

K1 CARRIER TELEPHONE TERMINAL  
 CHANNEL AND GROUP EQUIPMENT

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1.07 Unless otherwise specified, service must be removed from the terminal before tests are started, and at the completion of the test all test conditions should be removed and the equipment returned to normal operating conditions.

1.08 The abbreviation T.M.S. will denote transmission measuring set or system where used in this section.

1.09 The 31A T.M.S. may be used when the 42A T.M.S. is not available.

2. TESTS AND ADJUSTMENTS OF VACUUM TUBES AND GRID BATTERIES

(A) Grid Battery Voltage Check

2.01 A common grid battery supply is used to provide grid bias for the 311A output tube of the transmitting amplifier.

2.02 Separate sets of dry cell grid batteries are provided for the odd-numbered circuits and for the even-numbered circuits. Each set of grid batteries is equipped with an indicating type relay which will give a low voltage alarm and upon which the battery voltage may be read. Each set of grid batteries is equipped with a transfer key providing a switching arrangement so that both odd and

even-numbered amplifier circuits may be transferred to either battery, thus releasing one battery for test or replacement. After the transfer key of the battery to be tested has been operated, the operation of a test key places a resistance load across the battery for test purposes. The circuit is so arranged that the switching of the grid supply during the transfer operation will not interfere with the operation of the amplifiers.

2.03 Procedure - See Fig. 1

(1) Operate the TRNS key of the battery to be tested to the TRNS position.

(2) To measure the voltage of the battery with a resistance load across it, operate BAT TEST key and after ten seconds read the voltage on the sensitrol relay.

Requirement: Not less than 16 volts.

(3) If requirements are not met all eleven cells should be replaced and the voltage again checked as in (2).

(4) Restore the TRNS key to normal and with all keys in normal position, note the voltage reading on the sensitrol relay.

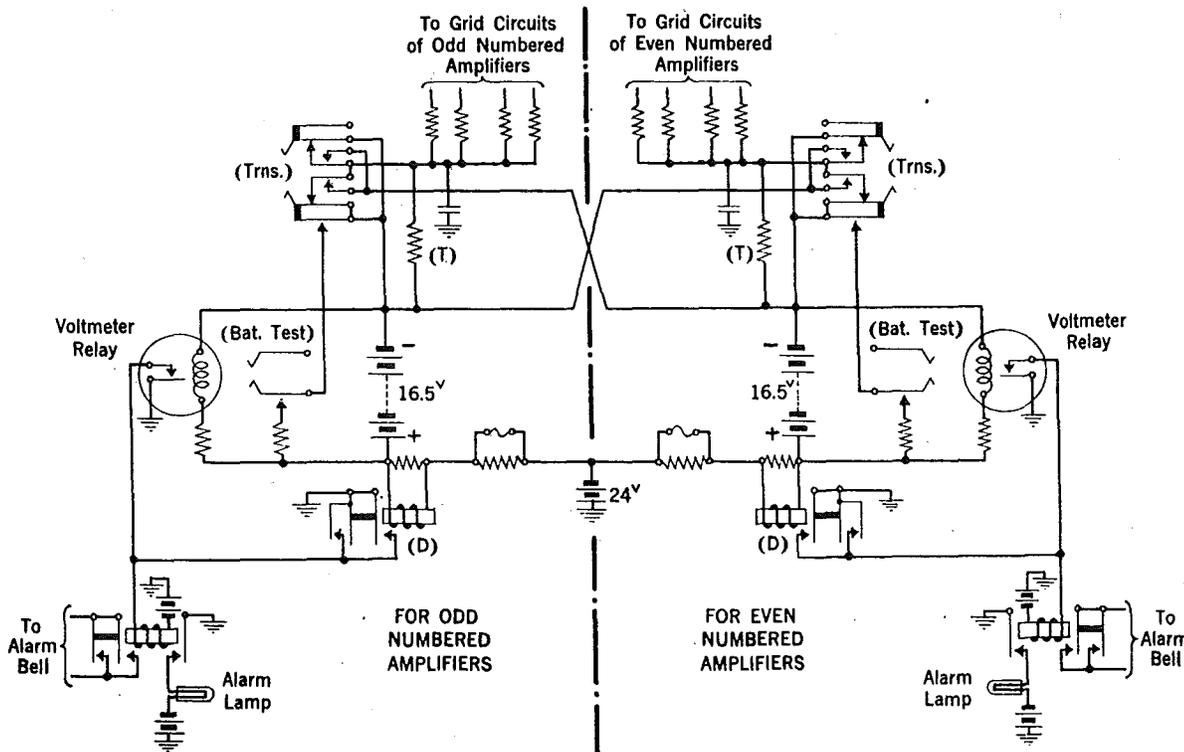


Fig. 1 - Grid Battery Test.

This gives the voltage under the operating conditions.

Requirement: Not less than 16 volts.

- (5) The alarm contact on the sensitrol relay should be set under the operating condition for 15.5 volts.

### (B) Vacuum Tube Heater Circuit Operation

2.04 For vacuum tube replacements it is necessary to open the heater circuit before removing the tube from or placing a tube in its socket. The heater circuit should not be opened except when the equipment is out of service.

2.05 In order to prevent possible damage to the tubes in feedback amplifiers whenever practicable the input to the amplifier (carrier leak, pilot channel energy or test tone) should be removed before the heater circuit is opened and no input should be applied to the amplifier until after all tubes have been energized for at least three minutes. Procedures which meet this requirement are given for each of the amplifiers except the transmitting amplifier for which satisfactory arrangements for preventing input are not readily available.

2.06 Apparatus:

- 1 - 258C Plug (open)
- 1 - 305A Plug

2.07 Procedure - Transmitting Amplifier:

- (1) To open the heater circuit, insert a 258C plug in the FIL jack on the amplifier panel.
- (2) To close the heater circuit, remove the 258C plug from the FIL jack.
- (3) After the heater circuit has been energized for at least 3 minutes the amplifier may be tested or returned to service.

2.08 Procedure - Channel Demodulator Amplifier

- (1) To open the heater circuit, insert a 258C plug in the FIL jack.

Caution: This operation opens the heater circuit of two Demodulator Amplifiers.

- (2) To close the heater circuit, remove the 258C plug from the FIL jack.

- (3) After the heater circuit has been energized for at least 3 minutes the amplifier may be tested or returned to normal.

2.09 Procedure - Auxiliary Receiving Amplifier

- (1) Before opening the heater circuit of the auxiliary receiving amplifier insert an open circuit or short-circuit plug in the GR DEM IN jacks.

- (2) To open the heater circuit, insert a 258C plug in the FIL jack on the amplifier panel.

- (3) To close the heater circuit, remove the 258C plug from the FIL jack.

- (4) After the heater circuit has been energized for at least 3 minutes, the open circuit or short-circuit plug may be removed from the GR DEM IN jacks and the auxiliary receiving amplifier may be tested or returned to service.

### (C) Vacuum Tube Tests

2.10 The vacuum tubes are tested by means of the 1R or 1AC tube test set without being removed from their sockets and may be tested while the system is in service. This set provides for measuring heater currents, space currents, grid currents and cathode activity as covered in the E40 Section. Limits applying to each measurement are given herein.

2.11 When it is necessary to replace vacuum tubes because of failure to meet requirements, the procedure given in the E24 Section covering the operating routines should be followed with respect to switching equipment out of service and the supplementary tests which should be made on the equipment when returned to service.

2.12 Heater current adjustments should not be made using the 1R or 1AC tube test set but where adjustments are shown to be necessary, they should be made in accordance with the information in an A502 Section of Central Office Maintenance Practices and the adjust values shown on the SD drawings, covering the equipment.

2.13 Apparatus:

- 1 - 1R or 1AC Tube Test Set
- 3 - 217D Plugs (600 ohms)

2.14 Procedure - Transmitting Amplifier

- (1) Make heater current, grid current, space current and cathode activity

tests in the order shown on Table I. Where grid current readings in excess of 5 microamperes are indicated, they should be read on the millivolt scale of the SPACE GRID meter of the 1R or 1AC tube test set. A deflection of 125 millivolts is equivalent to five microamperes of current on the grid current scale and similarly 750 millivolts is equivalent to 30 microamperes.

Requirements: Refer to Table I.

- (2) Replace vacuum tubes when requirements are not met. See Part 2(B).

#### 2.15 Procedure - Auxiliary Receiving Amplifier

- (1) Make heater current, space current and cathode activity tests in the order given on Table I.

Requirements: Refer to Table I.

#### 2.16 Procedure - Channel Demodulator Amplifiers

- (1) Make heater current and cathode activity tests as shown on Table I. Tube 1 is in odd-numbered channels and Tube 2 in succeeding even-numbered channels. The two channels use a common filament jack.

Requirements: Refer to Table I.

TABLE I  
TUBE TEST REQUIREMENTS  
AMPLIFIERS

TEST	TUBE	Transmitting Amplifier			Auxiliary Receiving Amplifiers		Chan. Dem. Ampl.
		1	2	3	1	2	1, 2
	TYPE	310A	310A	311A	310A	310A	310A
Heater Current) Min. in Amperes ) Max.				.58 .70		.29 .35	.29 .35
Grid Current Switch on 1R Set Max. Grid Current in Microamps. Max. Grid Current- Read on Millivolt Scale			G2 1.0	G3 375	G1 1.0	G2 1.0	
Space Current Switch on 1R Set Space Millivolts Min. Max.		P1 240 420	P2 240 420	P3 350 #1000	P1 330 490	P2 400 640	P1-P2 *300 *440
Cathode Activity Switch on 1R set Decrease Heater Current Amp. Cathode Activity Max. % when Grid Current Reading is 0-125 mv When reading is 126-375 mv		P1 15	P2 15	P3 .04 25 35	P1 15	P2 .02 15	P1-P2 .02 15

\* These space current measurements are for trouble location purposes and should be made with the potentiometer set for maximum gain (extreme clockwise position).

# This is read as 100 with the shunt key of the 1R or 1AC set in the non-operated position.

(2) The space current measurements marked with an asterisk are for trouble location purposes and should be made with the potentiometer set for maximum gain, that is, extreme clockwise position. After completing the space current measurement, the demodulator gain should be adjusted by means of the potentiometer to give the proper operating level.

(3) If the range of the SPACE PER CENT ZERO ADJUSTMENT rheostats of the 1R or 1AC tube test set will not permit of adjusting the space current to give a zero reference for the cathode activity test, the space millivolts should be read at normal heater current and at the decreased heater current. The Per Cent. Cathode Activity should be determined by taking the difference between the two space millivolt readings and basing the percentage on the space millivolts at normal heater current.

### 3. TESTS AND ADJUSTMENTS OF CHANNEL AND GROUP EQUIPMENT

#### (A) Transmitting Group Gain

3.01 This test covers the measurement of the carrier leak suppression filter, transmitting group modulator and transmitting amplifier. When modifications are made for tandem operation of K1 and K2 systems the test

also includes the 64 kc suppression filter. The procedure provides for an output test power of +10 dbm in order to minimize the effect of the pilot frequencies which are present at the transmitting amplifier output. Since all terminals may not be equipped with hybrid coils at the input to the group modulator circuit, requirements are given for both conditions. X wiring shown in Fig. 2 is standard for K1 group modulator circuits and Y wiring is provided when group modulator circuits are modified for tandem operation of K1 and K2 systems.

#### 3.02 Apparatus:

- 1 - 30A T.M.S.
- 1 - 17B Oscillator
- 4 - 3P20B Cords

#### 3.03 Procedure - See Fig. 2

- (1) Patch from the OUT or TST OSC OUT jacks of the 17B oscillator to the POTENTIOMETER IN jacks of the 30A set.
- (2) Patch from ATTEN OUT to GR MOD IN jacks.
- (3) Patch from GAIN OUT to EQ jacks.
- (4) Patch from TEST KEY OUT to 10 db IN jacks of 30A set and from 10 db OUT jacks to 135-ohm TC jacks.

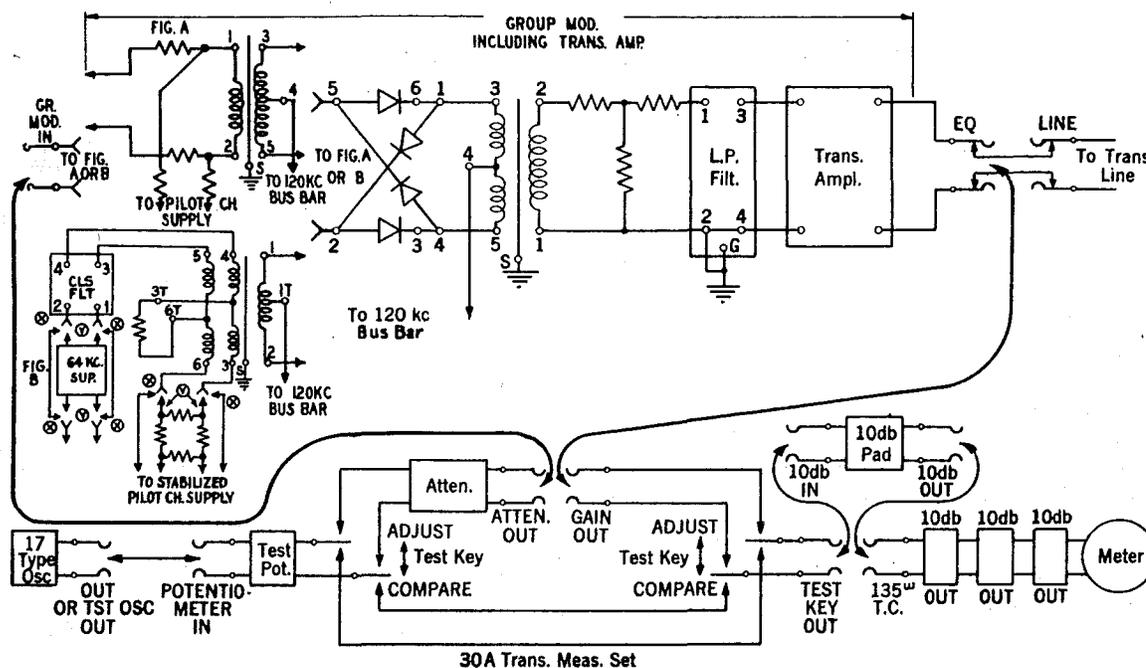


Fig. 2 - Transmitting Group Gain

- (5) Set the frequency of the 17B oscillator at 63 kc, 87 kc and 107 kc for the respective gain measurements.
- (6) Operate the test key of the 30A set to COMPARE position and adjust the test power to give a reading of 0 db on the meter of the 30A set.
- (7) With the attenuator set for 55 db, operate the test key to the ADJUST position and adjust the attenuator to give as close as possible 0 db reading on the meter of the 30A set.
- (8) The gain of the transmitting group circuit is equal to the attenuator setting corrected for the meter reading.

Requirements:

	Gain		
	63 kc	87 kc	107 kc
Group Mod. with or without Pilot hybrid	49.9-52.1	50.1-52.1	50.1-52.1
Group Mod. with or without Pilot hybrid. Modified for tandem operation of K1 and K2 systems	49.9-52.1	49.8-52.1	49.6-52.1

If the channel bank associated with the group equipment being measured is not equipped with a switching hybrid the transmitting group gain should be 3 db less than the above figures.

(B) Turnover Test of 109B Filter

- 3.04 In some instances 109B filters with incorrect internal wiring have been installed on group modem panels. If the 109B filter is correctly wired internally it will have a turnover within it at 87 kc due to phase shift. Since the series elements of the filter have relatively low loss a connection from terminals 1 to 3 is in effect a connection across terminals 1 and 2 and terminals 3 and 4, that is, from 1 to 3 directly and back through the series element to 2. Likewise, for a connection from terminal 2 to terminal 4. These two connections short-circuit the input and output terminals of the filter.
- 3.05 This may be seen readily by drawing a square, labeling two input terminals 1 and 2, and two output terminals 3 and 4. Dotted connections within the box from terminal 1 to

terminal 4 and from terminal 2 to terminal 3 may represent the turnover. Then connecting 1 to 3 and 2 to 4 external to the box it will be noted that one connects to 2 by way of 3, etc.

3.06 If the dotted lines are drawn internally between terminals 1 and 3 and terminals 2 and 4 and then the external connections are made from terminals 1 to 3 and terminals 2 to 4, it will be noted that the external wiring simply parallels the internal wiring and short-circuits the series element resulting in a slight decrease in the circuit loss. To determine whether or not the 109B filters already installed are wired correctly internally proceed as follows:

## 3.07 Procedure:

- (1) Measure the transmitting group gain at 87 kc.
- (2) Connect a wire from terminal 1 to terminal 3 and another wire from terminal 2 to terminal 4 of the 109B filter.

Requirement: If the filter is wired correctly internally the output as measured on the thermocouple should drop at least 10 db. If the filter is wired incorrectly internally the output will remain approximately the same.

(C) Check of Suppression Filter Losses

3.08 The carrier leak suppression filter loss and the 64 kc suppression filter loss if provided for tandem operation of K1 and K2 systems, may be checked at 64, 92 and 108 kc by using the pilot supply frequencies obtained at the PC LEV M1 jacks. The frequencies appearing at the EQ jacks will be 12, 28 and 56 kc. X wiring shown in Fig. 3 is standard for K1 group modulator circuits and Y wiring is provided when the group modulator circuits are modified for operation of K1 and K2 systems in tandem.

## 3.09 Apparatus:

- 1 - 31A or 42A T.M.S.
- 1 - 323A Plug (if 31A Set is used)
- 3 - 3P20B Cords
- 1 - 106A Res. (135 ohms)

## 3.10 Procedure - See Fig. 3

- (1) Patch from PC LEV M1 jacks to the GROUP MOD IN jacks.
- (2) If the 31A set is used terminate the EQ jacks with a 323A plug and connect

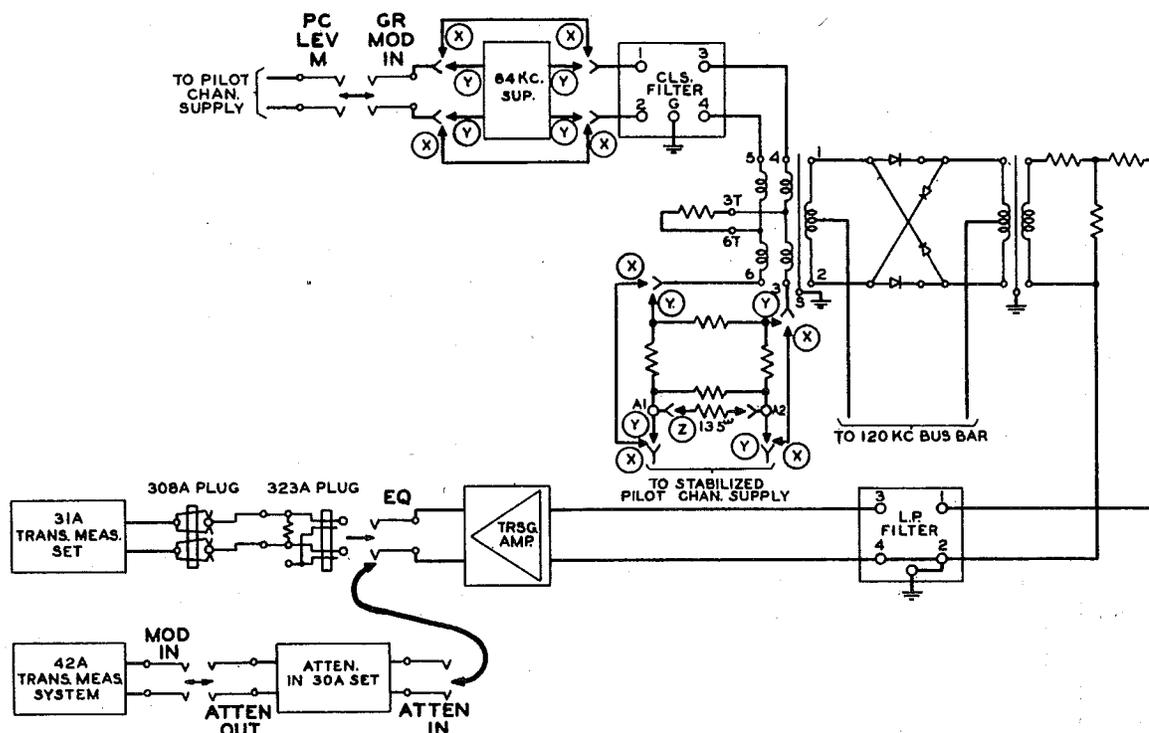


Fig. 3 - Carrier Leak Suppression Filter Loss

the cord of the 31A set to the 323A plug. If the 42A system is used patch from the EQ jacks to the ATTEN IN jacks of the 30A set and from the ATTEN OUT jacks to the MOD IN jacks of the 42A set.

(3) Disconnect the leads from terminals 3 and 6 on the group modulator hybrid coil and replace with a 135-ohm, 106A resistance. If the group modulator has been modified for operation of K1 and K2 systems in tandem disconnect the leads from terminals A1 and A2 and replace with a 135-ohm, 106A resistance.

(4) Tune the 31A set or 42A system and measure the output at 12, 28 and 56 kc. Record the output reading.

**Requirement:** The outputs as measured on the 31A set or 42A system should not exceed the following values: at 12 kc -32 dbm, at 28 kc -32 dbm and at 56 kc -31 dbm. If the 64 kc suppression filter is provided for tandem operation of K1 and K2 systems the requirement at 56 kc is -66 dbm.

(5) If the requirements at 12 and 26 kc are not met it will indicate that the carrier leak suppression filter is defective.

(6) If the requirement at 56 kc is not met disconnect entirely the 64 kc suppression filter, substituting wire in its place and remeasure at 56 kc.

**Requirement:** The output should not exceed -32 dbm.

(7) If this requirement is not met the CLS filter is defective. If it is met and the requirement of (4) is not met the 64 kc suppression filter is defective.

#### (D) Overall Transmitting Gain Adjustment, A1 or A2 Bank

3.11 The transmitting group equipment does not provide for the adjustment of gain of all channels but each channel modulator is provided with a pad adjustment so that the individual channels may be adjusted to give the required output level from the transmitting amplifier. The channel modulators of an A2 bank have an input pad also which may be removed from circuit when the level received at the MOD. IN jacks is -16 db instead of -13 db. These adjustments require that service be removed from one channel at a time while the measurements and adjustments are made. Requirements for the A1 and A2 channel bank are given.

3.12 Apparatus:

1 - 42A or 31A T.M.S.

3.13 Procedure - See Figs. 4 and 5

- (1) At the voice frequency patching bay, patch from SEND -13 jacks to the MOD IN jacks of the channel under test.
- (2) With the 31A or 42A T.M.S. calibrated and ready for test, measure the level of the LINE and EQ jacks in accordance with the information covering the 31A or 42A T.M.S.

- (3) Measure all channels. The 1000-Cycle points of the channels at the EQ jacks are listed in TABLE A.

Requirements: The output power should be  $+9 \pm 0.3$  dbm for A1 Banks and for A2 Banks if the modulator input pad (X wiring) is in circuit. If the input pad in the A2 Bank modulator is not in circuit (Y wiring) the output power should be  $+12 \pm 0.3$  dbm.

- (4) If the requirements are not met adjust the pad resistances in the modulator

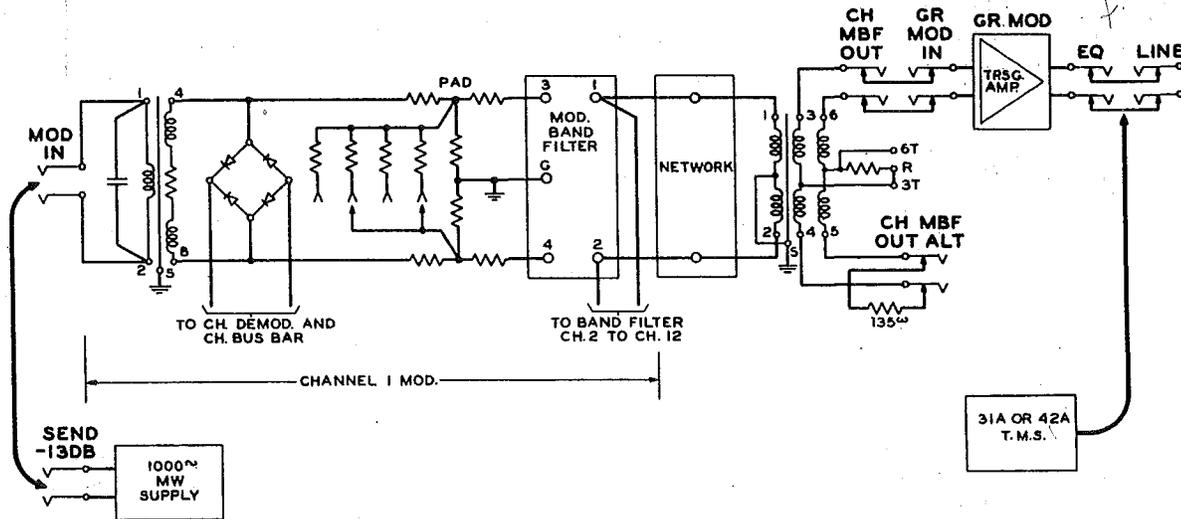


Fig. 4 - Transmitting Gain Adjustment - A1 Bank

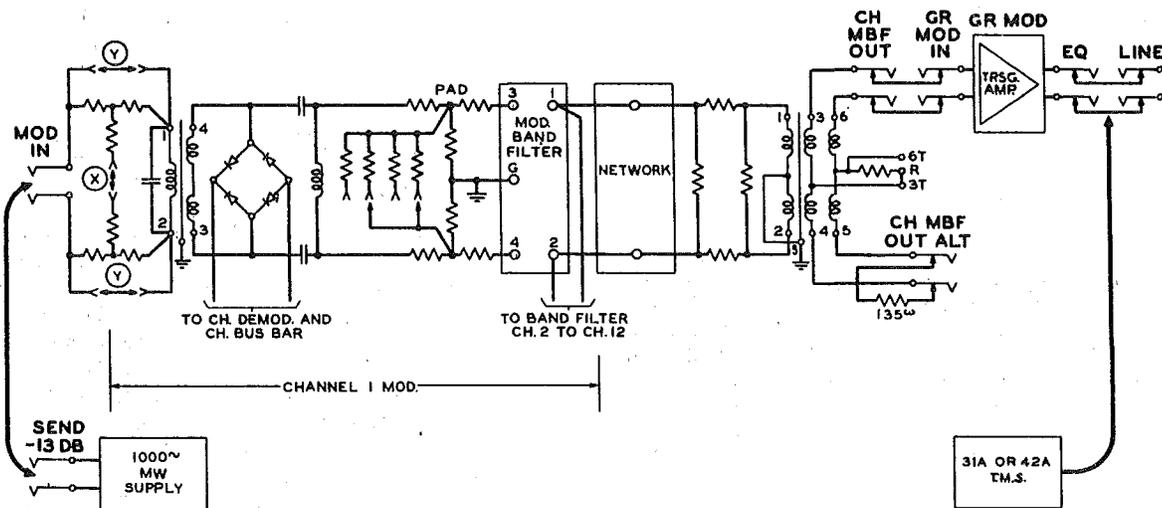


Fig. 5 - Transmitting Gain Adjustment - A2 Bank

TABLE A

Channel No.	1000-Cycle Point, kc	Required for 42A T.M.S. Only 17B Oscillator Settings, kc
1	13	117
2	17	113
3	21	109
4	25	105
5	29	101
6	33	97
7	37	93
8	41	89
9	45	85
10	49	81
11	53	77
12	57	73

circuit shown in Fig. 4 for the A1 bank and Fig. 5 for the A2 bank.

#### (E) Carrier Leak

3.14 Carrier leak is held to a minimum by the balance of the varistors of the modulator unit and by suppression in the channel band filters. No means of adjusting the modulator balance are provided and if the carrier leak does not meet requirements the varistor unit or channel filter should be replaced. The carrier leak of each channel may be measured at the output of the transmitting amplifier by means of the 31A or 42A T.M.S. without removing service from the terminal. The carrier leak of 16, 28 and 56 kc must be carefully differentiated from the pilot frequencies of 15.9, 27.9 and 55.9 kc, when these pilot frequencies are supplied.

#### 3.15 Apparatus:

- 1 - 31A or 42A T.M.S.
- 1 - 40B T.M.S.
- 1 - 135 Ohms 106A Resistance

#### 3.16 Procedure - See Figs. 4 and 5

- (1) The 1000-cycle input should not be connected during these tests. With the 31A or 42A T.M.S. calibrated and ready for test, measure the carrier leak at the LINE and EQ jacks in accordance with the information covering the 31A or 42A T.M.S.
- (2) Measure the carrier leak of all channels. The carrier frequencies are as shown in the table under Requirements.
- (3) When using the 42A T.M.S. to measure carrier leak of less than -20 dbm use

the 40B T.M.S. in conjunction with the 42A T.M.S.

(4) When stabilized pilot supply of 12, 28 and 56 kc, is provided remove the leads from terminals 3 and 6 of the Group Modulator hybrid coil and replace with a 135-ohm resistance. If the group modulator is modified for tandem operation of K1 and K2 systems remove the leads from terminals A1 and A2 and replace with a 135-ohm resistance.

Requirements: Carrier leak of each channel should not exceed dbm values shown in Table II.

(5) If the requirements are not met, replace the varistors in the channel modulator or the channel filter. On channels 1, 5 and 12, if the Carrier Leak Suppression Filter is provided, check its loss [see Part 3(B)] before replacing the varistors in the channel modulators or the channel filters.

#### (F) Transmitting Pilot Output of 15.9, 27.9 and 55.9 Kc

3.17 Pilot level measurements may be made with the 31A or 42A T.M.S. at the transmitting terminal EQ jacks to check the level adjustment of the three pilot frequencies 15.9, 27.9 and 55.9 kc before they are sent over the high frequency line. One individual adjustment of the output of each pilot channel and a common adjustment for all three are provided for all carrier systems employing the same carrier supply.

#### 3.18 Apparatus:

- 1 - 31A or 42A T.M.S.

#### 3.19 Procedure - Pilot Level Measurement - See Figs. 4 and 5

- (1) The 1000-cycle input should not be connected during these tests. With the 31A or 42A T.M.S. calibrated and ready for test, measure each pilot level in accordance with the information covering the 31A or 42A T.M.S.
- (2) The pilot frequencies are 15.9, 27.9 and 55.9 and if the 42A T.M.S. is used the 17-type oscillator settings are respectively 114.1, 102.1 and 74.1 kc.

Requirement: The pilot level readings should be  $0 \pm 1.5$  db which is equivalent to  $-11 \pm 1.5$  dbm at the +9 level point.

TABLE II

Chan- nel No.	Car- rier Freq. kc	17B Oscilla- tor settings when using the 42A System kc	Carrier Leak			
			Terminals Having Pilot Frequencies 15.9, 27.9 & 55.9 kc		12, 28 & 56 kc	
			<u>A1 Bank</u>	<u>A2 Bank</u>	<u>A1 Bank</u>	<u>A2 Bank</u>
			-dbm	-dbm	-dbm	-dbm
1	12	118	-10.0	-17	-35.0	-42
2	16	114	-10.0	-17	-10.0	-17
3	20	110	-10.0	-17	-10.0	-17
4	24	106	-10.0	-17	-10.0	-17
5	28	102	-10.0	-17	-35.0	-42
6	32	98	-10.0	-17	-10.0	-17
7	36	94	-10.0	-17	-10.0	17
8	40	90	-10.0	-17	-10.0	17
9	44	86	-10.0	-17	-10.0	17
10	48	82	-10.0	-17	-10.0	17
11	52	78	-10.0	-17	-10.0	-17
12	56	74	-10.0	-17	-35.0	-42

3.20 Procedure - Pilot Output Level Adjustment of 15.9, 27.9 and 55.9 kc Pilots - See Fig. 4 or 5

(1) Measure the level of each pilot channel at the output of the transmitting amplifier for all systems connected to the same carrier supply. Follow the procedure of Paragraph 3.19.

(2) If the difference in the level for any pilot frequency is 2 db or less, connect the 31A or 42A T.M.S. to the carrier system having the level closest to the average of all systems.

(3) On the pilot channel supply panel, adjust the rheostat corresponding to the pilot frequency being measured to give a reading as close as possible to 0 db on the 31A or 42A T.M.S.

(4) If at a single pilot frequency the difference between the measured level on the highest and lowest systems is greater than 2 db, investigate for wiring trouble.

(G) Transmitting Stabilized Pilot Output of 12, 28 and 56 Kc

3.21 Pilot level measurements are made with the 31A or 42A T.M.S. at the output of the transmitting amplifier to check the level adjustment of the three pilot frequencies 12, 28 and 56 kc. The regular supply is stabilized and has one individual adjustment of the output of each pilot frequency, which is common for all carrier systems connected to the

same Pilot Supply. The Alternate Supply is not stabilized and has no level adjustments.

3.22 Apparatus:

1 - 31A or 42A T.M.S.

3.23 Procedure - Pilot Level Measurement - See Fig. 4 or 5

(1) With the 31A or 42A T.M.S. calibrated and ready for test, measure each pilot level at the output of each transmitting amplifier in accordance with the information covering the 31A or 42A T.M.S. and with the TRNS switch in either the REG or ALT position as required.

(2) The pilot frequencies are 12, 28 and 56 kc and the 17-type oscillator settings (if the 42A T.M.S. is used) are respectively 118, 102 and 74 kc.

Requirements: The regular pilot supply level reading with the TRNS switch in the ALT position should be  $0 \pm 2.0$  db, which is equivalent to  $-11 \pm 2.0$  dbm at the +9 level point. The alternate pilot supply level reading with the TRNS switch in the REG position should not differ from the Regular Pilot supply levels at the same transmitting amplifier more than is shown in the table.

Diff. - db		
12 kc	28 kc	56 kc
$\pm 1.8$	$\pm 1.6$	$\pm 2.3$

11  
12.8 13.6

(3) If these requirements are not met check the pilot bus bar output levels as covered in the section covering the carrier supply.

(H) Receiving Group Loss

3.24 This test covers the loss measurement of the group demodulator and auxiliary receiving amplifier, and where the 7C pad is employed in the input to the group demodulator, provides for the adjustment of this pad. Where the 7A pad is used no adjustment is available.

3.25 If deviation regulation is provided the 7C pad should be adjusted to meet the requirement given in Paragraph 3.30.

3.26 If deviation regulation is not provided follow the system line-up procedure covered in another E34 Section in which curves are drawn for the average deviation from the output at 28 kc of all systems at each office for each test frequency. At the receiving terminal this average curve will provide a means for determining the average level for all systems at the REC AMP OUT jacks. This average level should be taken as the mean value between the maximum and minimum level. This average level is used as the input level at the group demodulator for the adjustment of the 7C pad to give the required output level at the GR DEM OUT jacks. The 7C pad setting should be the same for all paralleling systems.

3.27 When modifications of the group demodulator circuit are made for tandem operation of K1 and K2 systems the test also includes the 60 kc suppression filter. X wiring shown on Fig. 6 is standard for K1 and Y wiring is provided when the group demodulator circuit is modified for tandem operation of K1 and K2 systems.

3.28 Apparatus:

- 1 - 17B Oscillator
- 1 - 30A T.M.S.
- 1 - 323A Plug (135 ohms)
- 3 - 3P20B Cords

3.29 Procedure - Measurement of Group Demodulator Loss - 7A or 7C Pad - See Fig. 6

- (1) Insert the 323A plug (135 ohms) in REC AMP OUT jacks.
- (2) Patch from the OUT or TST OSC OUT jacks of the 17B oscillator to the POTENTIOMETER IN jacks of the 30A set.
- (3) Patch from LOSS IN jack of the 30A set to the GR DEM IN jacks.

- (4) Patch from LOSS OUT to GR DEM OUT jacks.
- (5) Set the frequency of the 17B oscillator at 13 kc, 33 kc and 57 kc for the respective gain measurements.
- (6) Operate the test key of the 30A set to COMPARE position and adjust the oscillator output to give a 0 db reading on the 30A set meter.
- (7) Operate the test key to ADJUST position and adjust the attenuator to give a reading as close as possible to 0 db on the 30A set meter.
- (8) The loss of the group demodulator and auxiliary receiving amplifier is the attenuator setting corrected for the meter reading.
- (9) Note the type of pad used at the input to the group demodulator and if 7C pad is employed, note the value of the resistance across terminals 3 and 4 of the pad.

Requirements:

- (a) For the 7A pad, the group loss should be between 13.1 and 14.7 db.
- (b) For the 7C pad with no hybrid coil in the auxiliary receiving amplifier, the group loss should be between the values given below for the three frequencies. See Note 1, Paragraph 3.30.

Res. Across Ter. 3 and 4, Ohms	Loss, db
None	3.6 - 5.2
483	5.6 - 7.2
213.8	7.6 - 9.2
125.6	9.6 - 11.2
82.7	11.6 - 13.2
57.8	13.6 - 15.2

- (c) For the 7C pad, with hybrid coil in the auxiliary receiving amplifier the group loss should be between the values given below. See Note 1, Paragraph 3.30.

Res. Across Ter. 3 and 4, Ohms	13 kc	33 kc	57 kc
None	6.3 - 8.7	5.8 - 8.0	5.8 - 8.0
483	8.3 - 10.7	7.8 - 10.0	7.8 - 10.0
213.8	10.3 - 12.7	9.8 - 12.0	9.8 - 12.0
125.6	12.3 - 14.7	11.8 - 14.0	11.8 - 14.0
82.7	14.3 - 16.7	13.8 - 16.0	13.8 - 16.0
57.8	16.3 - 18.7	15.8 - 18.0	15.8 - 18.0

3.30 Procedure - Adjustment of 7C Pad. System Equipped for Deviation Regulation

- (1) If deviation regulation is provided connect the resistance required to set the loss at  $14 \pm 1$  db. See Note 1.

Note 1: If the group demodulator circuit has been modified for operation of K1 and K2 systems in tandem the losses measured may be as much as 1.5 db more than specified.

3.31 Procedure - Adjustment of 7C Pad - System Not Provided with Deviation Regulation. See Fig. 6.

- (1) Determine the average level of all systems for all frequencies at the REC AMP OUT jacks. See Paragraph 3.26.
- (2) Insert the 323A plug (135 ohms) in REC AMP OUT jacks.
- (3) Patch from the OUT or TST OSC OUT jacks of 17B oscillator to the POTENTIOMETER IN jacks of the 30A set.
- (4) Patch from LOSS IN jacks of 30A sets to the GR DEM IN jacks.
- (5) Patch from LOSS OUT to GR DEM OUT jacks.
- (6) Set the frequency of the 17B oscillator to 33 kc.

- (7) Set the attenuator for a loss equal to the average level determined in item (1) above.

- (8) Operate the test key to ADJUST position and adjust the oscillator output to give a 0 db reading on 30A set meter.

- (9) Operate the test key to COMPARE position and read the 30A set meter.

Requirements: The measured output should be between -4 and -6 dbm.

- (10) If requirements are not met, connect the value of resistance required to meet requirement between terminals 3 and 4 of 7C pad.

7C Pad Loss, db	Res. Across Ter. 3 and 4, Ohms
44	None
46	483
48	213.8
50	125.6
52	82.7
54	57.8

(I) Channel Receiving Gain, A1 or A2 Bank

3.32 This test covers the measurement of the channel receiving gain, which includes only the channel demodulator circuit, and also provides for measuring the range of the channel demodulator potentiometer.

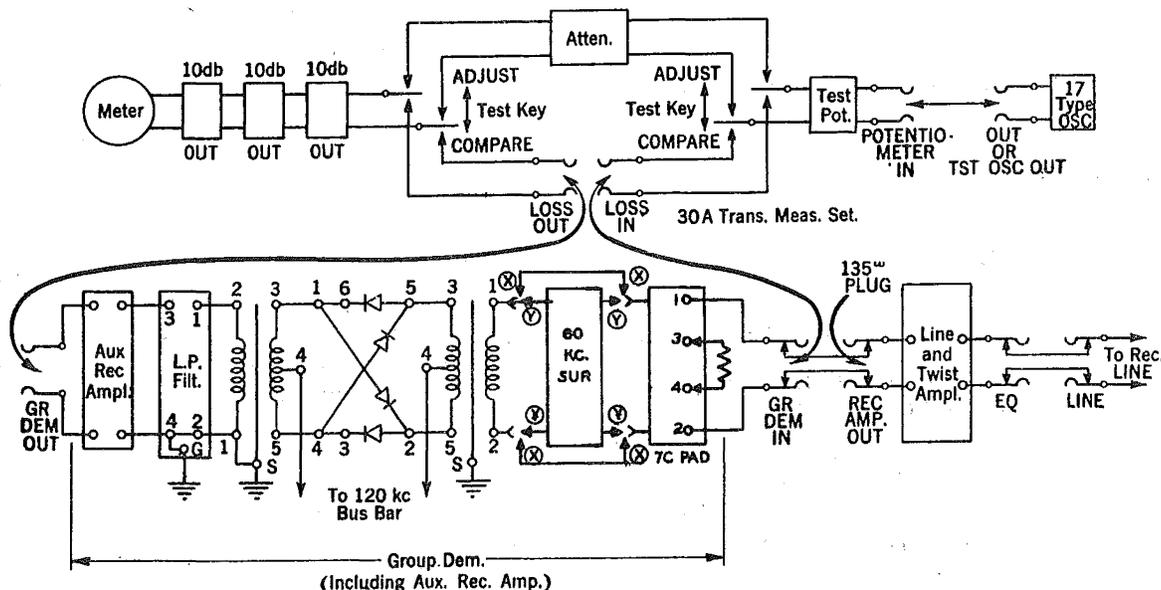


Fig. 6 - Receiving Group Loss

3.33 The channel receiving circuits for the A1 and A2 banks are similar in design and function. The receiving circuit of the A2 bank has a pad adjustment which the A1 bank does not have. The resistance pad between the channel band filter and the demodulator may be set at two values, 7.7 or 10.3 db. The 10.3 db pad is used when the level required at the demodulator amplifier output is +4 db and the 7.7 db pad is used when the level required is +7 db.

3.34 Apparatus:

- 1 - 4OB T.M.S.
- 1 - 17B Oscillator
- 1 - 30A T.M.S.
- 1 - 323A Plug (135 ohms)
- 2 - 3P2OB Cords
- 1 - 2P13B Cord

3.35 Procedure - See Figs. 7 and 8

- (1) Patch from the OUT or TST OSC OUT JACKS of the 17B oscillator to the POTENTIOMETER IN JACKS of 30A set.
- (2) Patch from the ATTEN OUT to the CH DBF IN JACKS.
- (3) Set the 17B oscillator to the frequency corresponding to the 1000-cycle

point of the channel under test as indicated below.

Channel	Frequency kc
1	107
2	103
3	99
4	95
5	91
6	87
7	83
8	79
9	75
10	71
11	67
12	63

- (4) Operate the test key to the COMPARE position and adjust the oscillator output to give a 0 db reading on the 30A set meter.
- (5) At the voice frequency patching bay, patch from the DEM OUT jacks of the channel under test to 600-OHM TEST jacks of 4OB Transmission Measuring System.
- (6) Set the demodulator potentiometer of all channels for maximum gain, that is, extreme clockwise position.
- (7) Operate the test key of the 30A set to the ADJUST position and adjust the attenuator to give as closely as possible a 0 db reading on the 4OB Transmission Measuring System.

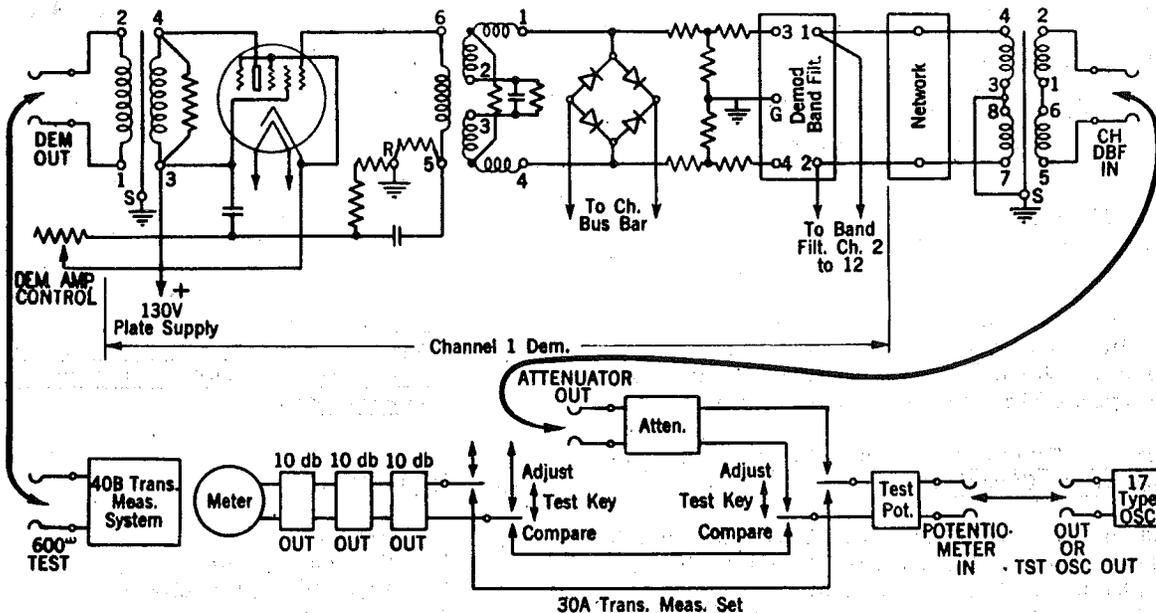


Fig. 7 - Channel Receiving Gain Test - A1 Bank

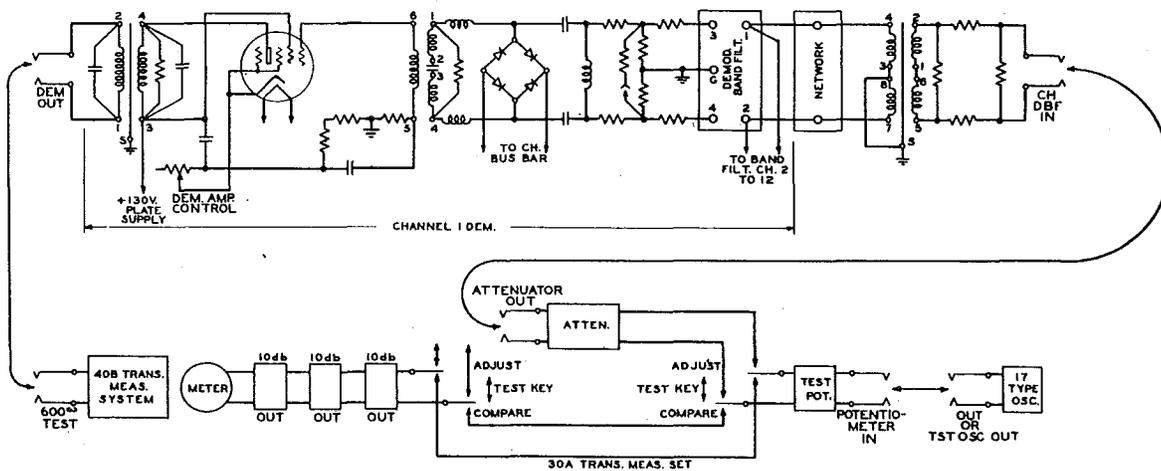


Fig. 8 - Channel Receiving Gain Test - A2 Bank

- (8) The channel gain is the attenuator setting corrected for the reading of 40B Transmission Measuring System.

Requirements: The gain should be between 12 and 18.5 db for an A1 bank or for an A2 bank if the demodulator pad is strapped for 10.3 db loss. If the pad is strapped for 7.7 db loss, the gain for an A2 bank should be between 14.6 and 21.1 db.

- (9) If the requirements are not met, change the vacuum tube in the amplifier, following the tube changing procedure given in the E24 Section covering the operating routine.
- (10) To check the range of the demodulator potentiometer, set the potentiometer for minimum gain, that is, extreme counter-clockwise position. Repeat the above procedure.

Requirements: The gain should be at least 8 db below that measured for maximum position, Items (6) and (7).

- (11) Reset the demodulator potentiometers in accordance with the procedure given in the E34 Section covering the overall system line-up for Type K systems.

#### (J) Test for Turnover in Transmitting and Receiving Group Circuits

3.36 When transferring terminal equipment from one carrier system to another, it is important that there are no turnovers in the wiring of the equipment. A gain measurement made with the two circuits bridged together should not show a large change in gain

as compared with the gain of the circuits measured separately unless there is a turnover in the wiring of one circuit with respect to the other or when they are connected to different Carrier Supplies. Two circuits having different components such as group modulators with and without Carrier Leak Suppression filters may also show turnover in excess of the requirement when bridged together. This test provides for measuring the following:

- Transmitting circuit including the group modulator and transmitting amplifier.
- Receiving circuit including the group demodulator and auxiliary receiving amplifier.

3.37 The following requirements apply only where all circuits connected to one Carrier Supply are checked against one circuit connected to the same Carrier Supply as a reference.

Caution: Care must be exercised to insure that there are no turnovers in the patches for the various test conditions.

#### 3.38 Apparatus:

- 30A T.M.S.
- 17B Oscillator
- 323A Plug (135 ohms)
- 3P20B Cords
- W3R Cord equipped with 308A Plug at one end and 305A Plug at the other



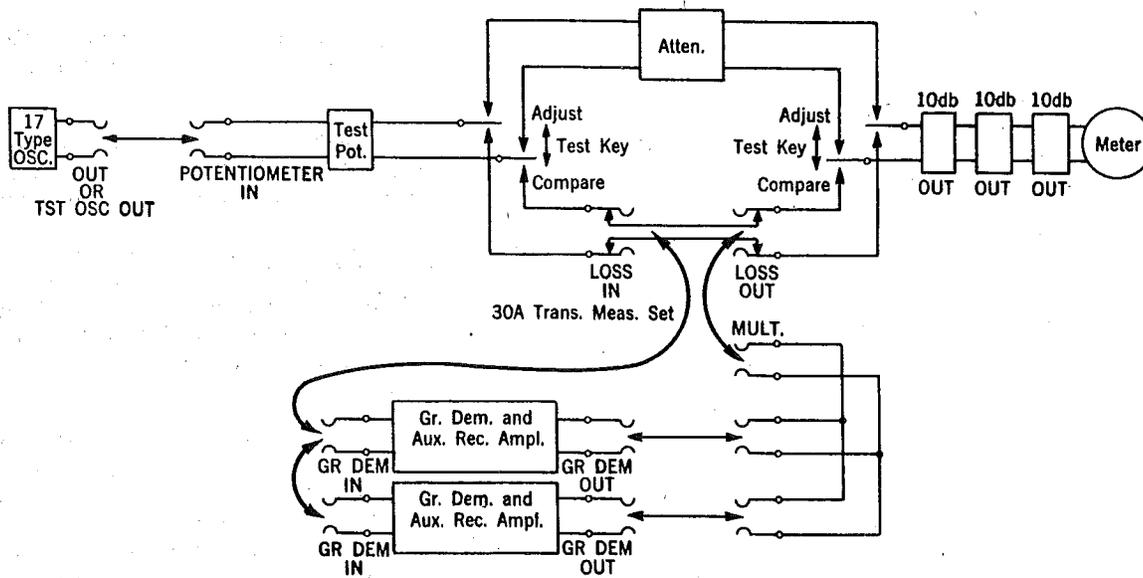


Fig. 10 - Test for Turnover in Receiving Group Circuit

for test procedure. The patches for this test are as follows:

- (a) OUT or TST OSC OUT jacks of 17B oscillator to POTENTIOMETER IN jacks of 30A set.
  - (b) LOSS IN to GR DEM IN jacks.
  - (c) GR DEM OUT to one set of multiple jacks of 30A set.
  - (d) LOSS OUT to second set of multiple jacks.
- (3) Bridge the input and output of the second receiving circuit to the input and output of the first circuit by making the following patches:
- (a) GR DEM IN jacks of second receiving circuit to GR DEM IN jacks of first circuit using the bridging patch cord.
  - (b) GR DEM OUT jacks of second receiving circuit to third set of multiple jacks.
- (4) Measure the loss at 33 kc of the two receiving circuits in parallel. See Paragraph 3.29, 3.30 or 3.31 for test procedure.

**Requirements:** The decrease in gain when the two units are in parallel from the average gain of the two units when measuring separately should not exceed 2.0 db.

- (5) Check all circuits against one as a reference. This will indicate a minimum number which should be checked for errors in wiring which cause a turnover with respect to the other circuits. Correct errors in wiring so that all circuits will be uniform and meet the above requirements.

#### (K) Test of Transmitting Hybrid Coil

3.41 This procedure provides a method of testing the hybrid coil used in the transmitting circuit between the output of the channel modulators and the input to the group modulator for switching purposes. It affords a check of the wiring of the coil for turnover errors. The gain is measured between the input to channel 6 modulator and the output of the transmitting amplifier under various connections of the hybrid coil. The requirements for this test assume that the requirements of Test 3(D), Overall Transmitting Gain Adjustment have been met.

#### 3.42 Apparatus:

- 1 - 30A T.M.S.
- 4 - 3P20B Cords
- 1 - 2P13B Cord
- 2 - 165C Plugs (open)
- 1 - 323A Plug (135 ohms)

#### 3.43 Procedure - See Fig. 11

- (1) At the voice frequency patching bay, patch from SEND - 13 to MOD IN jacks of channel 6.

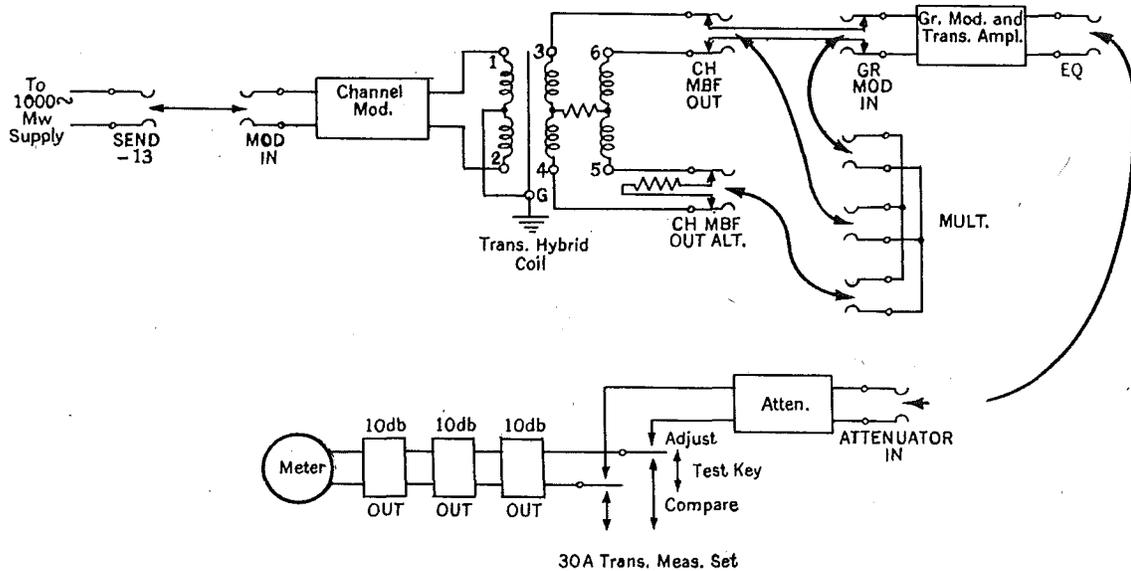


Fig. 11 - Test of Transmitting Hybrid Coil

- (2) Patch from CH MBF OUT to one set of multiple jacks of 30A set.
- (3) Patch from GR MOD IN to second set of multiple jacks.
- (4) Patch from EQ to ATTEN IN jacks.
- (5) Operate the test key of 30A set to ADJUST position and measure the output power. Note the 30A set reading.
- (6) Insert 165C plugs in CH MBF OUT ALT jacks. Measure the output power.

Requirements: The output should not change more than 1.0 db for an A1 bank or 1.5 db for an A2 bank from that measured in Item (5).

- (7) Remove the 165C plugs and patch from CH MBF OUT ALT to the third set of multiple jacks and measure the output power. Note the 30A set reading.

Requirements: The output power as measured should increase approximately  $3.0 \pm 1.0$  db from that measured in Item (5).

- (8) Remove the patch from the CH MBF OUT jacks to the multiple jack, insert a

323A plug (135 ohms) in the CH MBF OUT jacks and measure the output power.

Requirements: The output should not change more than 0.5 db from that measured in Item (5).

- (9) If requirements are not met, check the wiring of the hybrid coil.

#### (L) Overall Channel Transmission Characteristics

3.44 When it is not convenient to make overall channel transmission measurements as described in other E sections the transmission measurements may be made locally by using transmitting and receiving terminals (including channel banks and group equipment), to form the equivalent of a complete system without a high frequency line. Since the channel transmission frequency characteristics are determined mainly by the channel band filters and only a small effect is contributed by the line, this measurement should disclose any transmission irregularities which may exist.

#### 3.45 Apparatus:

- 1 - 40B T.M.S.
- 1 - Oscillator
- 1 - 30A T.M.S.
- 4 - 2P13B Cords
- 1 - P320B Cord

## 3.46 Procedure:

- (1) Patch the OSCILLATOR OUT jacks to the POTENTIOMETER IN jacks of the 30A set.
- (2) Patch the ATTEN OUT jacks to the 135-ohm jacks of the repeat coil. Set the attenuator at 15 db.
- (3) Patch the 600-ohm jacks of the repeat coil to MOD IN jacks of the channel to be measured. Patch from EQ jacks at the output of the transmitting amplifier to GR DEM IN jacks of the system to be measured.
- (4) Patch from GR DEM OUT jacks to the 600-ohm test jacks of the 40B T.M.S.
- (5) Operate the key in the 30A set to compare and set the oscillator to give an output of 1 milliwatt at 1000 cycles.
- (6) Operate the key to adjust and with the switch in the 40B T.M.S. at position A read the output of the DEM OUT jacks.
- (7) Set the oscillator at the following frequencies and repeat 6 and 7 for each frequency.

1000 cycles	2500 cycles
150 "	3000 "
200 "	3100 "
300 "	3200 "
500 "	3300 "
1500 "	3400 "
	1000 "

This second 1000-cycle measurement should be within 0.5 db. of the first 1000 cycle measurement and the measurements should be repeated until this requirement is met.

Requirements: For A1 or A2 banks. The lowest frequency at which the output is 10 db less than at 1000 cycles should not be higher than 150 cycles. The upper frequency at which the output is 10 db less than at 1000 cycles should not be lower than 3400 cycles. The output at other frequencies with reference to 1000 cycles should not deviate more than shown in the table. Minus means more loss than at 1000 cycles.

200	- .3	± 2.3 db
300	- 0	± 1.5 db
400-3000	- 0	± 1.2 db
3000-3300	- .5	± 1.5 db

Note: When measuring channel 12 of either an A1 or A2 bank in combination with K1 group equipment modified for operation of K1 and K2 systems in tandem the requirement is  $-2.3 \pm 2.0$  db.

(M) Direct Current Tests of Amplifier Equipment

3.47 Circuit troubles in the amplifiers will ordinarily be discovered as a result of routine level checks, gain measurements and vacuum tube tests. In locating specific circuit elements which may be in trouble, d-c measurements may be found useful. From a knowledge of the nature of the trouble, reference to the circuit drawing will indicate the desirability of making certain measurements. For convenient reference, resistance limits are given for the pilot channel supply alarm amplifier-rectifier, auxiliary receiving amplifier and transmitting amplifier. The test data applying to the line and twist amplifiers and auxiliary switching amplifier are given in the E34 Section covering the line and twist amplifier.

## 3.48 Apparatus:

1 - KS-8295 Volt-Ohmmeter

## 3.49 Procedure:

- (1) Remove all plate and filament battery fuses from the amplifier under test.
- (2) Measure the resistance of the various circuit elements with the volt-ohmmeter. The ohmmeter scale giving the greatest sensitivity should be used for each measurement. Continuity tests of direct wiring may also be made with the volt-ohmmeter.

Caution: In order to avoid damage due to magnetization of the coils, the volt-ohmmeter should be used for all resistance tests, as this limits the d-c testing voltage to less than 5 volts.

(3) Refer to SD-64320-01 or SD-64320-02 for circuit details of the auxiliary receiving amplifier, check of direct wiring and values of resistances. All 18 and 19 type resistances have a tolerance of  $\pm 5$  per cent. unless otherwise specified. The 106A resistances have a tolerance of  $\pm 1$  per cent. Table III gives the resistance value of coils, networks, etc., which are not shown on the SD drawing.

- (4) Tables IV and V give data for ohmmeter tests on the transmitting amplifier.



TABLE IV

OHMMETER TESTS ON TRANSMITTING AMPLIFIER  
TRANSFORMERS AND NETWORKS NOT INCLUDED

Measure				Limits - Ohms	
Apparatus	From Term.	Apparatus	To Term.	Max.	Min.
FIL ACT TST Jack	1	FIL ACT TST Jack	2	110	90
"	11	Socket 1	C	770	630
FIL ACT TST Jack (Tw. Amp. only)	11	IN Input Trans.	5	75	60
FIL ACT TST Jack (Test or Aux. Sw. Ampl. Only)	11	IN Input Trans.	5	42	34
FIL ACT TST Jack	11	FIL ACT TST Jack	10	18	12
"	6	"	5	1100	900
"	5	"	4	110	90
"	9	Terminal Strip	3	1100	900
Condenser C2	Lower	INST 2 Network	1	1430	1150
Terminal Strip	8	Socket 2	SC	56000	45000
PLT Retard Coil	1	" 3	G	570	470
"	1	PLT Retard Coil	2	160	105
FIL ACT TST Jack	10	Terminal Strip	2	18	7
"	8	INST 2 Network	3	1100	900
Condenser C7	Left	FIL ACT TST Jack	5	660	540
"	Left	Socket 2	C	220	180
Terminal Strip	1	IN Input Trans.	1T	1	0
"	1	"	S	1	0
"	1	"	Grd.Lug	1	0
"	1	FB Network	6	1	0
"	1	"	S	1	0
"	1	"	Grd.Lug	1	0
"	1	Condenser C1-C2	Middle	1	0
"	1	Socket 2	SP	1	0
"	1	Condenser C5-C6	Middle	1	0
"	1	Condenser C7-C8	"	1	0
"	1	Condenser C7-C8	Grd.Lug	1	0
"	1	Condenser C3-C4	Right	1	0
"	1	Resistance D	Left	1	0
"	1	" C	"	1	0
"	1	FIL ACT TST Jack	5	1	0
"	1	"	12	1	0
"	1	OUT Output Trans.	S	1	0
"	1	Shield for Tube 1	Base	1	0
"	1	Shield for Tube 2	"	1	0
"	1	Shield for Tube 3	"	1	0
"	1	Ground (Panel)		1	0
"	8	Ground (Panel)		Open	Open
FIL ACT TST Jack	2	Condenser C9	Left	1	0
"	2	Socket 1	SP	1	0
IN Input Trans.	2	FB Network	5	1	0
OUT Output Trans.	6	Socket 3	P	1	0
IN Input Trans. (Test or Aux.Sw. Ampl. Only)	4	Connecting Ckt.	Tip	1	0
IN Input Trans.	1T	"	Ring	1	0
OUT Input Trans.	1	"	Tip	1	0
"	4	"	Ring	1	0

TABLE V

OHMMETER TESTS ON TRANSMITTING AMPLIFIER  
TRANSFORMERS AND NETWORKS

Measure				Limits - Ohms	
From		To		Max.	Min.
Apparatus	Term.	Apparatus	Term.		
IN Input Trans.(1)	3	IN Input Trans.	1T	200	160
"	3	"	2	1.5	0
"	4	"	3	3.5	1.5
"	5	"	6	2500	15000
"	1	"	4	Open	Open
INST 1 Network	1	INST 1 Network	3	110000	90000
"	1	"	2	45000	35000
"	5	"	4	0.6 Meg.	0.4 Meg.
"	5	"	2	Open	Open
INST 2 Network	1	INST 2 Network	2	23000	19000
"	3	"	4	90000	70000
"	2	"	4	Open	Open
OUT BR Network	1	OUT BR Network	2	20	14
OUT OUTPUT Trans.	5	OUT Output Trans.	6	23	11
"	1	"	2	2.5	0.5
"	3	"	4	2.5	0.5
"	1T	"	3T	6.5	3.5
"	2	"	1T	0.5	0
"	3	"	3T	0.5	0
FB Network	1	FB Network	G	5	2.5
"	2	"	G	5	2.5
" (2)	5	"	6	320	250
" (2)	4	"	6	320	260
" (2)	4	"	5	105	85

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