension point unless coded signals are employed. Both methods have certain advantages for specific administrative set-ups. It is recommended that 1,225 cps signaling be employed at the ex-tension point and that signaling of a local AN/TCC-7 terminal be established by use of an auxiliary telephone circuit.

b. The control board circuit has priority over use of the order wire circuit from other points.

137. Message Channels, Adjustments

Twelve message channels are available for use upon completion of the installation and line-up of the system. The procedure for connecting the message channels is described in paragraph 84. The correct levels of the connecting circuits or equipments are given in paragraph 129. This paragraph describes the adjustments for normal message channel operation.

a. Switches and Controls. All switches and adjustments of controls on the AN/TCC-7 terminal should be left in the same positions as at the conclusion of the system line-up (paragraphs 113-129) and should not be disturbed unless a routine testing or trouble location procedure is undertaken. The normal position for all switches on the front panel is vertical (pointing down). All lamps should be extinguished except the green AC POWER lamp on the PP-827 (200-VOLT) POWER SUPPLY. The following lever switches should be operated to the positions indicated in (1) through (3) below.

(1) 2W-4W.

(a) For a 2-wire connection, operate the 2W-4W lever switch on the appropriate

CHAN panel of TA-219 CHAN MODEM to the 2W position.

(b) For a 4-wire connection operate the 2W-4W lever switch to the 4W position.

(2) *SPECIAL SERVICE.* Operate the three SPECIAL SERVICE lever switches inside the TA-227 SUBGROUP PANEL to the CHAN MODEM position.

(3) *60-108 KC.* Operate the 60-108 KC lever switch inside the GROUP PANEL to the REGULAR position.

b. Talking Over Channel. The telephone handset provided with the AN/TCC-7 terminal equipment may be used to talk over a message channel by making the adjustments indicated in (1) through (3) below.

(1) To talk to the distant AN/TCC-7 terminal, operate the CHANNEL TALK lever switch on the RT-280 ORDER WIRE PANEL to the LINE position. To talk to the local switchboard, operate the CHANNEL TALK lever switch to the TEST BD position. Signaling facilities are not provided in the AN/TCC-7 terminal for these circuits. Contact with local switchboards or test boards must be arranged by use of the auxiliary telephone circuit.

(2) Operate the TALK-MON lever switch to TALK on the appropriate channel of a TA-219 CHAN MODEM.

(3) At the distant AN/TCC-7 terminal, operate the CHANNEL TALK lever switch to the LINE position and the TALK-MON lever switch to the TALK position (on the same channel as used in (2) above).

138. Special Service Channels, Adjustment

The equipment may be arranged to provide transmission for special service channels of bandwidths wider than 4 kc. These are available for use upon completion of the installation and lineup of the system. The procedure for connecting the special service channels is described in paragraph 85. The correct levels of the connecting circuits or equipments are given in paragraph 129. The adjustments for the different types of special service operation are described in *a* through *c* below.

a. Adjustments for 4 to 20 KC channels.

(1) Operate the SPECIAL SERVICE 1 (2 or 3) lever switch inside the TA-227 SUBGROUP PANEL to the SPL SERV position. This condition will be indicated by the lighting of the white SPL SERV lamp on the SUBGROUP PANEL.

(2) For each lever switch left in the CHAN MODEM position, the corresponding TA-219 CHAN MODEM may be used to transmit four message channels in the usual manner.

b. Adjustments for 60-108 KC Channel. Operate the 60-108 KC lever switch inside the GROUP PANEL to the SPL SERV position. This condition will be indicated by the lighting of the white SPL SERV lamp on the GROUP PANEL.

c. Adjustments for 12-60 KC Channel. Operate the 12-60 KC lever switch on the GROUP PANEL to the SPL SERV position. This condition will be indicated by the lighting of the white SPL SERV lamp on the GROUP PANEL

Section II. ROUTINE TESTS

139. General

This section describes periodic checks and adjustments of the system to assure optimum performance. Procedures are given for the order wire circuits and carrier circuits.

140. Order Wire Circuit, General Considerations

a. Net loss.

(1) Variation in cable temperature may cause appreciable changes in the net loss of the order wire circuit. Increase in temperature increases the loss and reduces the intelligibility of the messages. A decrease in temperature decreases the loss which decreases the margin against the *singing* of the circuit.

(2) The order wire circuit net loss may be adjusted to maintain the desired loss over a temperature range from -55° F. to +130° F.

(3) The overall transmission from terminal to terminal should be checked at weekly intervals or at any time that the circuit

net loss appears excessive or a tendency toward *singing* is noticed (par. 141).

b. Frequency Characteristic.

(1) Variation in cable temperature may cause considerable changes in the frequency characteristics of the order wire circuit. Increase in temperature increases the slope (1700 cps loss minus 300 cps loss), while a decrease in temperature decreases the slope. Excessive slope reduces the intelligibility of the messages.

(2) Adjustments to correct for the effects of temperature on the frequency characteristic of the order wire circuit are described in paragraph 142.

141. Periodic Check of Order Wire Circuit Transmission (Adjustment of Circuit Net Loss)

The procedure outlined in *a* through *e* below, checks the adjustment of net loss of the order wire circuit. The procedure is described for the *AB* direction of transmission. It should be repeated for the *BA* direction.

a. Send a 1-kc test tone from the *A* AN/TCC-7 terminal by operating the SEND OW lever switch on the RT-280 ORDER WIRE PANEL to the ON position.

b. Use the TS-760 TEST PANEL at the *B* terminal to measure the received tone at the REC AMP OUT jack of the RT-280 ORDER WIRE PANEL (par. 253, item 39).

c. If the TEST PANEL meter reads between -7 db and +4 db, no adjustments are necessary.

d. If the TEST PANEL meter reads outside the range of -7 db to +4 db, readjust the AB REC GAIN controls on the RT-281 ORDER WIRE PANELS at all AN/TCC-8 repeaters. Adjust the REC GAIN control on the RT-280 ORDER WIRE PANEL at the *B* AN/TCC-7 terminal. These adjustments are made according to the procedure described in the order wire line-up in paragraph 114. These adjustments must be made in a definite order starting at the AN/TCC-8 repeater nearest the *A* terminal and progressing in the *AB* direction toward the *B* terminal.

e. After completion of the adjustments discussed in *a* through *d* above, restore the SEND OW lever switch at the *A* terminal to its nonoperated position.

142. Effects of Temperature on Order Wire Circuit Frequency Characteristic

The effects of temperature changes on the frequency characteristic of the order wire circuit may be partially overcome by adjusting the setting of the CABLE REELS TO NEXT AN/TCC-7 OR AN/TCC-8 switches on the RT-280 ORDER WIRE PANELS at AN/TCC-7 terminals and the RT-281 ORDER WIRE PANELS at AN/TCC-8 repeaters. The following rules (*a* through *d* below) provide an approximate means of making this adjustment. The adjustments are based on seasonal changes in average daily temperature rather than hourly variation of temperature during a day.

a. At an AN/TCC-7 or AN/TCC-8 point, when the average daily outside temperature is approximately 45° F., the CABLE REELS TO NEXT AN/TCC-7 OR AN/TCC-8 switch is operated to a position which includes the number of cable reels to the next attended point.

b. When the number of cable reels is between 104 and 160, operate the switch one step clockwise for each 20° F. increase in the average daily outside temperature at that location relative to 45° F., or one step counterclockwise for each 20° F. decrease.

c. If the number of cable reels is between 58 and 103, operate the switch one step clockwise for each 50° F. increase in the average daily outside temperature or one step counterclockwise for each 50° F. decrease.

d. If the number of cable reels is between 0 and 57 or if there is a radio connection, no adjustment is necessary.

143. Carrier Circuits, Summary of Routine Tests

Paragraphs 144 through 148 describe periodic checks and adjustments of the carrier circuits. The procedures, include checks of the power supply voltages, the system line-up, channel outputs, and modulation. The following table gives a summary

of how often each of these routine tests should be performed.

Routine test	Frequency of test
Checking power supply voltages	Daily
Checking 68-kc pilot	Daily
Checking 12-kc and 28-kc test frequencies	Weekly
Monitoring of message channels	Daily
Checking message channel outputs	Weekly
Checking system modulation	Weekly
Checking modulation of attended repeater sections and radio sections.	Monthly

144. Power Supply Voltages, Checks and Adjustment

Checks and adjustments of the power supply voltages at all attended points should be made daily.

a. AN/TCC-7 Terminal. At each AN/TCC-7 terminal the following steps should be taken.

(1) Use the TS-760 TEST PANEL to measure the PP-827 200 VOLT POWER SUPPLY voltage (par. 253 item 1). Adjust the 200 V ADJ control (if necessary) to obtain a reading of 0 db on the TEST PANEL meter.

(2) Measure the current on the CURRENT meter on the PP-826 600 VOLT POWER SUPPLY. Adjust the LOAD CURRENT control (if necessary) to obtain a reading of 100 milliamperes.

(3) Measure the PP-826 600 VOLT POWER SUP-PLY voltage (par. 253, item 2). Adjust the 600 V ADJ control (if necessary) to obtain a reading of 0 db on the TEST PANEL meter.

b. AN/TCC-8 Repeater. At each AN/TCC-8 repeater the following steps should be taken:

(1) Use the TS-761 TEST PANEL to measure the PP-827 200 VOLT POWER SUPPLY voltage (par. 258, item 1). Adjust the 200 V ADJ control (if necessary) to obtain a reading of 0 db on the TEST PANEL meter.

(2) Measure the current on the CURRENT meter on the PP-826 600 VOLT POWER SUPPLY which feeds power toward the *A* terminal. Adjust the LOAD CURRENT control (if necessary) to obtain a reading of 100 milliamperes.

(3) Measure the PP-826 600 VOLT POWER SUP-PLY voltage (par. 258, item 2). Adjust the 600 V ADJ control (if necessary) to obtain a reading of 0 db on the TEST PANEL meter.

(4) Repeat the steps in (2) and (3) above, for the PP-826 600-VOLT POWER SUPPLY which feeds power toward the *B* terminal.

145. Check of System Line-up, General

Changes in cable temperature cause changes in cable loss and frequency characteristics which are not compensated fully by the regulating networks. These deviations should be observed by periodic measurement of the transmission of the 12-kc and 28-kc test frequencies and the 68-kc pilot frequency (par. 121). When the deviations become excessive, the system line-up should be performed. The procedure for the check of system line-up is described in paragraphs 146 and 147.

146. System Line-up Checks of 68 Kc Pilot Frequency

Measurements of 68 kc should be made at all AN/TCC-7 and AN/TCC-8 points and should be carried out at daily intervals between the hours of 2100 and 2300.

a. AN/TCC-7 Terminal At each AN/TCC-7 terminal proceed as follows:

(1) Use the TS-760 TEST PANEL to measure the 68-kc signal at the REC IN jack on the GROUP PANEL (par. 253, item 24). The algebraic sum of the TEST PANEL meter reading and the numbers for ATTENUATOR push buttons operated should be between +2 and +18. If the reading is outside of these limits, repeat the system line-up procedure described in paragraph 121 for the appropriate direction of transmission.

(2) Measure the 68-kc signal at the REC AMP 1 OUT jack on the GROUP PANEL (par. 253, item 28). The TEST PANEL meter reading should be between -5 and +5 db. If the reading is outside of these limits, repeat the system line-up procedure described in paragraph 121 for the appropriate direction of transmission.

b. AN/TCC-8 Repeater. At each AN/TCC-8 repeater proceed as follows:

(1) Use the TS-761 TEST PANEL to measure

the 68-kc signal at the AB IN jack (par. 258, item 4) and the BA IN jack (par. 258, item 18) on the AM-708 REPEATER PANEL. For each measurement the algebraic sum of the TEST PANEL meter reading and the numbers for ATTENUATOR push buttons operated should be between +2 and +18. If the reading is outside of these limits, repeat the system line-up procedure described in paragraph 121 for the appropriate direction of transmission.

(2) Measure the 68-kc signal at the AB AMP 1 OUT jack (par. 258, item 8) and the BA AMP 1 OUT jack (par. 258, item 22) on the AM-708 REPEATER PANEL. The TEST PANEL meter reading should be between -5 and +5 db. If the reading is outside of these limits, repeat the system line-up procedure described in paragraph 121 for the appropriate direction of transmission.

147. System Line-up Checks of 12 Kc and 28 Kc Test Frequencies

Measurements of the 12-kc and 28-kc test frequencies should be made at the AN/TCC-7 terminals at weekly intervals. The measurements should be made between the hours of 2100 and 2300. The procedure described in *a* through *e* below, is for the *AB* direction of transmission and should be repeated for the *BA* direction.

Note. This procedure may not be performed while the system is being used for the transmission of 12- to 60-kc or 60- to 180-kc special service.

a. At the *A* AN/TCC-7 terminal, proceed as follows:

(1) Operate the 12 & 28 KC lever switch on the TA-228 CARRIER SUPPLY PANEL to the ON position.

(2) Use the TS-760 TEST PANEL to measure the 12-kc output at the TR AMP OUT jack on the GROUP PANEL (par. 253, item 17). Adjust the 12 KC control on the CARRIER SUPPLY PA-NEL to obtain a reading of 0 db on the TEST PANEL meter.

(3) Use the TS-760 TEST PANEL to measure the 28-kc test frequency output at the TR AMP OUT jack on the GROUP PANEL (par. 253, item 18). Adjust the 28 KC control on the CARRIER SUPPLY PANEL to obtain a reading of 0 db on the TEST PANEL meter.

b. At the *B* AN/TCC-7 terminal, proceed as follows:

(1) Use the TS-760 TEST PANEL to measure the 12-kc output at the REC AMP 2 OUT jack on the GROUP PANEL (par. 253, item 31). The reading on the TEST PANEL meter should be between -2 db and +2 db.

(2) Measure the 28-kc output at the REC AMP 2 OUT jack (par. 253, item 32). The reading on the TEST PANEL meter should be between -2 and +2 db.

c. If the 12-kc and 28-kc readings are within the given limits, no further checks of these frequencies are necessary.

d. If either the 12-kc or 28-kc reading falls outside the given limits, repeat the system line-up procedure described in paragraph 121.

e. When the adjustments are completed, operate the 12 & 28 KC lever switch on the TA-228 CARRIER SUPPLY PANEL at the *A* AN/TCC-7 terminal to its nonoperated position.

f. Repeat the procedure outline in *a* through *e* above, for the *BA* direction substituting *B* for *A* and vice versa in the instructions.

148. Monitoring of Message Channels

The message channels should be monitored at daily intervals to check for the presence of excessive noise or tones. Select a time of day when the circuits are moderately busy. Conduct the tests on all channels at the AN/TCC-7 terminals at both ends of the system. Considerable information may be obtained from the nature of the disturbances heard on the channels. Modulation usually is heard as a disturbance which has the cadence of speech but is unintelligible; it is inverted or translated in frequency. Crosstalk is often intelligible and may be characterized by echoes, *hollow* sounds, or bad frequency distortion. Noise may be heard as hisses or cracks (static), low frequency hum (power noise), or tones of other frequencies. The procedure for monitoring the message channels is outlined in *a* through *d* below.

a. At the *A* AN/TCC-7 terminal, operate the TALK-MON lever switch to the MON position on channel 1 of the TA-219 CHAN MODEM number 1.

b. Use the telephone handset supplied with the equipment and listen to the receiver. During the

quiet periods, listen for evidence of excessive tones, modulation, and noise.

c. Repeat the procedure discussed in *a* and *b* above, for each of the other channels of the terminal.

d. If excessive tones, modulation, or noise are heard on any channel, apply the trouble location procedures of paragraphs 186 and 193.

149. Message Channel Outputs, Checks and Adjustments

This paragraph describes the checks and adjustments of the message channel transmission. Aging of components and effects of temperature changes may produce changes in the net gain of the message channels. These changes should not be allowed to accumulate to magnitudes which would degrade the transmission of speech over the channels. The receiving channel gain adjustments should be checked at weekly intervals following the checks and adjustments of the 12-kc and 28-kc test frequencies described in paragraph 147. The tests are de-scribed for the *AB* direction of transmission and should be repeated for the *BA* direction.

Note. This procedure requires interruption of the message channel transmission.

a. At the *A* AN/TCC-7 terminal operate the SEND-MEAS lever switches to the SEND position on channel 2 of all three TA-219 CHAN MODEMS.

b. At the *B* AN/TCC-7 terminal, proceed as follows:

(l) Arrange the TS-760 TEST PANEL to measure the 1-kc signal at the CHANNEL OUT jack on the TEST PANEL (par. 253, item 3).

(2) Operate the SEND-MEAS lever switch of channel 2 on the TA-219 CHAN MODEM No. 1 to the MEAS position. Note the reading on the TEST PANEL meter. Restore the switch to its nonoperated position.

(3) Repeat the procedure in (1) above for channel 2 on the No. 2 and No. 3 CHAN MODEM panels.

(4) If the reading for any one of the three channels is outside of the limits of-.5 db to +.5 db, proceed as follows:

(a) At the *A* AN/TCC-7 terminal, repeat the procedure given in paragraph 91*c*.

(b) At the *B* AN/TCC-7 terminal, repeat the procedure given in paragraph 124*b*.

(5) If the reading for all three channels is within the limits of -.5 db to +.5 db, continue the procedure in *c* below.

c. At the *A* AN/TCC-7 terminal, restore all SEND-MEAS lever switches to their nonoperated positions. Operate the SEND-MEAS lever switch of channel 1 on the TA-219 CHAN MODEM No. 1, to the SEND position.

d. At the *B* AN/TCC-7 terminal, proceed as follows:

(1) Arrange the TS-760 TEST PANEL to increase the 1 KC signal output at the CHANNEL OUT jack on the TEST PANEL (par. 253, item 3).

(2) Operate the SEND-MEAS lever switch of channel 1 on the TA-219 CHAN MODEM No. 1, to the MEAS position.

(3) If the reading on the TEST PANEL meter is between -.5 db and +.5 db, no adjustment is necessary.

(4) If the reading is outside of the limits -.5 db to +.5 db, adjust the GAIN control of channel 1 to obtain a reading of 0 db.

e. Restore all SEND-MEAS keys to their nonoperated positions.

f. Repeat the steps in *c* through *e* above, for each of the 12 channels in turn.

g. Repeat the steps in *a* through *f* above for the *BA* direction of transmission, substituting *B* for *A* and vice versa in the instructions.

150. Modulation Tests at Attended Repeater Sections and Radio Sections

a. System. The system modulation test described in paragraph 128 should be repeated at weekly intervals.

b. Attended Repeater Sections and Radio Sections. At monthly intervals, or at any time that the system modulation test limits are not met, modulation tests should be made on all attended repeater sections and radio sections. Tests may be conducted on only one attended repeater section or radio section at a time. The testing should be coordinated by the control terminal to observe this limitation. The tests are described for the *AB* direction of transmission and should be repeated for the *BA* direction. The procedure is as follows:

(1) At the attended point at the *A* end of the section proceed as follows:

(a) If the *A* end of the section is an AN/TCC-7 terminal, arrange the TS-760 TEST PANEL to send 65 kc to the section (par. 255, item 3). Measure the 65-kc output at the TR AMP OUT jack on the GROUP PANEL (par. 253, item 20) and adjust the output to obtain a reading of 0 db on the TEST PANEL meter.

(b) If the *A* end of the section is an AN/TCC-8 repeater, arrange the TS-761 TEST PANEL to send 65 kc in the AB direction (par. 260, item 3). Measure the 65-kc output at the AB AMP 2 OUT jack on the AM-708 REPEATER PANEL (par. 258, item 14). Adjust the SEND control to obtain a reading of 0 db on the TEST PANEL meter.

(2) At the attended point at the *B* end of the section, proceed as follows:

(a) If the receiving end is an AN/TCC-7 terminal, measure the 62-kc signal at the REC 62 KC jack on the GROUP PANEL (par. 253, item 36).

(b) If the receiving end is an AN/TCC-8 repeater, measure the 62-kc signal at the AB 62 KC jack on the AM-708 REPEATER PANEL (par. 258, item 17). Depress the ATTENUATOR push buttons as required to obtain a reading on the TEST PANEL meter as close to 0 db as possible.

(c) Determine the algebraic sum of the TEST PANEL meter reading and the numbers for ATTENUATOR push buttons operated. Report this value to the control terminal. If the resultant number exceeds the limit given in the table below, the procedure of paragraphs 188, 191 and 192 should be followed. This table applies to attended repeater sections and radio sections; it should not be confused with the chart shown in paragraph 140*b*, which applies to the complete system.

Type of section	Limit (db)
Attended repeater section	
AN/TRC-24 radio section	14
One link	14
Two links	18
Three links	21.5
Four links	24

Note. Add 1.5 db to the limit for each additional radio link

(3) Restore the switches on the TS-760 or TS-761 TEST PANEL to remove the 65 kc (par. 255, item 3 or par. 260, item 3).

(4) The tests described in subparagraphs 1 through 3 above, should be applied for the *BA* direction of transmission after completing the *AB* direction. Substitute *B* for *A* and vice versa in the instructions.

(5) The test described in (1) through (4) above should be made on all attended repeater sections and radio sections. If the number of db as determined in (2) (c) above exceeds 6 db in either direction for two or more attended repeater sections, the procedure in paragraphs 188, 191 and 192 should be followed for each section.

Section III. TROUBLE LOCATION

151. General

a. This section outlines procedures for the location of system troubles. The procedures are intended to trace the trouble to a particular equipment component of the system (AN/TCC-7 terminal, AN/TCC-8 repeater, AN/TCC-11 repeater, spiral-four cable, or radio link). The technical manuals for the equipment explain the procedure for sectionalizing a trouble within the equipment.

b. The troubles are classified into a relatively small number of major types, with instructions for handling each type. Very often a system trouble will show symptoms of more than one type. In general, each major symptom helps to determine the nature and location of the trouble.

c. The procedures in most cases can sectionalize the trouble. First, the trouble is isolated to the specific attended repeater section (or radio section). Then the attended points at the ends of these sections are investigated. Then the particular unattended repeater section in trouble is determined. Finally, the trouble is traced to a particular AN/TCC-11 repeater or span of cable.

d. System trouble location procedures in general should be under the supervision of the control point. Many trouble location procedures require an interruption of the system transmission. This interruption will be indicated in the following instructions whenever it appears to be necessary.

Caution: Do not follow any procedure which causes interruption of the system transmission unless permission is granted by the control point.

e. A knowledge of the system theory is helpful in analyzing troubles and understanding procedures for locating them. Refer to chapter 5 for the system theory.

152. System Trouble Sectionalization Chart

The system trouble sectionalization chart provides a guide for isolating the trouble to a particular equipment or cable section. The table refers to paragraphs in which detailed procedures are given.

a. Form of Chart. The trouble sectionalization chart consists of five columns, as follows:

(1) *Trouble symptom.* This column lists the indication which an attendant might obtain during operation, as evidence that trouble exists in the system.

b. System Trouble Sectionalization Chart.

(2) *Probable trouble.* This column shows where to look for the trouble indicated by the particular symptom. Only the more likely probabilities are outlined.

(3) *Check or measurement.* This column describes the checks or measurements which indicate whether or not the probable trouble source is at fault. In many cases a number of checks are given which should be performed in the indicated sequence.

(4) *Normal indication.* This column gives the meter readings or other indications obtained if the probable trouble source is not at fault.

(5) *Further sectionalization checks.* Failure to obtain the required *normal indication* is not always conclusive proof that the probable trouble source under consideration is at fault. Accordingly, this column refers to the next check to be performed if the normal indication is not obtained. When there is conclusive proof as to the location and nature of the trouble this column gives instructions for dealing with the trouble.

Case	Trouble symptom	Probable trouble	Check or measurement	Normal indication	Further sectionalization checks
1	Pilot 68-kc transmission alarm (without complete loss of transmission, order wire or power failure (par. 165, 166)).	Equipment trouble or need for system line-up.	Use order wire circuit to determine the first attended point which is receiving the alarm. Measure the 68-kc input at that point (par. 166).	Sum of TEST PANEL meter reading and ATTENUATOR push buttons operated should be between 2 db and 18 db.	If normal indication is obtained, look for trouble in the equipment at the attended point. (See appropriate equipment technical manual.) If normal indication is not obtained perform a system line-up (pars. 121-124).
2	68-kc transmission low alarm (with complete loss of transmission, no order wire or power failure (par. 167)).		(1) Use order wire circuit to determine the first attended point which is receiving the alarm Measure the 68-kc input at that point (par. 167*b*).	Sum of TEST PANEL meter reading and ATTENUATOR push buttons operated should be between 0 db and 20 db.	If normal indication is obtained look for trouble in the equipment at the attended point. See appropriate equipment technical manual.) If sum is less than 0, apply check (2).

b. System Trouble Sectionalization Chart-Continued

Case	Trouble symptom	Probable trouble	Check or measurement	Normal indication	Further sectionalization checks
			(2) Measure the 68-kc output at the preceding attended point (par. 167*d*).	TEST PANEL meter should read between -2 db and +2 db.	If normal indication is obtained apply check (3). If normal indication is not obtained look for trouble in the equipment at this point or preceding it. (See appropriate equipment technical manual.)
			(3) Apply AN/TCC-11 repeater fault location tests (par. 107 or 108) from the attended points of check (1) and check (2) toward the section in trouble.	TEST PANEL meter should read more than 0 db.	If normal indication is not obtained for the first AN/TCC-11 repeater loop from the attended point of check (1), apply check (4). If normal indication is not obtained for the first AN/TCC-11 repeater loop from the attended point of check (2), apply check (5). If normal indication is not obtained for the second or third AN/TCC- 11 repeater loop, apply check (6). If normal indication is obtained for all AN/TCC-11 repeater loops, look for trouble in the cable section between the most distant AN/TCC-11 repeaters in the power loops fed from the attended points of check (1) and check (2).
			(4) Check circuit of the equipment at the attended point of check (1) from the cable to the input measuring jack.	See appropriate equipment technical manual.	If no trouble is found, apply check (6).
			(5) Check circuit of the equipment at the attended point of check (2) from the output measuring jack to the cable.	See appropriate equipment technical manual.	If no trouble is found, apply check (6).

b. System Trouble Sectionalization Chart-Continued

Case	Trouble symptom	Probable trouble	Check or measurement	Normal indication	Further sectionalization checks
			(6) Check the unattended repeater section in which trouble is indicated by check (3) par. 172).	See paragraph 172	If normal indication is not obtained at the AN/TCC-11 repeater, re-place the repeater (par. 157). If normal indication is obtained at the repeater (or if there is not conclusive evidence of a defective repeater), look for trouble in the cable (par. 161).
3	Excessive loss on order wire without a 68-kc alarm (par. 169).	Equipment trouble.	(1) Perform a lineup of the order wire circuit (pars. 114 through 119).	See paragraphs 114 through 119.	If normal indication cannot be obtained at any point, look for trouble in the section preceding that point. Apply check (2).
			(2) Check order wire circuits in the attended repeater section in trouble.	See paragraphs 169*d* and 172 and appropriate equipment technical manual.	When trouble is found in an AN/TCC-11 repeater, replace the repeater (par. 157).
4	Order wire failure without a 68-kc alarm (par. 170.)	Equipment trouble.	(1) Use the order wire and a message channel to locate the section in which the trouble is located (Par. 170*b*). Check the order wire circuits at the attended points at both ends of the section in trouble.	See appropriate equipment technical manual.	If no trouble is indicated apply check (2).
			(2) Check order wire circuits at the AN/TCC-11 repeaters in the section in trouble.	See paragraph 170 ...	When trouble is found in an AN/TCC-11 repeater replace the repeater (par. 157).
5	Order wire failure and 68-kc transmission failure (par. 171).	Equipment or cable trouble.	(1) Use the order wire and other means (par. 171*c*) to locate the section in which the trouble is located. Check the equipment at the attended points at the ends of this section.	See appropriate equipment technical manual.	If no trouble is indicated apply check (2).
			(2) Apply checks of case 4 modified as indicated in paragraph 171.	Same as in Case 4....	Same as in Case 4.

b. System Trouble Sectionalization Chart-Continued

Case	Trouble symptom	Probable trouble	Check or measurement	Normal indication	Further sectionalization checks
6	Power alarm (pars. 176-181).	AN/TCC-11 repeater trouble or cable trouble (par. 178).	(1) Measure the power loop resistance.	See paragraph 180*c*...	If resistance is high there is probably an open circuit in the power loop. If resistance is low there is probably a short circuit or ground on the power loop. Apply checks (2) and (3).
			(2) Apply checks at the attended point (par. 180).		
			(3) Apply checks at successive AN/TCC-11 repeaters (par. 181).		
7	Carrier alarm (par. 182).	AN/TCC-7 terminal trouble.	Check TA-228 CARRIER SUPPLY PANEL.	.....	Apply trouble location procedure as described in AN/TCC-7 terminal technical manual.
8	Message channel failure (par. 183).	AN/TCC-7 terminal trouble.	(1) Identify direction of transmission in trouble by attempting to talk on channel (par. 183*a*).		
		AN/TCC-7 terminal trouble.	(2) Identify the terminal in trouble by measurement of 1-kc test tone (par. 183*b*).	See paragraph 183*b* ..	Apply trouble location procedure as described in AN/TCC-7 terminal technical manual.
9	Special service channel failure, 4 to 20 kc (par. 184).	AN/TCC-7 terminal trouble.	Identify the terminal in trouble by measurement of 1-kc test tone.	See paragraph 184	Apply trouble location procedure as described in AN/TCC-7 terminal technical manual.
10	Failure of 12 message channels (par. 185).	AN/TCC-7 terminal trouble.	Identify the terminal in trouble by measurement of 1-kc test tone.	See paragraph 185	Apply trouble location procedure as described in AN/TCC-7 terminal technical manual.
11	Interchannel modulation (pars. 186 through 192).	Defective tube	(1) Apply system modulation test for direction of transmission in which trouble is observed (par. 128).	Sum of TEST PANEL meter reading and ATTENUATOR push buttons operated should not exceed 20 db (for all cable system).	If normal indication is not obtained apply check (2).
			(2) Apply modulation test for each attended repeater section and radio section (par. 150).	Sum of TEST PANEL meter reading and ATTENUATOR push buttons operated should not exceed 14 db for any one section, or 6 db for each of two or more additional sections (for attended repeater sections).	If normal indication is not obtained apply check (3) to the attended points at the ends of each section which exceeds the limit.

b. System Trouble Sectionalization Chart-Continued

Case	Trouble symptom	Probable trouble	Check or measurement	Normal indication	Further sectionalization checks
			(3) Apply modulation test to amplifiers at attended points at both ends of section in trouble (par. 189 or 190).	TEST PANEL meter reading should not exceed -5 db.	If normal indication is not obtained replace the tubes in the amplifier, one at a time, until normal indication is obtained. If normal indication is obtained, the trouble lies outside of the attended point. For a radio section, consult the technical manual for the radio equipment. For an attended repeater section, apply check (4).
			(4) Apply filament activity test to amplifier tubes at each AN/TCC-11 repeater in attended repeater section in trouble (par. 160*c*).	Decrease in test set meter readings should be less than 5 db; reading should be within the limits of -5 db to +5 db.	If normal indication is not obtained replace the AN/TCC-11 repeater (par. 157). Apply check (2) to the attended repeater section in which the AN/TCC-11 repeater is replaced. If check (2) gives a normal indication apply check (1) for the system. If check (2) does not give a normal indication apply check (4) to the next AN/TCC-11 repeater.
12	Excessive noise and crosstalk (pars. 193 through 196).	Cable or equipment trouble.	(1) Measure 68 kc at inputs of all attended points (par. 194).	Sum of TEST PANEL meter reading and ATTENUATOR push buttons operated should be between 0 and 20 db.	If normal indication is obtained apply check (2). If normal indication is not obtained look for trouble in the attended section preceding the point of measurement (par. 166*d*).
			(2) Sectionalize the trouble by turning off power at various locations while monitoring the channel in trouble (par. 195).	No change in noise heard on channel.	If a change in noise is heard the trouble is in the equipment, from which power is removed (apply tests as described in the appropriate equipment technical manual), or in the power loop from which power is removed. Apply checks (3) and (4).
			(3) Make resistance and capacity measurements on the cable (par. 196*a*).	See paragraph 161.	Replace or repair defective cable.
			(4) Check AN/TCC-11 repeaters.		Replace each AN/TCC-11 repeater in succession with a spare (par. 157).

153. Tests of AN/TCC-11 Repeaters, General

Many of the trouble location procedures involve sending a repairman to an AN/TCC-11 repeater point to make tests. The following paragraphs (154 through 160) discuss general considerations relating to testing at AN/TCC-11 repeater points. This testing should be done under the direct supervision of an attendant at an AN/TCC-7 or AN/TCC-8 point whenever possible. Some of the procedures are for the attendant at the attended point; others are for the repairman at the AN/TCC-11 repeater, and are to be transmitted to him by the attendant at the attended point.

154. Equipment required at AN/TCC-11 Repeater for System Trouble Location

To make tests at an AN/TCC-11 repeater point the following equipment is necessary:

a. A plan of the attended repeater section, showing the locations of the AN/TCC-11 repeaters, power loop division, and settings of the controls for each repeater.

b. TS-712 test set.

c. EE-8 telephone.

d. Ohmmeter.

e. Spare AN/TCC-11 repeater.

f. Any other equipment required by the specific test procedure (par. 161).

155. General Procedure at AN/TCC-11 Repeater for System Trouble Location

a. At the AN/TCC-11 repeater point, use the order wire to call an attended point if possible. This procedure is described in paragraph 134.

b. Remain in continuous communication with an attended point and carry out the instructions sent from that point.

c. Take care to prevent rain, snow, or excessive moisture from entering the repeater through any openings left uncovered during the tests.

d. Securely replace all covers on the AN/TCC-11 repeater before leaving the point.

156. Use of TS-712 Test Set at AN/TCC-11 Repeater

a. The TS-712 test set is connected to the AN/TCC-11 repeater as follows:

(1) Remove the TEST cover at the J2 end of the AN/TCC-11 repeater (fig. 43).

(2) Connect the cable from the TS-712 test set to the repeater by engaging connector P1 on the cable with the J3 connector on the repeater.

b. The TS-712 test set permits communications over the order wire as described in paragraph 134.

c. The TS-712 test set also provides circuits which permit a number of measurements on the AN/TCC-11 repeater. The use of the measuring circuits is covered in paragraph 263.

d. The artificial cable is a network which simulates the transmission characteristics of twenty-three ¼-mile reels of spiral-four cable. This network is used to loop back a transmission path from the output of a repeater in one direction to the input in the other direction. Use the net-work in accordance with the test instructions.

e. Check the TS-712 test set according to the procedure outlined in paragraph 264. Make these checks at an attended point whenever a trip to in AN/TCC-11 repeater is required.

157. Replacing AN/TCC-11 Repeaters

Use the following procedure when the test instructions call for replacing an AN/TCC-11 repeater.

a. On the repeater which is to be used as a substitute, set the GAIN AMP 1, GAIN AMP 2, REP and PWR LOOP-PWR THRU switches in the same position as the positions of the corresponding switches on the removed repeater.

b. The PP-826 600-VOLT POWER SUPPLY supplies power to the repeater to be replaced should be turned off (operate the AC POWER switch to OFF) when requested to do so by the lineman. If the PWR LOOP-PWR THRU switch is set at PWR LOOP, turn off the power supplies at both ends of the attended repeater section.

Warning: Do not touch the contacting surfaces within the cable connector unless certain that power has been removed. Failure to observe this caution may result in dangerous electrical shock.

c. The AN/TCC-11 repeater is removed from the circuit by disconnecting the cable connectors at the two ends of the repeater. Note the cable which was connect to the J1 connector on the repeater.

d. Install the substitute repeater by connecting the cable connectors to the two ends of the repeater. Make sure that the same cable is connected to the J1 end as on the repeater which was removed.

e. Turn on the PP-826 600-VOLT POWER SUPPLY which supplies power to the repeater

(operate the AC POWER switch to ON) when requested to do so by lineman.

158. Use and Replacement of Lightning Arresters at AN/TCC-11 Repeaters

a. The AN/TCC-11 repeater is equipped with a number of carbon block lightning arresters (protectors) designed to protect the apparatus within the repeater against damage from power surges induced on the cable by lightning or other causes. The circuit schematic location of these lightning arresters is shown in figure 49. The physical location of the lightning arresters is shown in figures 42 and 43.

b. A lightning arrester may become damaged to the extent of creating a short circuit which may cause a transmission or power failure.

c. When an AN/TCC-11 repeater is found to be faulty and a lightning arrester is suspected, each lightning arrester must be removed from its socket, checked and examined as described in *f* and *g* below. Particular attention should be given to the lightning arresters in the circuit which is believed to be faulty. Replace each lightning arrester as soon as it is checked.

d. Removal of a lightning arrester from its socket may create a short circuit across the circuit to which the socket is connected. This may cause transmission failure in a direction in which service is being maintained, or a power failure.

Caution: Obtain permission from the control point before removing lightning arresters connected to a circuit through which service is

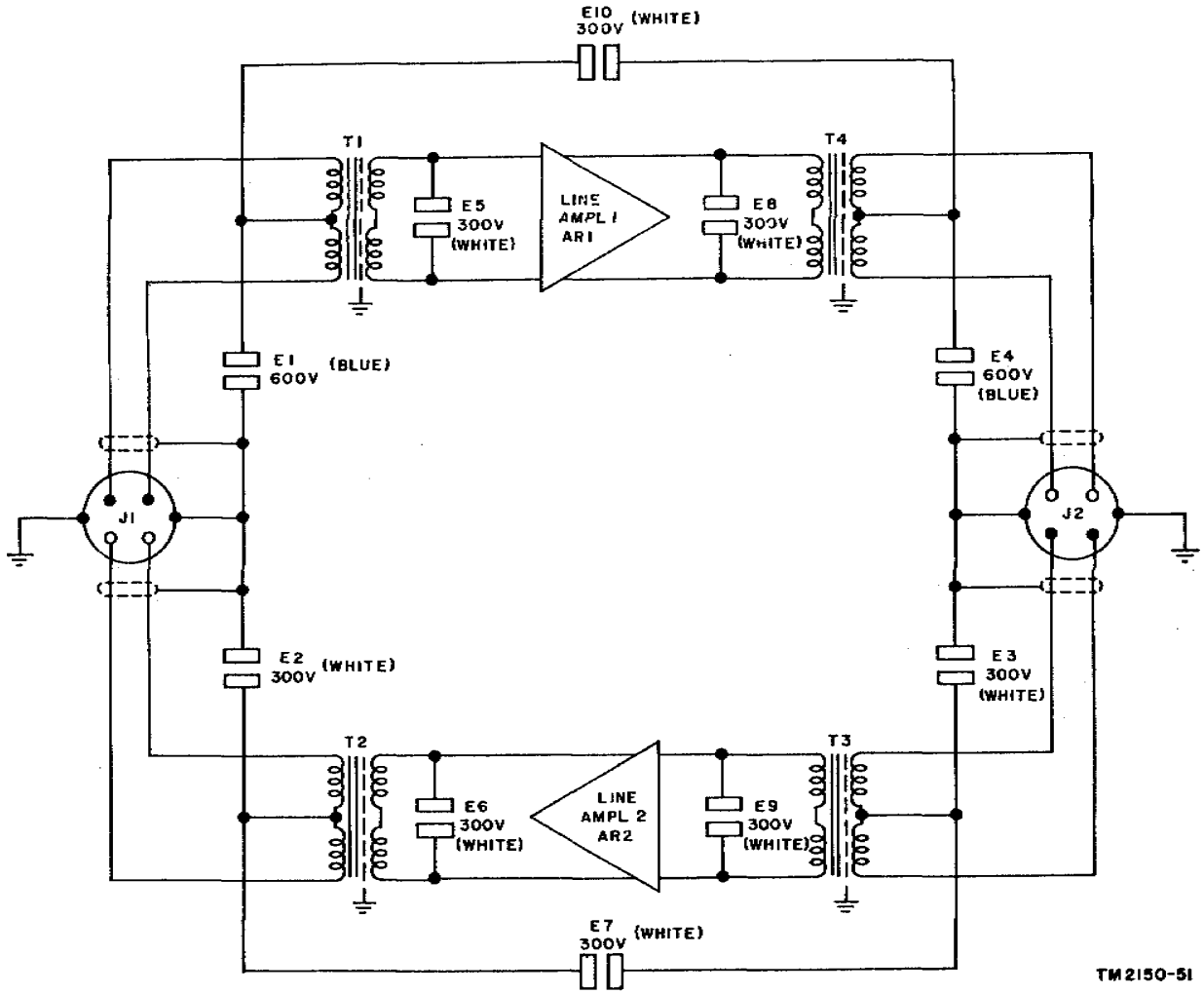


Figure 49. AN/TCC-11 repeater, arrangement of amplifiers and lightning arresters, functional diagram.

maintained. Avoid touching contacts within the socket; high voltage may be present. When possible, arrange to have power removed from the line before removing lightning arresters.

e. Lightning arresters marked with red characters are connected to circuits at which high voltage to ground may be present. Special care should be used when removing and replacing these lightning arresters if power is on. Other lightning arresters (not marked in red) may be removed and replaced without danger of exposure to the line voltage.

f. Measure the resistance of the lightning arrester with an ohmmeter by contacting the metal sleeve and outer carbon block. Push against the carbon block to make certain that it is seated properly. The resistance should be greater than 200,000 ohms

g. Inspect the lightning arrester for evidence of damage, loose particles of carbon, pitted surfaces, etc.

h. Replace a defective lightning arrester with one of the same color from the spares included with the TS-712 test set.

159. Identification of AB and BA Amplifiers at AN/TCC-11 Repeaters Using TS712 Test Set

When the TS-712 test set is used to make measurements on an AN/TCC-11 repeater, it is often necessary to identify an amplifier in the repeater with the direction (*AB or BA*) in which it transmits.

a. The relation of each amplifier to the direction of transmission is shown in figures 47 and 49. It is determined by the power loops as follows:

(1) If the AN/TCC-11 repeater is in a power loop fed from the A end of the attended repeater section, amplifier No. 1 transmits in the AB direction and amplifier No. 2 transmits in the BA direction.

(2) If the AN/TCC-11 repeater is in a power loop fed from the *B* end of the attended repeater section, amplifier No. 1 transmits in the *BA* direction and amplifier No. 2 transmits in the AB direction.

(3) The J1 connector of the AN/TCC-11 repeater is connected to the cable leading toward the attended point from which the repeater receives power.

b. If the identification of an amplifier is uncertain, follow the procedure outlined in (1) through (3) below. The instructions are written for a case in which it is required to identify the amplifier for the *AB* direction of transmission.

(1) Send 1 kc over the order wire circuit in the AB direction by operating the SEND OW lever switch on the RT280 ORDER WIRE PANEL at, the *A* AN/TCC-7 terminal to the ON position.

(2) Supply a 1,000-cps tone from the terminal for this measurement. Use the TS-712 test set to measure the input to the AMP 1 IN 1 KC at the AN/TCC-11 point in question. If no reading is obtained, try measuring at the AP 2 IN 1 KC.

(3) When a reading is obtained, restore the SEND OW lever switch to its non operated position then reoperate it a few times. Observe that the reading at the AN/TCC-11 repeater responds to this procedure. This identifies the amplifier being measured with the AB direction of transmission.

c. If it is inconvenient or impossible to send 1 kc to the AN/TCC-11 repeater being investigated, the same procedure may be followed using a 1,600-cps signal. This signal is sent over the order wire circuit by operating the RING lever switch on the RT-281 ORDER WIRE PANEL to the ON position at an AN/TCC-8 repeater point at the *A* end of the attended repeater section. This signal also may be obtained by operating the ORDER WIRE lever switch to the RING position on the RT-280 ORDER WIRE PANEL at an AN/TCC-7 terminal.

160. Normal System Readings at AN/TCC-11 Repeater Using TS-712 Test Set

This paragraph gives readings which should be obtained with a TS-712 test set connected to an AN/TCC-11 repeater in a normally operating system.

a. Repeater Voltage. Measure the d-c voltage across the repeater (par. 263, item 1). The TS-712 test set meter should read within ± 1 db of the BAT mark.

b. Space Currents. Measure the space currents of tubes V1 and V2 in amplifiers No. 1 and No. 2 (par. 263, items 4 through 7). The meter should read between-2 and +5 db.

c. Filament Activity. Measure the filament activity of each tube (par. 263, items 4 through 7 and note 3). The meter reading should not

fall more than 5 db below the reading obtained in b above. In addition, the meter should read between −5 and +5 db. See caution note in paragraph 192.

d. 68-kc Measurements. Measure the 68-kc pilot at the input and output of each amplifier. The normal readings are as follows:

(1) *Input to amplifier No. 1.* Refer to paragraph 263, item 9. The meter should read between-7 and +7 db.

(2) *Output of amplifier No. 1.* Refer to paragraph 263, item 10. The meter should read between−5 and +5 db

(3) *Input to amplifier No. 2.* Refer to paragraph 263, item 13. The meter should read between−7 and +7 db.

(4) *Output of amplifier No. 2.* Refer to paragraph 263, item *14.* The meter should read between−5 and +5 db.

e. 1-kc (or l,600-cps) Measurements. Have 1 kc (or 1,600 cps) sent to the AN/TCC-11 repeater. Measure the signal at the input and output of amplifiers No 1 and No. 2 (par. 263, items 8, 11, 12, or 15). The table below shows the meter readings which should be obtained

Number of repeaters in power loop attended point from Test set tone is received	Adjustment of TS-712 test set and meter reading											
	First AN/TCC-II (nearest sending point)				Second AN/TCC-II				Third AN/TCC-II			
	Test set switches		Meter reading		Test set switch		Meter reading		Test set switches		Meter reading	
	OW GAIN	1 KC SENS	AMP IN	AMP OUT	OW GAIN	1 KC SENS	AMP IN	AMP OUT	OW GAIN	1 KC SENS	AMP IN	AMP OUT
0	High	High	-4. 5	- 3. 0	High.....	High.....	-13. 5	-12.0	.....	.....	.....	.....
1	High	High	+5. 0	+6. 5	High.....	High.....	-4. 0	2. 5	High.	High.....	-13. 0	-11.5
2	Med.....	Low.....	-7. 5	- 5. 0	High.....	High.....	+4. 0	+5. 5	High.	High.....	5. 0	- 3. 5
3	Low.....	Low.....	+1. 5	+5. 5	Med.....	Low	-6. 5	- 4. 0	High.	High.....	+5. 0	+6. 5

Note. Above table gives approximate readings of 1-kC test tone. When 1,600 cps is measured, the readings should be approximately 1 db higher.

161. System Cable Trouble Location

The exposure of the spiral-four cable makes it susceptible to damage from lightning, gun fire, vehicles, or sabotage. This paragraph describes checks of the cable to aid in the location of cable troubles.

a. Resistance. Measurements of resistance with an ohmmeter may help to locate a fault. Remove power from the cable before making any measurements.

(1) *Loop measurements.* Disconnect the cable connectors at the point where the measurement is to be made. Measure the resistance of each pair (fig. 48) in the direction in which trouble is suspected. The normal value depends on the number of reels installed to the test repeater or terminal (par. 173). A reading greater than 1 megohm indicates an open circuit. A reading considerably lower than normal indicates a probable short circuit. The distance to the short-circuit may be estimated from the value of the resistance measurement. Measurements at the junctions of the successive reels of cable should quickly pin-point the trouble.

(2) *Resistance to ground.* Measurements of resistance to ground of each conductor in the cable aid in the location of complete or partial grounds on the cable. If no trouble is present, the resistance should exceed 1 megohm. If trouble is present, the resistance measurements should identify the faulty pair and give some clue as to its location. The trouble cannot be located accurately from the data because a resistance to ground at the point of the trouble may have any value. Figure 50 shows approximate resistance values of the cable and repeater circuits which may be helpful in interpreting the resistance to ground measurements. The particular cable reel in trouble may be determined exactly by making resistance measurements at successive junctions of cable reels

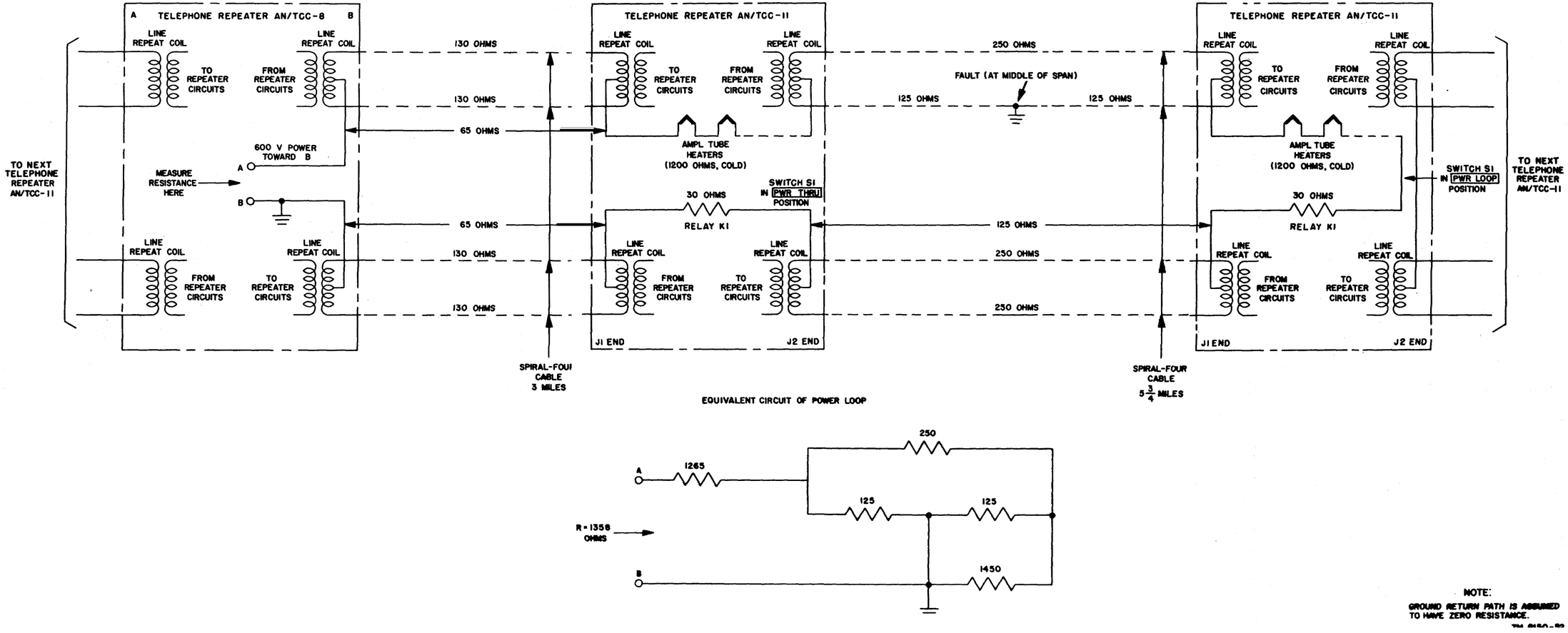


Figure 50. -Typical power loop with ground on cable, functional diagram

b. Capacity Measurements of capacity with a Test Set TS-27/TSM (Sig C stock No. 3F4325-27) may be helpful in locating an open circuit or an unbalance in the cable. The use of this test set is described in TM 11-2057.

(1) *Capacity of pair.* Measurement of the capacity of a pair may be helpful in locating an open circuit in the cable. The capacity measurement is significant only when the cable loop is open. The following table shows approximate values of capacitance for the number of reels indicated.

No. of reels	Capacity between conductors of pair (μf)
6	0.127
12	.254
18	.380
23	.486

(2) *Capacity to* ground. Measurements of capacity to ground of each conductor in the cable may indicate the existence of unbalance which is causing trouble. Remove the connectors at both ends of the cable span being measured from the equipment to which they are connected normally. The capacity measurements have no significance unless this is done. A normal cable should approximate the values shown in the following table.

No. of reels	Capacity of each wire to sheath (μf)
6	0.20
12	.41
18	.61
23	.78

c. Clearing of trouble. Clear a trouble which has been traced to a definite cable reel by replacing the reel or repairing it according to instructions included in TB SIG 233.

162. Loss of Transmission in System, General Troubles

Troubles which can cause interruption of transmission over the carrier circuits, order wire circuits or both are outlined in *a* through c below.

a. Indication of Trouble.

(1) Loss of transmission over the carrier circuits is indicated by 68-kc transmission alarms.

(2) Loss of transmission over the order wire circuit is indicated by inability to communicate on the order wire.

(3) Trouble in a power loop causes interruption of power delivered to the loop and is indicated by a power alarm.

b. Location of Trouble. The nature of the trouble furnishes useful clues as to its location.

(1) A 68-kc alarm indicates trouble in the portion of the circuit which transmits the carrier frequencies. This circuit is shown by the solid lines in figure 51.

(2) Loss of order wire transmission indicates trouble in the portion of the circuit which transmits over the order wire. This circuit is shown by the dotted lines in figure 51.

(3) Simultaneous loss of carrier and order wire transmission indicates trouble in both the carrier circuits and the order wire circuits, or in the circuit which is common to both. These circuits are shown by the heavily shaded lines in figure 51.

(4) A power alarm indicates trouble in the power loop. A complete power loop is shown in figure 45. More details of the power loop within the AN/TCC-11 repeater are shown in figure 53.

(5) A power failure usually causes a carrier circuit failure, but not necessarily an order wire failure.

c. Examples of trouble. The following table lists typical troubles and the circuits which will be affected by them.

Trouble	Circuits affected
Single wire cable break	Carrier, order wire (probably no power failure).
Short circuit on a cable pair	Carrier, order wire (no power failure).
Open circuit in AN/TCC-11 repeater amplifier.	Carrier only.
Open circuit in low pass filter	Order wire only.
Open circuit in power loop in AN/TCC-11 repeater	Carrier, power (no order wire failure).
Cross from one wire of one cable pair to one wire of	Probable power failure, carrier failure, probably

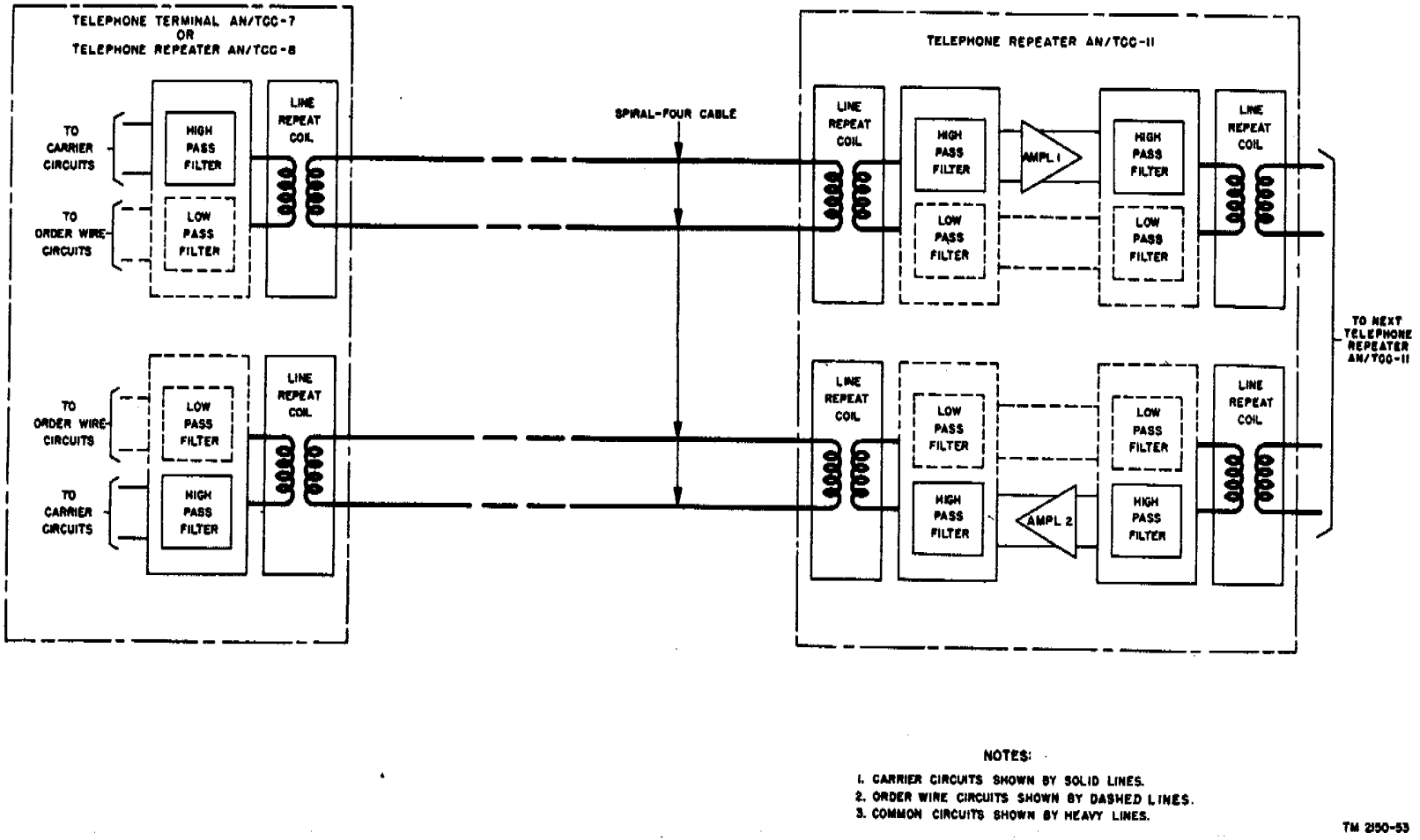


Figure 51. Carrier and order wire circuits, functional diagram.

163. Trouble Indicated by 68-kc Transmission Alarms, General

Paragraphs 164 through 167 describe the procedure to be taken when a 68-kc transmission alarm is received. The troubles considered include the partial loss of transmission and the complete loss of transmission.

164. System Transmission Failure-Operation of 68-kc Transmission Alarms

a. Failure of transmission at any location in the system causes 68-kc alarms to be received at all AN/TCC-8 and AN/TCC-7 points beyond the location of the trouble.

b. At each AN/TCC-7 point a 68-kc transmission alarm is indicated by the lighting of a red lamp, LOW or HIGH, on the GROUP PANEL, and the sounding of a buzzer.

c. At each AN/TCC-8 point a 68-kc transmission alarm in the *AB* direction is indicated by the lighting of a red lamp, AB LOW or AB HIGH, on the AM-708 REPEATER PANEL and the sounding of a buzzer. A similar alarm in the *BA* direction is indicated by the BA LOW or BA HIGH lamp and the buzzer.

d. At either an AN/TCC-7 or an AN/TCC-8 point, the LOW alarm lamp lights when the 68-kc output to the cable drops more than 1.5 db below normal. The HIGH alarm lamp lights when the 68-kc output to the cable rises more than 1.5 db above normal.

e. With normal operation of the regulating circuits in the equipment at the attended points, a change in 68-kc output of 1.5 db results from a change in 68-kc input of more than 8 db from normal.

f. When an alarm is indicated, the buzzer may be silenced by operating the appropriate ALARM CUTOFF lever switch to LOW, if the LOW lamp is lighted, or HIGH if the HIGH lamp is lighted. The alarm lamp will remain lighted

g. Upon restoring the 68-kc transmission to normal, the alarm lamp will be extinguished and the buzzer will sound. The buzzer may be silenced by restoring the ALARM CUTOFF lever switch to the NORMAL position.

165. Preliminary Procedure on Reception of 68-kc Alarm

The following instructions pertain to trouble in the AB direction of transmission.

a. When an alarm is received, silence the buzzer by operation of the ALARM CUTOFF lever switch.

b. Call in all stations on the order wire and determine the station nearest the A terminal which receives the alarm.

c. From this point measure the 68-kc. output at the REC AMP 2 OUT jack on the GROUP PANEL at an AN/TCC-7 point (par. 253, item 33) or the AB AMP 2 OUT jack on the AM-708 REPEATER PANEL at an AN/TCC-8 point (par. 258, item 15).

166. Procedure When Transmission is Not Entirely Lost

This procedure applies if a 68-kc alarm high is obtained at the point determined in paragraph 165*b* or if the meter reading obtained in paragraph 165*c* is greater than-5 db (pointer indicates to right of-5 db).

a. Measure the 68-kc input at the REC IN jack on the GROUP PANEL at an AN/TCC-7 point (par. 253, item 24), or the AB IN jack on the AM-708 REPEATER PANEL at an AN/TCC-8 point (par. 258, item 4).

b. If the algebraic sum of the TEST PANEL meter reading and the operated ATTENUATOR push buttons is between 2 and 18 db, the trouble is probably in the equipment at the station. Consult the appropriate equipment technical manual.

c. If the sum is outside the limits of 2 db to 18 db, perform a system line-up in the AB direction (paras. 121 through 124).

d. If at any step during the system line-up procedure it is not possible to meet the limits specified, look for trouble in the portion of the system between that point and the preceding point at which normal performance was obtained. The following procedure should be applied to locate the fault:

1 Apply the fault location tests (paras. 107 and 108) at both ends of the attended repeater section in which the trouble is located. Failure to meet the test limits of any step in this procedure should identify a defective unattended repeater section. For example, if the test in which the REP 1 push button is depressed gives a satisfactory result, but the REP 2 and REP 3 tests give readings out of limits, the second section (ending in the second AN/TCC-11 repeater) is defective.

(2) If trouble is indicated in an unattended repeater section adjacent to an attended point, check the equipment at the attended point according to instructions in the appropriate equipment technical manual.

(3) Apply the procedure for locating trouble within the unattended repeater section (par. 172) identified in (2) above. If no specific trouble is revealed, it may be necessary to check all unattended repeater sections in succession.

167. Procedure When Transmission Is Entirely Lost

This procedure applies when transmission is entirely lost, as indicated by a meter reading (par. 165c) less than-5 db (pointer indicates to left of-5 db), or on receipt of a report of circuit failure.

a. If the point determined in accordance with instructions in paragraph 165*b* is an AN/TCC-8 repeater point, restore 68 kc to the cable circuit beyond that point by arranging the TS-761 TEST PANEL to send 68 kc in the AB direction (par. 260, item 1).

b. Measure the 68-kc input at the REC IN jack on the GROUP PANEL at an AN/TCC-7 point (par. 253, item 24) or the AB IN jack on the AM-708 REPEATER PANEL, at an AN/TCC-8 point (par. 258, item 4).

c. If the algebraic sum of the TEST PANEL meter reading and the operated ATTENUATOR push buttons is between 0 and 20 db, the equipment at that station is probably in trouble. Consult the applicable equipment technical manual.

d. If no reading is obtained, measure the 68-kc output at the preceding attended point (toward the A terminal). At an AN/TCC-7 point, measure at the TR AMP OUT jack on the GROUP PANEL (par. 253, item 19). At an AN/TCC-8 repeater point measure at the AB AMP 2 OUT jack on the AM-708 REPEATER PANEL (par. 258, item 15). If the TEST PANEL meter reading is within the limits of-2 db to +2 db, the trouble lies in the attended repeater section beyond this point. If the reading is outside the limits of-2 db to +2 db, the trouble is in the equipment at this point or preceding it (toward the A terminal).

e. If no power alarm is received and if the order wire circuit remains normal, the trouble is probably a faulty AN/TCC-11 repeater. Apply the procedure described in paragraph 166*d*.

168. Order Wire Circuit, System Troubles, General

Trouble in the order wire circuit and 68-kc transmission circuit often occur at the same time. In this event, the procedures referred to in paragraph 163 should be applied first. Paragraphs 169 through 171 describe methods of dealing with troubles in the order wire circuit. These methods should be used if the procedure of paragraph 163 is unsuccessful or if the trouble appears only in the order wire circuit.

169. Excessive Loss in Order Wire Circuit

a. The loss in the order wire circuits increases as the temperature increases. At any time that the loss is excessive, the procedure outlined in paragraph 141 should be followed to compensate for the effects of temperature change.

b. At an extremely high temperature, the gain of the order wire amplifiers may not be sufficient to make up the increased circuit loss. Inability to reach the desired TEST PANEL meter reading of 0 db when adjusting the order wire REC GAIN controls indicates this condition (par. 141). The deficiency of gain will increase as the distance from the sending AN/TCC-7 terminal increases, but should not exceed 2 db for each attended repeater section. That is, at the first AN/TCC-8 repeater point from the sending AN/TCC-7 terminal, the deficiency of gain should not exceed 2 db, at the second AN/TCC-8 point, 4 db, etc.

c. If the order wire gain deficiency exceeds the values indicated in b above, the order wire circuit should be investigated for trouble. Perform the order wire line-up procedure (par. 114) and determine the attended repeater section in which the trouble is located by noting where the gain deficiency first appears.

d. The attended repeater section where trouble is suspected should be investigated as follows:

(1) These instructions are for the case in which the trouble appears in the *AB* direction of transmission.

(2) The dotted lines in figure 51 show the order wire circuit in an attended repeater section and should be helpful in following the trouble locating procedure.

(3) Send 1 kc over the order wire circuit in the *AB* direction by operating the SEND OW lever switch on the RT-280 ORDER

WIRE PANEL at the *A* AN/TCC-7 terminal to ON.

(4) Apply the procedure in paragraph 172 to sectionalize the trouble. Make checks at the attended points at both ends of the attended repeater section in trouble before investigating the AN/TCC-11 repeaters. Refer to the appropriate equipment technical manual for the procedure.

170. Complete Loss of Order Wire Transmission Only

If the order wire failure occurs without a 68-kc transmission failure, the trouble must be in a part of the circuit not common to the order wire and carrier circuits (see dotted lines in fig. 51). The procedure for localizing the trouble is as follows:

a. As soon as an order wire failure is noticed, sound a general call on the order wire. By noting the stations which do not respond, determine the attended station beyond which the trouble lies. If the failure is noted at an AN/TCC-8 point and no stations respond, the trouble is probably in the order wire circuits of the AN/TCC-8 repeater. Refer to the AN/TCC-8 technical manual.

b. Communicate with the AN/TCC-7 terminal beyond the order wire break by using channel 1 (or any suitable channel) of the group of 12 message channels. This is accomplished as follows:

(1) At the AN/TCC-7 terminal which is aware of the trouble, arrange to have channel 1 of the TA-219 CHAN MODEM No. 1 removed from service.

(2) Operate the TALK-MON lever switch to TALK on channel 1 of TA-219 CHAN MODEM No. 1. Operate the CHANNEL TALK lever switch on the RT-280 ORDER WIRE PANEL as follows:

(a) Operate the switch to TEST BD to talk to the local switchboard operator.

(b) Operate the switch to LINE to talk over the line.

(3) Instruct the switchboard operator to signal over channel 1 to the switchboard operator at the distant AN/TCC-7 terminal.

(4) Use the telephone handset provided with the AN/TCC-7 terminal to talk to the distant operator. Instruct this operator to contact the AN/TCC-7 terminal attendant at that end of the system and instruct him to talk on channel 1 by making the adjustments in (2) above, at that point.

(5) Inform the distant operator of the failure of the order wire transmission circuit.

(6) Switch back to the order wire and talk to determine whether the transmitting or receiving path is defective. If both appear to be normal, the trouble may be in the tuning of the ringer-oscillator plug-in unit of the order wire circuit at the *A* terminal. Refer to the AN/TCC-7 technical manual.

(7) The order wire circuit may be paralleled with channel 1 by operating the ORDER WIRE lever switch to TALK on the RT-280 ORDER WIRE PANEL. Using this arrangement at the *A* AN/TCC-7 point, the *A* attendant may talk to the *B* AN/TCC-7 attendant and to the attended points between the *A* terminal and the order wire circuit break but not to the attended points between the *B* terminal and the break. He may signal the *B* attendant only through the cooperation of the switchboard operators.

c. Sound a general call on the order wire at the distant AN/TCC-7 terminal and determine the attended station beyond which the trouble lies and the direction of transmission in which it exists. This information, added to that obtained in accordance with *a* above, fixes the attended repeater section in which the trouble is located.

d. Check the order wire circuits at the attended points at the ends of the section in trouble by sending a 1-kc test tone from each AN/TCC-7 terminal to the point and checking the order wire line-up (par. 114). In addition, apply the checks described in the appropriate equipment technical manuals. If no trouble is found, continue as indicated in *e* through j below.

e. Send a repairman to the first AN/TCC-11 point from the attended point at each end of the attended repeater section in trouble. The procedure outlined below will apply to the repairman sent out from the *A* end of the section. It is assumed that the trouble exists in the *AB* direction.

f. Before the repairman leaves the *A* point, determine the time that power will be removed from the power loop fed from the *A* point to the section in trouble. Allow ample time for the man

to reach the first AN/TCC-11 point. Removal of power will cause interruption of service.

g. At the first AN/TCC-11 point, attempt to call the *A* point over the order wire. If successful, request that 1 kc be sent over the order wire circuit in the AB direction and carry out the procedure in paragraph 174*a* and *c*. If the repeater appears to be in trouble, request permission to replace it with a spare. If no trouble is indicated, set a time for power to be removed later, go to the next AN/TCC-11 point and repeat the procedure at that point.

h. If communication with the *A* point from the first AN/TCC-11 point over the order wire is impossible, it -may be assumed that the repeater is defective. Check the lightning arresters. If the trouble is not cleared by this procedure, wait until the time set for removal of power, then replace the AN/TCC-11 repeater with a spare.

i. Proceed in this manner by going to successive AN/TCC-11 repeaters until reaching the end of the power loop.

j. When a repeater is replaced, check the overall order wire circuit to assure that the trouble has been cleared.

171. Complete Loss of Order Wire and 68-kc Transmission

Complete loss of order wire transmission in one or both directions makes location of the trouble difficult since the order wire circuit always is relied upon as an aid. The following procedure should help in dealing with this condition:

a. As soon as the 68-kc transmission failure or the order wire failure is noticed, sound a general call on the order wire on both sides of the section in trouble. By noting the stations which do not respond, determine the attended repeater section in which the order wire circuit is inoperative.

b. Proceed as described in paragraphs 165 through 167 with the additions below. The instructions cover the case in which transmission is lost in the *AB* direction.

c. The attended point at the *B* end of the attended repeater section in trouble will receive a 68-kc transmission alarm, and the attendant there will be aware of the trouble. When the general call on the order wire is answered, the *B* attendant will not hear the A attendant and he will not know whether the *A* attendant hears him, furthermore, the *A* attendant may not be aware that there is any trouble. To make sure that the *A* attendant takes some action the *B* attendant should cause a 68-kc alarm at the *A* point by removing power from the cable toward *A*. This is done by operating the AC POWER switch to OFF on the PP-826 Volt POWER SUPPLY. This action interrupts transmission in the *BA* direction. After 2 minutes restore the AC POWER switch to ON.

d. The *B* attendant should make complete checks from his equipment, as described in paragraph 166. When he has completed these tests, he should sound a general call on the order wire to announce the results of his tests, thus passing on the information to the *A* attendant. If the *B* attendant finds trouble, he should dispatch a repairman to the point of trouble to repair it. If the *B* attendant finds no trouble, he should dispatch a repairman to the most distant AN/TCC11 point in the power loop fed from the *B* point.

e. When the *A* attendant becomes aware of the trouble, he should make complete checks from his equipment, as described in paragraph 166. If he finds trouble, he should dispatch a repairman to the point of trouble to repair it. If he finds no trouble, he should listen for a message from the *B* attendant. If he receives no message within 15 minutes, he should dispatch a repairman to the most distant AN/TCC-11 point in the power loop fed from the A point. If he receives assurance that the *B* attendant is sending out a repairman, the *A* attendant need not send one unless he locates trouble with the repeater fault location tests.

f. When two wires, one in each direction of transmission, break in the section of cable between the last repeaters (most distant from the attended points) in the power loops fed by the *A* and *B* points, 68-kc alarms will be received at the *A* and *B* points and the order wire transmission will be lost in both directions. After following the procedures given in *c* to *e* above, repairmen should be sent from both the *A* and *B* points to expedite the localization of the trouble.

g. When the trouble consists of a single wire break near the A point and the procedures given in *c* through *e* above are followed, the trouble will be located quickly by the *A* attendant. The repairman sent from the *B* point makes an unnecessary trip. However, this procedure is desirable to take care of all possibilities.

h. A man dispatched from the *B* point to an AN/TCC-11 repeater should attempt to contact

the *A* attended point to inform the attendant of conditions. He should then make checks at that repeater as described in paragraph 174. If no trouble is found, he should go to the next AN/TCC-11 repeater toward the *A* point and repeat the procedure. He should continue making measurements at successive AN/TCC-11 repeaters until the trouble is found.

172. Trouble Location in Unattended Repeater Section, General

Suggestions for isolating a trouble within an unattended repeater section (fig. 52) are covered in this paragraph. The particular section in trouble may be known as a result of application of the AN/TCC-11 repeater fault location tests (paras. 107 and 108) or by other evidence. If the particular section in trouble is not known, it may be necessary to investigate all the unattended sections within the attended repeater section in succession. The trouble symptoms should give evidence as to whether the trouble is in an AN/TCC-11 repeater or in the spiral-four cable. When the symptoms indicate that certain steps in the procedure are not applicable, those steps should be omitted. The procedure discussed in paragraphs 173 through 175 is used if the trouble exists in an unattended repeater section in a power loop fed from the *A* end of the attended repeater section.

173. Trouble in Attended Point at Near End of Unattended Repeater Section

When the unattended repeater section in trouble includes an attended point, make the following checks at that point:

a. Make checks to determine whether the trouble is located within the equipment at the attended point. Refer to the AN/TCC-7 terminal or the AN/TCC-8 repeater technical manual for the procedure.

b. Turn off the PP-826 600-VOLT POWER SUPPLY which feeds power to the section in trouble (operate the AC POWER switch to OFF). This procedure causes interruption of service. Disconnect the cable leading to the section in trouble. Measure the resistance of each pair in the cable (fig. 48). The normal resistance depends on the number of cable reels to the first AN/TCC-11 repeater. The following table gives approximate values at 55° F.

No. of reels	Approx res (ohms)
23	495
18	385
12	260
6	130

174. Trouble in AN/TCC-11 Repeater at Near End of Unattended Repeater Section

When the unattended repeater section in trouble does not include an attended point (such as the unattended repeater section shown in fig. 52), make the following checks at the AN/TCC-11 repeater point nearer the *A* end of the attended repeater section.

a. Make 68 kc and 1 kc measurements at the AN/TCC-11 repeater (par. 160*d* and *e*). The following conclusions may be drawn:

(1) Failure to obtain a reading at a particular point indicates trouble in the attended repeater section, preceding that repeater point or a short circuit closely following that particular point.

(2) A reading higher than the value expected (par. 173*b*) indicates an open circuit beyond the measured point.

b. Arrange to have the voltage removed from the AN/TCC-11 repeater and disconnect the spiral-four cable from the *AB* output end of the repeater (J2). This procedure causes interruption of service. Make the following resistance measurements with an ohmmeter.

(1) Measure the resistance at the cable connector on the AN/TCC-11 repeater for each pair of wires (fig. 43). The resistance should be approximately 5 ohms. Failure to obtain a correct reading indicates trouble in the AN/TCC-11repeater.

(2) Measure the resistance at the cable connector on the spiral-four cable for each pair of wires (fig. 48). The resistance should be 500 ohms ±5 percent (twenty three ¼-mile reels at 55° F.). Failure to obtain a correct reading indicates trouble in the cable.

c. If trouble is indicated in the AN/TCC-11 repeater, check the lightning arresters associated with the point where the trouble appears to be

located (fig. 49). If replacing the lightning arresters fails to clear the trouble, replace the AN/TCC-11 repeater (par. 157). Observe whether the system trouble is cleared.

175. Trouble in AN/TCC-11 Repeater at Far End of Unattended Repeater Section

Make the following checks at the AN/TCC-11 repeater at the far end of the unattended repeater section in trouble (away from the *A* end of the attended repeater section).

a. Repeat the procedure in paragraph 174*a*.

b. Repeat the procedure in paragraph 174*b* for the *AB* input end of the repeater (J1).

c. Repeat the procedure in paragraph 174*b* for the *AB* output end of the repeater (J2).

d. Repeat the procedure of paragraph 174*c*.

176. Power Alarms, General

A power alarm is received at an AN/TCC-7 terminal point or AN/TCC-8 repeater point when the resistance of a power loop fed from that point becomes abnormal. A power failure usually causes an interruption of system transmission in both directions. Paragraphs 177 through 181 describe the operation of the alarms and suggest procedures for locating the trouble.

177. Functioning of Power Alarms

a. The PP-826 600-VOLT POWER SUPPLY delivers a regulated current of 100 milliamperes to the power loop. Changes in resistance of the power loop cause changes in the output voltage of the power supply. The high and low voltage alarm limits are initially set to operate if the voltage rises 75 volts or falls 65 volts with respect to the normal value.

b. Power alarms are indicated by the lighting of the lamps and the sounding of a buzzer. When an alarm is received, operate the ALARM CUTOFF lever switch to the ON position to silence the buzzer.

c. If the resistance of the power loop becomes abnormally low (caused by a short circuit in the cable, for example), a low voltage will be indicated by the lighting of the LOW VOLTAGE and LOAD ALARM lamps and the sounding of a buzzer. Current will be removed from the power loop,

d. Operate and release the RESTORE lever switch. The LOW VOLTAGE lamp will be extinguished.

(1) If the power loop resistance has not fallen more than 1,500 ohms (approximately), current will be restored to the power loop. If the power loop resistance remains low enough to cause an alarm, the LOW VOLTAGE lamp again will light and current will be removed from the line after about 15 seconds. The LOAD ALARM lamp remains lighted.

(2) If the power loop resistance has fallen more than 1,500 ohms (approximately), current will not be restored to the line. The LOW VOLTAGE lamp will remain extinguished and the LOAD ALARM lamp will remain lighted.

e. If the resistance of the power loop becomes abnormally high (caused by an open circuit in the power loop, for example), a high-voltage alarm will be indicated by the lighting of the HIGH VOLTAGE and LOAD ALARM lamps and the sounding of a buzzer. Current will be removed from the power loop.

f. Operate and release the RESTORE lever switch. The HIGH VOLTAGE lamp will be extinguished.

(1) If the power loop resistance has not risen to more than 100,000 ohms (approximately), current will be restored to the power loop. If the power loop resistance remains high enough to cause an alarm, the HIGH VOLTAGE lamp will light again and current will be removed from the line after about 10 seconds. The LOAD ALARM lamp will remain lighted.

(2) If the power loop resistance has risen to more than 100,000 ohms (approximately), current will not be restored to the line. The HIGH VOLTAGE lamp will remain extinguished and the LOAD ALARM lamp will remain lighted.

g. If the power supply is left as in *d* (2) or *f*(2) above, the current will be restored to the line at any time that the trouble is cleared. The LOAD ALARM lamp will be extinguished and the buzzer will sound. Operate the ALARM CUTOFF lever switch to OFF to silence the buzzer.

178. Trouble Location by Observing Performance of Order Wire Circuit

a. If a power alarm is accompanied by a failure of the order wire circuit, the trouble probably is located in the spiral-four cable.

b. If the order wire circuit continues to perform,

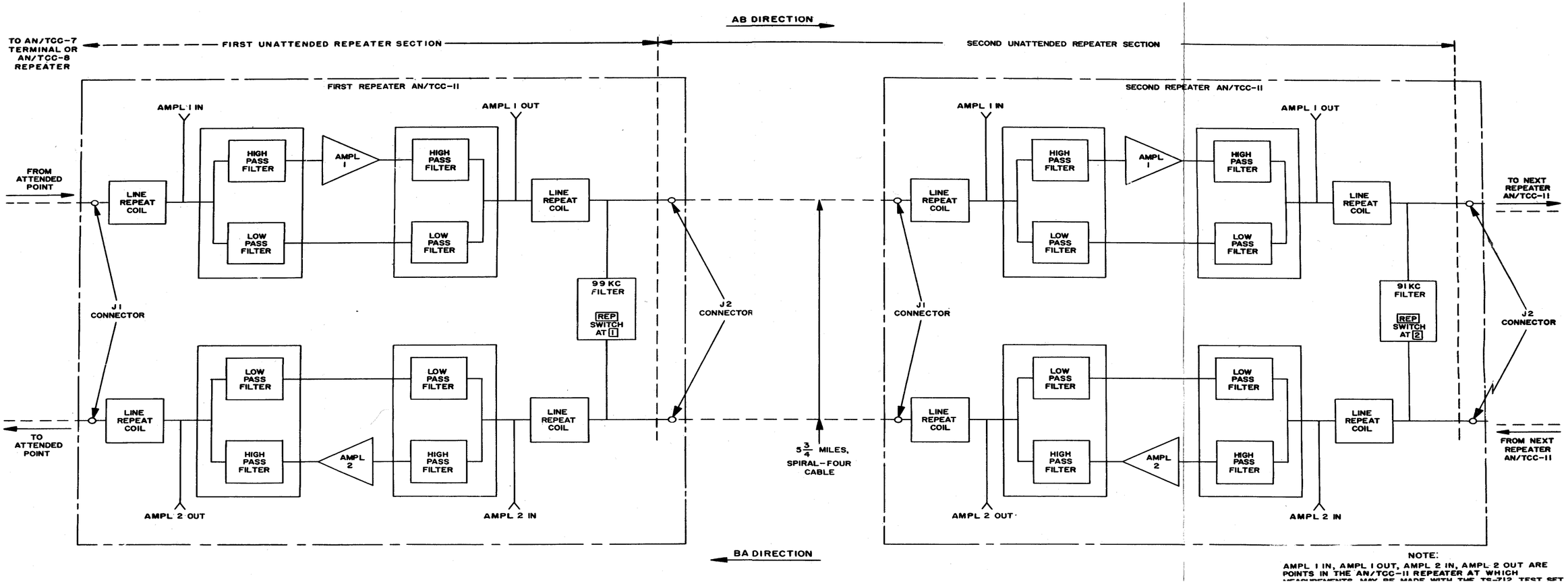


Figure 52. Unattended repeater section, functional diagram.

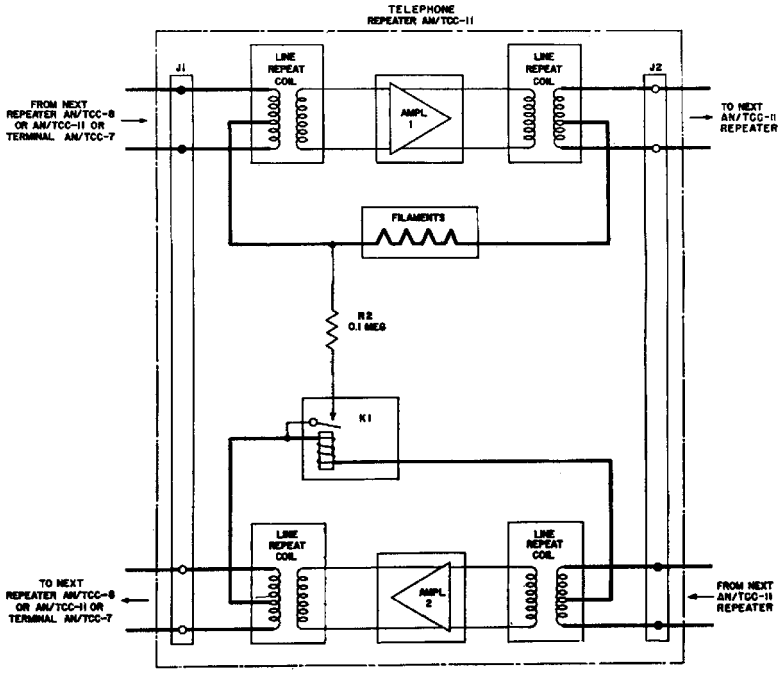
the trouble probably is located at an AN/TCC-11 repeater.

179. Power Loop Open

a. A high resistance in the power loop is indicated by lighting of the HIGH VOLTAGE and LOAD ALARM lamps. Upon operating the RESTORE lever switch, the HIGH VOLTAGE lamp will be extinguished. If it remains extinguished, the power loop is probably open.

b. Figure 53 is a simplified diagram of the power loop circuit arrangement in an AN/TCC-11 repeater in which the PWR LOOP-PWR THRU switch (not shown) is in the PWR THRU position. When power is removed from the AN/TCC-11 repeater, relay K1 releases and causes a resistance of 100,000 ohms (R2) to be bridged across the power loop.

c. Measurement of the resistance of the power loop may indicate the location of the open circuit. Remove power from the PP-826 VOLT POWER SUPPLY on which the alarm is indicated by operating the AC POWER switch to OFF. At an AN/TCC-7 terminal, disconnect the cable from the POWER SUPPLY to the JUNCTION PANEL by disengaging the connector at the



NOTE:
POWER LOOP SHOWN BY HEAVY LINES.
TM2150-55

Figure 53. Power loop circuit in AN/TCC-11 repeater, functional diagram.

JUNCTION PANEL Use an ohmmeter to measure the resistance of the power loop by measuring across pins A and B (ground) of connector J102 (marked TO 600 V POWER SUPPLY on the JUNCTION PANEL. At an AN/TCC-8 repeater disconnect the cable from the POWER SUPPLY to the AM-708 REPEATER PANEL and measure across pins A and B (ground) of connector J18 or J19 (marked 600 V POWER TOWARD A and 600 V POWER TOWARD B. respectively).

d. The following table lists the probable location of the open circuit for various values of resistance measured.

Aprx res (ohms)	Location of trouble in power loop
Greater than:	
200,000	Between point of measurement Slid resistor R2 in first AN/TCC-11 repeater.
100,000	Between resistors R2 in first and second AN/TCC-11 repeaters.
50,000	Between resistors R2 in second and third AN/TCC-11 repeated.
33,000	Beyond resistor R2 in third AN/TCC 11 repeater.

180. General Procedure, Power Loop Trouble at Attended Point

a. Power loop resistance measurements (par. 179*c*) help to locate any type of power loop trouble.

b. If an open circuit is indicated before resistor R2 of the first repeater, a measurement of the resistance and capacity of each pair in the cable (par. 161) may help to locate the open.

c. In the event of a grounded wire in the cable, a measurement of the power loop resistance may help to locate the trouble. The table below lists power loop resistance data. Figure 50 shows an example of the use of this table to locate a grounded conductor.

Portion of power loop	Approx d-c res (ohms at 55^0 F.)
6 reels of cable	70
12 reels of cable	130
18 reels of cable	195
23 reels of cable	250
1 AN/TCC-11 repeater (path with heaters-no power)	1,200
1 AN/TCC-11 repeater (path without heaters)	30

Note. Cable reels are assumed to be, exactly one fourth mile long. Cable resistance values represent totals for both sides of the power loop

181. Power Loop Trouble at AN/TCC-11 Repeater

a. Dispatch a repairman to the AN/TCC-11 repeater near the trouble determined from the tests above (par. 180). The repairman should be supplied with a Test Set TS-27/TSM. Set a time at which power will be removed from the power loop in trouble. This prevents injury to the repairman in the event that the trouble clears itself and power is restored automatically.

b. The information obtained from paragraph 178 indicates whether the trouble is in an AN/TCC-11 repeater or in a section of cable.

c. Upon reaching the AN/TCC-11 repeater, use the order wire to call the attended point in the same power loop. If unable to contact the attended point, wait until the agreed time before opening the cable connector. This precaution is necessary to avoid the hazard of power which may be restored while the cable connector is being handled.

d. If the AN/TCC-11 repeater is suspected to be in trouble, check the lightning arresters (par. 158). If this procedure fails to clear the trouble, replace the repeater with a spare.

e. If the cable is suspected to be in trouble, remove the cable from the repeater in the direction in which the trouble is suspected. Use the Test Set TS-27/TSM to make resistance and capacity measurements on the cable by connecting to the wires at the cable connector (fig. 48). Refer to figure 45 which shows the power loop circuit. Refer to paragraphs 161 and 180*c* for the proper interpretation of the resistance and capacity values obtained.

f. If able to talk on the order wire and no trouble is found from that AN/TCC-11 repeater, set another time for removal of power and move to the next AN/TCC-11 repeater.

182. Functioning of Carrier Alarms

The AN/TCC-7 terminal contains alarms that indicate failure of the 120-kc carrier supply and the 68-kc pilot supply. This paragraph describes the operation of these alarms.

a. 120-kc Alarm. A failure of the 120-kc carrier causes loss of transmission from the AN/TCC-7 terminal at which the failure occurs (except 12-to 60-kc special service). The loss is indicated by the lighting of the 120-KC ALARM lamp on the TA-228 CARRIER SUPPLY PANEL and the sounding of a buzzer.

b. 68-kc Alarm.

(1) A failure of the 68-kc pilot at an AN/TCC-7 terminal is indicated by the lighting the of the 68-KC ALARM lamp on the TA-228 CARRIER SUPPLY PANEL and the sounding of a buzzer.

(2) If only the 68-kc pilot fails, system transmission is not interrupted immediately. However, as long as the 68-kc pilot is off, the gain of the automatic regulated amplifiers (at the AN/TCC-8 repeaters and in the receiving circuit of the AN/TCC-8 terminal) will drift upward and the system transmission soon will be in trouble.

(3) If measurements of the 68-kc pilot at any point disclose a beat exceeding plus and minus 0.2 db on the test meter the cause may be a lack of synchronization of the 68-kc pilots for the two directions of transmission. Check the setting of the CARP-SYNC lever switch on the TA-228 CARRIER SUPPLY PANEL at the two AN/TCC-7 terminals (par. 125*b*). In the terminal at which the CARRSYNC switch is set to REMOTE, look for trouble in the carrier synchronizing circuits of the CARRIER SUPPLY PANEL and GROUP PANEL, (see the AN/TCC-7 terminal technical manual).

c. General.

(1) To silence the alarm buzzer, operate the appropriate ALARM CUTOFF lever switch.

(2) When the trouble has been cleared, the buzzer will sound. Restore the ALARM CUTOFF switch to its nonoperated (vertical) position.

(3) Trouble location procedures for the TA-228 CARRIER SUPPLY PANELS are given in the AN/TCC-7 terminal technical manual.

183. Failure of a Message Channel

Failure of a message channel may be reported by a switchboard operator or noted during a routine check of message channel transmission. If no 68-kc alarms or other symptoms occur, the trouble is probably in a terminal of the AN/TCC-7 system. This paragraph describes a procedure for determining the terminal in trouble.

a. Direction of Transmission. If the direction of transmission in trouble is not known, follow the procedure in (1) through (4) below.

(1) Arrange for attendants at the two AN/TCC-7 terminals to talk; on the message channel in trouble (par. 137*b*).

(2) Ability to hear satisfactorily at each AN/TCC-7 point should indicate which direction of transmission is in trouble.

(3) If neither direction of transmission appears to be in trouble, talk to the nearby switchboard over the message channel at each AN/TCC-7 point (par. 137*b*). No transmission indicates a trouble between the TALK-MON lever switch on the TA-219 CHAN MODEM and the switchboard.

(4) If no trouble is indicated conclusively by (1) through (3) above, check the message channel output (par. 149) for both directions of transmission.

b. Location of Trouble. The procedure outlined in *a* above determines which direction of transmission is in trouble. The following procedure determines which terminal of the system is in trouble. The instructions below pertain to trouble in the *AB* direction.

(1) At the *A* AN/TCC-7 terminal, operate the SEND-MEAS lever switch to SEND on the message channel in trouble.

(2) Use the TS-760 TEST PANEL to measure the signal at the MOD IN jack (with the same number as the TA-219 CHAN MODEM in which the message channel is located) OF the TA-227 SUBGROUP PANEL, (par. 253, item 4, 5, or 6). The TEST PANEL, meter should read not less than -3 db. If the reading fluctuates (because of talking on other channels connected to the same TA-219 CHAN MODEM), the minimum readings should not be loss than -3 db. Operate the SEND-MEAS lever switch several times at the SEND and nonoperated positions. The reading should drop at least 3 db when the switch is nonoperated, and should return to the first value when the switch is operated to SEND. Failure to meet these requirements indicates trouble in the message channel transmitting circuits of the *A* terminal. Refer to the technical manual for the AN/TCC-7 terminal.

(3) If the TEST PANEL meter reading meets the requirements outlined in (2) above, the trouble probably is located in the message channel receiving circuits of the *B* terminal. Refer to the AN/TCC-7 terminal technical manual.

184. Failure of a Special Service Channel (4 to 20 kc)

Use the following procedure in case of failure of a 4- to 20-kc special service channel or a group of four message channels from the same TA-219 CHAN MODEM. It is assumed that no 68-kc alarms or other symptoms have occurred.

a. To determine the direction of transmission in trouble, observe the special service transmission failure or apply the procedure in paragraph 183*a* if message channels are involved. The instructions below pertain to trouble in the *AB* direction.

b. At the *A* AN/TCC-7 terminal, operate the SPECIAL SERVICE (1, 2, or 3) lever switch on the TA-227 SUBGROUP PANEL to CHAN MODEM (if it is not in that position already). Choose the switch corresponding to the number of the 4- to 20-kc channel in trouble.

c. Operate the SEND-MEAS lever switch on channel 2 of the appropriate TA-219 CHAN MODEM to the SEND position.

d. Use the TS-760 TEST PANEL to measure the output at the 60-108 KC OUT jack on the TA-227 SUBGROUP PANEL (par. 250, item 10, 11, or 12). The frequency measured and the paragraph 253 item number reference depend on the number of the TA-219 CHAN MODEM being used. Use the information in the following table to select the applicable paragraph 253 item number reference for the desired TA-219 CHAN MODEM frequency measurement.

TA-219 CHAN MODEM	Frequency	Par. 253 item number reference
1	67	10
2	83	11
3	99	12

e. The TEST PANEL meter should read between-4 and +4 db. If the reading is outside these limits, the trouble is probably in the transmitting circuits of the TA-227 SUBGROUP PANEL of the *A* terminal. Refer to the AN/TCC-7 terminal technical manual.

f. If the reading of the TEST PANEL meter *(e* above) is within limits, measure the 11-kc output at the appropriate DEM OUT jack on the TA-227 SUBGROUP PANEL at the *B* terminal (par. 253, item 7, 8, or 9).

g. The TEST PANEL meter should read between-4 and +4 db. If the reading is outside these limits, the trouble is probably in the receiving circuits of the TA-227 SUBGROUP PANEL of the *B* terminal. Refer to the AN/TCC-7 terminal technical manual.

h. If readings within limits are obtained in e and g, above, there may be trouble at either AN/TCC-7 terminal between the MOD IN jack and the SPECIAL SERVICE binding posts on the TA-227 SUBGROUP PANEL or the fault may be between the DEM OUT (1, 2, or 3) jack on the SUBGROUP PANEL and the demodulator band filter in the corresponding TA-219 CHAN MODEM. Refer to the technical manual for telephone terminal AN/TCC-7.

185. Failure of All 12 Message Channels

Use the following procedure in case of failure of all 12 message channels, or failure of a 60- to 108-kc or 12- to 60-kc special service channel. It is assumed that no 68-kc alarms or other symptoms have occurred.

a. To determine the direction of transmission in trouble, follow the procedure below or apply the procedure in paragraph 183a. The instructions below pertain to trouble in the AB direction.

b. At the *A* AN/TCC-7 terminal, operate the 60-108 KC lever switch and the 12-60 KC lever switch on the GROUP PANEL to the REGULAR position.

c. Operate the SEND MEAS lever switch to the SEND position on channel 2 of the No. 2 TA-219 CHAN MODEM.

d. Use the TS-760 TEST PANEL to measure the 37-kc output at the TR AMP OUT jack on the GROUP PANEL (par. 253, item 21).

e. The TEST PANEL meter should read between-3 and +3 db. If the reading is outside these limits, the trouble is probably in the transmitting circuits of the GROUP PANEL at the *A* terminal. If the reading is within these limits, the trod probably is located in the receiving circuits of the GROUP PANEL at the *B* AN/TCC-7 terminal. Refer to the AN/TCC-7 terminal technical manual.

186. Excessive Modulation Products in System

a. Cause.

(1) Circuits transmitting two or more frequencies generate modulation products whose frequencies are equal to the sums and differences of multiples of the transmitted frequencies. The AN/TCC-7 system transmits several frequencies simultaneously and generates numerous modulation products.

(2) The amplitude of the products is limited by the performance of the amplifiers distributed throughout the system. These amplifiers use negative feedback to stabilize the transmission and reduce the amplitude of the modulation products. As the tubes in the amplifiers age, however, the magnitude of this feedback decreases and the amplitude of the modulation products increases.

b. Symptoms. Excessive modulation results in tones or noise that have properties similar to those of inverted speech. For example, the frequencies of speech on one message channel may modulate with the 68-kc pilot to produce frequencies falling in a different message channel and heard as noise with the cadence of speech. Excessive modulation may be mistaken for noise or crosstalk.

c. Monitoring Channels. Monitor a noisy channel to observe the magnitude and nature of the noise. Apply the monitoring procedure (par. 148) for the particular channel in question. Study the nature of the noise to determine whether the trouble is excessive modulation or static noise.

187. Location of Source of Excessive Modulation, General

The procedure for locating a source of excessive modulation is similar to the sectionalizing procedure described in paragraph 151*c*. First verify the existence of excessive modulation for the whole system. Next, take the measurements of individual attended repeater and radio sections to determine which section is in trouble.

a. System Test. When excessive modulation is reported and verified by monitoring tests, perform the system modulation tests described in paragraph 128. Failure to meet the limit is evidence of excessive modulation. Follow the procedure described in *b* below.

b. Attended Repeater Section. Locate the source of excessive modulation in a particular attended repeater or radio section by following the procedure of paragraph 150*b*. Perform the tests only for the direction of transmission in which the trouble is known to exist. The procedure may reveal more than one section contains a source of excessive modulation.

188. Excessive Modulation in Amplifiers at Attended Points

The procedure of paragraph 187 determines the attended repeater or radio sections that contain sources of excessive modulation. Check the amplifiers at the attended points at the ends of these sections. The following are some general considerations:

a. Perform the tests only on the amplifiers that transmit in the direction of transmission in which the trouble exists.

b. Perform the tests on the amplifiers at the attended points at both ends of all sections in trouble.

c. Conduct tests at only one point at a time. Coordinate the testing with the control terminal to observe this limitation

d. Paragraphs 189 and 190 cover the details of the procedure.

189. Excessive Modulation in Amplifiers at AN/TCC-7 Terminal

Use the following procedure to determine whether a source of excessive modulation is located in the amplifiers at an AN/TCC-7 terminal point.

a. Transmitting Amplifier. If the modulation trouble is in the direction of transmission in which the AN/TCC-7 terminal transmits, proceed as follows:

(1) Arrange the TS-760 TEST PANEL to send 65 KC to the transmitting amplifier input (par. 255, item 3). Measure the 65-kc output at the TR AMP OUT jack on the GROUP PANEL (par. 253, item 20) and adjust the output to obtain a reading of 0 db on the TEST PANEL meter.

(2) Measure the 62-kc power at the TR 62 KC jack on the GROUP PANEL (par. 253, item 23). Read the meter on the TS-760 TEST PANEL with no ATTENUATOR push buttons operated.

(3) If the reading exceeds-5 db, the transmitting amplifier is contributing excessive

modulation trouble may be cleared by performing the operations indicated in (4) and (5) below.

(4) This step causes an interruption of the system transmission. Replace tubes V1 and V2 (one at a time) in plug-in amplified AR3 (transmitting amplifier) of the GROUP PANEL Observe the meter reading as each tube is replaced The meter reading should drop below -7 db when the bad tube is replaced.

(5) Restore the SEND switch on the TS-760 TEST PANEL to the CHECK GAINCHECK HF position.

b. Receiving Amplifiers If the modulation trouble is in the direction of transmission in which the AN/TCC-7 terminal receives, proceed as follows:

(1) Arrange the TS-760 TEST PANEL to send 65 kc to receiving amplifier 1 input (par. 255, item 4). Measure the 65-kc power at the REC AMP 2 OUT jack on the GROUP PANEL (par. 253, item 34) and adjust the output to obtain a reading of 0 db on the TEST PANEL meter.

(2) Measure the 62-kc power at the REC 62 KC jack on the GROUP PANEL (par. 253, item 36). Read the meter on the TEST PANEL with no ATTENUATOR push buttons operated.

(3) If the reading exceeds-5 db, the receiving amplifiers are causing excessive modulation. The trouble may be cleared by performing the operations indicated in (4) and (5) below.

(4) This step causes an interruption of the system transmission. Replace tubes V1 and V2 (one at a time) in plug-in amplifiers AR1 and AR2 (receiving amplifiers 1 and 2) of the GROUP PANEL. Observe the meter reading as each tube is replaced. (Allow a minute or two for the reading to stabilize.) The meter reading should drop below -7 db when the bad tube is replaced.

(5) Restore the SEND switch on the TEST PANEL to the CHECK GAIN-CHECK HE position. Adjust the 65 KC REC control at its extreme counterclockwise position.

190. Excessive Modulation in Amplifiers at AN/TCC-8 Repeater

Use the following procedure to determine whether excessive modulation originates in the amplifiers at an AN/TCC-8 repeater point. The instructions pertain to modulation trouble in the AB direction of transmission.

a. Arrange the TS-761 'T'EST PANEL to send 65 kc in the *AB* direction (par. 260, item 3). Measure the 65-kc output at the *AB* AMP 2 OUT jack on the AM-708 REPEATER PANEL (par. 258, item 14) and adjust the SEND control to obtain a reading of 0 db on the TEST PANEL meter.

b. Measure the 62 kc power at the *AB* 62 KC jack on the AM-708 REPEATER PANEL (par. 258, item 17). Read the meter on the TEST PANEL with no ATTENUATOR push buttons operated.

c. If the reading exceeds -5 db, amplifier *AB* AMP 1 or *AB* AMP 2 is contributing excessive modulation. The trouble may be cleared by performing the operation in *d* below.

d. This operation causes an interruption of the system transmission. Replace tubes V1 and V2 (one at a time) in plug-in amplifiers AR1 and AR2 (AB AMP 1 and AB AMP 2) in the REPEATER PANEL. (The corresponding amplifiers for the *BA* direction are AR3 and AR4.) Observe the meter reading as each tube is replaced. (Allow a minute or two for the reading to stabilize.) The meter reading should drop below-7 db when the bad tube is replaced.

e. Restore the SEND lever switch on the TS-761 TEST PANEL to CHECK.

191. Excessive Modulation in Radio Section

If the modulation trouble is in a radio section and the tests in paragraphs 189 and 190 reveal no sources, the trouble must be within a radio link. The procedure for locating troubles within radio links is included in the technical manual for the radio equipment.

192. Excessive Modulation in Unattended Repeaters

If the modulation trouble is in an attended repeater section and the tests of paragraphs 189 and 190 reveal no sources of excessive modulation, the trouble must be in an AN/TCC-11 repeater**.** Apply the following procedure to locate the AN/TCC-11 repeater in trouble.

Caution: Before measuring activity(*b* below) contract the attendant at the attended point from which power is fed to the AN/TCC-11 repeater being tested Request a measurement of the output of the appropriate POWER SUPPLY. If the TEST PANEL, meter reading at the attended point is less than -.5 db the attendant must readjust the 600 V ADJ control to obtain a reading of 0 db. Failure to observe this caution may result in a power alarm which removes power from the line.

a. Go to the first AN TCC-11 repeater in the section in which the trouble exists.

b. Use the TS-712 test set to measure the activity of the tubes in the AN/TCC 11 repeater, one at a time (par. 160*c*) If the decrease in the meter reading for any tube exceeds 5 db or if the reading is outside the limits of-5 to +5 db, that tube probably is causing modulation.

c. If a tube is suspected to be in trouble, replace the repeater with a spare (par. 157).

d. After replacing a repeater, check the modulation of the attended repeater section. Use the procedure in paragraph 150*b* for the direction of transmission in which the trouble had existed.

e. If the trouble is not cleared by the tests at the first AN/TCC-11 repeater, go to the next AN/TCC-11 repeater and again perform the procedure in *b* to *d* above.

f. Repeat this procedure for all AN/TCC-11 repeaters in succession until the trouble is cleared.

g. After the excessive modulation of an attended repeater section has been cleared, check the system modulation (par. 128) to verify that the system trouble has been cleared.

193. Location of Noise and Crosstalk

Paragraphs 194 through 196 describe procedures for locating sources of excessive noise and excessive crosstalk. The two types of trouble are grouped together because the procedure is the same for each. Moreover the two troubles have common causes and often occur together.

a. Causes of Noise.

(1) Static electrical disturbances induce voltages in the cable and equipment circuits. The disturbances are heard as hisses and cracks Normally, this noise is not objectionable. Typical sources of objectionable noise are the severe electrical storms along the route of the cable**.** These storms may increase the noise level to a noticeable degree.

(2) Another source of noise is voltage induced into the cable from a power line of other circuit transmitting relatively large amounts of power If the precaution expressed in paragraph 46*d* is observed (with regard to avoiding a cable route close to and parallel to a transmission line) this noise should not be objectionable

(3) Cable troubles may increase the pickup of static or power noise. Any unbalance in the impedance of the two wires of a pair in the cable to ground or an actual ground on one wire will increase noise pickup.

(4) Circuit troubles that cause considerable increase in transmission loss at some point in the system may cause high gain output of some amplifiers, thus amplifying normal noise to an objectionable level. In most cases this condition causes a 68-kc transmission alarm. However**,** the excessive gain may exist without bringing in an alarm.

(5) Faulty regulation or insufficient range of regulation may result in excessive system gain at some frequency that causes the circuit to oscillate, or sing.

b. Causes of Crosstalk.

(1) Crosstalk may occur through coupling between the pair transmitting in one direction and the pair transmitting in the other direction. It may occur also between two adjacent cables. Normally, the magnitude of this crosstalk is low enough to be unobjectionable.

(2) Cable and circuit faults described in *a(3)* and (4) above may increase the crosstalk to an objectionable amount

c. Symptoms of Noise and Crosstalk.

(1) Noise is heard as hisses, cracks, or tones (resulting from a system sing), not having the character of speech.

(2) Crosstalk sometimes appears as intelligible speech at a low level. It also may cause echoes, bad frequency distortion, a *hollow* sounding circuit, or oscillations that may result in an audible tone.

d. Monitoring Channels. Monitor a noisy channel to observe the magnitude and nature of the noise. Apply the monitoring procedure (par. 148) for the particular channel in question. If circuit

sing is suspected, operate the 2W-4W lever switch of the channel being monitored to 4W. If the tone disappears, perform a carrier system line-up (paras. 121 through 125).

194. Check of 68-Kc Inputs for Noise or Crosstalk Location

The measurement of 68-kc power at the inputs of the receiving amplifiers at all attended points, helps to locate noise or crosstalk trouble. The procedure is as follows:

a. Measure the 68-kc inputs at all attended points in the direction of transmission in which the trouble exists. The instructions below pertain to trouble in the *AB* direction.

b. Measure the 68-kc power at the REC IN jack on the GROUP PANEL at an AN/TCC-7 terminal (par. 253 item 24) or the AB IN jack on the AM-708 REPEATER PANEL at an AN/TCC-8 repeater (par. 258, item 4).

c. If the algebraic sum of the meter reading and the numbers of the operated ATTENUATOR push buttons is less than 0 db, there is probably trouble in the attended repeater section preceding the point of measurement. Investigate this attended repeater section as described in paragraph 166*d*.

195. Sectionalizing Noise and Crosstalk Trouble in System

If the checks of paragraph 194 do not disclose the trouble, it may be traced to a particular part of the system by removing power from various portions of the system. Start at one end and proceed toward the other. Note that this procedure will cause an interruption of the system transmission. The instructions below pertain to trouble in the *AB* direction**.**

a. At the *B* terminal, operate the REGULATOR lever switch on the GROUP PANEL chassis to the MAN position. At all AN/TCC-8 repeater points operate the AB REGULATOR lever switch on the AM-708 REPEATER PANEL, chassis to the MAN position.

b. At the *B* terminal, monitor the channel in trouble (par. 148) while the power is turned off at various locations. Listen for a reduction in noise when the power is removed (*c through h* below). A large reduction in noise indicates trouble in the equipment or power loop from which power was removed**.**

c. Remove power from the *A* AN/TCC-7 terminal by operating the AC INPUT switch of the PP-827 200-VOI,T POWER .SUPPLY to the OFF position.

d. Restore power to the *A* AN/TCC-7 terminal and remove power from the power loop fed by the PP-826 600-VOLT POWER SUPPLY at this point (operate AC POWER switch to OFF).

e. Restore power to the power supply turned off in above. At the first AN/TCC-8 repeater point in the *AB* direction remove power from the PP-826 600-VOLT POWER SUPPLY which feeds power to the power loop toward the *A* AN/TCC-7 terminal.

f. Restore power to the power supply turned off in *e* above. Remove power from the PP-827 200-VOLT POWER SUPPLY at this point.

g. Restore power to the power supply turned off in *f* above. Remove power from the PP-826 600-VOI,T POWER SUPPLY which supplies power to the power loop toward the *B* AN/TCC-7 terminal.

h. Continue in this manner removing power from successive parts of the system until the section in trouble is found.

i. If the trouble is located within an AN/TCC-7 terminal or an AN/TCC-8 repeater, continue to monitor the channel in trouble and follow test procedures described in the appropriate equipment technical manual.

j. When the trouble has been cleared, restore all REGULATOR lever switches *(a* above) to the AUTO position.

196. Location of Noise and Crosstalk Trouble Within Power Loop

If the trouble is located within a power loop, it may be caused by a defective cable or AN/TCC11 repeater. Check the sections of cable and AN/TCC-11 repeaters in succession until the trouble is located.

a. Cable Troubles.

(1) Resistance and capacity measurements of the cable may reveal faults that cause excessive noise and crosstalk. The measurements are described in paragraph 161. This procedure causes an interruption of the system transmission.

(2) It will be necessary usually to make resistance measurements to ground and capacity measurements at the AN/TCC-11 repeaters to locate the trouble. Be sure that power has been remover! from

the cable before disconnecting the cable connector to make resistance measurements on the conductors in the cable. Measurements made on the cable in each direction at successive AN/TCC-11 repeaters determine the particular unattended repeater section in trouble and the approximate location of trouble within that section.

b. .AN/TCC-11 Repeater. To determine whether an AN/TCC-11 repeater is a source of noise, replace it with a spare (par. 157).

Section IV. OPERATION UNDER UNUSUAL CONDITIONS

197. General

Circumstances may require the AN/'I'CC-7 systems to be operated under unusual conditions. These conditions are described in paragraphs 198 through 218. Some of the unusual operating conditions involve the use of commercial equipments. Detailed information concerning commercial equipments appears in TM 11-486.

198. Interconnection With Commercial Systems

Under certain conditions, it may be desirable to interconnect the AN/TCC-7 system with a commercial telephone system. Provisions have been made for such a connection at the AN/TCC-7 terminal.

a. The AN/TCC 7 terminal channels may enter a commercial installation (par. *199a)* on a v-f basis either as 2-wire or 4-wire circuits.

b. Connection points (par. 1*99b)* have been provided on the AN/TCC-7 terminal to permit the output of commercial channel banks in the 60- to 108-kc frequency range to be transmitted through an AN/TCC-7 system.

c. Connection points (par. 199c) are provided on the AN/TCC-7 terminal to permit the terminal to be used in place of a commercial channel bank in a commercial system. Connections may be made to commercial group equipment operating in the 60- to 108-kc range.

199. Procedures for Interconnection With Commercial Systems

Procedure for Interconnection of AN/TCC-7 Channels with Commercial V-f Circuits. Commercial v-f circuits may be connected directly to the TA-219 CHAN MODEM of the AN/TCC-7 terminal. The circuits may be either 2-wire or 4-wire as required. Voice frequency signaling equipment must be included in the commercial portion of the connection. The connecting circuits must be arranged to provide the impedance and levels facing the AN/TCC-7 terminal as described in (1) and (2) below.

(1) *2-wire collections.* 2-wire connections must provide 600 ohms nominal impedance with the transmitting and receiving levels not exceeding 0 db and -3 db respectively

(2) *4-wire connections. 4-wire* connections must provide 600 ohms impedance towards the AN/TCC-7 terminal. Normally, the 4-wire transmitting and receiving levels are -4 db and + 1 db, respectively, at the AN/TCC-7 terminal. These may require some readjustments for compatibility with commercial circuits at the commercial patching board. As an example, commercial installations employing most type J. K, or L carrier telephone systems are arranged for patching circuits having transmitting and receiving levels of-13 db (or-16 db) and +4 db (or +7 db), respectively. The transmitting level of the AN/TCC-7 terminal may be converted to -12 db by wiring out the 8 db pad which immediately precedes the input transformer of the modulator in each channel circuit of the TA-219 CHAN MODEM. The receiving level of the AN/TCC-7 terminal may be adjusted-by means of the channel receive GAIN controls of the TA-219 CHAN MODEM.

b. Interconnection. OF AN/TCC-7 Terminal and Commercial Channel Bank Equipment. When the AN/TCC-7 system line-up is completed, the system is properly adjusted to interconnect the AN/TCC-7 terminal with a commercial telephone system. The connecting circuits should be arranged to provide the proper impedances and levels facing the AN/TCC-7 terminals.

(1) Connection, from commercial system channel bank to AN/TCC-7 equipment.

(a) Connect the modulator output of a commercial system channel bank of 12 message channels in the 60- to 108-kc frequency range to the MOD IN

binding posts on the GROUP PANEL of tile AN/TCC-7 terminal.

(b) Connect the demodulator input of the commercial system channel bank to the DEM OUT binding posts on the GROUP PANEL.

(c) Disconnect the two cables from the TA-227 SUBGROUP PANEL, which normally connect to connectors on the SUBGROUP PANEL marked TO GROUP PANEL, and TO JUNCTION PANEL.

(2) *Levels and impedance at AT/TCC-7 terminal*.

(a) Adjust the output of the commercial system to produce a -42-db level at the MOD IN binding post of the AN/TCC-7 terminal. Adjust the input to the commercial system to receive a-5 db input from the DEM OUT binding posts of the AN/TCC-7 terminal.

(b) The impedances of the commercial equipment demodulator input and modulator output must be matched to 135 ohms.

c. Interconnection of AN/TCC-7 Terminal and Commercial System Group Equipment The commercial system must be lined up before interconnection with the AN/TCC-7 terminal. After the commercial system and the AN/TCC-7 terminal have been interconnected, the individual AN/TCC-7 terminal channels must be lined up. The connecting circuits must be arranged to provide the proper impedances and levels facing the AN/TCC-7 terminal.

(1) *Connection from AN/TCC-7 equipment to commercial system group equipment*.

(a) Connect the 60-108 KC OUT binding posts on the TA-227 SUBGROUP PANEL to the 60- to 108-kc group modulator input of the commercial system.

(b) Connect the 60-108 KC IN binding posts on the TA-227 SUBGROUP PANEL to the group demodulator output of the commercial system.

(2) *Levels and impedance at AN/TCC-7 terminal.*

(a) Adjust the input to the commercial system to receive a-42-db level from the 60-108 KC OUT binding posts of the AN/TCC-7 terminal. Adjust the output of the commercial system to produce a -5-db input at the 60-108 KC IN binding posts of the AN/TCC-7.

(b) The impedances of the commercial equipment demodulator output and modulator input must be matched to 135 ohms.

200. Operation With One Telephone Repeater AN/TCC-11 Removed From System

The system may be operated with one AN/TCC-11 repeater removed. This operation should be employed only in an emergency. Such an emergency might occur when an AN/TCC-11 repeater becomes defective and no spare is available. The changes in adjustments and line-up procedure are described in paragraphs 201 through 204. To restore transmission temporarily, remove the defective AN/TCC-11 repeater and connect together the cable connectors which were previously connected to this repeater. Rearrange the power loops as described in paragraph 201 before restoring power to the line. Replace the defective AN/TCC-11 repeater and restore operation to normal as soon as possible.

201. Power Loop Changes Required When One AN/TCC-11 Repeater Is Removed From an Attended Repeater Section

a. If the PWR LOOP-PWR THRU switch was operated to the PWR LOOP position on the removed repeater, operate the PWR LOOP-PWR THRU switch to the PWR LOOP position at either of the adjacent AN/TCC-11 repeaters (preferably the one in the direction faced by connector J2 of the removed repeater).

b. Make any required readjustments in the PP826 600-VOLT POWER SUPPLY which supplies power from the two ends of the attended repeater section to the power loops affected by the removal of the AN/TCC-11 repeater. If the length of cable supplied by a power loop is increased, it may be necessary to readjust the high-voltage alarm setting of the PP-826 600-VOLT POWER SUPPLY approximately 25 volts upward.

202. Gain and Equalization Readjustment Required When One AN/TCC-11 Repeater is Removed From an Attended Repeater Section

The omission of an AN/TCC 11 repeater creates a loss of gain and a change in equalization which

must be compensated for by readjustments in the remaining AN/TCC-11 points within the attended repeater section and at the attended points at both ends of the section.

a. The gain is restored by increasing the output from the attended point toward the section (by readjustment of the transmitting CABLE REELS TO FIRST AN'/TCC-11) and by increasing the gain of some of the ANT/'I'CC-11 repeaters proceeding the removed AN/TCC-11 repeater. Any additional remaining gain deficiency is made up by increasing the gain of the AN/TCC-l l repeater s beyond the missing repeater, and by readjusting the Flat control and the receiving CABLE Reels TO FIRST AN/TCC-11 switch at the attended point at the receiving end of the section (par. 218).

b. The equalization is restored partly at the attended points at both ends of the section by adjusting the CABI,E REELS TO FIRST AN/TCC-11 switches to higher members. The remaining equalization is obtained by adjusting the SLOPE and BULGE controls (par. 203).

c. Note the original settings of the CABLE REELS TO FIRST AN/TCC-11 switches at the attended points and the GAIN controls at the AN/TCC-11 repeaters so that they may be reset when normal operation is restored.

203. Changes in Line-up Procedure at Attended Points When One AN/TCC-11 Repeater is Removed From an Attended Repeater Section

Line up the system (paras. 113 through 125) by making the changes in line-up procedure outlined in *a* through *c* below. These changes are for a line-up in the *AB* direction. Similar changes in line-up procedures must be made in the BA direction.

a. Transmitting Adjustments at the A End of Section. At the attended point at the *A* end of the attended repeater section, containing the AN/TCC-11 point from which the repeater was removed, operate the CABLE REELS TO FIRST AN/TCC-11 switch according to directions in (1), (2) or (3) below.

(1) If the first AN/TCC-11 repeater from the attended point is removed, set the switch to the 23 position.

(2) If the second AN/TCC-11 repeater from the attended point is removed, set the switch to a position three reels more than normal (if possible).

(3) If the third or more distant AN/TCC-11 repeater from the attended point is removed, set the switch to its normal position.

b. Receiving adjustment at the A End of Section. When the attended point at the A end of the section is an AN/TCC-8 point make receiving adjustments in the *AB* direction as follows:

(1) If the first AN/TCC-11 repeater is removed:

(a) Set the CABLE REELS TOWARD A TERM TO FIRST AN/TCC-11 (AB IN) control to a position three reels more than normal (if possible).

(b) Adjust the AB FLAT ADJ 68 KC control to obtain a TEST PANEL meter reading of +3 db at the AB AMP 1 OUT jack.

(*c*) Adjust the AB AUTO REG OUTPUT control to obtain a meter reading of +3 db at the AB AMP 2 OUT jack.

(d) Readjust the 68-kc transmission alarm limits as described in paragraph 101*d*.

(e) Adjust the AB SLOPE ADJ 12 KC and AB BULGE ADJ 28 KC controls to obtain meter readings of approximately 3 db at the AB amp 2 OUT jack for the 12-kc and 28-kc test frequencies, respectively.

(2) If the second or more distant AN/TCC11 repeater is removed, follow the normal line-up procedure (paras. 113-125).

c. Adjustments at B end of Section. At the attended point at the B end of the section proceed as follows:

(1) Measure the 68-kc output at the AB (or REC) AMP 1 OUT jack. Adjust the CABLE REELS TO FIRST AT\T/TCC-11 (receiving from the missing AN/TCC-11 repeater) toward higher numbers until a reading of 0 db +2 db is obtained on the TEST PANEL, meter. If the reading is still below 0 db with the CABLE REELS switch at the 23 position, adjust the appropriate Flat ADJ 68 KC control to obtain a reading as close as possible to 0 db.

(2) Measure the 68-kc output at the AB (or REC) AMP 2 OUT jack. Adjust tile AUTO REG OUTPUT control to obtain a meter reading equal to that obtained at the AMP 1 OUT jack. If

necessary, readjust the 68-kc transmission alarm limits as described in paragraph 101d.

(3) Adjust the SLOPE ADJ 12 KC and BULGE ADJ 28 KC controls to obtain meter readings at the AMP 2 OUT jack approximately equal to that obtained for 68 kc, using the 12-kc and 28-kc test frequencies, respectively.

(4) At an AN/TCC-7 point, if the meter reading at the REC AMP 1 OUT jack is less than 0 db, the deficiency is made up by adjustment of the gain controls beyond that point (DEM GAIN in the GROUP PANEL, DEM 1, 2, and 3 GAIN on the TA-227 SUBGROUP PANEL, and GAIN on the channels of the TA-219 CHAN MODEMS).

(5) If, at an AN/TCC-8 repeated point, the meter reading at the AB AMP 1 OUT jack is less than 0 db, the deficiency is made up by increasing the setting of the CABLE REELS TOWARD B TERNIINAL TO FIRST AN/TCC-11 (AB OUT by three reels for each 3 db of gain deficiency.

204. Adjustment of Remaining AN/TCC-11 Repeaters When One AN/TCC-11Repeater Is Removed From Attended Repeater Section

a. The GAIN control of the amplifiers in the three preceding AN/TCC-11 repeaters (or all of the preceding repeaters in the attended repeater sections if fewer than three are used) which transmit toward the location of the omitted AN/TCC11 repeater, should be adjusted upward to obtain a reading near (but not exceeding) +6 db at the amplifier outputs.

b. The GAIN controls of the amplifiers transmitting away from the location of the omitted AN/TCC-11 repeater in all AN/TCC-11 repeaters beyond that point should be set to the HIGH position. In general, no meter indication can be obtained when measuring at the input and output of these amplifiers with the T~712 test set.

205. Emergency Operation, System Extended Beyond 200-Mile Range

a. In an emergency, a single AN/TCC-7 system may be operated over a maximum distance of 500 miles if a sufficient number of repeaters are available. As soon as a sufficient number of AN/TCC-7 terminals are available, the single AN/TCC-7 system should be converted to normal length AN/TCC-7 systems arranged for tandem operation.

b. Operation over distances exceeding 200 miles may result in considerable degradation of perform- on some broad band special services anal v-f telegraph. Other types of service will not be affected quite so much, although the noise, the crosstalk, and the modulation performance will be poorer. In addition, the band width of the order wire circuit will be reduced and the net loss of the circuit may increase.

c. Deviations of the circuit net loss from the nominal 3 db loss (for which the channels are adjusted at the time of line-up) will increase at some frequencies as the length of the system is increased beyond 200 miles. Some increase in the 3-db channel net loss may be advisable to avoid the possibility of circuit oscillation (4-wire *sing* around terminals). Increase in loss is accomplished during the system line-up procedure by adjusting the CHAN gain controls (par. 124c) to obtain TEST PANEL meter readings less than 0 db (adjustment to 0 db results in a 3-db net loss).

206. Emergency Operation When Field Wire Is Patched Into The Cable

a. In an emergency, short lengths of defective spiral-four cable may be replaced with WD1 or WD14 field wire. A maximum of one-fourth mile of field wire may be used as a patch in any unattended repeater section. A system line-up should be performed at the time of the repair. If the initial line-up is carried out in dry weather, it should be repeated when the field wire is wet. When long patches of field wire are used, it may be necessary to increase the net loss (par. 205c) of the message channels to a value greater than 3 db to prevent circuit oscillation (4-wire *sing* around terminals). The field wire should be replaced with spiral-four cable as soon as possible.

b. Patch each spiral-four cable pair with a field wire pair well spliced and well wrapped with electrical insulating tape and protective tape covering. Connect the shield braids of the cables to be joined with a third field wire pair. Wrap the braid well with bare field wire and tape the braid with insulating and protective tape. The shield braid connection is carried through mainly for

protective reasons. Keep the transmission pairs away from power lines and other sources of noise interference. Crosstalk between pairs will be at a minimum if the pairs are kept approximately 6 inches apart.

207. Emergency Operation Using Paper-Insulated Cable Instead of Spiral-4 Cable

The system may be operated over paper insulated land cables for an indefinite period of time. However, equalization and regulation are of an emergency character. It may be necessary to increase the net loss of the message channels to a value greater than 3 db to avoid circuit oscillation (par. 205c).

a. One- and Two-Cable Systems.

(1) If only one multipair insulated cable is available, pairs should be selected and checked for crosstalk as described in paragraph 218.

(2) If two cables are available, transmission is confined to pairs in one cable for one direction and to pairs in the other cable for the other direction. At repeater points, the directions of transmission are transposed between cables to reduce near end crosstalk.

b. Spacing of Repeaters.

(1) With AN/TCC-11 repeaters, use spacings which correspond to a cable loss of 22.3 db at 68 kc at 45° F. Repeater spacings for 19-gage cable may be about the same as for spiral-four cable.

(2) Spacings of AN/TCC-7 or AN/TCC-8 equipment without AN/TCC-11 repeaters may be extended to distances corresponding to a loss of 33 db at 68 kc.

(3) The table below gives the loss of cables of various types.

Loss of nonloaded entrance cable

Toll entrance cable

Gage	Loss (db per mile)		
	12 kc	28 kc	68 kc
10	0.6	0.95	1.6
13	.85	1.2	2.1
16	1.4	1.75	2.65
19	2.45	3.0	4.0

Exchange cable

Gage	Commer-cial type	Loss (db per mile)		
		12 kc	28 kc	68 kc
10		0.64,	1.0	1.7
13	TJ	.98	1.4	2.25
16	NH	1.6	2.0	3.0
19	DNB	2.75	2.4	4.4
19	CNB	3. 3	4.2	5.6
22	TS	4.6	5.7	6.9
22	ANA	4.9	6.1	7.4
22	CSA	5.3	6.7	8.2
24	NS	6.1	8.0	9.6
24	CSM	6.5	8.7	10.5
24	DSM	7.2	9.6	12.0
26	AST	8.4	11.4	14.4
26	BST	9.0	12.6	16.0

c. Power Loops. A power loop may contain not more than two AN/TCC-11 repeaters. If the cable is in poor condition and will not stand the 350 to 400 volts required to supply power to two AN/TCC-11 repeaters in a power loop, one AN/TCC-11 repeater may be tried, or AN/TCC-8 repeaters may be used in the system instead of AN/TCC-11 repeaters.

208. Emergency Operation Using Open Wire Lines Instead of Spiral-4 Cable

An AN/TCC-7 system may be operated over open wire. Carrier transposed lines should be used. The maximum allowable distance between repeaters varies from 40 to 80 miles, depending on the type of line and number of repeaters used. The line attenuation, the slope, the noise, and the crosstalk are factors which limit the maximum spacing. The line-up of the system is subject to considerable variation with temperature and wetness, and should be checked frequently. Systems of appreciable length may require an increase of the net loss of message channels beyond 3 db to prevent occasional oscillation of the system. Paragraphs 209 through 217 cover the application of an AN/TCC-7 system to open wire.

Caution: Only AN/TCC-8 repeaters may be used with open wire. AN/TCC-11 repeaters may not be used because the high voltage which is used to feed power to them over the line would present an extreme hazard to line maintenance screws. Moreover, the high leakage of open wire lines in wet weather will reduce the current delivered to the AN/TCC-11 repeaters beyond the minimum value required for their operation

209. Transpositions Required When Open Wire Lines Are Used

a. Open wire lines chosen for operation with an AN/TCC-7 system should be transposed for the carrier frequency band up to at least 68 kc. Transpositions should be similar to those used in the commercial type C or type J carrier system, in which transpositions occur at intervals of 2, 4, or 5 poles.

b. Inadequate transpositions cause appreciable crosstalk and transmission irregularities which limit the repeater gain and may impair the transmission of some channels. On lines transposed for voice frequency only (transposition intervals of 8 to 10 poles or more), such difficulties will arise in the region of 20 kc and above. On type C carrier transposed lines, difficulty begins around 90 kc; on type J carrier lines, well above 140 kc.

c. On many commercial open wire lines, v-f lines may be found on even-numbered crossarms (counting them from the top of the pole). Carrier transposed lines may be found on odd-numbered crossarms. Some lines are equipped for carrier circuits only; others are equipped for voice circuits only.

210. Crosstalk Considerations When Open Wire Lines Are Used

This paragraph discusses the crosstalk considerations which apply to operation of an AN/TCC-7 system operating over open wire lines. Crosstalk sometimes limits the length of the system and the allowable span between repeaters.

a. Near End Crosstalk in Same System. A limit of 25 db is necessary to minimize near-end crosstalk (crosstalk from a pair transmitting in one direction to the pair receiving from other direction). The limit is set at this value to restrict the frequency of errors in full-duplex voice-frequency carrier-telegraph transmission. For transmission of speech, near-end crosstalk shows up as an increase in sidetone, and a limit of less than 25 db may be tolerated.

b. Intersystem Crosstalk. 50 db is the desired limit for crosstalk from a pair of one system to a pair of another system transmitting in either direction.

c. Choice of Pairs.

(1) Crosstalk on pairs to be used should be measured with AN/TCC-7 or AN/TCC-8 equipment by transmitting 68 kc on each outgoing pair in sequence. In each case, measure the power received on all incoming pairs. As more systems are put into operation on pairs, the near-end and intersystem crosstalk may change because of interaction between systems. A recheck for crosstalk should be made.

(2) Pole pairs should be avoided because of high crosstalk, more noise, and greater transmission irregularities.

(3) Adjacent pairs on the same cross arm should be used if near end crosstalk is low; one pair for each direction of transmission in the same carrier system. The crosstalk is usually too high to permit use of adjacent pairs on two different systems.

(4) Pairs on the same cross arm separated by the pole or pairs on separate arms are preferred for separate systems. The same principle applies to long repeater spans in a single system.

(5) Wires of any one pair spaced 12 inches apart are subject to more crosstalk than wires spaced 8 inches apart or less. The average difference in crosstalk is 6 db. Wires of a pair spaced 12 inches apart and closed to 2 or 4 inches apart at every other pole are approximately equivalent to wires spaced 8 inches apart.

d. Crosstalk Loss Requirements. Crosstalk loss requirements for pairs are tabulated below in terms of losses at 68 kc. An intersystem requirement of 48-db loss has been established at 68 kc to allow about 50-db loss at 57 kc (the 1-kc point in the highest frequency message channel), and .to allow more loss in the 12- to 60-kc band. The near-end crosstalk requirement for a single system has been established at 24 db for 68 kc which allows a loss of approximately 25 db below 60 kc.

Loss requirements (in db) for crosstalk between pairs at 68 kc

Type of crosstalk	Number of repeaters			
	0	1	2	4
Near end (one system)	24+ G	27+G	29+G	31+B
Near end (intersystem)	48+G	51+G	53+G	55+G
Far end (intersystem)	48	51	53	55

Note. G-Repeater or receiving carrier amplifier gain in db.

e. Reduction of Intersystem Crosstalk. The intersystem crosstalk between two pairs may be reduced by opening any unused pairs in the open wire line at repeater points and terminating the lines in 600 ohms on each side of the break. A less effective alternative is to open the unused pairs without adding terminations. A third possibility is to short-circuit and ground the unused pairs.

211. Noise Considerations When Open Wire Lines Are Used

a. A satisfactory AN/TCC-7 system noise level is 38 dba at a 0 db level at the receiving terminal for 5 percent static noise. This limit is reached when the line loss between repeaters and terminals is used as shown in the table below.

Maximum 68-kc line loss per repeater span as limited by noise _

Type of line		Noise at repeater or terminal input (5 percent static at 57 kc) In dba	Maximum permissible 68-kc line loss per repeater span in db (wet weather) Number of repeaters			
Diameter in mils	Material		0	1	2	4
080	Copper.....	11	29	26	24	22
104	.....	12	28	25	23	21
128	.....	13	27	24	22	20
165	.....	15	25	22	20	18
080	Copper-steel (40 percent conductivity	9	27 31	24	22	20 28
104	.....	11	29	26	24	22
128	.....	12	28	25	23	21
165	.....	14	26	23	21	19
080	Copper-steel (30 percent conductivity)	8	32	29	27	25
104	.....	10	30	27	25	23
128	.....	11	29	26	24	22
165	.....	13	27	24	22	20
080	Steel.....	1	39	36	34	32
109	.....	2	36	35	33	31
134	.....	3	37	34	32	30

b. Lines with large unbalances caused by grounds, crosses with other lines, nonuniform sags, or broken insulators may be noisy. Proximity to power lines, especially if these are faulty and not well balanced, may cause excessive noise on the open wire line.

212. Repeater Limitations When Open Wire Lines Are Used

a. The AN/TCC-7 terminal and the AN/TCC-8 repeater have sufficient gain available to be operated on open wire spans of lengths for which the 68-kc loss is not more than 33 db. The distance that may be spanned, however, usually is limited by crosstalk and noise as indicated in paragraph 210 and i, c, and d below. The lengths of line which may be used depend on the type of line and the operating conditions.

b. The slope range between 12 and 68 kc which can be equalized at an AN/TCC-7 or an AN/TCC-7 point is limited to 14 db. This factor sometimes limits the maximum useful distance between repeaters. This distance, in terms of 68-kc loss, is given in the table below for several types of open wire line.

Maximum 68 kc teas (with DP insulators (Sig C stock No. 3G1815-1) in wet weather) corresponding to 14 db slope from 12 to 68 kc.

Type of line		Loss at 68 kc in db for which the 12-kc loss is 14 db less
Diameter in mils	Material	
080	Copper.....	26
104	.....	23
128	.....	23
165	.....	22
080	Copper-steel (40 percent conductivity-	38
104	.....	38
128		38
165		29
080	Copper-steel (30 percent conductivity	38
104	.....	38
128	.....	38
165	.....	38
165	Nonreferromagnetic (20 to 100 percent conductivity)	24
165	(10 percent conductivity)-------	34
109	Steel (1.2 oz zinc coating	38
	(2.4 oz zinc coating)	35

c. Typical losses for various types of lines are given in the following table:

Loss of typical open wire lines at kc

Diameter in mils	Type of line: Material	Loss in db per mile at 68 kc: Dry	Wet-CS insulators	Wet-DP insulators (Sig C stock No.3G1815-1
80	Copper	0.26	0.31	0.36
104		.22	.27	.32
128		.18	.23	.28
165		.15	.19	.24
080	Copper-steel (40 percent conductivity)	.35	.40	.45
104		.23	.28	.33
128		.18	.22	.27
165		.14	.18	.23
				.45
				.33
				.27
				.23
104	Copper-steel (30 percent conductivity)	.31	.36	.41
128		.22	.27	.32
				.41
				.32
165	Nonferromagnetic percentage of conductivity	.15	.19	.24
	100	.16	.20	.24
	90	.17	.21	.25
	80	.18	.22	.26
	70	.19	.24	.29
	60	.21	.26	.31
	50	.24	.28	.32
	40	.28	.32	.36
	30	.34	.38	.42
	20	.50	.54	.58
	10			

Loss of typical open wire lines at 68 kc-Continued

Diameter in mils	Type of line: Material	Loss in db per mile at 68 kc: Dry	Wet-CS insulators	Wet-DP insulators (Sig C stock No. 3G1815-1)
109	Steel (1.2 oz zinc coating).....	1.85	1.9	1.95
	(2.4 oz zinc coating.....	1.45	1.5	1.55

Notes.

1. Loss values apply for inch spacing wires.
2. For *12* -inch spacing subtract 0.02 db per mile (dry) or 0.01 per mile (wet).
3. Loss values apply for 53 insulators per wire per mile.

d. From the table in b and c above, and the table in paragraph 211a, spacing of repeaters and terminals can be determined. As a rough guide, the spacing usually will be limited to a 68-kc loss of 18 to 30 db (a, above). For a single system installation noise will usually be the limiting factor which determines the maximum permissible loss, although for copper lines slope is sometimes the limitation. For an installation of two or more systems the near-end crosstalk between two systems is often the limitation. Pairs should be chosen which meet the crosstalk requirements (par. 210d). If the open wire pairs show usually high crosstalk (low loss) the gain and repeater spacing must be reduced to the point where the crosstalk limits are met or the excess crosstalk tolerated. The maximum permissible loss should be checked with the table in b above to verify that the permissible range of slope is not exceeded.

e. The following table presents the maximum allowable spans of open wire between repeaters for several types of open wire and various numbers of repeaters.

Maximum distance between repeaters for several types of open w ire line and various numbers of repeaters

Diameter in mils	Material	68 kc loss in db per mile (Note 1)	No. Repeaters (1 span)		
			Open wire line		Max dist. (ml) with entrance cable (Note 2)
			68 kc gain (db)	Max. dist (mil).	
			(Note 4)		(Note 3)
80	Copper	0.36	26	72	64
104		32	23	72	64
128		.28	23	83	73
165		.24	22	91	81
08	Copper-steel (40 percent conductivity)	.45	(Note 3)		Note 3)
0104		.33	31	69	60
128		.27	29	88	76
165		.23	28	104	89
			26	113	95
			(Note 3)		(Note 3)
104	Copper-steel (30 percent conductivity	.41	30	73	63
128		.32	29	91	78

Maximum distance between repeaters for several types of open w ire line and various numbers of repeaters

Diameter in mils	Material	68 kc loss in db per mile (Note 1)	2 Repeaters (2 span)			4 repeaters (5 spans)		
			Open wire line			Open wire line		
			68 kc gain (db)	Max.dist (mil). (Note 2)	Max dist. (ml) with entrance cable	68 kc gain (db)	Max. dist (mil) (Note 2)	Max dist. (ml) with entrance cable
			(Note 3)		(Note 3)	(Note 3)		(Note 3)
80.....	Copper	0.36	24	67	55	22		50
104	.....	32	23	72	59	21	61	53
128	.....	.28	22	78	64	20	65	57
165	.....	.24	20	83	66	18	71	58
							75	
			(Note 3)		(Note 3)	(Note 3)		(Note 3)
080	Copper-steel (40 percent conductivity)	.45		58	49	24	53	44
104	.....	.33		26 73	60	22	66	54
128	.....	.27		24 85	70	21	78	63
165	.....	.23		23 91	74	19	82	65
				21				
			(Note 3)		(Note 3)	(Note 3)		(Note 3)
104	Copper-steel (30 percent conductivity)	.41	25	61	51	23	56	46
128	.....	.32	24	75	62	22	69	56

Note

1. Loss is given for a wet in with DP insulators.
2. Maximum distance represents span of open wire line with 1 mile of 19 gauge toll entrance cable.
3. Limited by noise consideration.
4. Limited by slope consideration

f. In most cases the maximum distance is limited by the consideration of noise, as described in paragraph 211. The distances may be increased if an increase in noise may be tolerated. For the copper open wire, slope is the limitation.

g. There may be no open wire pairs available which meet the crosstalk requirements of paragraph 210, particularly in an installation of two or more systems. In such a case the maximum distance must be reduced or poorer system crosstalk must be tolerated. The following is a typical example.

(1) Assume an open wire line using 128 mil copper conductors on which it is proposed to install two systems with four repeaters in each system.

(2) The table in e above, gives 20 db as the maximum permissible 68 kc gain and 71 miles as the maximum distance, as limited by noise. This would require an inter system near-end crosstalk of 55 db+20 db or 75 db. Upon measuring crosstalk of the available pairs, it may be seen that the best near-end crosstalk from system 1 to system 2 is 65 db, which is 10 db poorer than the realignment.

(3) In order to meet the crosstalk requirement it is necessary to reduce the 68 kc gain by 10 db, resulting in a maximum permissible gain of 10 db and a maximum repeater spacing of .35 miles.

213. Impedance Matching Considerations Between Open Wire Lines and Toll Entrance Cable (or Exchange Cable)

a. Coupling Arrangement Because open wire line impedance is approximately 600 ohms, the repeating coil coupling arrangement shown in figure 54 is required to match the 1.35 ohms impedance of the AN/TCC-7 and AN/TCC-8 equipment

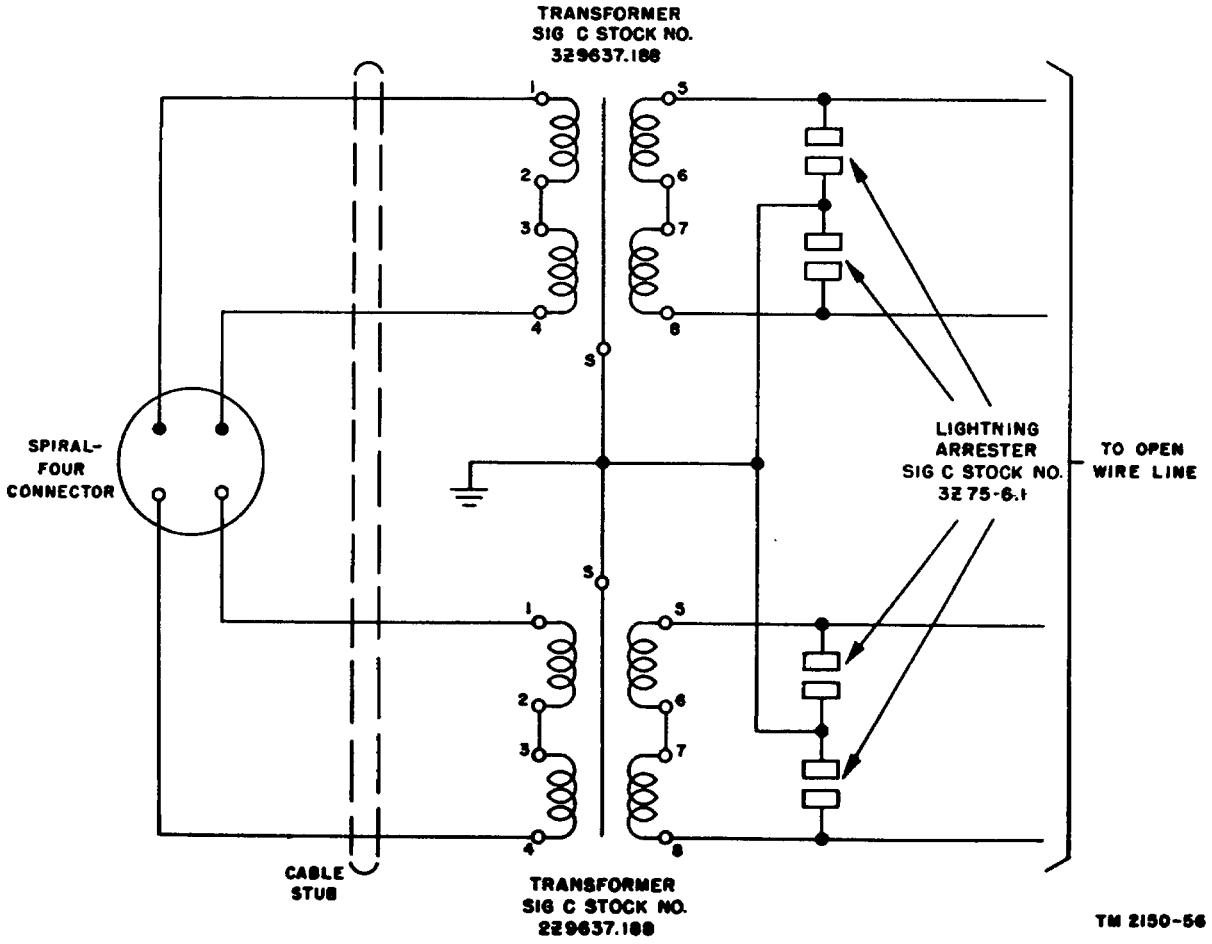


Figure 54. Partial schematic, showing connection of AN/TCC-7 terminal or AN/TCC-8 repeater to open wire line.

over the 12-to 68-kc band. This results in some mismatch at the order wire frequency. However, without a coupling arrangement, carrier frequency crosstalk may be degraded approximately 10 db.

b. Entrance Cable.

(1) The nonloaded toll entrance cable or the exchange cable presents frequency and impedance characteristics similar to those of a spiral-four cable. AN/TCC-7 terminals and AN/TCC-8 repeaters may be connected directly to these cables without the coupling arrangement required for open wire *(a* above).

(2) Toll entrance cable loaded for carrier operation is unlikely to pass the complete 12- to 68-kc band (cut-off probably occurs above 30 kc). Limited operation of an AN/TCC-7 system is possible with manual regulation restricted to flat adjustment at 12 kc and slope adjustment at 28 kc. Measure the 12-kc output at the receiving amplifier output and adjust the FLAT control to obtain 0 db. Then measure the 28-kc output and adjust the SLOPE control to obtain 0 db. These adjustments will not be independent of each other and should be repeated until they are lined correctly. It is possible to arrive at a satisfactory setting of slope adjustment and then to confine regulation to flat adjustment at 12 kc and bulge adjustment at 28 kc. These adjustments then will be independent of each other. The coupling arrangement of figure 54 should be used to connect the AN/TCC-7 terminal and the AN/TCC-8 repeater to the loaded entrance cable.

(3) The maximum length of the nonloaded toll entrance and the exchange cable are given in the table below.

Length of nonloaded entrance cable having 14 db slope from 12 to 68 kc

Toll entrance cable		Exchange cable	
Gage	Length	Gage	Commercial Type / Length (ml)
13	10	10	11
16	10	13	TJ 9
19	8	16	NH 8
		19	CNB 7
		19	GNB 5
		22	TS 5
		22	ANA 5
		22	CSA 4
		24	NM 3.5
		24	CSM 3
		24	DSM 2.5
		26	AST 2
		26	BST 2

(4) If open wire lines are used in tandem with entrance cables, the maximum length of an open wire line will be limited by the length of the entrance cable. Noise usually will be the limiting factor. Paragraph 207b(3) gives 12-kc, 28-kc, and 68-kc losses for various cables. Repeater spacing should be based on the 68-kc losses of open wire and cable in proportion to the lengths of each, subject to the noise limitation. The crosstalk requirement corresponding to this repeater spacing (par. 210d) then should be checked. In addition, the slope corresponding to the lengths of open wire and entrance cable should be determined from the table of paragraph 212b and the table of b(3) above to assure that the slope limit of 14 db is not exceeded.

(5) In the table in paragraph 212e, the column listing maximum distance with entrance cable is based on a span consisting of 1 mile of 19 gage toll entrance cable and the indicated distance of open wire. The noise consideration is the limiting factor. However, when copper open-wire lines are used, the slope becomes the primary limiting factor.

214. Emergency Order Wire Line-Up When Open Wire Lines Are Used

The line-up of the order wire circuit of an AN/TCC-7 system operated over open wire is performed in the same manner as that used for a

spiral-four cable system with the following exceptions:

a. Operate all CABLE REELS TO NEXT AN/TCC-7 or AN/TCC-8 switches on the ORDER WIRE PANELS to the position marked 0-11.

b. Adjust the transmitting amplifier outputs by following the first line in the O W TR AMP ADJ table (par. 23).

215. Emergency Carrier Line-Up When Open Wire Lines Are Used

The initial carrier line-up of an AN/TCC-7 system employing open wire is carried out in a manner very similar to that followed for a spiral four cable system. Pilot and test frequencies are transmitted from the AN/TCC-7 terminal at one end of the system and adjustments of the receiving circuits are made at successive AN/TCC-8 repeaters and the receiving AN/TCC-7 terminal at the other end. The procedure then is repeated for the other direction of transmission. A brief outline of the procedure is given in *a* through 9 below.

a. Set all cable building out networks for no loss by operating the appropriate CABLE REELS TO FIRST AN/TCC-11 switches to the 23 position. Operate all SLOPE and BULGE controls to the O position.

b .At the AN/TCC-7 terminal at the sending end of the system, arrange the controls to send the 68-kc pilot and the 12-kc and 28-kc test frequencies over the line, as described in paragraph *91b.*

c. At the first AN/TCC-8 repeater, measure the 68-kc power at the output of receiving amplifier No. 1 in the direction of the transmission being lined up. Adjust the appropriate FLAT control to obtain a reading of 0 db on the TEST PANEL meter. If a reading of 0 db is not obtained, adjust the appropriate input CABLE REELS TO FIRST AN/TCC-11 (TOWARD A TERMINAL or TOWARD B TERMINAL) switch to a lower number until it becomes possible to obtain a reading of 0 db with the FLAT control.

d. .Adjust the regulating circuits as described in paragraph 123*d* through *f*.

e. Measure the 12-kc power at the output of receiving amplifier No. 2 and adjust the SLOPE control to obtain a reading between-.8 db and +.8 db.

f. Measure the 28-kc power at the output of receiving amplifier No. 2 and adjust the BULGE control to obtain a reading between-.4 db and +.4 db.

g. Repeat the procedure of c through f above at successive AN/TCC-8 repeaters and at the receiving AN/TCC-7 terminal.

216. Check of System Line-up When Open Wire Lines Are Used

The 68-kc loss and slope of open wire change considerably with the temperature and the degree of wetness. For this reason the lineup of an AN/TCC-7 system operated over open wire should be checked at least once a day, and whenever the condition of the line changes from dry to wet, or vice versa. If measurements are out of limits, check the line-up as follows:

a. Check the 68-kc pilot as described in paragraph 146a(2) and b(2).

b. Check the 12-kc and 28-kc test frequencies as described in paragraph 147.

217. Open Wire System Operation Under Sleet Conditions

Sleet causes a considerable increase in the slope and 68-kc loss of an open wire line and may cause impaired operation of the system. A Winch radial thickness of ice increases the a**t**tenuation of a pair about .4 db per mile at 68 kc and .03 db per mile at 12 kc. Thus, operation of the system during sleet periods probably will be limited to the message channels which occupy the lower carrier frequencies on the line because the slope which can be equalized by the AN/TCC-7 terminal and the AN/TCC-8 repeater is limited to 14 db. The maximum gain available is 38 db at 12 kc and 68 kc. The 28-kc bulge adjustment allows 3.5 db additional gain in the region of 28 kc.

218. Crosstalk Measurement in System Using Paper-lnsulated Cable Pain or Open Wire Pain

When operation of an AN/TCC-7 system over paper-insulated cable pairs or open wire pairs is planned, the pairs should be selected on the basis of their crosstalk properties. This paragraph describes a procedure for measuring crosstalk by use of the AN/TCC-7 terminal or the AN/TCO-S repeater.

a. *Near* End *Crosstalk.* When choosing two pairs to use for an AN/TCC-7 system, the procedure outlined below should be followed

until two pairs are found which meet the near end crosstalk requirements of paragraph 210*d*.

(1) Connect one pair to the AN/TCC-7 terminal or the AN/TCC-8 repeater and arrange the equipment to send 68 kc at the normal output power (0 dbm), with the transmitting cable building out equalizer set at the 23 position. Note that the transmitting cable building out equalizer control in the AN/TCC-7 terminal is marked CABLE REELS TO FIRST AN/TCC-11. In the AN/TCC-11 repeater the cable building out equalizer control for one direction is marked CABLE REELS TO FIRST AN/TCC-11 TOWARD A TERMINAL; for the other direction the control is marked CABLE REELS TO FIRST AN/TCC-11 TOWARD B TERMINAL. Terminate the distant end of this pair in 135 ohms (for nonloaded cable pairs) or 600 ohms (for open wire pairs and loaded toll entrance cable pairs).

(2) Terminate both ends of the pair to be measured in the appropriate resistance. At the same point as in (1) above, connect the MEASURE cord of the TEST PANEL to the termination of the pair to be measured by use of the MEASURE cord adapter provided with the AN/TCC-7 terminal and the AN/TCC-8 repeater.

(3) Arrange the switches on the TEST PANEL as follows:

(a) Operate the MEASURE switch to the TRANSMISSION position.

(b) Operate the MEASURE SELECTIVE switch to the 68 KC position.

(c) Operate the MEASURE NON-SELECTIVE switch to the 62 KC position.

(4) Determine the TEST PANEL meter reading. Operate the ATTENUATOR push buttons as required to keep the reading on scale if possible, and adjust the FINE TUNE control for a maximum reading. Determine the sum of the meter reading and the ATTENUATOR push buttons operated (par. 253, note 3). The near end crosstalk loss in db is equal to 70 minus this sum for a 600-ohm termination, or 63.5 minus this sum for a 135-ohm termination.

(5) Continue to send on the same pair as in (1) above and measure the crosstalk to each additional pair in succession by applying the procedure of (2) through (4) above.

(6) Repeat the procedure of (1) through (5) above by sending on each pair in succession and measuring on all others.

b. Intersystem Crosstalk. When a second AN/TCC-7 system is to be added to a paper insulated cable or open wire route over which another AN/TCC-7 system is in operation, two pairs should be chosen which meet the intersystem crosstalk requirement of paragraph 210*d*. The following procedure describes the measurement of intersystem crosstalk. The procedure does not apply if there are any AN/TCC-11 repeaters in the section being measured.

(1) On the existing AN/TCC-7 system, measure the 68-kc output at the REC (or AB or BA) AMP 2 OUT jack at the receiving end of the repeater section being investigated. This normally should measure 0 db on the TEST PANEL meter.

(2) Terminate the transmitting end of the pair to be measured in 135 ohms (for cable pairs) or 600 ohms (for open wire pairs). Disconnect the AN/ TCC-7 terminal or the AN/TCC-8 repeater at the receiving end from the pair normally used for receiving. Terminate the disconnected pair, and connect the equipment to the pair to be measured.

(3) Connect the MEASURE cord of the TEST PANEL to the appropriate REC 62 KC jack. Arrange the switches on the TEST PANEL as described in *a*(3) above.

(4) Determine the sum of the TEST PANEL meter reading and ATTENUATOR push buttons operated as described in *a*(4) above. The intersystem crosstalk in db is equal to 70 minus this sum.

(5) Measure each additional pair in succession by applying the procedure of (2) through (4) above.

CHAPTER 5

THEORY AND PERFORMANCE

Section I. FREQUENCY ALLOCATION AND REPEATER SPACING

219. General

This section outlines the considerations which determine the frequency bands and repeater spacings used in AN/TCC-7 systems. The fundamental objective of an AN/TCC-7 system is to provide a communications system capable of transmitting 12 message channels and an order wire channel for a maximum distance of 200 miles over one nonloaded spiral-four cable, radio links, or combinations of cable and radio.

220. Advantages of 12- to 60-kc Frequency Band

A frequency band of 12 to 60 kc is used for transmission of the 12 message channels in both directions because of the advantages listed in *a* through *c* below.

a. The frequency characteristic of the cable is smooth that may be accurately equalized. The loss versus frequency characteristic of Cable Assembly CX-1065/G is shown in figure 55.

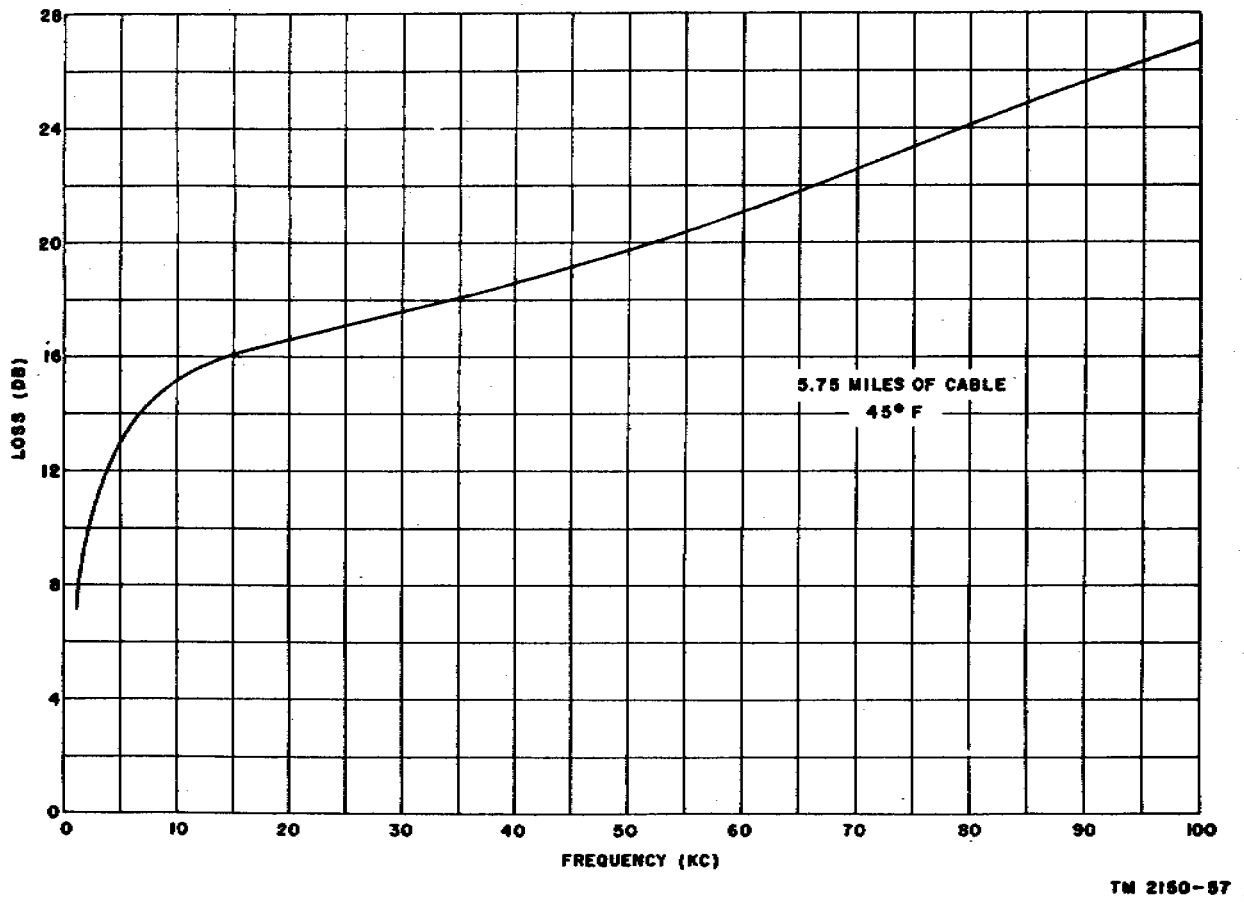


Figure 55. Loss versus frequency characteristics of Cable Assembly CX-1065/G.

b. The crosstalk between the two pairs of the cable results in satisfactory near-end crosstalk with reasonable repeater spacing when the 12- to 60-kc band is used for both directions of transmission.

c. Use of the same frequency band for both directions results in a system which is easier to operate and maintain than a system using different frequency bands for the two directions.

221. Frequency Allocation for AN/TCC-7 System

The steps by which the 12 message channels are translated from v-f to the 12- to 60-kc band by the transmitting circuits of the AN/TCC-7 terminal are shown in figure 56. The receiving circuits translate the 12- to 60-kc signals received from the cable to v-f in steps which are the reverse of those shown by the arrows in figure 56.

a. TA-219 CHAN MODEM. Groups of four message channels (each with a frequency band which is located between 0 and 4 kc) are translated to a band from 4 to 20 kc by the TA-219 CHAN MODEM panel. Three TA-219 CHAN MODEM panels are supplied as part of the AN/TCC-7 terminal to provide 12 message channels.

b. TA-227 SUBGROUP PANEL. The three 4- to 20-kc bands in the outputs of the three TA-219 CHAN MODEM panels are applied to the TA-227 SUBGROUP PANEL. The 4- to 20-kc band from the TA-219 CHAN MODEM No. 1 is modulated with a 56-kc carrier frequency and a band filter selects the upper side band of from 60 to 76 kc. In a similar manner, the 4- to 20-kc band from the TA-219 CHAN MODEM No. 2 is modulated with a carrier frequency of 72 kc to the band of 76 to 92 kc. The 4- to 20-kc band from the TA-219 CHAN MODEM No. 3 is modulated with a carrier frequency of 88 kc to the band of 92 to 108 kc. The outputs of the three subgroup modulator band filters in the TA-227 SUBGROUP PANEL then are combined to occupy the band from 60 to 108 kc.

c. Group Modulator. The final step of frequency translation is accomplished by a group modulator circuit in the GROUP PANEL. This circuit modulates the 60- to 108-kc group from the TA-227 SUBGROUP PANEL with a 120-kc carrier to produce a 12- to 60-kc group. This group then is amplified for transmission over the spiral-four cable or the radio link.

d. Demodulation. The steps by which the 12 message channels are demodulated from the 12- to 60-kc band are the reverse of those described in *a* through *c* above.

e. Special Service. Circuit arrangements are provided to utilize the three 4- to 20-kc bands, the 60- to 108-kc band, or the 12- to 60-kc band for transmission of special service facilities.

(1) Each 4- to 20-kc bandwidth special service signal is applied directly to the SUBGROUP PANEL. The 4- to 20-kc special service signals are modulated in the subgroup and group panels in the same manner as message channel signals for transmission to the distant terminal.

(2) A 60- to 108-kc special service signal is applied to the GROUP PANEL and modulated by the 120-kc carrier frequency for transmission to the distant terminal.

(3) A 12- to 60-kc special service signal is applied to the GROUP PANEL and transmitted to the distant terminal without modulation.

222. Repeater Spacing in AN/TCC-7 System

a. Maximum Spacing. The maximum spacing between repeaters for a cable installation is approximately 5¾ miles (twenty-three ¼-mile cable reels). This is determined by considerations of noise, crosstalk, and the loss versus frequency characteristic of the cable.

b. Unattended Versus Attended Repeater Spacing.

(1) To conserve manpower, it is desirable to place as many repeaters as possible at unattended locations. However, the number of unattended repeaters that may be used in succession is limited by the problem of applying power to the unattended points.

(2) The unattended AN/TCC-11 repeaters receive power over the cable from PP-826 600-VOLT POWER SUPPLY panels which are part of the AN/TCC-7 terminal or the AN/TCC-8 repeater. The maximum voltage applied to the cable is 600 volts; this value places a limit of three on the number of AN/TCC-11 repeaters which may receive power from one PP-826 600-VOLT POWER SUPPLY.

(3) With three AN/TCC-11 repeaters supplied power from one end of an attended repeater section and three from the other end, a total of six AN/TCC-11 repeaters may be used between

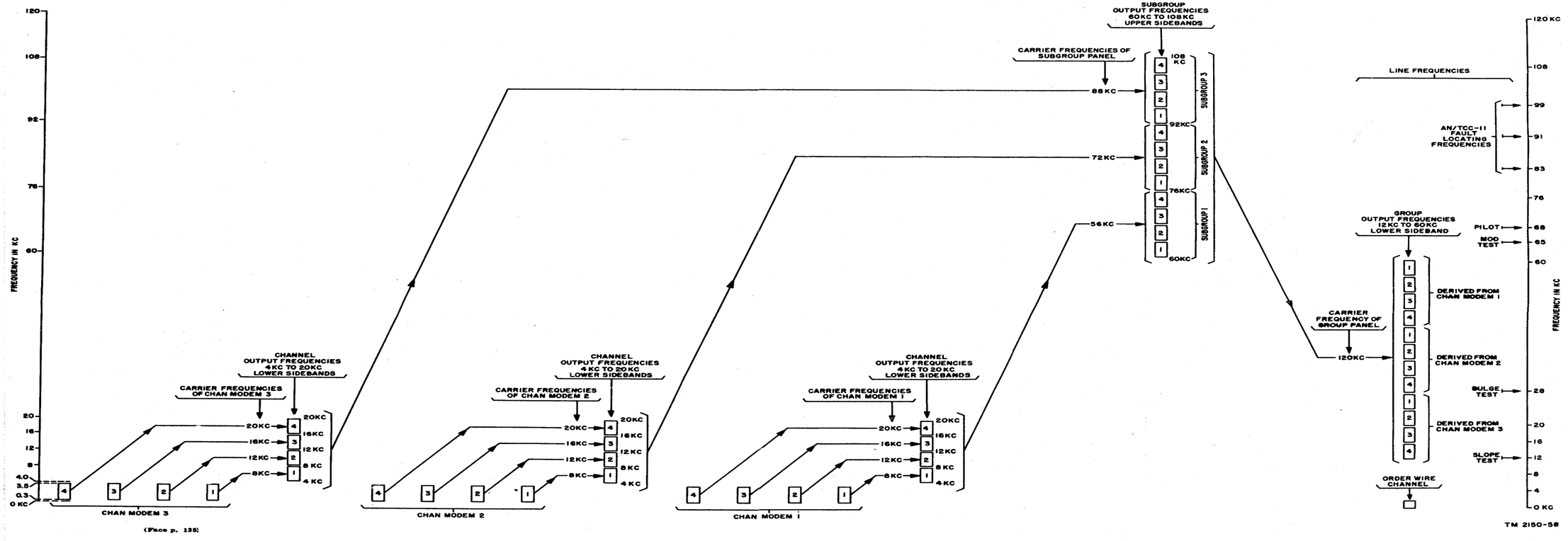


Figure 56. Frequency allocation chart for AN/TCC-7 system.

attended points. This is the maximum number of AN/TCC-11 repeaters that may be contained within an attended repeater section thus places a limitation of 40 miles on the maximum spacing between attended points (AN/TCC-7 or AN/TCC-8 points). The minimum distance between attended points is one-half mile.

(4) Repeaters for the order wire circuit are supplied with the equipment at attended points. The maximum spacing of 40 miles (governed by carrier frequency considerations) is also suitable for an order wire circuit of limited bandwidth (par. 237*b*).

223. Carrier Amplifier Arrangement in AN/TCC-7 System

The gain required to compensate for the cable loss is provided by amplifiers in the AN/TCC-7 terminal and the AN/TCC-8 (attended) and AN/TCC-11 (unattended) repeaters. These amplifiers have flat frequency response over the carrier frequency band and use negative feedback to stabilize their performance. The arrangement of the amplifiers in the system is shown in figure 57.

a. AN/TCC-7 Terminal.

(1) The AN/TCC-7 terminal contains a transmitting amplifier AR3 which amplifies the carrier frequency band: for transmission over the cable. The amplifier output level is 0 db (par. 9*b*).

(2) The receiving circuit contains two amplifiers designated amplifier AR1 and amplifier AR2 (receiving amplifiers 1 and 2). These circuits amplify the received carrier signals to a 0-db transmission level.

(3) All three amplifiers are identical plug-in units. The circuits of these units are modified by connections in the GROUP PANEL into which the units are plugged.

b. AN/TCC-8 Repeater.

(1) The AN/TCC-8 repeater contains four amplifiers, two for each direction of transmission. Those used in the *AB* direction are referred to as AB AMP 1 and AB AMP 2. Those used in the *BA* direction are referred to as BA AMP 1 and BA AMP 2.

(2) In each direction of transmission, the arrangement of amplifiers in the AN/TCC-8 repeater is the same as the arrangement of amplifiers in the receiving circuit of the AN/TCC-7 terminal. The amplifiers are identical plug-in units.

c. AN/TCC-11 Repeater. The AN/TCC-11 repeater contains two amplifiers, one for each direction of transmission, designated AMP 1 and AMP 2. These are plug-in units but are different from those used in the AN/TCC-7 and the AN/TCC-8 equipments.

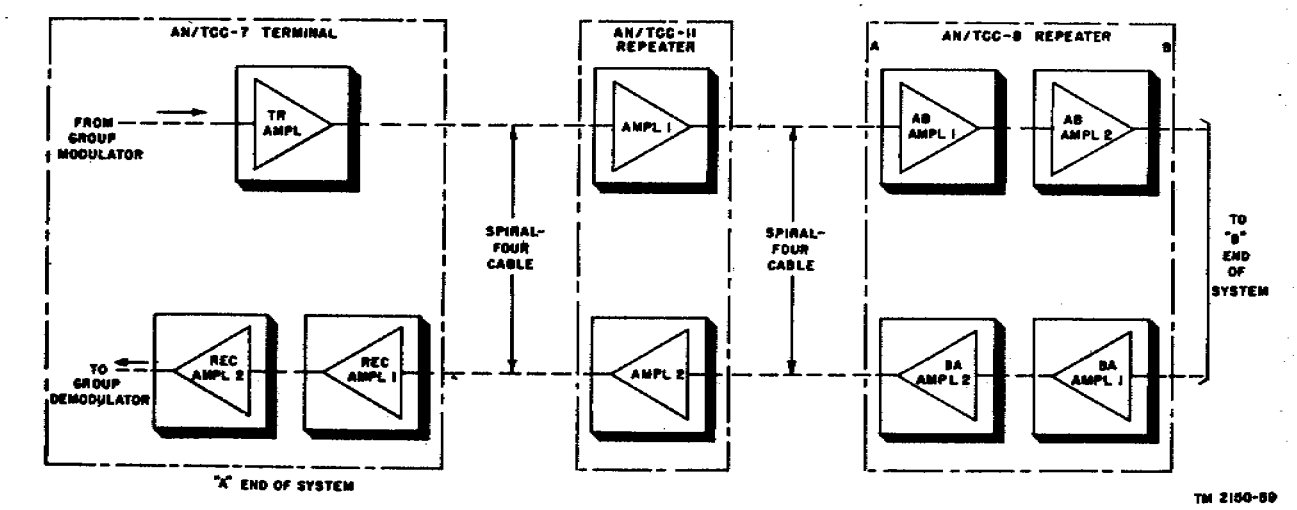


Figure 57. AN/TCC-7 system, simplified block diagram showing arrangement of carrier amplifiers

Section II. EQUALIZATION AND REGULATION

224. General

This section covers the equalization and temperature regulation necessary to compensate for the cable characteristics. Networks are provided which add to the cable loss so that a uniform loss is provided over the frequency band used. In addition, networks are provided to compensate for the delay distortion. Regulator networks are provided to compensate automatically for the variation of the cable loss with temperature changes.

225. Equalization, General

The response of the amplifying and modulating circuits of the system is essentially flat over the band of frequencies transmitted. Therefore the loss (which varies with frequency) of the cable must be compensated for by equalizing networks. Figure 58 shows the position of the equalizing networks in the system. These networks make the over-all transmission flat with frequency at the temperature existing at the time of the system line-up. Paragraphs 226 through 233 describe the various networks.

226. Basic Equalizers, Function

At the receiving end of each unattended repeater section a basic equalizer network is provided which compensates for the loss versus; frequency characteristic of 5¾ miles of average cable at 45° F. One network is provided for each direction of transmission.

227. Deviation Equalizers, Function

a. The deviations from flat transmission remaining after equalization by the basic equalizer networks are corrected by deviation equalizers. These are located at the receiving ends of all attended repeater sections.

b. The deviation equalizer in the AN/TCC-7 terminal compensates only for the characteristics of the transmitting and receiving circuits of the AN/TCC-7 terminal over the 12- to 68-kc band. The AN/TCC-7 terminal is arranged in this manner to take care of system applications in which the system will be made up of two AN/TCC-7 terminals interconnected by radio links only.

c. The AN/TCC-8 repeater contains two deviation equalizers, one for each direction of transmission. Each equalizer corrects for the characteristics of the amplifiers and other circuits in the AN/TCC-8 repeater and for the accumulated deviations of five AN/TCC-11 repeaters.

228. Cable Building-out Networks, Function

a. The unattended repeater sections adjacent to attended points may vary in length from ½ mile to 6 miles (two to twenty-four ¼-mile cable reels). Cable building-out networks are provided at the attended points to build out the adjacent unattended repeater sections to the approximate equivalent of 23 reels plus or minus 1 reel.

b. The building-out networks are adjustable and are controlled by switches. The switch positions are designated with numbers which represent the number of cable reels in the section being built out. The number of reels of cable to which the network is equivalent at any switch position is the difference between 23 cable reels and the number of cable reels indicated by the switch position. For example, if the section to be built out contains 15 cable reels, the switch should be set to 14 (the nearest setting provided). The network then would be equivalent to 23 minus 14, or 9 cable reels. The total length to which the section was built out would be 15 plus 9, or 24 cable reels.

c. The building-out network has a loss versus frequency characteristic which approximately matches the cable characteristic from 12 kc to 100 kc at 45° F.

d. Two building-out networks are provided in the AN/TCC-7 terminal, one for the transmitting path and one for the receiving path. The switches which control them are located in the GROUP PANEL and are designated CABLE REELS TO FIRST AN/TCC-11, TR (Transmitting); and CABLE REELS TO FIRST AN/TCC-11, REC (Receiving).

e. Four building-out networks are provided in the AN/TCC-8 repeater, one for the transmitting end and one for the receiving end for each of the two directions of transmission. The switches which control the building-out networks are located on the AM-708 REPEATER PANEL and have the following designations: CABLE REELS TO FIRST AN/TCC-11 TOWARD B TERM, AB OUT (*AB* transmitting); CABLE REELS TO FIRST AN/TCC-11 TOWARD A TERM, AB IN *(AB* receiving); CABLE REELS TO FIRST AN/TCC-11 TOWARD A TERM, BA OUT *(BA* transmitting); CABLE REELS TO

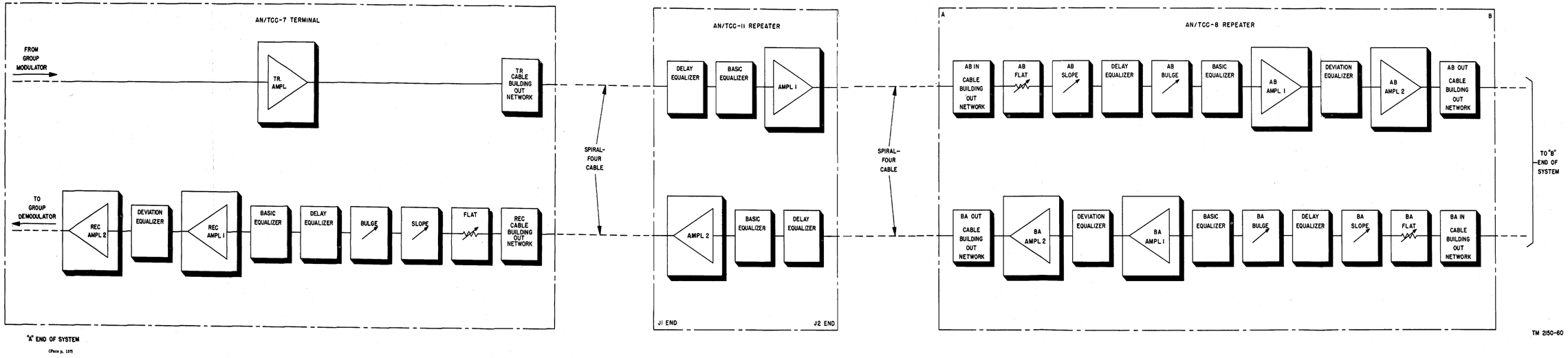


Figure 58. AN/TCC-7 system, simplified block diagram showing arrangement of equalizing networks.

FIRST AN/TCC-11 TOWARD B TERM BA IN (*BA* receiving).

229. Factors Affecting System Equalization

a. A number of factors cause large deviations between the loss versus frequency characteristics of the cable and the compensating characteristics of the basic equalizers and the deviation equalizers. Some of these factors are listed in (1) through (4) below.

(1) The cable loss versus frequency characteristic varies appreciably with temperature.

(2) Some variation in magnitude and shape of the loss characteristic arises from physical variations in the cable construction.

(3) The repeater spacing is normally 5¾ miles (twenty-three ¼-mile reels) but variations of plus or minus ¼ mile (one reel) are permitted under certain conditions (par. 67).

(4) The building-out networks may build out the attended repeater sections adjacent to attended points to the equivalent of 5¾ miles plus or minus ¼ mile (23 plus or minus 1 reel). There are inherent small deviations between the building-out network characteristics and the cable it is to match.

b. Manual flat, slope. and bulge adjustments are provided at attended points to correct for the deviations described in *a* above.

c. Test frequencies of 12-kc and 28-kc and a 68-kc pilot frequency are provided in the AN/TCC-7 terminal for use in adjusting the slope, bulge, and flat controls, respectively.

230. Flat Adjustment

a. A flat-loss control is provided in the receiving circuit of each attended repeater. The control circuit consists of a variable bridged-T network which uses a double potentiometer for adjustment purposes. The adjustment of this control affects the entire 12- to 99-kc frequency band. Adjustments are made in terms of 68-kc frequency loss, based upon the power of the received 68-kc pilot. In this manner, the flat-loss control provides general compensation for the variations discussed in paragraph 229*a*.

b. A single flat-loss control is provided in the AN/TCC-7 terminal. The control is located in the GROUP PANEL and is designated FLAT ADJ 68 KC.

c. Two flat-loss controls are provided in the AN/TCC-8 repeater, one for each direction of transmission. They are located in the AM-708 REPEATER PANEL and are designated AB FLAT ADJ 68 KC and BA FLAT ADJ 68 KC.

d. Each flat control provides a range of continuous loss adjustment of approximately ±10 db.

e. A control of flat gain for each direction of transmission is provided in the AN/TCC-11 repeater. Each of the two amplifiers in the AN/TCC-11 repeater is provided with three values of feedback to give an average gain, or a gain 2.5 db greater than average, or a gain of 2.5 db less than average. The desired gain is selected by operation of the GAIN AMP switch. The GAIN AMP switch normally is set to the AVG position at the time of installation. This control compensates for a large variation of 68-kc loss within an unattended repeater section, and reduces the total variation which might accumulate within an attended repeater section. The control affects the entire 12- to 99-kc frequency band. Adjustments are made in terms of 68-kc loss based upon the power of the received 68-kc pilot.

231. Slope Adjustment

a. An adjustable slope network is provided at the receiving end of each attended repeater section. Slope is defined as the difference between the loss at 68 kc and the loss at 12 kc. The slope network provides 11 different slopes all having approximately the same loss at 68 kc. (fig. 59) The slope adjustment has a range of approximately ±7 db.

b. The slope control adjustment is made in terms of 12-kc loss based upon the power of the received 12-kc test frequency. The control compensates for the slope which has accumulated in an attended section.

c. In the AN/TCC-7 terminal, a single slope network is provided and controlled by the SLOPE ADJ 12 KC control located in the GROUP PANEL.

d. In the AN/TCC-8 repeater, two slopes networks are provided, one for each direction of transmission. They are controlled by the AB SLOPE ADJ 12 KC and BA SLOPE ADJ 12 KC controls located in the AM-708 REPEATER PANEL.

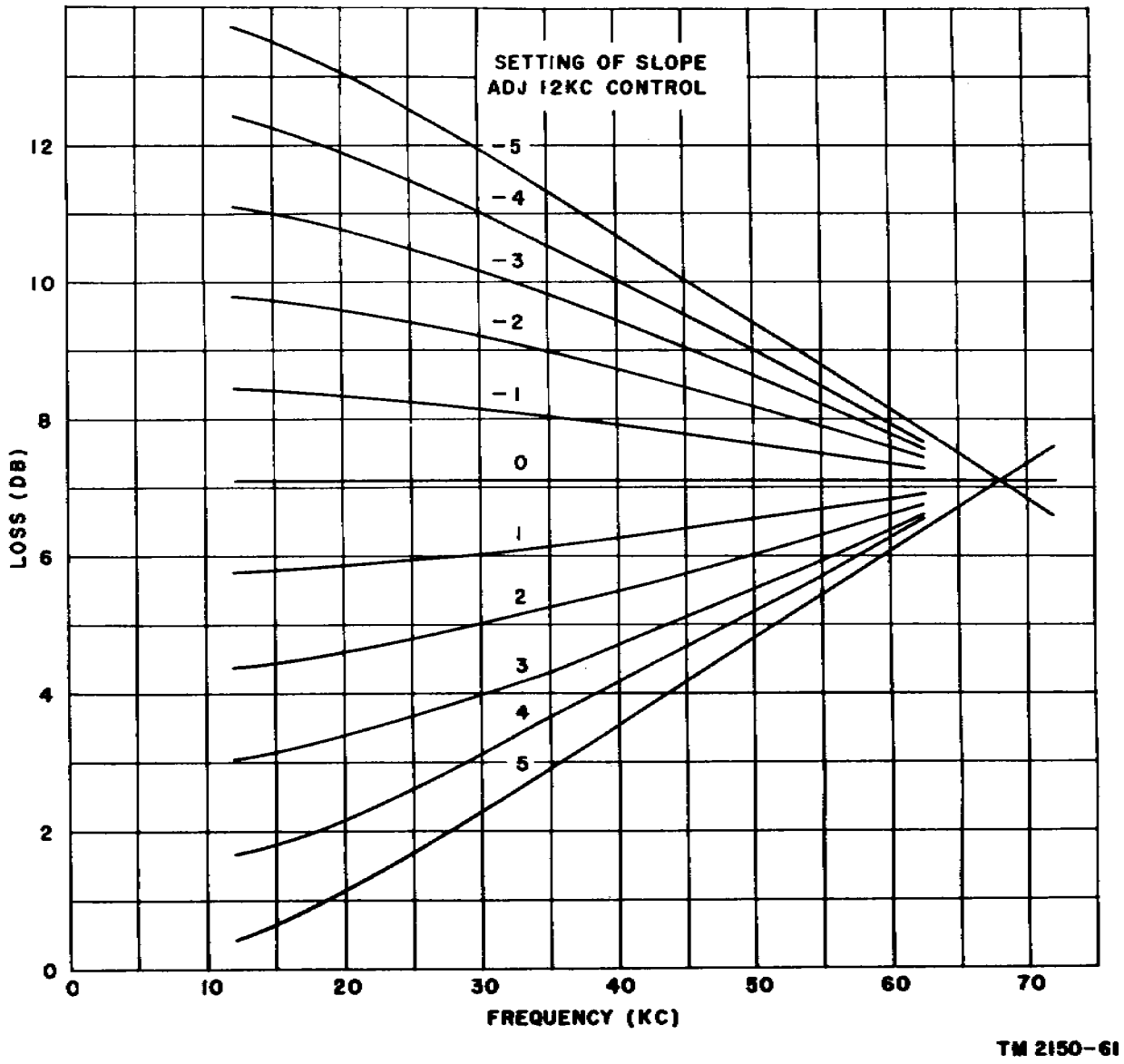


Figure 59. Characteristics of slope network.

232. Bulge Adjustment

a. An adjustable bulge network is provided at the receiving end of each attended repeater section. Bulge is defined as the difference between the loss at 28 kc and the loss at 12 kc (after the 12-kc and 68-kc losses have been made equal by reducing the slope to 0 db). The bulge network provides 11 curves with approximately the same loss at 12 kc and 68 kc and furnishes a range of bulge adjustment of ±3.5 db (fig. 60).

b. The bulge control adjustment is made in terms of 28-kc loss based upon the power of the received 28-kc test frequency. The control compensates for the bulge which has accumulated in the attended repeater section.

c. In the AN/TCC-7 terminal, a single bulge network is provided. This is controlled by the BULGE ADJ 28 KC control located in the GROUP PANEL.

d. The AN/TCC-8 repeater contains two bulge networks, one for each direction of transmission. They are controlled by the AB BULGE ADJ 28 KC and BA BULGE ADJ 28 KC controls located in the AM-708 REPEATER PANEL.

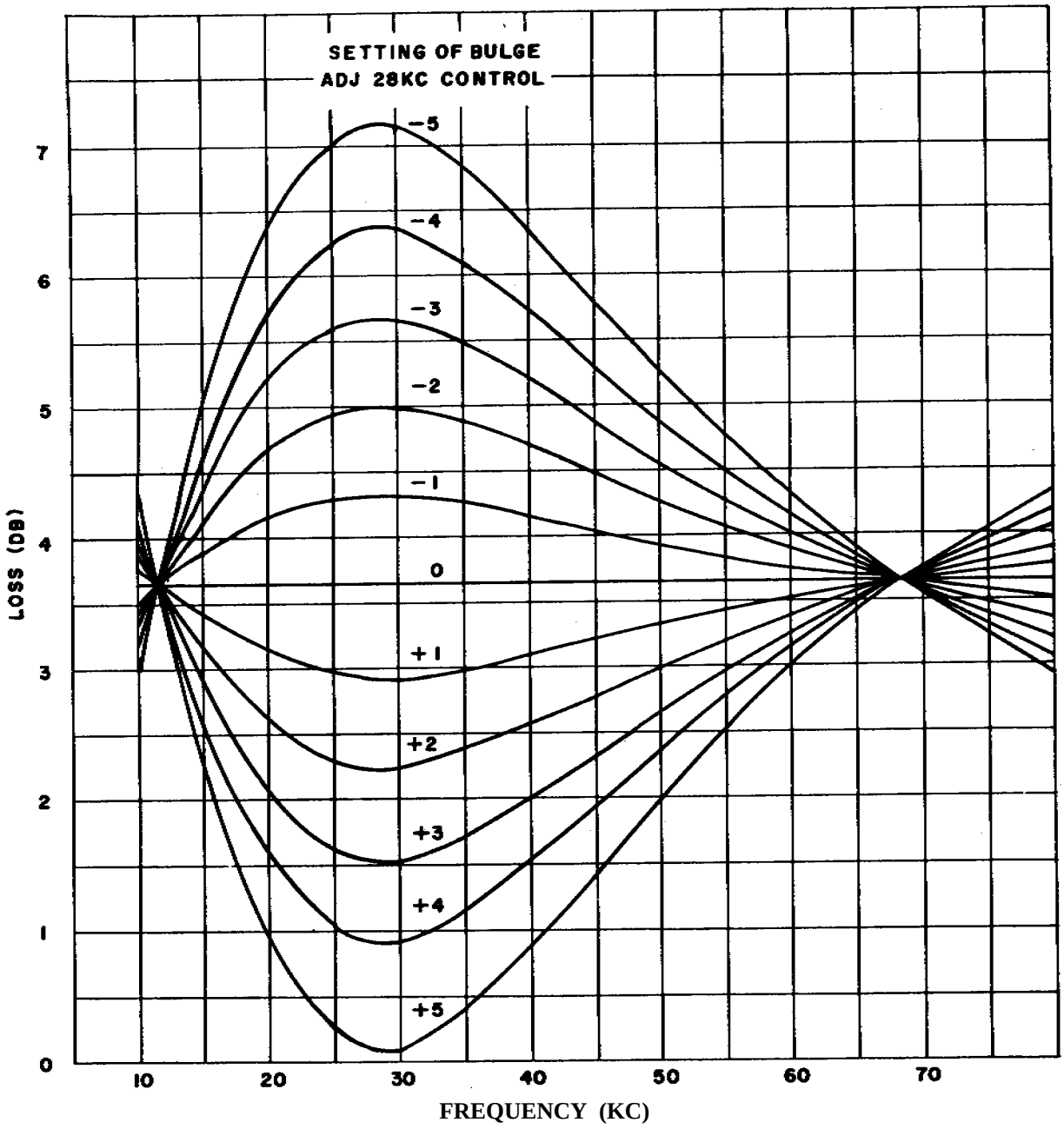


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Figure 60. Characteristics of bulge network.

233. Delay Equalizers

a. Delay equalizer networks are provided in the AN/TCC-7, AN/TCC-8, and AN/TCC-11 equipments to reduce the delay distortion in the band of 15 kc to 45 kc in order to improve system performance for 12- to 60-kc special service use. Each delay equalizer corrects for the delay distortion of the high-pass sections of two high-pass low-pass filters: the input filter of the equipment proper and the output filter of the preceding equipment.

b. The AN/TCC-7 terminal contains one delay equalizer in the receiving circuit. The AN/TCC-8 and AN/TCC-11 repeaters each contain two delay equalizers, one for each direction of transmission.

234. Variation of Cable Loss With Temperature

a. The cable loss versus frequency characteristic varies appreciably in magnitude and shape as the temperature varies. Figure 61 shows the loss versus frequency characteristics of 5¾ miles of cable at three temperatures. The differences are shown in more pronounced form in figure 62 which shows the relations of the loss characteristics at the same three temperatures after the corrections of the equalizer networks have been applied.

b. The variations of loss with temperature are corrected by periodic system line-ups, at which time the flat, slope, and bulge controls are readjusted. However, appreciable deviations in the over-all system frequency characteristic accumulate in the intervals between system line-ups unless other corrective measures are provided (*c* below).

c. Automatic temperature regulation circuits are

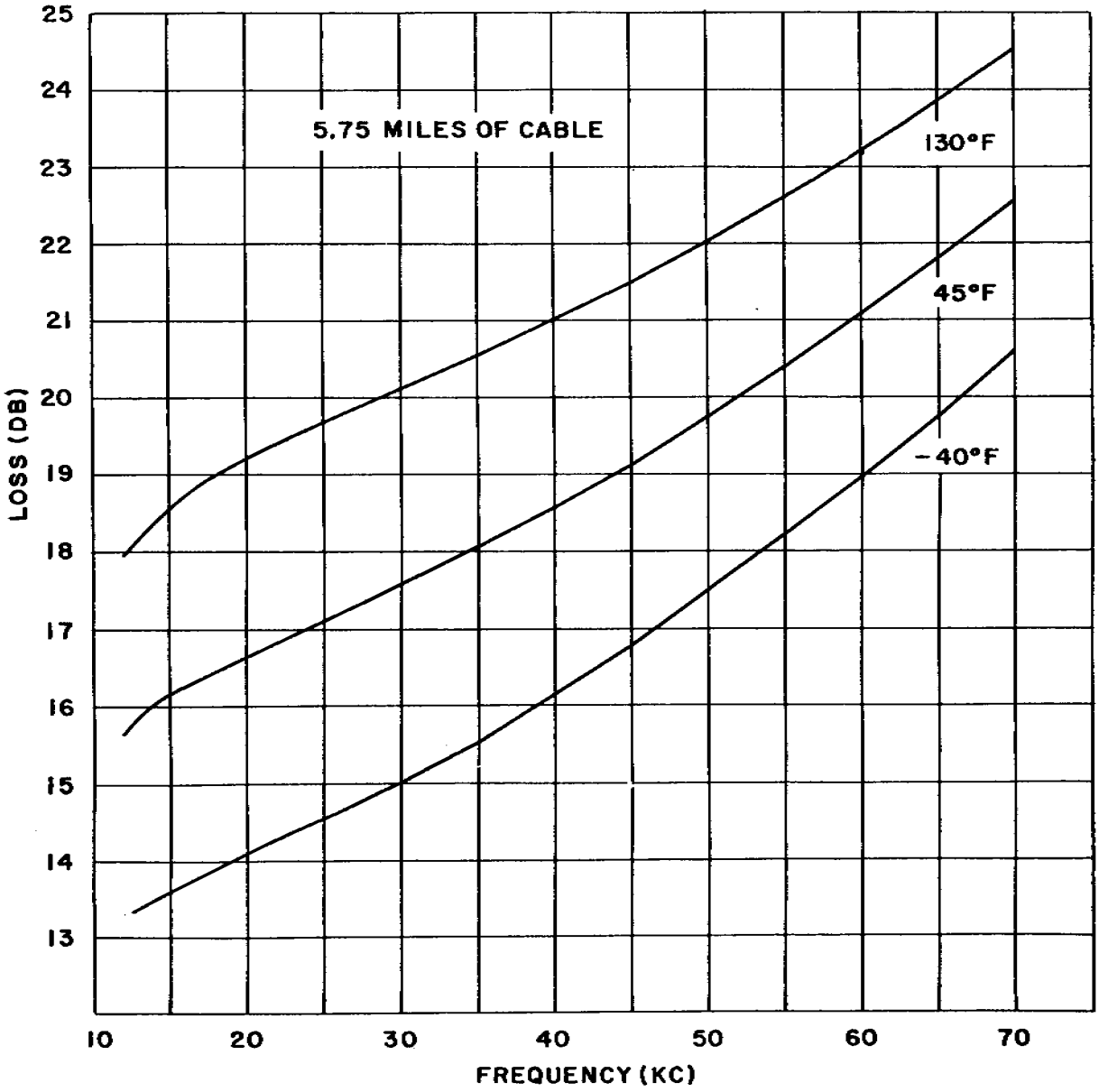

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Figure 61. Cable Assembly CX-1065/G, variation loss with temperature.

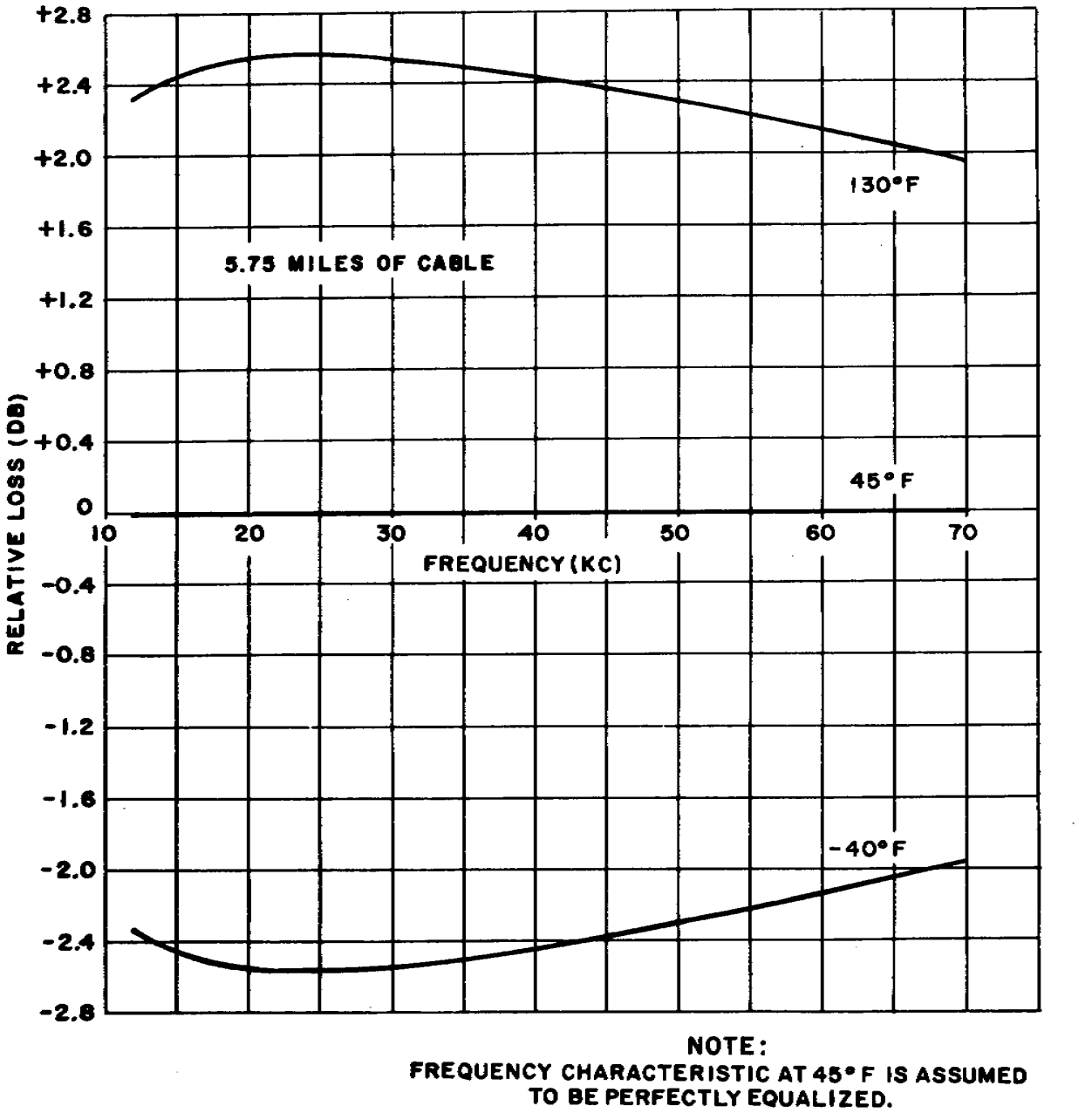

Figure 62. Cable Assembly CX-1065/G, relative loss at different temperatures.

included in the system to compensate for the deviations described in *a* above. These circuits are described in paragraphs 235 and 236. Figure 63 is a representative block diagram of the arrangement of regulating circuits in an AN/TCC-7 system.

235. Temperature Regulation Circuits in AN/TCC-11 Repeaters

a. The variation in loss with temperature in the 5¾ miles of cable (twenty-three ¼-mile reels) of an unattended repeater section is corrected approximately by a regulation circuit in the AN/TCC-11 repeater at the receiving end of the section.

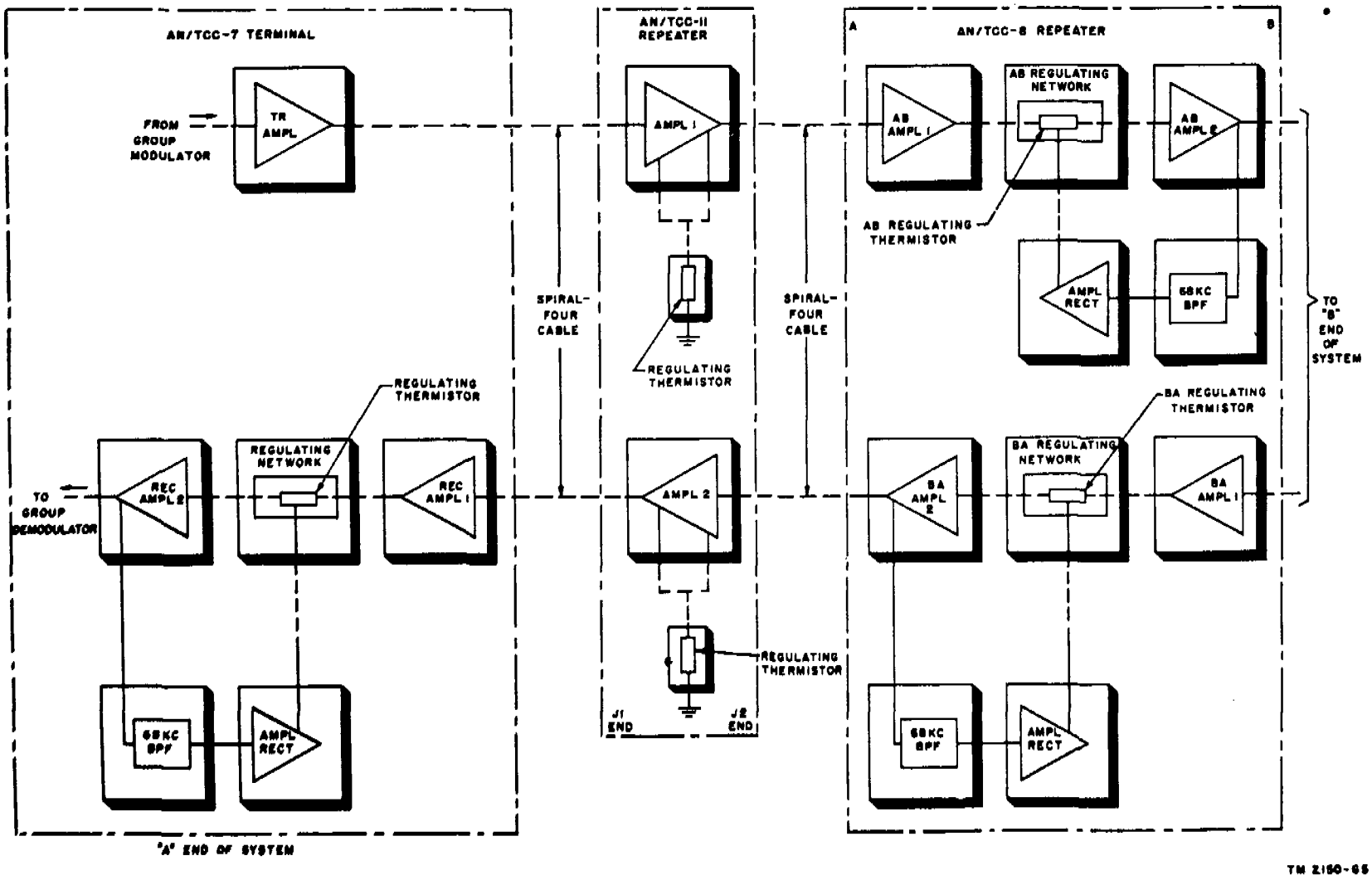

Figure 63. Simplified block diagram of AN/TCC-7 system, showing arrangement of regulating circuits.

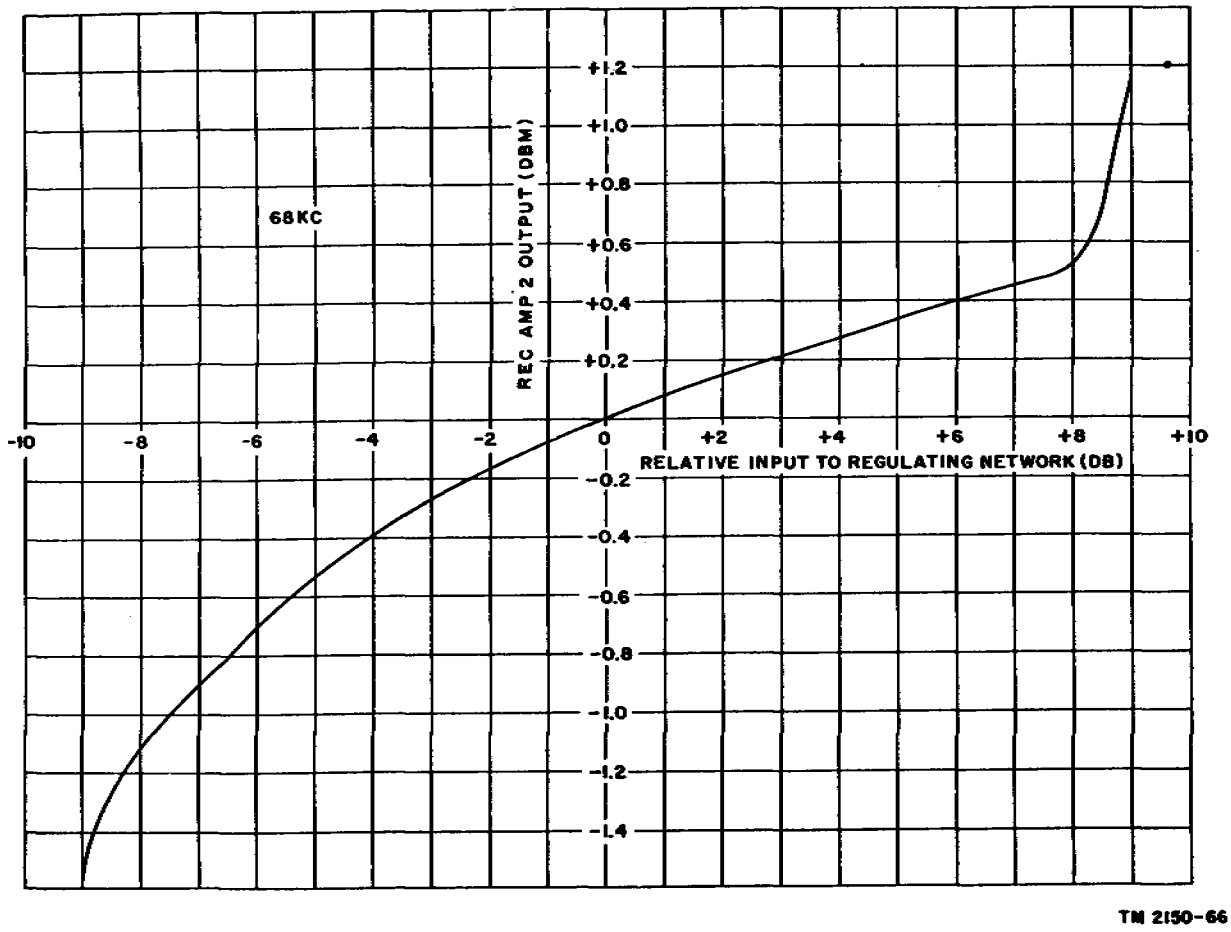

Figure 64. Output versus input of regulation circuit at attended point.

The circuit consists of a network (located in the feedback path of the amplifier) which contains a disk thermistor. The disk thermistor resistance varies with the ambient temperature. As the resistance of the thermistor changes, the loss of the network changes and causes corresponding changes in the amplifier gain. There is a separate regulation circuit in each of the two amplifiers in the AN/TCC-11 repeaters.

b. The variations in amplifier gain with thermistor temperature coincide with the variations in loss of 5¾ miles of cable at these same temperatures. Thus, if the thermistor temperature follows the cable temperature, correction of the cable loss variations will be obtained. For this reason the AN/TCC-11 repeater should be installed so that the conditions which affect the temperature of the cable will also affect the temperature of the thermistor.

c. Temperature lag of the regulating thermistor relative to that of the cable will introduce an error in the correcting action of the regulating circuit . Imperfection of the thermistor resistance versus temperature characteristic also contributes to the error. However, the average error of an attended repeater section may be corrected by adjustment of the slope, bulge, and flat controls at the end of the section. After proper adjustments are made, the net uncorrected error should not exceed an effective difference of ±20° F. between thermistor temperature and cable temperature.

236. Temperature Regulation Circuits at Attended Points

a. The errors in temperature regulation that accumulate in an attended repeater section are corrected automatically by a regulation circuit in the attended point at the end of the section. This circuit consists of a thermistor-controlled network which introduces a variable loss between receiving amplifier No. 1 and receiving amplifier No. 2.

b. The regulation circuit is under the control of

the 68-kc pilot output of receiving amplifier No. 2. The circuit operates to maintain a relatively constant 68-kc output over a considerable range of input. Figure 64 shows a typical output versus input characteristic at 68 kc. Note that for a relative input change of +8 db to -8 db, the output varies only from +.5 dbm to -1.1 dbm. Thus, the variation in flat loss with temperature is accurately corrected.

c. In addition to changing its flat loss in response to a change in 68-kc input, the regulating network provides the proper shape to its loss versus frequency characteristic. The network provides a number of loss curves (fig. 65) which are the inverse of the loss curves of cable caused by temperature change (fig. 62). The cable losses indicated by the curves marked 130° F., 45° F., and -40° F. (fig. 62) are offset by the network losses indicated by the curves marked 240 ohms, 600 ohms, and 1,500 ohms (fig. 65), respectively. Thus, the regulation circuit automatically corrects for the effects of temperature over the entire 12- to 68-kc band.

d. The AN/TCC-7 terminal contains one regulation circuit located in the GROUP PANEL. The AN/TCC-8 repeater contains two regulation circuits located in the AM-708 REPEATER PANEL, one for each direction of transmission.

e. A manual control of the 68-kc gain may be substituted for the automatic regulation by operating the REGULATOR lever switch to the MAN position. The manual control is used when transmission of the 68-kc pilot is lost. In the absence of a 68-kc input to the regulation circuit, the gain will go to maximum when operating with automatic regulation. This may result in the building up of excess gain over the system sufficient to make the system oscillate.

Section III. ORDER WIRE CIRCUIT

237. General

a. In addition to the 12 message channels, an order wire circuit is required to provide a channel for use in system maintenance and trouble location procedures. The circuit is arranged for maximum reliability and has been made relatively independent of the message channel circuits. Even though message channel circuits may fail, the order wire circuit may remain operable.

b. The order wire uses a v-f band of approximately 300 to 1,700 cps. Noise and crosstalk considerations indicate that a maximum spacing of 40 miles between repeaters is feasible if the upper end of the frequency band transmitted is limited to 1,700 cps. This spacing affords the advantage of locating the order wire repeater at the same points as the carrier frequency repeaters. The order wire frequency band is relatively narrow by message channel standards, but satisfactory transmission of speech is provided.

c. The order wire circuit provides means of communication between any two attended points in the system and from any AN/TCC-11 repeater point to an attended point, usually the point from which the AN/TCC-11 repeater receives power (par. 238*b*). Figure 66 shows a functional block; diagram of the order wire circuit arrangements at the AN/TCC-7 terminal, the AN/TCC-8 and the AN/TCC-11 repeaters.

238. Arrangement of Order Wire Circuit at AN/TCC-11 Repeaters

a. The order wire circuit is bypassed around the carrier amplifiers in the AN/TCC-11 repeaters through high-pass, low-pass filter sets, as shown in figure 66. Thus, the order wire circuit is made independent of the carrier circuits. Failure of the carrier amplifiers or a loss of carrier amplifier power will not disturb the order wire circuit.

b. A talking circuit from an AN/TCC-11 repeater is obtained by connecting a TS-712 test set to the repeater and an EE-8 telephone to the test set. The TS-712 test set provides talking paths which bridge on the through order wire circuit in both directions of transmission. Speech signals from the EE-8 telephone are transmitted in both directions, but the signals reach the attended point at one end of the attended repeater section considerably stronger than reach the other end. Good transmission always will be provided to the attended point from which the AN/TCC-11 repeater receives power.

239. Arrangement of Order Wire Circuit at Attended Points

a. Separation of Order Wire Circuit From Carrier Circuits. At the AN/TCC-7 and the AN/TCC-8 points, the order wire circuit is separated from the carrier

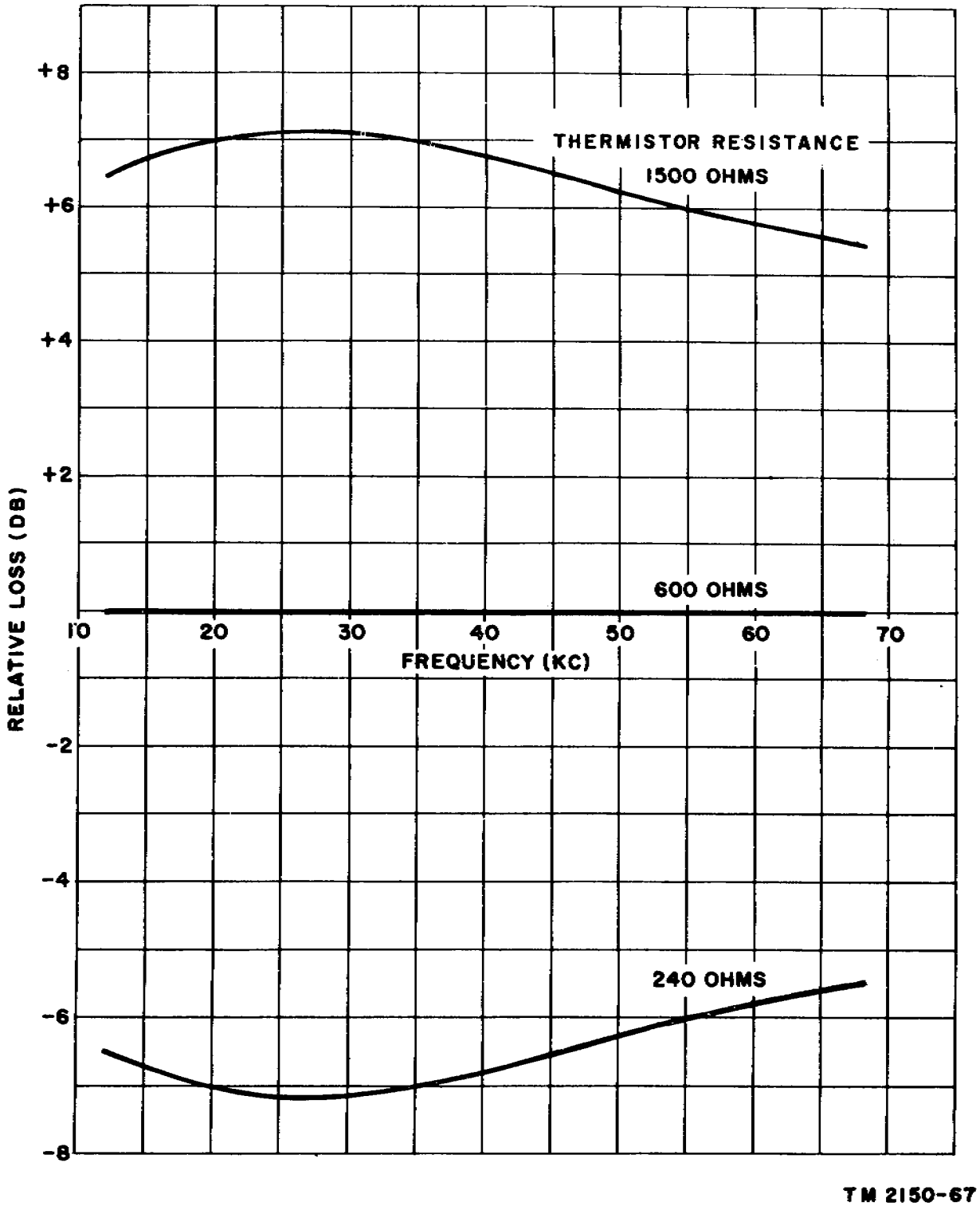

Figure 65. Attended point regulating network, relative loss versus thermistor resistance.

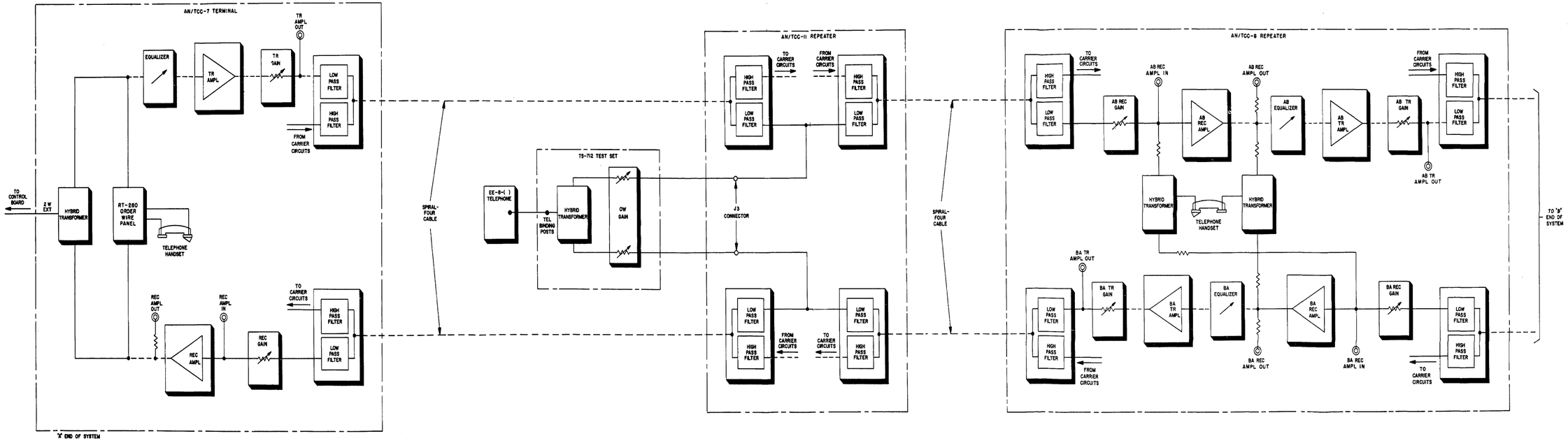

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Figure 66. -Functional block diagram of AN/TCC-7 system, arrangement of order wire circuit.

circuits by high-pass, low-pass filter sets. Thus, the order wire circuit is completely independent of the carrier circuits except for the line repeat coils and the cable through which both signals are transmitted.

b. Arrangement of Order Wire Circuit at an AN/TCC-7 Terminal

(1) The order wire circuit in the AN/TCC-7 terminal is located in the RT-280 ORDER WIRE PANEL, as shown in figure 66. Transmitting gain and receiving gain are provided. The transmitting gain circuit consists of fixed gain plug-in amplifier followed by an adjustable pad designated TR GAIN. The transmitting output is adjusted (using a 1-kc test tone) in accordance with the number of cable reels to the first AN/TCC-11 repeater and the number of AN/TCC-11 repeaters in the power loop fed from the AN/TCC-7 point. This adjustment assures correct circuit loss between the telephone handsets in the AN/TCC-7 terminal and the following AN/TCC-11 or an AN/TCC-8 repeaters. The maximum power delivered to the cables + 20dbm when 0 dbm is applied at the input to the 2W EXT binding posts. This is the power used for a 40-mile attended repeater section.

(2) The receiving gain circuit consists of a fixed gain plug in amplifier proceeded by an adjustable pad designated REC GAIN. The receiving amplifier output is adjusted (using the 1-kc test tone) to a value which adjusts the energy to the telephone handset receiver at the terminal to the desired level. This adjustment compensates for the variations in length of attended repeater sections which may be used.

(3) The transmitting and receiving paths are joined by a hybrid transformer to a form a 2-wire circuit which may be extended to a local point separated from the AN/TCC-7 location. This extension may be used for administration purposes between test or control boards located at the ends of the system (par. 136) The telephone handset supplied with the AN/TCC-7 terminal may be bridged on the order wire talking and receiving path to communicate over the order wire circuit from the AN/TCC-7 terminal location. The telephone handset also may be switched to any message channel to talk out over the system or back to the switchboard.

c. Arrangement of Order Wire Circuit at an AN/TCC-8 Repeater.

(1) The order wire circuit in the AN/TCC-8 repeater is located in the RT-281 ORDER WIRE PANEL. As shown in figure 66, it contains adjustable transmitting gain and receiving gain circuits for both directions of transmission. The through order wire circuit contains a receiving amplifier and transmitting amplifier in tandem. The amplifiers are identical to the plug-in units that are used in the AN/TCC-7 terminal. The gains are controlled in the same manner and with the same considerations as in the AN/TCC-7 terminal (*b* above).

(2) The circuit which provides for communication from the AN/TCC-8 repeater contains talking and receiving paths which bridge on the through circuit. The arrangement permits listening with the telephone handset to signals which come from each direction of transmission, and permits talking out in both directions at the same time.

240. Circuit Net Loss of Order Wire Circuit

The net loss of the order wire circuit between various points in the system is discussed in *a* through *c* below. It is difficult to measure the net loss of the order wire circuit on a system basis. As a guide in judging system performance, the order wire circuit is compared with a field wire line equipped with EE-8 telephones. The net loss values for the order wire circuit between various points in the system are those of such a field wire line which would provide equivalent talking performance.

a. Circuits to AN/TCC-7 Terminal Point

(1) From any attended point to an AN/TCC-7 terminal point, the net loss is approximately 9 db.

(2) From an AN/TCC-11 repeater point to an AN/TCC-7 terminal point, the net loss is somewhat variable, depending on the exact arrangement of AN/TCC-11 repeaters and in the circuit, but will range

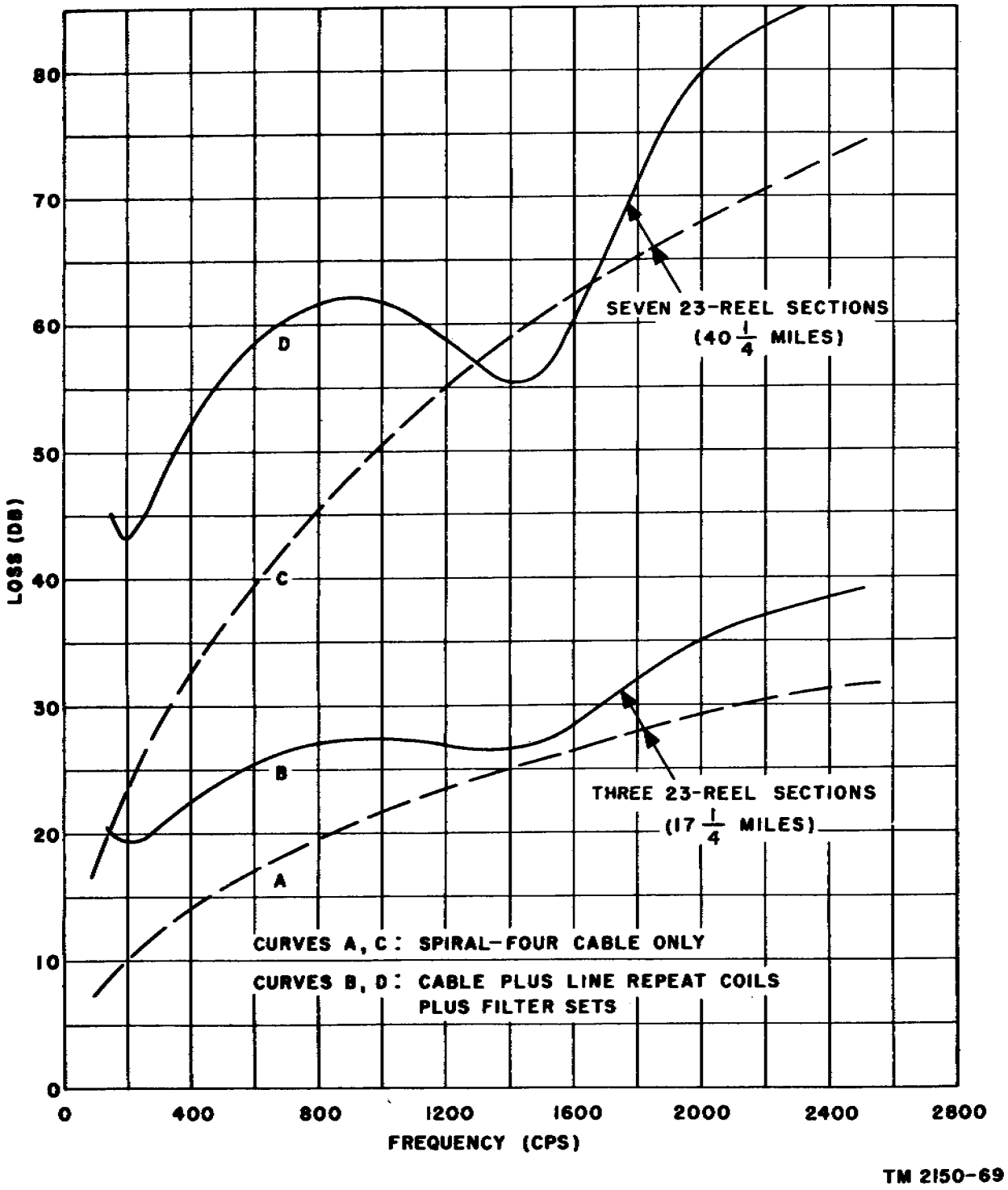


Figure 67. Order wire circuit loss versus frequency.

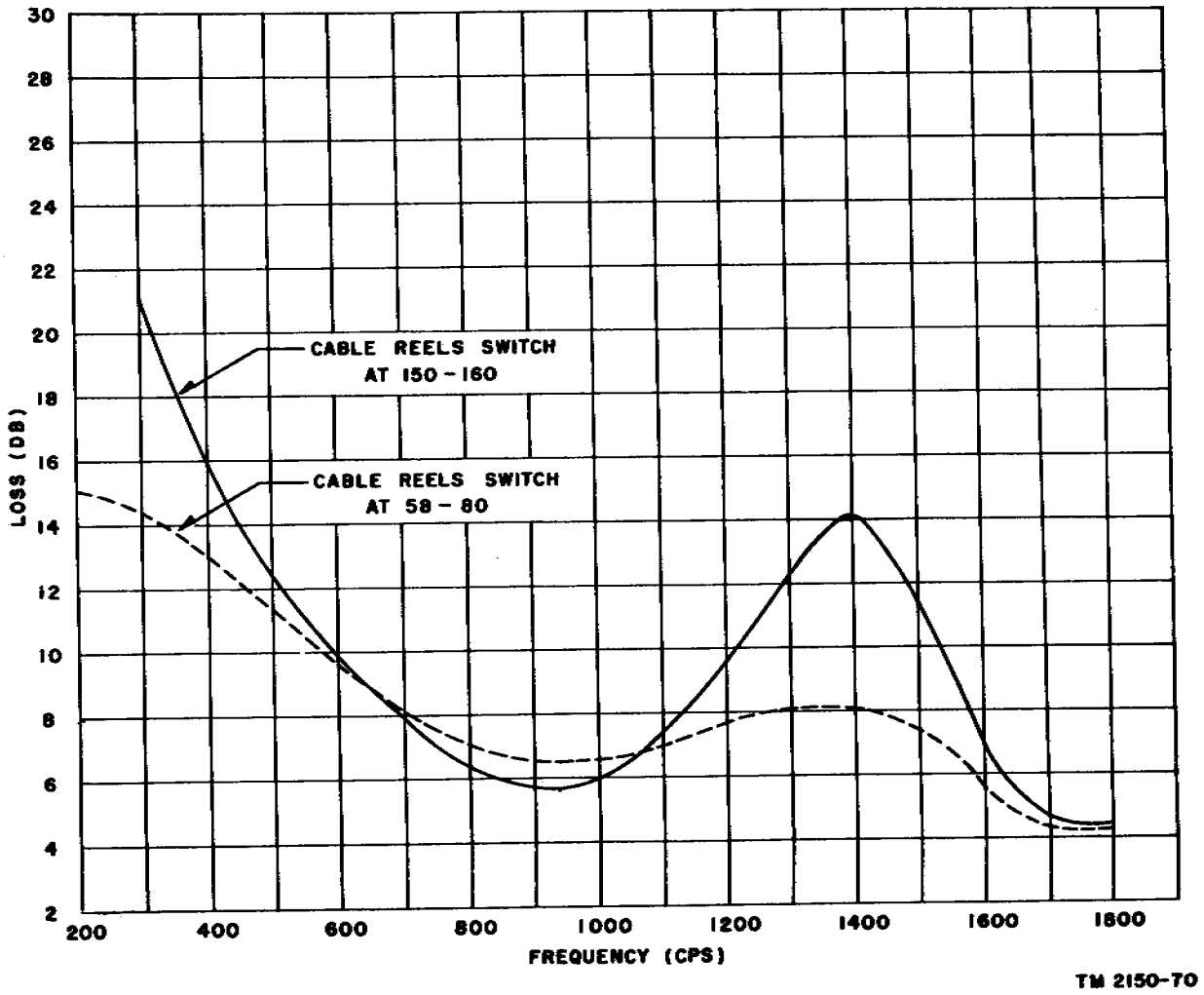


Figure 68. Order wire equalizer characteristics.

from approximately 9 db to 15 db.

b. Circuits to AN/TCC-8 Point.

(1) From any attended point to an AN/TCC-8 repeater point, the net loss is approximately 12 db.

(2) From an AN/TCC-11 repeater point to an AN/TCC-8 repeater point, the net loss ranges from 12 db to 18 db.

c. 2-Wire Extension Circuit. The net loss for the order wire circuit between 2-wire extension circuit connections is approximately 12 db.

241. Equalization in Order Wire Circuit

a. The loss versus frequency characteristic of the cable over the range of frequencies used by the order wire is shown in figure 67, curves *A* and *C*. These curves are modified to curves *B* and *D* by the presence of the line repeat coils and the high-pass, low-pass filter sets in the order wire path through the AN/TCC-11 repeaters (which are spaced at 5¾ mile intervals in the attended repeater section) and at the attended points at the ends of the section.

b. The order wire circuit loss versus frequency characteristic for each attended repeater section is compensated by an equalizer network preceding the order wire transmitting amplifier at the transmitting end of the section. Because the attended section may vary in length from ½ mile to 40 miles (2 to 160 cable reels), the equalization is provided in a number of steps. The equalizer network is controlled by a switch designated CABLE REELS TO NEXT AN/TCC-7 OR AN/TCC-8, with positions numbered to represent the actual number of cable reels to the next attended point. The characteristics of a

representative order wire equalizer network are shown in figure 68.

c. There is one equalizer network in the AN/TCC-7 order wire circuit, and two in the AN/TCC-8 order wire circuit, one for each direction of transmission. In each case, the control switch (CABLE REELS TO NEXT AN/TCC-7 OR AN/TCC-8) is operated to a position for which the designation includes the number of cable reels to the next attended point in the direction of transmission indicated by the switch designation (AB or BA at an AN/TCC-8 point).

242. Temperature Regulation in Order Wire Circuit

The loss versus frequency characteristic of the cable varies appreciably with temperature over the range of frequencies used by the order wire circuit. This effect is compensated by periodic manual adjustments. The variation in loss at 1,000 cps is corrected by periodic adjustment of the receiving gain at successive attended points. An approximate correction for the variation in slope of the loss versus frequency characteristic is obtained by adjusting the order wire equalizer switch in accordance with the prevailing temperature.

243. Signaling Over Order Wire Circuit

a. A 1,600-cps tone is used for signaling over the order wire circuit. The order wire panel at each attended point is equipped with a ringer-oscillator circuit. This circuit is a plug-in unit which contains a source of 1,600 cps and a receiving circuit which indicates the reception of an incoming 1,600-cps signal by causing a lamp to light and a buzzer to sound.

b. Signaling from an AN/TCC-11 repeater is accomplished with the aid of circuits in the TS-712 test set and the EE-8 telephone. Rotation of the handle of the EE-8 telephone generates power which energizes a transistor oscillator within the TS-712 test set to deliver the 1,600-cps signal.

c. Sufficient margin has been provided in the receiving circuit of the ringer-oscillator so that the received signal may drop about 25 db below normal and still cause the circuit to respond.

d. Signaling is available between any two attended points and from any AN/TCC-11 repeater to the attended point from which the AN/TCC-11 repeater receives power (par. 238*b*). There is no provision for signaling to an AN/TCC-11 point.

e. Signaling over the order wire from the 2-wire extension on the AN/TCC-7 terminal is accomplished by means of external v-f ringing equipment such as Telegraph-Telephone Signal Converter TA-182/U. No provisions are made for signaling from an AN/TCC-7 terminal to the local 2-wire extension. When communication between an AN/TCC-7 terminal and the local 2-wire extension is required, an auxiliary telephone circuit must be provided for local use (par. 136).

Section IV. SYSTEM PERFORMANCE

244. General

This section describes the expected performance of a system containing 200 miles of spiral-four cable. The effect of the presence of radio links within the system is described briefly.

245. Noise in System

a. The principal factor contributing to noise in a cable system is static noise. Assuming 300 μμf unbalance to ground per ¼-mile reel of cable, the 5 percent static noise at the low level point on the line is -4 dba (decibel adjusted) at 60 kc. This adds up to a maximum of 38 dba at the 0 db level for a 200-mile cable system.

b. The presence of radio links within the system may increase the noise to a maximum of 45 dba.

246. Crosstalk in System

a. The requirement for system near end equal-level crosstalk, based on the use of the system for full duplex telegraph operation (par. 210*a*) is 25 db. The crosstalk contributed by the cable is the most important factor. This is a function of the capacity unbalance from pair to pair. The unbalance is not expected to be greater than 15 μμf per ¼-mile reel; this value gives a minimum crosstalk loss of about 27 db for a 200-mile system.

b. The crosstalk is affected somewhat by the contributions of the AN/TCC-7 terminals, the AN/TCC-8 repeaters, and the AN/TCC-11 repeaters. However, the total of these contributions should not cause the net near end crosstalk loss to be less than 25 db.

c. The intersystem (far end) crosstalk is not less than 50 db (par. 210*b*).

247. Excessive Modulation in System

a. Cause. Unwanted modulation products are generated because of nonlinearity of the amplifiers and the components in the system (par. 186). The system is engineered so that the normal magnitude of these products is tolerable. However, aging of tubes in the amplifiers may cause the modulation to increase beyond the tolerable limit.

b. Modulation Test. Test circuits are provided in the AN/TCC-7 terminal, the AN/TCC-8 repeaters, and the AN/TCC-11 repeaters for measuring the modulation performance of the entire. system or any section of the system.

(1) *Attended points.* At the AN/TCC-7 terminal and the AN/TCC-8 repeater a source of 65 kc is available and may be connected to the carrier transmission path for either direction of transmission. The 65-kc signal is transmitted with a power of 0 dbm at the 0 db level. This frequency combines with the 68-kc pilot, which is normally present, to produce modulation products because of the inherent nonlinearity of the system. One product, 2 times 65 minus 68, or 62 kc is used for carrier telephone testing. This product is used as the index of the condition of the system with respect to intermodulation. Test circuits are provided to measure the amplitude of the 62-kc product at test jacks located at the carrier amplifier outputs. Thus a modulation measurement may be made for the entire system, for any attended repeater section, or for the amplifiers within any attended point.

(2) *AN/TCC-11 Repeaters.* At the AN/TCC-11 repeaters, circuits are provided for connection to the TS-712 test set to measure the activity of each tube. This test reveals the presence of a weak tube which may cause excessive modulation.

c. Modulation Values.

(1) The following table (applicable only to system using no radio sections) lists values of modulation under normal performance conditions (*b*(1) above). Also listed are the limiting values of modulation which call for investigation when they are exceeded.

Portion of system	Normal performance		Limiting value	
	dbm	Sum of test set meter reading and operated ATTENUATOR push buttons (db)	dbm	Sum of test set meter reading and operated ATTENUATOR push buttons (db).
Entire system (200 miles or less).	-58	+12.....	-50	20
1 attended repeater section (40 miles or less).	-72	-2	-56	14
Each of two or more attended repeater sections (par 150*b*(5)).	.....	.....	-64	6
Amplifiers in AN/TCC-7 or AN/TCC-8 equipment.	-89	Below scale	-75	-5

(2) The TEST PANEL circuit when arranged to measure 62 kc has a sensitivity that causes the meter to read 0 db for an input of-70 dbm. Thus the value of the 62-kc measurement in negative dbm is 70 minus the algebraic sum of the ATTENUATOR push buttons operated and the TEST PANEL meter reading.

248. Frequency Characteristic of System

The frequency characteristics expected for a system containing 200 miles of cable are as follows:

a. Message Circuit. The overall frequency characteristic of each message circuit has a variation in loss of -4.5 db to +1.5 db (relative to the value at 1,000 cps) for 300 cps to 3,500 cps. A representative characteristic is shown in figure 69.

b. Special Service (4 to 20 kc). The 4- to 20-kc special service channels have a frequency characteristic such that the difference between the maximum and minimum loss between 4 and 20 kc does not exceed 4 db.

c. Special Service (12 to 60 kc). The 12- to 60- kc special service channel has a frequency characteristic

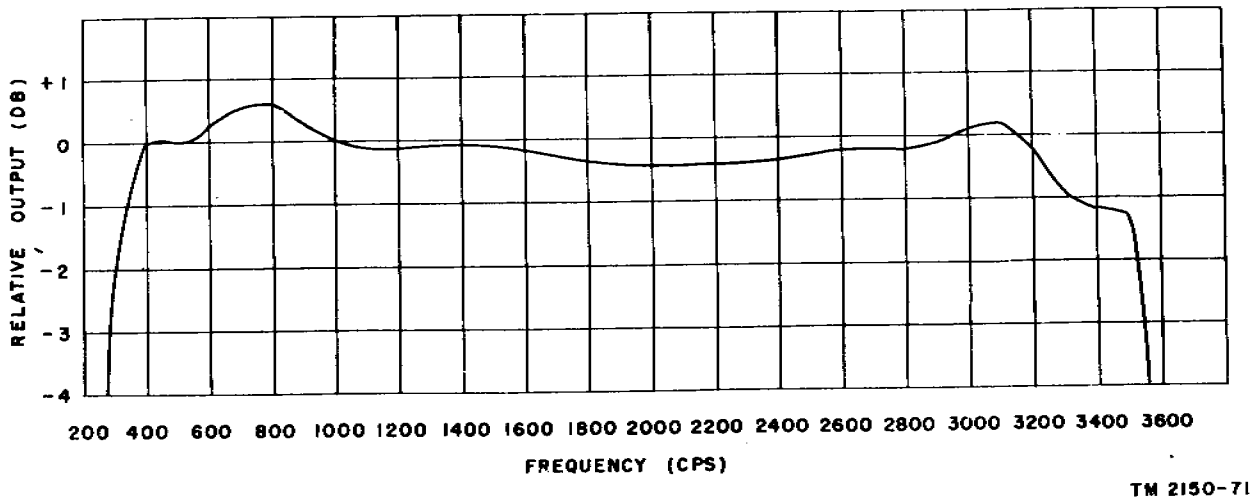


Figure 69. Typical message channel frequency characteristic.

such that the difference between the maximum and minimum loss between 12 and 60 kc does not exceed 6 db.

249. Temperature Range of System

The variation in performance of a 200-mile cable system with temperature is as follows:

a. The temperature range over which the system meets the performance stated in paragraph 248 is ±30° F. relative to a temperature between 0° F. and 100° F. at which the system line-up was performed.

b. The system meets the performance outlined in paragraphs 245 through 248 over a temperature range from -40° F. to +132° F.

c. The system operates to the extent of providing intelligible transmission of speech on message channels over a temperature range from -65° F. to +150° F.

250. Order Wire Performance in System

The order wire circuit performance for a 200 mile cable system, is as follows:

a. Frequency Characteristic

(1) From 300 cps to 1,650 cps the loss is not greater when 10 db more than the loss at 1,000 cps and not lower than 3 db less than the loss at 1,000 cps.

(2) The differences between maximum loss and minimum loss from 300 cps to 1,650 cps does not exceed 10 db.

b. Temperature Range

(1) The values of circuit loss given in paragraph 252 may be obtained over a temperature range from -55° F. to + 130° F.

(2) At temperatures above + 130° F., the circuit loss may increase but the order wire circuit will provide intelligible communication up to at least + 150° F.

CHAPTER 6

TESTING FACILITIES

Section I. TELEPHONE TERMINAL AN/TCC-7

251. General

This section contains information concerning the use of testing facilities built into the AN/TCC-7 terminal. Tables are included which described the use of the TS-760 TEST PANEL the calibration of the TS-760 TEST PANEL, and the procedure for sending test and pilot frequencies from the AN/TCC-7 terminal. Frequent reference is made to these tables throughout this technical manual; they are grouped together in this section for convenience.

252. AN/TCC-7 Terminal, Measuring Points

The AN/TCC-7 terminal contains a number of test jacks at which measurements may be made with the TS-760 TEST PANEL. Tests at these jacks are made by insertion of the MEASURE cord attached to the Test PANEL. Figure 70 shows the location of these test points with respect to the circuits of the AN/TCC-7 terminal.

253. Use of TS-760 TEST PANEL Measuring Circuits

When a procedure in this manual requires the use of the TS-760 TEST PANEL, the test procedure is described and reference is made to a specific item in the table below. The table lists all measurements that may be made with the TS-760 TEST PANEL. The connections of the MEASURE cord and the settings of the switches on the front panel for each measurement are given. The controls on the TS-760 TEST PANEL are shown in figures 22 and 24. The procedure in this manual describing the test gives the TS-760 TEST PANEL meter reading which should be obtained.

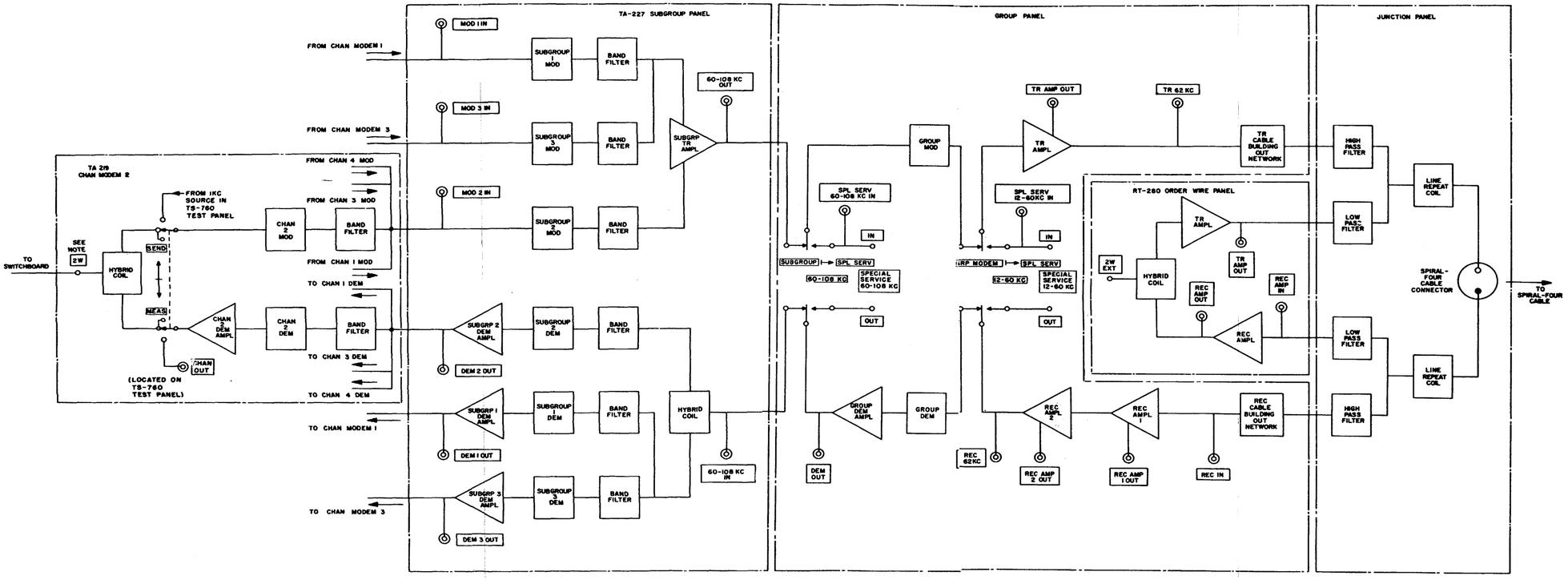


Figure 70. -AN/TCC-7 terminal test points, block diagram.

Item No.	Connection of MEASURE cord		Freq measured (kc)	MEASURE	Settings of switches		Notes
	Jack	Panel			MEASURE SELECTIVE	MEASURE SELECTIVE	
1			D-c	200 VOLTS	OFF	OFF	
2			D-c	600 VOLTS	OFF	OFF	
3	CHANNEL OUT	TS-760 TEST PANEL	1	TRANSMISSION	OFF	CHANNEL OUT	1.
4	MOD 1 IN	TA-227 SUBGROUP PANEL	4-20	TRANSMISSION	OFF	SUB GRP MOD IN	
5	MOD 2 IN	TA-227 SUBGROUP PANEL	4-20	TRANSMISSION	OFF	SUB GRP MOD IN	
6	MOD 3 IN'	TA-227 SUBGROUP PANEL	4-20	TRANSMISSION	OFF	SUB GRPMOD IN	
7	DEM 1 OUT	TA-227 SUBGROUP PANEL	11	TRANSMISSION	OFF	SUB GRP DEM OUT	
8	DEM 2 OUT	TA 227 SUBGROUP PANEL	11	TRANSMISSION	OFF	SUB GRP DEM OUT	
9	DEM 3 OUT'	TA-227 SUBGROUP PANEL	11	TRANSMISSION	OFF	SUB GRP DEM OUT	
10	60-108 KC OUT	TA-227 SUBGROUP PANEL	67	TRANSMISSION	67 KC	OFF	2.
11	60-108 KC OUT	TA-227 SUBGROUP PANEL	83	TRANSMISSION	83 KC	OFF	2.
12	60-108 KC OUT	TA-227 SUBGROUP PANEL	99	TRANSMISSION	99 KC	OFF	2.
13	60-108 KC IN	TA-227 SUBGROUP PANEL	83	TRANSMISSION	OFF	SUB GRP 60-108 KC IN	
14	SPL SERV 60-108 KC IN.	GROUP PANEL	60-108	TRANSMISSION	OFF	SPL SERV 60-108 KC IN	
15	DEM OUT	GROUP PANEL	83	TRANSMISSION	OFF.	GRP DEM OUT	
16	SPL SERV 12-60 KC IN.	GROUP PANEL.	12-60	TRANSMISSION	OFF	GRP SPL SERV 12-60 KC IN.	
17	TR AMP OUT	GROUP PANEL	12	TRANSMISSION	12 KC	OFF	2.
18	TR AMP OUT	GROUP PANEL	28	TRANSMISSION	28 KC	OFF	2.
19	TR AMP OUT	GROUP PANEL	68	TRANSMISSION	68 KG	OFF	2.
20	TR AMP OUT	GROUP PANEL	65	TRANSMISSION	65 KC 1	OFF	2.
21	TR AMP OUT	GROUP PANEL	37	TRANSMISSION	37 KC	OFF	2.
22	TR ANP OUT	GROUP PANEL	83, 91, 99	TRANSMISSION	OFF	FAULT TEST	3.
23	TR 62 KC	GROUP PANEL	62	TRANSMISSION	GRP PANEL 62 KC	GRP PANEL 62 KC	2 and 3.
24	REC IN	GROUP PANEL	68	TRANSMISSION	68 KC	OFF	2 and 3.
25	REC IN	GROUP PANEL	12	TRANSMISSION	12 KC	OFF	2 and 3.
26	REC IN	GROUP PANEL	28	TRANSMISSION	28 KC	OFF	2 and 3.
27	REC IN	GROUP PANEL	83, 91, 99	TRANSMISSION	OFF	FAULT TEST	3.
28	REC AMP 1 OUT	GROUP PANEL	68	TRANSMISSION	68 KC	OFF	2.
29	REC AMP 1 OUT	GROUP PANEL	12	TRANSMISSION	12 KC	OFF	2.
30	REC AMP 1 OUT	GROUP PANEL	28	TRANSMISSION	28 KC	OFF	2.
31	REC AMP 2 OUT	GROUP PANEL	12	TRANSMISSION	12 KC	OFF	2.
32	REC AMP 2 OUT	GROUP PANEL	28	TRANSMISSION	28 KC	OFF	2.
33	REC AMP 2 OUT	GROUP PANEL	68.	TRANSMISSION	68 KC	OFF	2.
34	REC AMP 2 OUT	GROUP PANEL	65	TRANSMISSION	65 KC	OFF	2.
35	REC AMP 2 OUT	GROUP PANEL	37	TRANSMISSION	37 KC	OFF	2

36	REC 62 KC	GROUP PANEL	62	TRANSMISSION	GRP PANEL 62 KC	GRP PANEL 62 KC	2 and 3.
37	TR AMP OUT	RT-280 ORDER WIRE PANEL	1 (or 1.6)	TRANSMISSION	OFF	OW TR AMP OUT	3.
38	REC AMP IN	RT-280 ORDER WIRE PANEL	1 (or 1.6)	TRANSMISSION	OFF	OW REC AMP	
39	REC AMP OUT	RT-280 ORDER WIRE PANEL	1 (or 1.6)	TRANSMISSION	OFF	OW REC AMP	
40	All jacks	TA-228 CARRIER SUPPLY PANEL	Carrier	TRANSMISSION	OFF	CARR SUPPLY	

NOTES

1. Operate SEND-MEAS lever switch to the MEAS; position on the appropriate channel of TA-219 CHAN MODEM.

2. Adjust the FINE TUNE control on the TS-760 TEST PANEL for maximum meter reading. If unable to tune to maximum or if the maximum occurs with the FINE TUNE control near either end of its range, make the adjustments of paragraph 254, step 5.

3. Operate the ATTENUATOR push buttons as required. The instructions sometimes give test limits in terms of the algebraic sum of the TS-760 TEST PANEL meter reading and the number of db represented by the ATTENUATOR push buttons operated. When a negative meter reading its obtained it should be subtracted from the sum of the ATTENUATOR values. Examples are shown below:

(a) If the 5-db and 10-db ATTENUATOR push buttons are operated and the meter reads +2, the algebraic sum is 5+10+2=17 db.

(b) If the 10-db ATTENUATOR push button is operated and the meter reads-3, the algebraic sum is 10 - 3=7 db.

254. Calibration of TS-760 TEST PANEL

The TS-760 TEST PANEL should be checked and calibrated at frequent intervals by following the procedure given in the table below.

Step No.	Connect MEASURE cord to	Setting of switches				Procedure
		SEND	MEASURE	SELECTIVE	NONSELECTIVE	
1	CHECK 1 KC jack	CHECK GAIN-CHECK HF.	TRANSMISSION	OFF	CHECK 1 KC CHECK HF	Adjust 1 KC control to obtain reading of 0 db on meter.
2	CHECK HF jack	CHECK GAIN-CHECK HF.	TRANSMISSION	OFF	CHECK 1 KC CHECK HF	Adjust HF control to obtain reading of 0 db on meter.
3	CHECK HF jack	CHECK GAIN-CHECK HF.	TRANSMISSION	CHECK GAIN	OFF	Adjust FINE TUNE control for maximum reading on meter. If a maximum reading cannot be obtained or if a maximum reading occurs with the FINE TUNE control near either end of its range make the adjustments of step No. 5. Adjust GAIN control to obtain reading of 0 db on meter. If 0 db cannot be obtained (a possibility at extreme temperatures), adjust the GAIN control to approximately midposition. Adjust the AMP GAIN control in the plug-in i-f amplifier to obtain reading as near to 0 db on meter as possible. If necessary, adjust the GAIN control to obtain reading of 0 db on meter.
4	Not connected	CHECK GAIN-CHECK HF.	TRANSMISSION	OFF	OFF	Normal settings when TS-760 TEST PANEL is not in use.
	Note. Perform the following steps only when called for by the test procedure instructions or for routine maintenance					
5	TR AMP OUT jack on GROUP PANEL	.....	TRANSMISSION	68 KC	OFF	Set FINE TUNE control at the middle of its range. Adjust COARSE TUNE control for maximum reading on meter.
6	CHECK HF jack	CHECK GAIN-CHECK HF.	TRANSMISSION	CHECK GAIN	OFF	Leave FINE TUNE and COARSE TUNE controls as adjusted in step No. 5 above. Adjust HF FREQ (C51) capacitor (on left side of chassis) for maximum reading on meter.

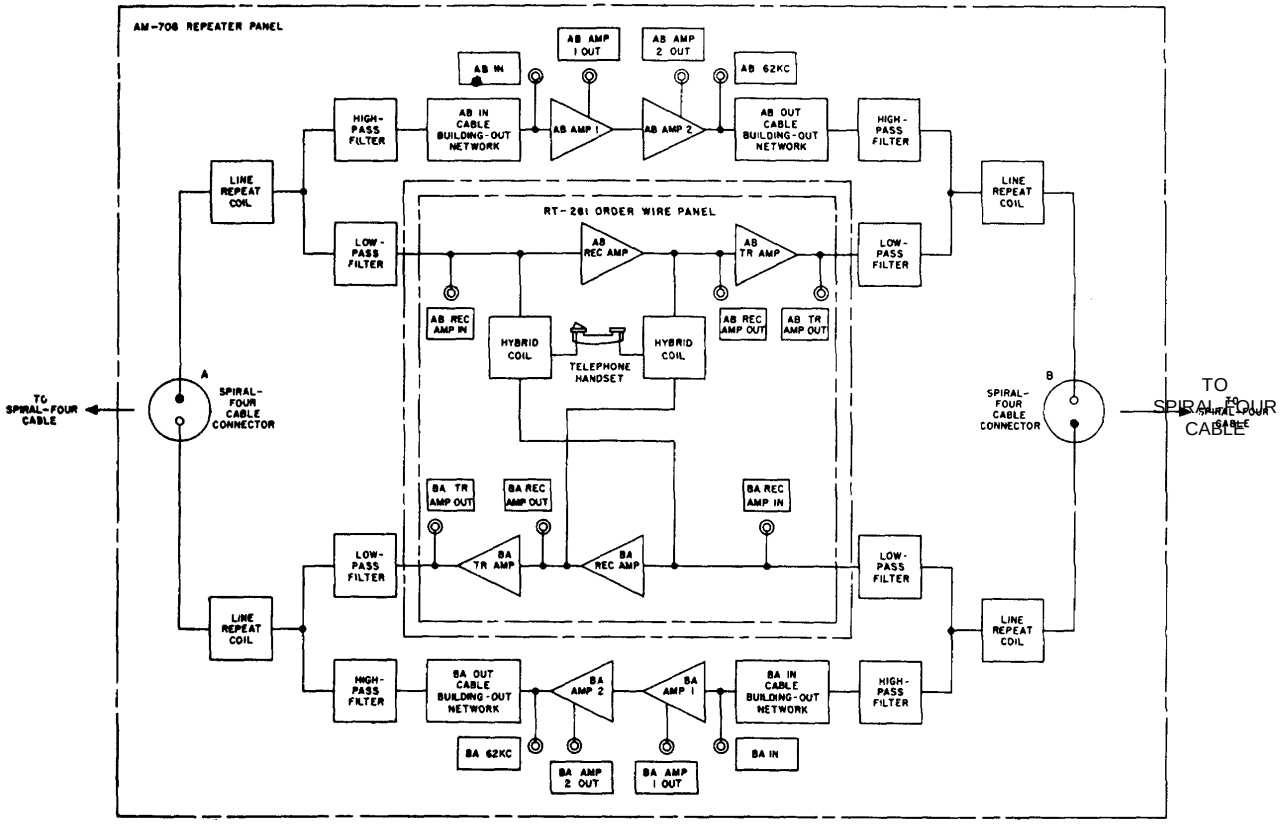
255. Procedure for Sending Test and Pilot Frequencies from AN/TCC-7 Terminal

The AN/TCC-7 terminal provides test frequencies for the line-up and the maintenance of the system. When tests employing these frequencies are described in this technical manual, reference is made to a specific item in the table below, which gives the procedure for sending each test frequency. The table lists the test frequency being sent, the part of the circuit at which the frequency is introduced, and the settings of the controls used to send the frequency and adjust its power.

Item No.	Frequency (kc)	Point of insertion	Control used to send test frequency			Control used to adjust power		Notes
			Name	Location	Position	Name	Location	
1	1	Channel modem input.	SEND-MEAS	TA-219 CHAN MODEM.	SEND	1 KC (adjusted during calibration of TS-760 TEST PANEL).	TS-760 TEST PANEL.	
2	1	Order wire equalizer input.	SEND OW	RT-280 ORDER WIRE PANEL.	ON	1 KC (adjusted during calibration of TS-760 TEST PANEL).	TS-760 TEST PANEL.	
3	65	Transmitting amplifier input.	SEND	TS-760 TEST PANEL.	65 KC TR OR FAULT TEST.	65 KC TR OR FAULT TEST.	TS-760 TEST PANEL.	1.
4	65	Receiving amplifier 1 input.	SEND	TS-760 TEST PANEL.	65 KC REC	65 KC REC	TS-760 TEST PANEL.	1.
5	99	Transmitting amplifier input.	SEND	TS-760 TEST PANEL.	65 KC TR OR FAULT TEST.	65 KC OR FAULT TEST.	TS-760 TEST PANEL.	1 and 2.
6	91	Transmitting amplifier input.	SEND	TS-760 TEST PANEL.	65 KC TR OR FAULT TEST.	65 KC TR OR FAULT TEST.	TS-760 TEST PANEL.	1 and 3.
7	83	Transmitting amplifier input.	SEND	TS-760 TEST PANEL.	65 KC TR OR FAULT TEST.	65 KC TR OR FAULT TEST.	TS-760 TEST PANEL.	1 and 4.
8	12	Transmitting amplifier input.	12 and 28 KC	TA-228 CARRIER SUPPLY PANEL.	ON	12 KC	TA-228 CARRIER SUPPLY PANEL.	
9	28	Transmitting amplifier input.	12 and 28 KC	TA-228 CARRIER SUPPLY PANNEL.	ON	28 KC	TA-228 CARRIER SUPPLY PANEL.	
10	68	Transmitting amplifier input.	Pilot is always connected.	.....	.....	68 KC	TA-228 CARRIER SUPPLY PANEL.	

NOTES

1. Operate the SEND switch to the CHECK position when not in use.
2. Depress FAULT TEST, REP 1 push button on TS-760 TEST PANEL.
3. Depress FAULT TEST, REP 2 push button on TS-760 TEST PANEL.
4. Depress FAULT TEST, REP 3 push button on TS-760 TEST PANEL.



TM 2150-36

Figure 71. AN/TCC-8 Repeater, test points, block diagram.

Section II. TELEPHONE REPEATER AN/TCC-8

256. General

This section contains information describing the use of the testing facilities built into the AN/TCC-8 repeater. Tables are included which describe the use of the TS-761 TEST PANEL, the calibration of the TS-761 TEST PANEL, and the procedure for sending test frequencies from the AN/TCC-8 repeater. Frequent reference is made to these tables throughout this technical manual; they are grouped in this section for convenience.

257. AN/TCC-8 Repeater, Measuring Points

The panels of the AN/TCC-8 repeater contain a number of test jacks at which measurements may be made with the TS-761 TEST PANEL by insertion of the MEASURE cord attached to the TS-761 TEST PANEL. Figure 71 shows the locations of these test points with respect to the circuits of the AN/TCC-8 repeater.

258. Use of TS-761 TEST PANEL Measuring Circuits

When a test described in this technical manual requires the use of the TS-761 TEST PANEL, reference is made to a specific item in the table below. The table lists all the measurements that may be made by use of the TS-761 TEST PANEL. The table gives the connections of the MEASURE cord and the settings of the switches on the front panel for each measurement. The controls of the TS-761 TEST PANEL are shown in figures 32 and 34. The procedure in this manual describing the test gives the TS-761 TEST PANEL meter reading which should be obtained.

Item No.	Connection of MEASURE cord		Freq. measured (kc)	Setting of switches			NOTES
	Jack	Panel		MEASURE	MEASURE SELECTIVE	MEASURE NONSELECTIVE	
1	.....	.....	D-c	200 VOLTS	OFF	OFF	
2	.....	.....	D-c	600 VOLTS TOWARD A.	OFF	OFF	
3	.....	.....	D-c	600 VOLTS TOWARD B.	OFF	OFF	
4	AB IN	AM-708 REPEATER PANEL	68	TRANSMISSION	68 KC	OFF	1 and 2.
5	AB IN	AM-708 REPEATER PANEL	12	TRANSMISSION	12 KC	OFF	1 and 2.
6	AB IN	AM-708 REPEATER PANEL	28	TRANSMISSION	28 KC	OFF	1 and 2.
7	AB IN	AM-708 REPEATER PANEL	83, 91, 99	TRANSMISSION	OFF	FAULT TEST	2.
8	AB AMP 1 OUT	AM-708 REPEATER PANEL	68	TRANSMISSION	68 KC	OFF	1.
9	AB AMP 1 OUT	AM 708 REPEATER PANEL	12	TRANSMISSION	12 KC	OFF	1.
10	AB AMP 1 OUT	AM-708 REPEATER PANEL	28	TRANSMISSION	28 KC	OFF	1.
11	AB AMP 2 OUT	AM-708 REPEATER PANEL	37	TRANSMISSION	37 KC	OFF	1.
12	AB AMP 2 OUT	AM-708 REPEATER PANEL	12	TRANSMISSION	12 KC	OFF	1.
13	AB AMP 2 OUT	AM-708 REPEATER PANEL	28	TRANSMISSION	28 KC	OFF	1.
14	AB AMP 2 OUT	AM-708 REPEATER PANEL	65	TRANSMISSION	65 KC	OFF	1.
15	AB AMP 2 OUT	AM-708 REPEATER PANEL	68	TRANSMISSION	68 KC	OFF	1.
16	AB AMP 2 OUT	AM-708 REPEATER PANEL	83, 91, 99	TRANSMISSION	OFF	FAULT TEST	
17	AB 62 KC	AM-708 REPEATER PANEL	62	TRANSMISSION	REP PANEL 62 KC.	REP PANEL 62 KC.	1 and 2
18	BA IN	AM-708 REPEATER PANEL	68	TRANSMISSION	68 KC	OFF	1 and 2
19	BA IN	AM-708 REPEATER PANEL	12	TRANSMISSION	12 KC	OFF	1 and 2
20	BA IN	AM-708 REPEATER PANEL	28	TRANSMISSION	28 KC	OFF	1 and 2
21	BA IN	AM-708 REPEATER PANEL	83, 91, or 99.	TRANSMISSION	OFF	FAULT TEST	2.
22	BA AMP 1 OUT	AM-708 REPEATER PANEL	68	TRANSMISSION	68 KC	OFF	1.
23	BA AMP 1 OUT	AM-708 REPEATER PANEL	12	TRANSMISSION	12 KC	OFF	1.
24	BA AMP 1 OUT	AM-708 REPEATER PANEL	28	TRANSMISSION	28 KC	OFF	1.
25	BA AMP 2 OUT	AM-708 REPEATER PANEL	37	TRANSMISSION	37 KC	OFF	1.
26	BA AMP 2 OUT	AM-708 REPEATER PANEL	12	TRANSMISSION	12 KC	OFF	1.
27	BA AMP 2 OUT	AM-708 REPEATER PANEL	28	TRANSMISSION	28 KC	OFF	1.
28	BA AMP 2 OUT	AM-708 REPEATER PANEL	65	TRANSMISSION	65 KC	OFF	1.
29	BA AMP 2 OUT	AM-708 REPEATER PANEL	68	TRANSMISSION	68 KC	OFF	1.
30	BA AMP 2 OUT	AM-708 REPEATER PANEL	83, 91, 99	TRANSMISSION	OFF	FAULT TEST	

31	BA 62 KC	AM-708 REPEATER PANEL	62	TRANSMISSION	REP PANEL 62 KC.	REP PANEL 62 KC.	1 and 2.
32	AB REC AMP IN	RT-281 ORDER WIRE PANEL	1 (or 1.6)	TRANSMISSION	OFF	OW REC AMP	
33	AB REC AMP OUT	RT-281 ORDER WIRE PANEL	1 (or 1.6)	TRANSMISSION	OFF	OW REC AMP	
34	AB TR AMP OUT	RT-281 ORDER WIRE PANEL	1 (or 1.6)	TRANSMISSION	OFF	OW TR AMP OUT	2.
35	BA REC AMP IN	RT-281 ORDER WIRE PANEL	1 (or 1.6)	TRANSMISSION	OFF	OW REC AMP	
36	BA REC AMP OUT	RT-281 ORDER WIRE PANEL	1 (or 1.6)	TRANSMISSION	OFF	OW REC AMP	
37	BA TR AMP OUT	RT-281 ORDER WIRE PANEL	1 (or 1.6)	TRANSMISSION	OFF	OW TR AMP OUT	2.

NOTES

1. Adjust the FINE TUNE control on the TS-761 TEST PANEL for maximum meter readings. If maximum cannot be obtained or if the maximum occurs with the FINE TUNE control near either end of its range, make the adjustments of paragraph 259, step 4.

2. Operate the ATTENUATOR push buttons as required. The instructions sometimes give test limits in terms of the algebraic sum of the TS-761 TEST PANEL meter reading and the number of db represented by the ATTENUATOR push buttons operated. When a negative meter reading is obtained it should be subtracted from the sum of the ATTENUATOR values. Examples are shown below:

(a) If the 5 db and 10 db ATTENUATOR push buttons are operated, the meter reads + 2, the algebraic sum is 5+10+2=17 db.

(b) If the 10 db ATTENUATOR push button is operated and the meter reads -3, the algebraic sum is 10-3=7 db.

259. Calibration of TS-761 Test PANEL

Check and calibrate the TS-761 TEST PANEL at frequent intervals in accordance with the procedure outlined in the table below.

Step	Connect MEASURE cord to	Settings of switches					Procedure
		SEND	FREQUENCY	MEASURE	MEASURE SELECTIVE	NON-SELECTVE	
1	CHECK OSC jack	CHECK	68 KC	TRANSMISSION	OFF	CHECK OSC	Adjust OSC control to obtain reading of 0 db on meter.
2	CHECK OSC jack	CHECK	68 KC	TRANSMISSION	CHECK GAIN	OFF	Adjust the FINE TUNE control for a maximum reading on meter. If maximum cannot be obtained by tuning or if the maximum reading occurs with the FINE TUNE control near either end of its range, make the adjustments of step 4. Adjust GAIN control to obtain reading of 0 db on meter. If 0 db cannot be obtained (a possibility at extreme temperatures), adjust the GAIN control to approximately midposition. Adjust the AMP GAIN to obtain a reading as near to 0 db on the meter as possible. If necessary, adjust GAIN control to obtain 0 db reading on meter.
3	Not connected *Note:* Perform the following steps only when called for by the instructions or for routine maintenance.	CHECK	FAULT TEST	TRANSMISSION	OFF	OFF	Normal settings when TS-761 TEST PANEL is not in use.
4	AB AMP 2 OUT jack on AM-708 REPEATER PANEL.	.....	.....	TRANSMISSION	68 KC	OFF	Set FINE TUNE control at the middle of its range. Adjust COARSE TUNE control for maximum reading on meter.
5	CHECK OSC jack	CHECK	68 KC	TRANSMISSION	CHECK GAIN	OFF	Leave FINE TUNE and COARSE TUNE controls as adjusted in step No. 4 above. Adjust HF FREQ (C5) capacitor (on left side of chassis) for maximum reading on meter.

260. Procedure for Sending Test Frequencies From AN/TCC-8 Repeater

The TS-761 TEST PANEL of the AN/TCC-8 repeater provides test frequencies for the line-up and the maintenance of the system. When a procedure in this technical manual describes a test employing a test frequency, reference is made to a frequency and adjusting its power specific item in the table below, which gives the procedure for sending each test frequency. The table lists the frequency sent, the part of the circuit at which the frequency is introduced, and the settings of the controls for sending the frequency is introduced, and the settings of the controls for sending the frequency and adjusting its power.

Item No.	Frequency (kc)	Point of insertion	Setting of switches*		Control to adjust power	Notes
			SEND DIRECTION	SEND FREQUENCY		
1	68	AB AMP 1 input	AB	68 KC OR CHECK	SEND	
2	68	BA AMP 1 input	BA	68 KC OR CHECK	SEND	
3	65	AB AMP 1 input	AB	65 KC	SEND	
4	65	BA AMP 1 input	BA	65 KC	SEND	
5	99	AB AMP 1 input	AB	FAULT TEST	SEND	Depress FAULT TEST REP 1 push button.
6	99	BA AMP 1 input.	BA	FAULT TEST	SEND	Depress FAULT TEST REP 1 push button.
7	91	AB AMP 1 input	AB	FAULT TEST	SEND	Depress FAULT TEST REP 2 push button.
8	91	BA AMP 1 input	BA	FAULT TEST	SEND	Depress FAULT TEST REP 2 push button.
9	83	AB AMP 1 input	AB	FAULT TEST	SEND	Depress FAULT TEST REP 3 push button.
10	83	BA AMP 1 input	BA	FAULT TEST	SEND	Depress FAULT TEST REP 3 push button.

*When the sending circuits are not in use, operate the SEND DIRECTION switch to the CHECK position and the SEND FREQUENCY switch to the FAUL TEST.

Section III. TEST SET TS-71 2/TCC-11

261. General

This section contains information concerning the use of the TS-712 test set. The method of connecting the TS-712 test set to an AN/TCC-11 repeater is described. A table is included which summarizes all measurements that may be made with the TS-712 test set. The procedure for checking the TS-712 test set is also covered. Frequent reference is made to this information throughout this manual; it is assembled in this section for easy reference.

262. Connection of TS-712 Test Set to AN/TCC-11 Repeater

The TS-712 teat set is used to measure d-c and signal voltages at various points in the AN/TCC11 repeater. The TS-712 test set must be connected to the repeater to make the measurements. Connect the TS-712 test set as described in *a* and *b* below.

a. Remove the TEST cover at the J2 end of the AN/TCC-11 repeater (fig. 43)

b: Connect the cable from the TS-712 test set to the repeater by engaging connector P1 on the cable with the J3 connector on the repeater.

263. Use of TS-712 Test Set Measuring Circuit

When a procedure described in the technical manual requires the use of the TS-712 test set, reference is made to a specific item in the table below. The table lists the settings of the switches on the panel of the TS-712 test set (fig. 37) for all measurements. The procedure describing the test gives the TS-712 test set meter reading which should be obtained.

Item No.	Quantity measured	Frequency (kc)	Settings of switches			Notes
			POWER	MEASURE	SELECTOR	
1	Voltage across repeater	D-c	ON	REP VOLTS		
2	Filament voltage	D-c	ON	A BAT	(The setting of the SELECTOR switch for items 1 through 7 is arbitrary.)	1
3	Plate voltage	D-c	ON	B BAT		2
4	Space current-tube Vl of amplifier 1.	D-c	ON	V1 AMP 1		3
5	Space current-tube V2 of amplifier 1	D-c	ON	V2 AMP 1		3
6	Space current-tube Vl of amplifier 2.	D-c	ON	V1 AMP 2		3
7	Space current-tube V2 of amplifier 2.	D-c	ON	V2 AMP 2		3
8	Input to amplifier 1 (db)	1 (or 1.6)	ON	TRANS	AMP 1 IN 1 KC	4
9	Input to amplifier 1 (db)	68	ON	TRANS	AMP 1 IN 68 KC	
10	Output of amplifier 1 (db)	68	ON	TRANS	AMP 1 OUT 68 KC	
11	Output of amplifier 1 (db)	1 (or 1.6)	ON	TRANS	AMP 1 OUT 1 KC	4
12	Input to amplifier 2 (db)	1 (or 1.6)	ON	TRANS	AMP 2 IN 1 KC	4
13	Input to amplifier 2 (db)	68	ON	TRANS	AMP 2 IN 68 KC	
14	Output of amplifier 2 (db)	68	ON	TRANS	AMP 2 OUT 68 KC	
15	Output of amplifier 2 (db)	1 (or 1.6)	ON	TRANS	AMP 2 OUT 1 KC	4

NOTES

1. Adjust A BAT control to obtain reading at the BAT mark on TS-712 test set meter.

2. Adjust B BAT control to obtain reading at the BAT mark on TS-712 test set meter.

3. To measure filament activity read the TS-712 test set meter with V ACT leer switch at the NORMAL position. Operate V ACT switch to the TEST position and not change in meter reading after 1 minute. Restore V ACT switch to the NORMAL position

4. Operate the 1 KC SENS lever switch to the LOW or the HIGH positions as required to obtain a meter reading on scale.

264. Check of Accuracy of TS-712 Test Set

The TS-712 test set may be checked at an attended point. by connecting it to the TS-760 TEST PANEL of an AN/TCC-7 terminal as described in *a* below or the TS-761-TEST PANEL of an AN/TCC-8 repeater according to the procedures in *b* below.

a. Check of TS-712 Test Set at AN/TCC-7 Terminal.

(1) Connect the cable from the TS-712 test set to the TS-760 TEST PANEL by engaging connector PI on the cable with connector J5 on the TS-760 TEST PANEL.

(2) Calibrate the TS-760 TEST PANEL according to the procedure outlined in paragraph 254.

(3) Operate the SEND switch on the TS-760 TEST PANEL to the CHECK GAIN-CHECK HF position.

(4) Check the TS-712 test set according to the procedure in *c* below.

b. Check of TS-712 Test Set at AN/TCC-8 Repeater.

(1) Connect the cable from the TS-712 test set to the TS-761 TEST PANEL by engaging connector P1 on the cable with connector J5 on the TS-761 TEST PANEL.

(2) Calibrate the TS-761 TEST PANEL according to the procedure in paragraph 259.

(3) Operate the SEND DIRECTION switch on the TS-761 TEST PANEL to the CHECK position and the SEND FREQUENCY switch to the 68 KC OR CHECK position.

(4) Check the TS-712 test set according to the procedure in *c* below.

c. Check of TS-712 Test Set.

(1) Check the A and B battery voltages (par. 263, items 2 and 3).

(2) Operate the MEASURE control to the TRANS position, and the SELECTOR switch to the AMP 2 IN 68 KC position.

(3) Adjust the GAIN control (on chassis below the front panel) (fig. 38) to obtain a reading of 0 db on the TS-712 test set meter.

(4) Operate the SELECTOR switch to the AMP 1 IN 1 KC position, the ORDER WIRE switch to the RING position, and the OW GAIN switch to the HIGH position. Connect the L1 and L2 terminals of Telephone EE-8 to the TEL binding posts (L1 and L2) of the TS-712 test set.

(5) Operate the crank of the Telephone EE-8 at a normal speed. The TS-712 test set meter should read between -4 db and +4 db.

APPENDIX

REFERENCES

Note. For availability of items listed, check 310-20-3, SR 310-20-4, SR 310-20-5, and SR 310-20-7. Check Department of the Army Supply Manual SIG 1 for Signal Corps Supply Manuals.

1. Regulations

AR 380-5 ..... Safeguarding Security Information.
AR 750-5 ..... Maintenances Responsibilities and Shop Operation..
SR 725-405-5 ..... Preparation and Submission of Requisitions for Signal Corps Supplies.

2. Auxiliary Equipment and Test Equipment

TM 11-333 ..... Telephones EE-8, EE-8-A, and EE-8-B.
TM 11-900 ..... Power Unit PE-75-C, -D, -J, -K, -P, -S, -T, -U, -W, -AA, -AB, -AC, and AE.
TM 11-900A ..... Power Unit PE-75-AF.
TM 11-2057 ..... Test Set TS-27/TSM.

3. Other Publications

TM 11-2148 ..... Telephone Repeater AN/TCC-11.
TB SIG-233..... Preliminary Operating Procedures for New Spiral-Four Cable Assembly CX-1065/G Telephone Cable Assemblies CX-1606/G, and CX-1512/U, and Telephone Loading Coil Assembly CU-260/G.
TM 11-486 ..... Electrical Communication System Engineering.
TM 11-2137 ..... Telegraph -Telephone Signal Converter TA-182/U .
SR 310-20-3 ..... Index of Training Publications.
SR 310-20-4 ..... Index of Technical Manuals, Technical Regulations, Technical Bulletins, Supply Bulletins, Lubrication Orders, Modifications Work Orders
SR 310-20-5 ..... Index of Administrative Publications
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