

OVERALL LINEUP
TWO-WIRE REPEATERED NONLOADED PBX-CO TRUNK
WITH NETWORK AT PBX

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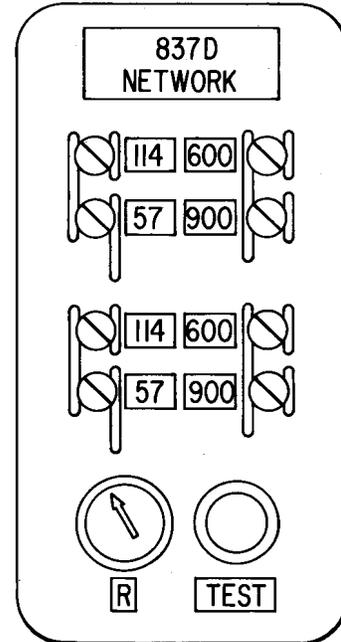


Fig. 1—837D Network—Face Plate View

1. GENERAL

1.01 This section provides installation and lineup procedures for 2-wire repeatered nonloaded PBX-CO trunks. It includes lineup of an E6 repeater with an associated 830C network at the CO, and lineup of an 837C or 837D network (Fig. 1) at the PBX.

Note: In the rest of this section "837D network" will mean "837C or 837D network."

1.02 This section is reissued to:

- Change format (to step procedure)
- Change Table A

- Change and expand Table B
- Change Fig. 5.

Since this is a general revision, arrows normally used to indicate changes have been omitted.

1.03 Use of these procedures should result in a substantial improvement in both the frequency response and the echo return losses at both ends of the trunk circuit. Dial pulsing is not adversely affected.

1.04 The repeater and networks may be used with facilities that are between 2.75 kft and 18 kft in length and that have bridged taps up to 6 kft with any amount being aerial cable.

1.05 Because of the large number of facilities differing in gauge, length, amount of bridged tap, and the need to improve return losses and insertion losses, four elements in the 830C network and one element in the 837D network must be adjusted. Prescribing the settings for the adjustable elements to obtain optimum performance is impossible. Because of variations among cable pairs and networks, each facility must be lined up individually to obtain maximum benefit from the repeater and networks. To attain the unusually high return losses required, each network must be adjusted to the specific pair with which it will operate.

1.06 While the lineup procedure is rather simple, it does require optimizing adjustments, first at the PBX and then at the central office. If a compromise network, short-circuit termination, and a 1-kHz, 1-mW signal source are available at the nonrepeated end (837D network) of the facility, however, a craftsperson at the CO can optimize the 830C network and adjust the gain without help from the PBX.

2. APPARATUS

2.01 Table A lists the equipment required for the lineup procedures and the location where the equipment is needed.

3. PREPARATION

3.01 The test equipment, repeater, and networks should be taken to the appropriate locations. The necessary power should be connected to the test equipment.

3.02 Installation and lineup of the E6 repeater for use with a nonloaded cable will require the following *basic* steps:

- (a) Assembly of the repeater.
- (b) Initial adjustment of repeater gain unit and 830C network at the central office.
- (c) Installation and lineup of 837D network at the PBX.
- (d) Final adjustment of 830C network.
- (e) Measurement of 1-kHz insertion loss and readjustment of repeater gain, if necessary.
- (f) Stability test (singing checks).

4. ASSEMBLY OF THE E6 REPEATER

4.01 The following procedure describes the assembly of the E6 repeater.

STEP	PROCEDURE
1	<p>The E6 repeater gain unit (831-type network) and connector block are mounted in the aluminum chassis prior to shipment. The 830C, 832B, and 837D networks are shipped separately. Slide the 830C network into the repeater (usually the NETWORK B side) and make secure by tightening four screws on the connector block. In addition to securing the network, these screws make the required electrical connections between the gain unit, the network, and the line.</p>
2	<p>Mount the 832B network (Section 103-104-110) in the NETWORK A side of the repeater and secure it by tightening four screws. These screws also make the required electrical connections. The 832B network terminates the office side of the repeater in 900 ohms to maintain stability and to supply termination during lineup at the PBX end of the line.</p> <p><i>Note 1:</i> If an 832B network is not available, an 832A may be substituted in the E6 repeater and an external 900-ohm resistor plugged into the LINE A REP jack of the 54B test stand.</p> <p><i>Note 2:</i> A photograph of the E6 repeater, 830C network, 837D network, 832B network, and 831-type network is shown in Fig. 2.</p>

TABLE A
APPARATUS REQUIRED FOR E6 REPEATER
LINEUP ON NONLOADED CABLE

APPARATUS REQUIRED	LOCATION USED		TYPE OF TEST		TYPE OF POWER NEEDED
	CO	PBX	RETURN LOSS	TRANS- MISSION	
Line Extension Cord ED-97023-30	1	—	X	X	—
J99254A, L1 Transmission Measuring Set (54A) (TMS) with Cords	1	—	—	X	110 to 120 volts, 60 Hz 48 Vdc, and ground sup- plied from 54B Test Stand (Power obtained from J87241B at PBX)
J99254B Test Stand (54B)	1	—	X	X	
J99254C Return Loss Meas- uring Set (54C) (RLMS) with Cords	1	1	X	—	
J87241B Power Supply (if 54C Set is used)	—	1	X	—	110 to 120 volts, 60 Hz
KS-20501 Return Loss Meas- uring Set (RLMS) (Alternative to the 54C RLMS)	1	1	X	—	110 to 120 volts, 60 Hz
J94023A Transmission Meas- uring Set (23A or D) (TMS) (or equivalent)	1	1*	—	X	—
1-kHz, 1-Milliwatt Supply	1	—	—	X	—
Termination of 900 ohms or 600 ohms† ±5% in series with 2μF ± 20%, 500 wVdc or 4125A or 4125B Network	—	1	X	—	—
4097A or 4097B Network	1	—	X	X	—
832A Network	1	—	X	X	—
832B Network‡	1	—	X	—	—
Circuit Layout Record	1	1	X	X	—
KS-14418 Headphones with 419A Plug	1	—	X	—	—
3 Power Cords with P5F Jones Connectors	3	—	X	X	—
Shorting Plug	—	1	X	—	—

* Not needed at PBX if 1 milliwatt is available at PBX.

† Termination depends upon PBX impedance.

‡ A resistor equal to 900 ohms ±5% may be connected to the LINE A REP jack on the 54B test stand as a substitute.

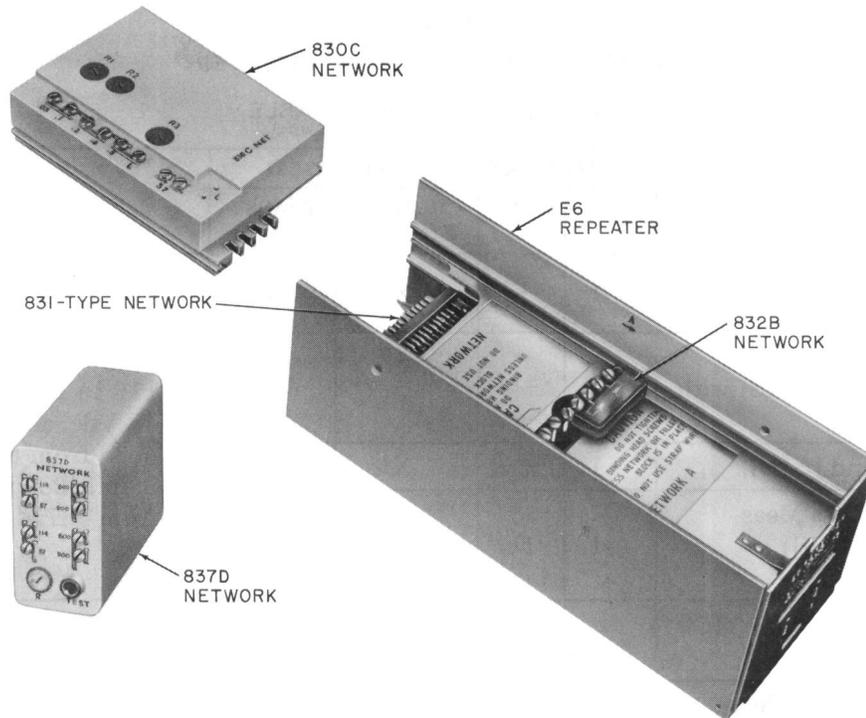


Fig. 2—E6 Repeater and Networks Used on Nonloaded Cable Between a Central Office and PBX

5. ADJUSTMENT OF REPEATER GAIN

5.01 Gain adjustment of the E6 repeater consists of setting the adjusting screws of the 831-type

gain network to the gain required on the circuit layout record (CLR). At the CO, the gain of the E6 repeater should be checked by using the procedure in the following steps.

STEP	PROCEDURE
1	<p>Place the printed wiring board side of the 831-type network face up. Loosen screws labeled A through K and 1 through 9. All adjustments on the gain network are made by tightening or loosening these screws.</p> <p><i>Note:</i> Contact with the printed wiring board conductors is made under the screwheads. Therefore, the screwheads should be either fully down on or fully clear of the printed wiring board, as required.</p>
2	<p>Set the 54B test stand and 54A transmission measuring set (TMS) near the -48 volt power distribution outlet, which is provided on bays equipped with E6 repeaters.</p>
3	<p>Connect -48 volt power from the repeater bay to the 54B test stand and patch the TMS TST PWR jack of the 54B to the TEST PWR jack of the 54A TMS, using the P5F cords. Patch the TMS A and B jacks of the 54B to the A and B jacks of the 54A, using the 3P7B cords with 310-type plugs (see Fig. 3).</p>

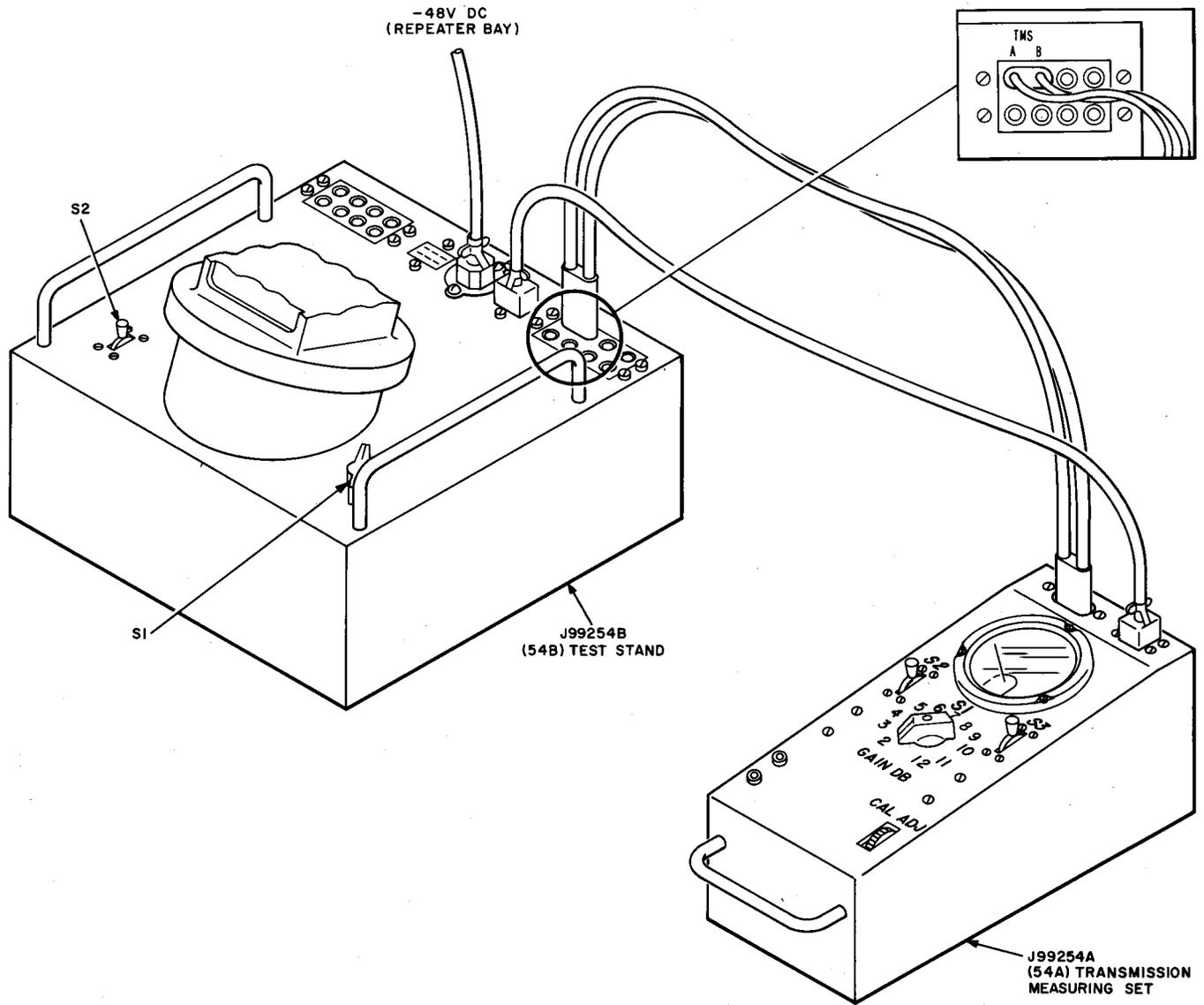


Fig. 3—Converter Gain—Test Equipment Connections

STEP	PROCEDURE
4	<p>Note: The 54A TMS has neither a switch to apply power nor a pilot light. No warm-up period is necessary. No connection to the cable pairs is required for the gain adjustment of the 831-type network.</p> <p>Carefully insert the repeater into the 54B test stand. Lower (<i>do not drop or force</i>) the repeater into the stand so that the repeater terminals at the back of the repeater fit into the connector of the test stand. Rotate the turret of the 54B test stand so that the 831-type network side of the repeater is easily accessible.</p>

STEP	PROCEDURE
5	<p>All screws on the 831-type network should have been loosened as in Step 1. Consult the CLR for the specified gain adjustments. Refer to Table B to determine the necessary screw settings for this specified gain value.</p> <p>Example: In the row corresponding to 12-dB gain, screws A, B, C, E, H, K, and 1, 2, 4, 5, 7, 9 are listed to be turned down. Tighten these firmly, but not excessively, and leave all other screws raised.</p> <p>Caution: <i>Excessive tightening may strip threads.</i></p> <p>Converter Unit Gains</p>
6	<p>On the 54B test stand, set switch S2 to the neutral position and switch S1 to the GAIN position.</p>
7	<p>Set switch S2 on the 54A TMS to CAL and adjust the knurled knob CAL ADJ to give a 0-dB reading. Then set switch S2 to MEAS position. The position of other keys and knobs on the 54A TMS does not affect this reading.</p>
8	<p>Loosen the K screw on the 831-type network to separate the series and shunt gain units. Rotate gain dB knob S1 on the 54A to 12 dB. Operate switch S3 to SERIES and rotate gain knob S1 counterclockwise until the meter reads between 0 and +1 dB. The series converter gain equals the sum of the gain-knob setting and the meter reading. Note this value.</p>
9	<p>Throw switch S3 from SERIES to SHUNT. Measure and note this gain.</p>
10	<p>Compare the two measured gain values with the values given in Table B.</p> <p>Example: For 12-dB total gain, the separate converters should measure 7.9-dB gain as shown in Table B. If both series and shunt gain measurements fall within ± 0.2 dB of this value and the difference between the two gain readings is less than 0.2 dB, proceed to measure the combined gain as described in Steps 13 through 17. If not, adjust the gain of either the series or shunt converter or both as in the following steps.</p>
11	<p>Verify that the proper screws are turned down and that all others are clear of the printed wiring board. If no error can be found and the series-converter gain measurement deviates by more than ± 0.2 dB from the listed value, set switch S3 to SERIES. Recalibrate as in Step 7 and then restore switch S2 to MEAS. Adjust screws A through J on the 831-type network series converter to within ± 0.1 dB of the value listed in the table.</p> <p>Note: Screw A gives the finest gain change; screws B, C, etc, give larger changes in approximately 2:1 steps. Tightening a screw on the series converter lowers the gain; loosening a screw raises the gain.</p>
12	<p>If the shunt-converter gain measurement deviates by more than ± 0.2 dB from the listed value, set switch S3 to SHUNT and adjust the measured gain to within ± 0.1 dB of the listed value, using screws 1 through 9 on the 831-type network.</p>

TABLE B
831-TYPE NETWORK
E6 GAIN-UNIT SETTINGS

TOTAL 1-KHZ GAIN (DB)	SERIES OR SHUNT GAIN† (DB)	SERIES SCREWS DOWN	SHUNT SCREWS DOWN	TOTAL 1-KHZ GAIN (DB)	SERIES OR SHUNT GAIN† (DB)	SERIES SCREWS DOWN	SHUNT SCREWS DOWN	TOTAL 1-KHZ GAIN (DB)	SERIES OR SHUNT GAIN† (DB)	SERIES SCREWS DOWN	SHUNT SCREWS DOWN	TOTAL 1-KHZ GAIN (DB)	SERIES OR SHUNT GAIN† (DB)	SERIES SCREWS DOWN	SHUNT SCREWS DOWN
MEASURED*															
0.0	0.0	BCDGHJK	123	3.4	1.8+	ADEFGJK	13467	6.8	4.0	CDEJK	1578	10.1	6.3+	DGHK	469
0.1	0.0	ABDGHJK	14	3.5	1.9	BCEFGJK	567	6.9	4.0+	BDEJK	3578	10.2	6.4	BCGHK	12469
0.2	0.1	ADGHJK	134	3.6	2.0	CEFGJK	12567	7.0	4.1	ABCEJK	123578	10.3	6.5	ABGHK	13469
0.3	0.1+	BCGHJK	5	3.7	2.0+	AEEFGJK	23567	7.1	4.2	CEJK	24578	10.4	6.5+	AGHK	123469
0.4	0.2	ABGHJK	35	3.8	2.1	ABCDGJK	24567	7.2	4.3	AEJK	134578	10.5	6.6	BCDEFHK	2569
0.5	0.2+	GHJK	235	3.9	2.1+	CDFGJK	134567	7.3	4.4	ABCDJK	1234578	10.6	6.7	ABDEFHK	3569
0.6	0.3	BCDEFHJK	145	4.0	2.2	ADFGJK	8	7.4	4.5	CDJK	2678	10.7	6.8	DEFHK	4569
0.7	0.3+	CDEFHJK	345	4.1	2.3	ABCFGJK	128	7.5	4.5+	ADJK	13678	10.8	6.9	BCEFHK	124569
0.8	0.4	BDEFHJK	2345	4.2	2.3+	CFGJK	238	7.6	4.6	ABCJK	123678	10.9	7.0	CEFHK	234569
0.9	0.4+	DEFHJK	16	4.3	2.4	AFGJK	148	7.7	4.7	CJK	24678	11.0	7.1	AEFHK	179
1.0	0.5	BCEFJK	36	4.4	2.5	BCDEGJK	348	7.8	4.7+	AJK	134678	11.1	7.2	BCDFHK	1279
1.1	0.6	ABEFHJK	1236	4.5	2.5+	ABDEGJK	12348	7.9	4.8	ABCDEFGHK	1234678	11.2	7.2+	CDFHK	2379
1.2	0.6+	AEFHJK	246	4.6	2.6	DEGJK	258	8.0	4.8+	CDEFCHK	25678	11.3	7.3	ADFHK	1479
1.3	0.7	BCDFHJK	1346	4.7	2.6+	ACEGJK	1358	8.1	4.9	ADEFCHK	135678	11.4	7.4	ABCCHK	12479
1.4	0.7	ABDFHJK	56	4.8	2.7	BEGJK	458	8.2	5.0	ABCECHK	1235678	11.5	7.5	CFHK	23479
1.5	0.7+	ADFHJK	1256	4.9	2.8	ABCDGJK	12458	8.3	5.1	CECHK	245678	11.6	7.5+	BFHK	579
1.6	0.8	BCFHJK	2356	5.0	2.8+	CDGJK	23458	8.4	5.1+	AEFCHK	345678	11.7	7.6	ABCDEHK	2579
1.7	0.9	CFHJK	1456	5.1	2.9	ADGJK	168	8.5	5.2	BCDFCHK	12345678	11.8	7.7	CDEHK	13579
1.8	0.9+	AFHJK	3456	5.2	2.9+	BCGJK	368	8.6	5.3	CDFCHK	9	11.9	7.8	BDEHK	4579
1.9	1.0	ABCDEHJK	123456	5.3	3.0	CGJK	12368	8.7	5.4	ADFCHK	129	12.0	7.9	ABCEHK	124579
2.0	1.0	CDEHJK	27	5.4	3.1	AGJK	2468	8.8	5.5	ABCCHK	239	12.1	8.0	ACEHK	134579
2.1	1.1	BDEHJK	137	5.5	3.2	ABCDEHJK	13468	8.9	5.5+	CFCHK	149	12.2	8.0+	BEHK	1234579
2.2	1.2	ABCEHJK	47	5.6	3.2+	CDEFJK	568	9.0	5.6	AFCHK	349	12.3	8.1	EHK	2679
2.3	1.2	ACEHJK	1247	5.7	3.3	ADEFJK	12568	9.1	5.6+	ABCDECHK	12349	12.4	8.1+	BCDCHK	3679
2.4	1.3	BEHJK	2347	5.8	3.4	ABCEHJK	23568	9.2	5.7	ACDECHK	159	12.5	8.2	CDCHK	23679
2.5	1.3	ABCDHJK	157	5.9	3.5	CEFJK	14568	9.3	5.8	ABDECHK	1259	12.6	8.2+	BDCHK	14679
2.6	1.4	ACDHJK	357	6.0	3.5	AEFJK	34568	9.4	5.9	DECHK	2359	12.7	8.3	DCHK	124679
2.7	1.4+	BDHJK	12357	6.1	3.6	ABCDHJK	234568	9.5	6.0	BCECHK	1459	12.8	8.4	BCHK	134679
2.8	1.5	DHJK	2457	6.2	3.6+	CDFJK	178	9.6	6.1	CECHK	12459	12.9	8.5	CHK	5679
2.9	1.5+	ACHJK	13457	6.3	3.7	ADFJK	378	9.7	6.1+	BEGCHK	23459	13.0	8.6	BHK	125679
3.0	1.6	BHJK	167	6.4	3.8	ABCCHK	12378	9.8	6.2	ABCDCHK	169	13.1	8.7	HK	135679
3.1	1.7	HJK	367	6.5	3.8+	CFJK	2478	9.9	6.2+	ACDCHK	1269	13.2	8.8	BCDEFCHK	1235679
3.2	1.7+	BCDEFGJK	12367	6.6	3.9	BFJK	3478	10.0	6.3	ABDCHK	1369	13.3	8.9	CDEFCHK	145679
3.3	1.8	ABDEFGJK	2467	6.7	3.9+	ABCDEJK	123478								

Notes: * Measured total gain is the gain measured with a 54A TMS. Possible variation in measured gain due to component allowances is ± 0.3 dB for gains above 13 dB and in proportion for lower gains.

† Measured series or shunt gain with the K screw UP.

STEP	PROCEDURE
	<p>Note: Screws 1, 2, etc, are the fine-gain adjustment. Loosening a screw on this converter lowers the gain; tightening a screw raises the gain.</p> <p> <i>The gains of the individual converters must agree with each other within 0.2 dB before combined gain is measured.</i></p> <p>13 Tighten screw K on the 831-type network and leave it in this position. (This screw connects the series and shunt converter units together in the operating position.)</p> <p>14 Recalibrate the 54A TMS.</p> <p>15 Set switch S3 to SH & SER and measure combined gain. This should check specified gain to within ± 0.3 dB. Record the measured gain in pencil in the rectangular recess on the front face of the repeater after the word GAIN.</p> <p>16 With switch S3 on SH & SER, operate switch S2 to LOAD MEAS; the meter reading will decrease slightly. If this decrease is less than 0.4 dB, record the gain measurement on the repeater face. This data will be valuable for future maintenance checks on the repeater.</p> <p>17 Repeaters that fall off in gain more than 0.4 dB between MEAS and LOAD MEAS are considered defective. Their converters should be returned to the Western Electric Company for repair.</p>

6. INITIAL ADJUSTMENT OF IMPEDANCE MATCHING NETWORK

6.01 Initial adjustment of the 830C network consists of setting the impedance and response of

the network to an approximate value suitable for lineup of the 837D network at the PBX end of the line. If settings are not shown on the CLR, the 830C network should be adjusted as follows.

STEP	PROCEDURE
1	Set the dial of each adjustable resistor (R1, R2, and R3) on the 830C network to the middle of its range. Set the inductor of the network to the prescribed value given on the CLR. If none is given, set the inductor to .8 millihenry (mH). (Do this by loosening, or screwing out, the screw labeled .8 and ensuring that the L, .05, .1, .2, and .4 screws are tightened, or turned fully in.)
2	Remove the repeater from the 54B test stand and insert the 832B network into the NETWORK A side of the repeater to terminate the office side of the repeater in 900 ohms. Then plug it into the proper slot on the E6 repeater shelf. Tag or place an identifying mark on the repeater so that it may be easily identified for final adjustment. Ensure that the repeater is powered and that the disabling plugs have been removed from the jack strip.
3	The circuit is now ready to have the 837D network aligned at the PBX end of the line.

7. INSTALLATION AND LINEUP OF 837D NETWORK

7.01 The 837D network at the PBX should be adjusted before the 830C network at the CO is adjusted.

STEP	PROCEDURE
1	<p>At the PBX end of the line, connect terminals 1 and 2 of the 837D network to the proper line and connect terminals 3 and 4 to the tip and ring terminals of the proper trunk circuit. Turn down the adjusting screws (of the 837D network) labeled 600 or 900, depending upon whether the PBX impedance is 600 ohms or 900 ohms. (This applies to the 837D network only; the 837C network does not have these screws, because it is a 900-ohm only device).</p>
2	<p>Set the adjusting screws labeled 57 and 114 on the face of the 837D network to the building-out resistance (BOR) required on the CLR. If building out is not required, the screws should be tightened, or turned into the network. BOR is added to the circuit for those cases in which insufficient loop resistance can cause false dial pulsing; it is also added to reduce temperature effects on the line. Set the R potentiometer to the value given on the CLR. If none is given, set to 4.</p> <p> <i>Set both 57 screws or both 114 screws and both 600 screws or both 900 screws to the same position to avoid severe circuit unbalance.</i></p>
3	<p>Connect 54C return loss measuring set (RLMS),* the J87241B power supply, and the 837D network as shown in Fig. 4. Set the switches on the 54C RLMS as follows:</p> <p>S1 to 500—2500 ~</p> <p>S2 to SEND LEVEL CAL</p> <p>S3 to 900Ω 2MF for 837C and 837D when used with 900Ω</p> <p>S3 to EXT NET for 837D when used with 600Ω. Connect a 600Ω plus 2.16 μF termination to the EXT NET jacks.</p> <p>AT1 to RETURN-LOSS scale.</p> <p>*Where available, the KS-20501 return loss measuring set may be used as an alternative to the 54C RLMS. It is powered from commercial 60-Hz supply only and needs no auxiliary supply. Where this section specifies using the 500- to 2500-Hz sweep of the 54C RLMS, the echo range of the KS-20501 RLMS may be used. Where this section specifies using the 2000- to 3000-Hz sweep (in lining up the 830C network), the high range of the KS-20501 RLMS may be used. Although the readings of the 54C RLMS and the KS-20501 RLMS usually differ a little from each other, use the same numerical requirements for the readings of the KS-20501 RLMS and the 54C RLMS.</p>
4	<p>Calibrate the 500- to 2500-Hz range of the 54C RLMS to 0 dB and then set switch S2 to MEAS.</p>

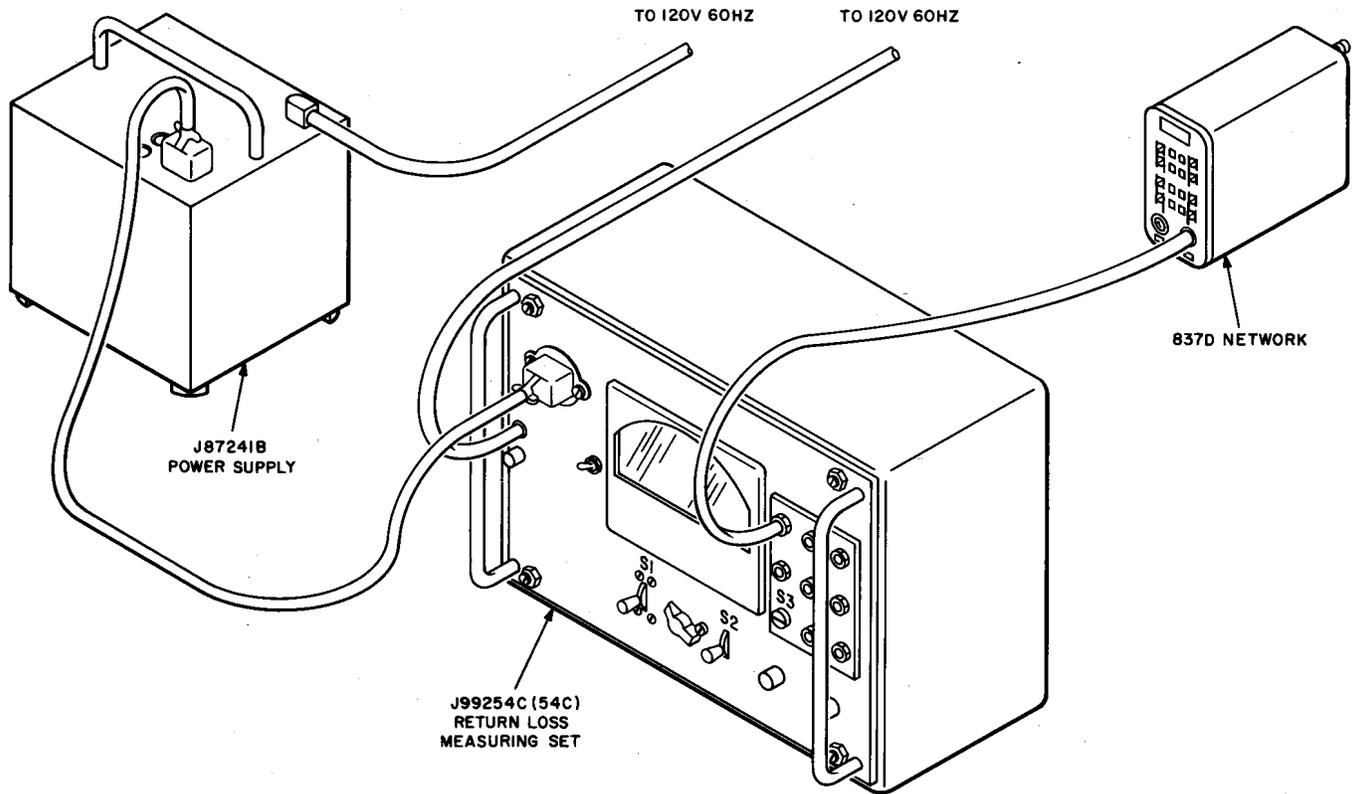


Fig. 4—Return-Loss Adjustment of 837D Network—Test Equipment Connections

STEP	PROCEDURE
5	<p>Adjust the R dial on the 837D network for a maximum return loss reading on the 54C RLMS. A return loss of 22 dB should be obtained, although 18 to 22 dB is acceptable. If return loss readings are within limits, refer to Step 7. If more than 22 dB is obtained, rotate the R dial in a <i>clockwise</i> direction until the 54C RLMS indicates a return loss of exactly 22 dB.</p> <p> <i>Do not obtain 22 dB by rotating R dial counterclockwise as this will result in an objectionable increase in the transmission loss of the line.</i></p>
6	<p>If a minimum reading of 18 dB cannot be obtained in Step 5, check the cable connections between the 837D network and the 54C RLMS. Then make the following checks in order:</p> <ul style="list-style-type: none"> (a) Check 837D network terminal connections. (b) Ensure that the E6 repeater is firmly in place on the shelf and that dc power has been applied. (c) Install a new 837D network and repeat the lineup procedure.

STEP	PROCEDURE
7	If a satisfactory return loss was obtained in Step 5, disconnect the 54C RLMS and the power supply from the 837D network. This completes the lineup of the 837D network.

8. FINAL ADJUSTMENT OF 830C NETWORK

8.01 To complete the lineup of the 830C network and to check net insertion loss, assistance at the PBX is required. The assistance is needed at the PBX to terminate the trunk with a 900-ohm

or 600-ohm resistor in series with a 2- μ F capacitor, to make final adjustments of the 830C network, and to apply a 1-kHz source at 1 milliwatt to check net insertion loss. The following procedure should be used.

STEP	PROCEDURE
1	Request that a termination be placed on the trunk at the PBX end depending on PBX impedance: 900-ohm resistor in series with 2- μ F capacitor for 900-ohm PBX, 600-ohm resistor in series with 2- μ F capacitor for 600-ohm PBX. A 4125A (600-ohm) or 4125B (900-ohm) network may be used to terminate the link.
2	Remove the appropriate E6 repeater from the shelf. Loosen the four screws on the NETWORK A side of the repeater and remove the 832B network. Replace the 832B network with the 832A dummy network and insert the repeater into the 54B test stand as instructed in Step 4 of Part 5. Set switch S1 on the 54B test stand to NORM and switch S2 to neutral. Rotate the turret of the 54B test stand so that the adjustable resistors on the 830C network are easily accessible.
3	Connect LINE EXT A and B jacks on the 54B test stand to the vacant position on the repeater shelf, using the cord per ED-97023-30, Group 2. Use a P5F cord to patch from the TST PWR jack of the 54C RLMS to the RLMS TST PWR jack of the 54B test stand. Use a 3P7B cord to connect the RL jack of the 54B to the MEAS RL jack of the 54C. Connect the 4097-type network to the pin jacks of the 830E network as shown in Fig. 5. The 4097-type network (Fig. 6) provides an easily adjusted inductance for determining the proper setting of inductance in the 830C network. Table C provides data for transcribing the value of inductance obtained with the 4097-type network to the 830C network.
4	<p>If the 4097B network is used, set the turn key to the 830C position. When connecting the 4097A or B network to the 830C network, loosen the screw labeled L on the 830C network to remove the internal inductance of the 830C network from the circuit. Set the 4097-type network to the prescribed value or, if the prescription setting is not supplied, to .8 mH.</p> <p>Note: If a 4097-type network is not available, a cut-and-try method utilizing the inductance screws on the 830C network must be used to obtain the proper inductance setting. This may be done as follows:</p> <p>(a) Tighten down the L screw on the 830C network. This enables the internal inductance of the network.</p>

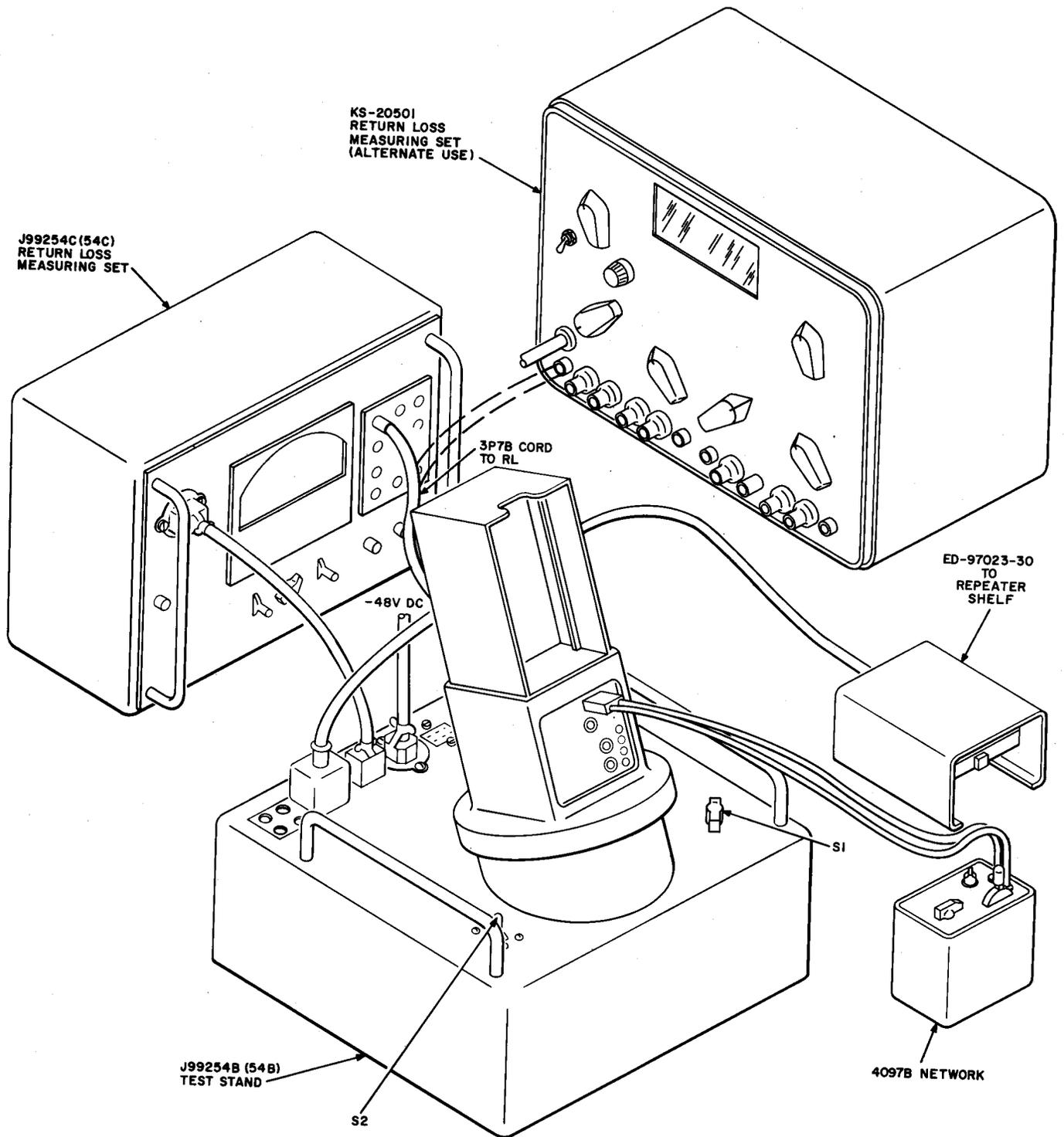


Fig. 5—Return-Loss Adjustment of E6 Repeater—Test Equipment Connections

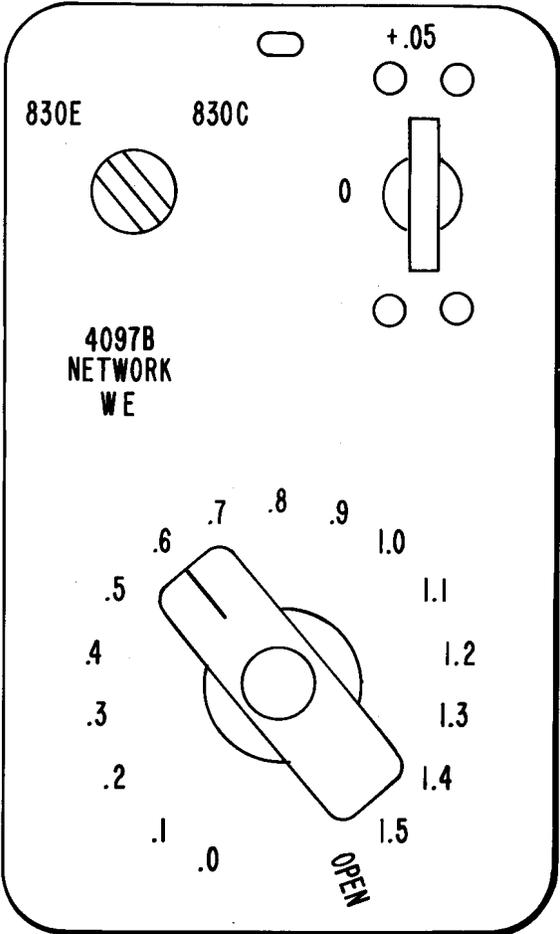


Fig. 6—4097B Network—Face Plate View

TABLE C
SETTING OF INDUCTANCE IN 830C NETWORK
FROM 4097A OR 4097B NETWORK

INDUCTANCE* (4097A or 4097B NETWORK)	SCREW TERMINALS† (830C NETWORK)				
	.8	.4	.2	.1	.05
0	X	X	X	X	X
0.05	X	X	X	X	—
0.10	X	X	X	—	X
0.15	X	X	X	—	—
0.20	X	X	—	X	X
0.25	X	X	—	X	—
0.30	X	X	—	—	X
0.35	X	X	—	—	—
0.40	X	—	X	X	X
0.45	X	—	X	X	—
0.50	X	—	X	—	X
0.55	X	—	X	—	—
0.60	X	—	—	X	X
0.65	X	—	—	X	—
0.70	X	—	—	—	X
0.75	X	—	—	—	—
0.80	—	X	X	X	X
0.85	—	X	X	X	—
0.90	—	X	X	—	X
0.95	—	X	X	—	—
1.00	—	X	—	X	X
1.05	—	X	—	X	—
1.10	—	X	—	—	X
1.15	—	X	—	—	—
1.20	—	—	X	X	X
1.25	—	—	X	X	—
1.30	—	—	X	—	X
1.35	—	—	X	—	—
1.40	—	—	—	X	X
1.45	—	—	—	X	—
1.50	—	—	—	—	X
1.55	—	—	—	—	—

Note: The maximum value of 1.60 mH, obtainable on the 4097A network, cannot be set into the 830C network.

*Sum of inductance indicated on rotary and key switches on 4097A or 4097B network.

†X indicates screws that should be tightened down to obtain equivalent inductance on 830C network.

STEP	PROCEDURE
5	<p>(b) Set the inductance to the prescription value or, if the prescription setting is not supplied, to .8 mH. The latter is obtained by loosening, or screwing out, the screw labeled .8 mH and tightening down the .05, .1, .2, and .4 screws. Tightening down a screw removes the particular value of inductance from the network circuit.</p> <p>(c) To increase or decrease network inductance, use combinations of screws as shown in Table C.</p> <p>Calibrate both frequency ranges (500 to 2500 ~ and 2000 to 3000~) of the 54C RLMS to 10-dB return loss on the meter, rather than to 0 dB. This will prevent overloading the E6 repeater.†</p> <p>Note: Subsequent readings will have to be reduced by 10 dB to give the true return loss.</p> <p>†Since the output of the KS-20501 RLMS is appreciably lower than that of the 54C RLMS, no provision has been made for reducing its output.</p>
6	<p>The objective in the next part of the lineup procedure is to obtain the maximum return loss. The 830C network contains four adjustable elements that must be set to optimize the performance of the specific gain unit and cable facilities with which it works. The adjustment procedure is necessary to obtain satisfactory return losses not only in the 500- to 2500-Hz range and 2000- to 3000-Hz range, but also at frequencies below 200 and above 3000 Hz. A high return loss assures adequate margin against echo and singing. To ensure satisfactory operation, it is also necessary to have the return loss in the 500- to 2500-Hz range at least as large as in the 2000- to 3000-Hz range. To meet these requirements, measure return loss with the 54C RLMS by performing the following steps in sequence:</p> <p>(a) Set switches on the 54C RLMS as follows:</p> <p style="padding-left: 40px;">S1 to 500—2500 ~</p> <p style="padding-left: 40px;">S2 to MEAS</p> <p style="padding-left: 40px;">S3 to 900Ω 2MF</p> <p>(b) Adjust R2 for maximum return-loss indication on the 54C RLMS.</p> <p>(c) Adjust R3 for maximum return loss.</p> <p>(d) Increase or decrease the value of inductance (L) by operating the switch and key on the 4097-type network until maximum return loss is obtained.</p> <p>(e) Readjust R3 for maximum return loss.</p> <p>(f) Readjust R2 for maximum return loss.</p> <p>(g) Repeat Step (d). If a significant increase in return loss is indicated (ie, 0.5 dB), repeat Steps (e), (f), and (g) until additional return loss cannot be obtained.</p>

STEP	PROCEDURE
	<p>(h) Set switch S1 on the 54C RLMS to the 2000—3000 ~ position.</p> <p>(i) Adjust R1 for maximum return loss.</p> <p>(j) Readjust the value of inductance as instructed in Step 4.</p> <p>(k) Readjust R1 for maximum return loss.</p> <p>(l) Set switch S1 on the 54C RLMS to the 500—2500 ~ position.</p> <p>(m) Readjust the value of inductance as instructed in Step (d).</p> <p>(n) Readjust R1 for maximum return loss.</p> <p>(o) Readjust R2 for maximum return loss.</p> <p>(p) Readjust R3 for maximum return loss.</p> <p>(q) If indicated return loss in the 2000- to 3000-Hz range is greater than at the 500- to 2500-Hz range, decrease the value of inductance in 0.05-mH steps until the return loss in the 500- to 2500-Hz range is greater. Repeat Steps (o) and (p) for optimum results.</p> <p>Requirement: The return loss measurement obtained should be equal to or greater than the value specified on the CLR.</p>
7	<p>If the requirement in Step 6 cannot be met, readjust R2, R3, and the inductance. If requirements still cannot be met, replace the 830C network with a new network and repeat the entire lineup procedure (refer to Parts 4 through 8). If the requirements still cannot be met, refer to the responsible engineering department.</p>
8	<p>If acceptable values of return loss are obtained in the lineup procedure, tighten the L screw on the 830C network and set in the amount of inductance (L) that was obtained with the 4097-type network (see Table C).</p>
9	<p>Disconnect the 4097-type network from the 830C network and, if there has been any noticeable reduction from the previous indication, readjust R1, R2, and R3 for maximum return loss with the 54C RLMS in the 500- to 2500-Hz range.</p>
10	<p>Request that the termination be removed at the PBX. This completes the lineup of the 830C network.</p>

9. MEASUREMENT OF 1-KHZ INSERTION LOSS

9.01 The insertion loss at 1 kHz is measured by applying 1 mW of power at 1 kHz at one end of the circuit and measuring the response at

the other end with a 23A or 23D TMS (see Section 103-223-100). Depending upon the type of 1-mW supply that is available at the PBX, either of the following two methods of measurement may be used.

STEP	PROCEDURE
1	<p>Method with mW at PBX</p> <p>If a mW of power at the PBX can be dialed up from the CO or if a 71B milliwatt reference generator can be plugged in at the PBX, use Fig. 7 for test equipment connections. In either case the generator impedance should be that of the nominal PBX impedance (either 900 ohms or 600 ohms). The generator should be calibrated to put 1 mW into a load equivalent to the nominal impedance of the PBX. On the 54B test stand, set switch S1 to NORM and switch S2 to neutral.</p>
2	<p>Method with mW at CO</p> <p>If a mW supply is not available at the PBX, then a mW supply at the CO should be dialed from the PBX. Test connections are shown in Fig. 8. The 23A or D TMS at the PBX should be used to dial up the mW supply and to measure the loss. The impedance of the 23A or D should be set to the nominal PBX impedance. If the repeater at the CO is in the 54B test stand for this measurement, set switch S1 to NORM and switch S2 to neutral.</p>
3	<p>If the measured insertion loss on the 23A or D TMS at the PBX end of the line is not within ± 0.2 dB of the desired net loss (noted on the CLR), change the gain of the E6 repeater as described in Part 5.</p>
4	<p>If the gain of the repeater requires a change in excess of 1 dB, recheck the 500- to 2500-Hz and 2000- to 3000-Hz return loss. If return loss requirements are not within limits, repeat the lineup procedure as described in Part 8.</p>

10. STABILITY TESTS (SINGING CHECK)

10.01 The E6 repeater is designed to be stable under all operating conditions (idle condition, dial pulsing, etc). After the circuit is lined up,

there should be a margin of safety against singing. The following steps will assure this margin of safety when the circuit is checked for singing under the severe test of an open circuit at the central office and a short circuit at the PBX trunk circuit.

STEP	PROCEDURE
1	<p>Connect the 54B test stand, repeater, and KS-14418 headphone equipped with a 419A plug as shown in Fig. 9. The 419A plug connects into the TST 2 jacks on the front of the repeater.</p> <p>Note: Do not plug the headphone into the TST 1 jack as it may make the repeater sing.</p>
2	<p>Obtain a short circuit by either of two methods:</p> <ul style="list-style-type: none"> (a) Insert a shorting plug into the TST jack of the 837D network. (b) Operate the attendant dial at the PBX when it is connected to the trunk under test.

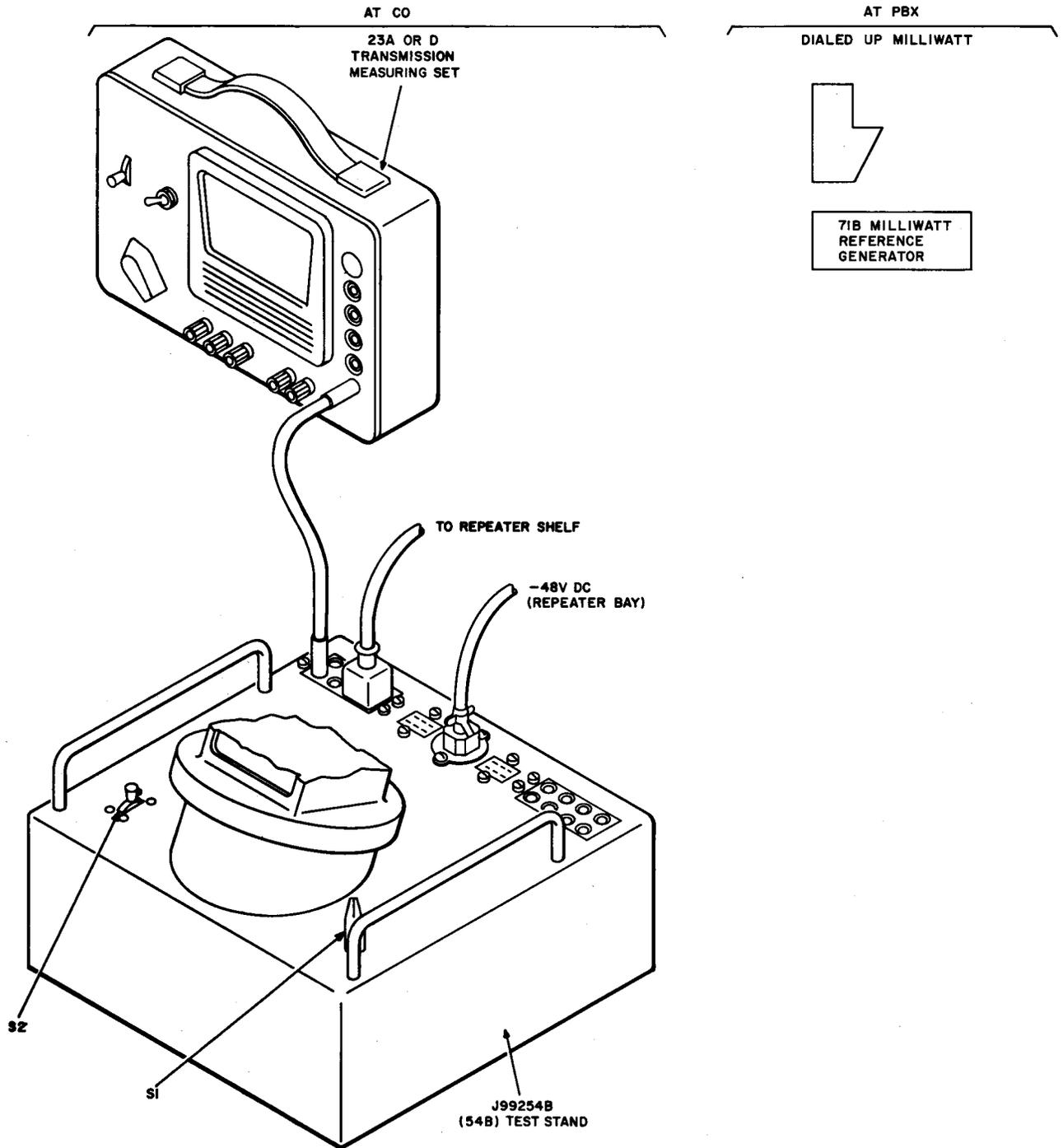


Fig. 7—Measurement of 1-kHz Insertion Loss—Method with mW at PBX

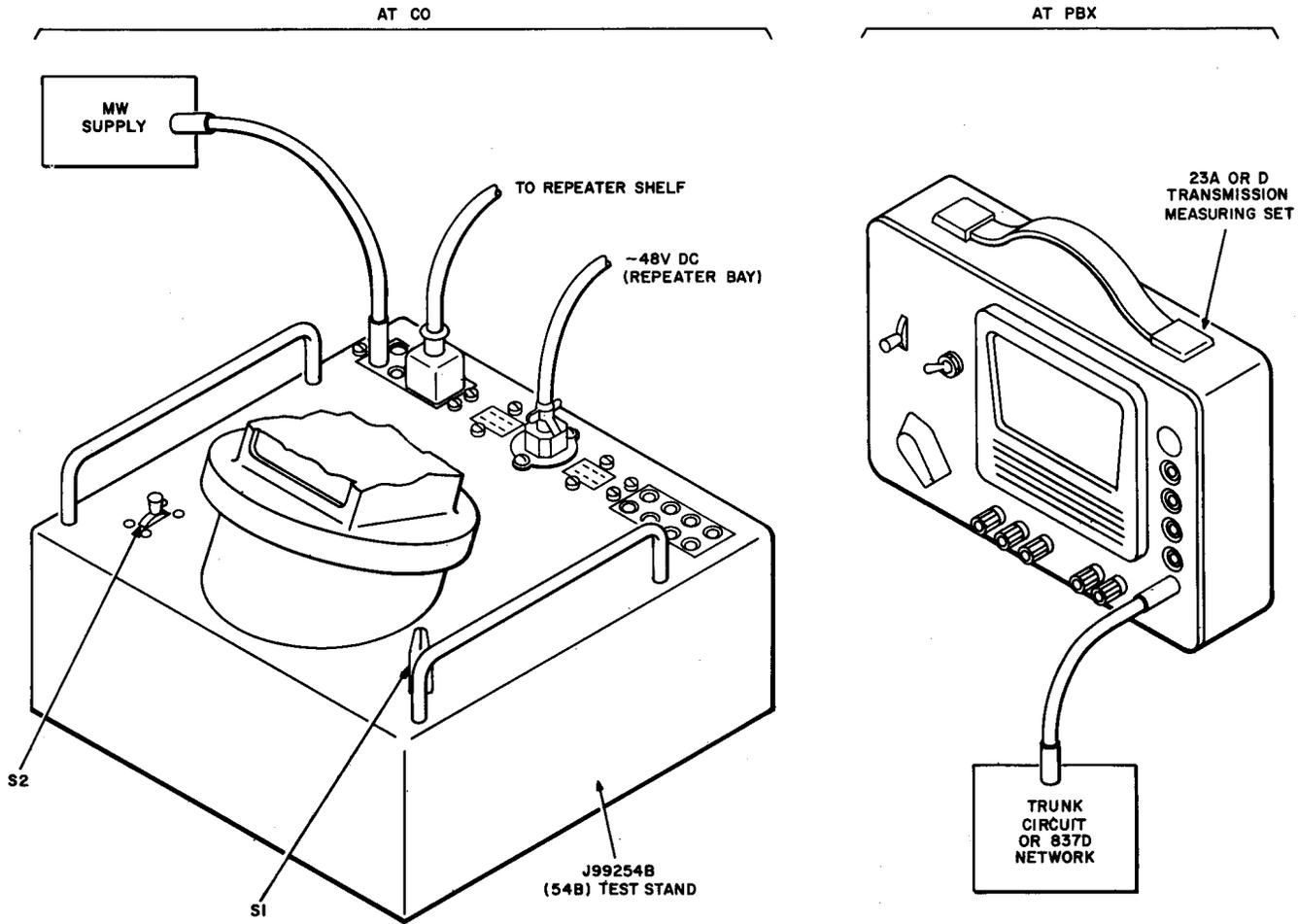


Fig. 8—Measurement of 1-kHz Insertion Loss—Method with mW at CO

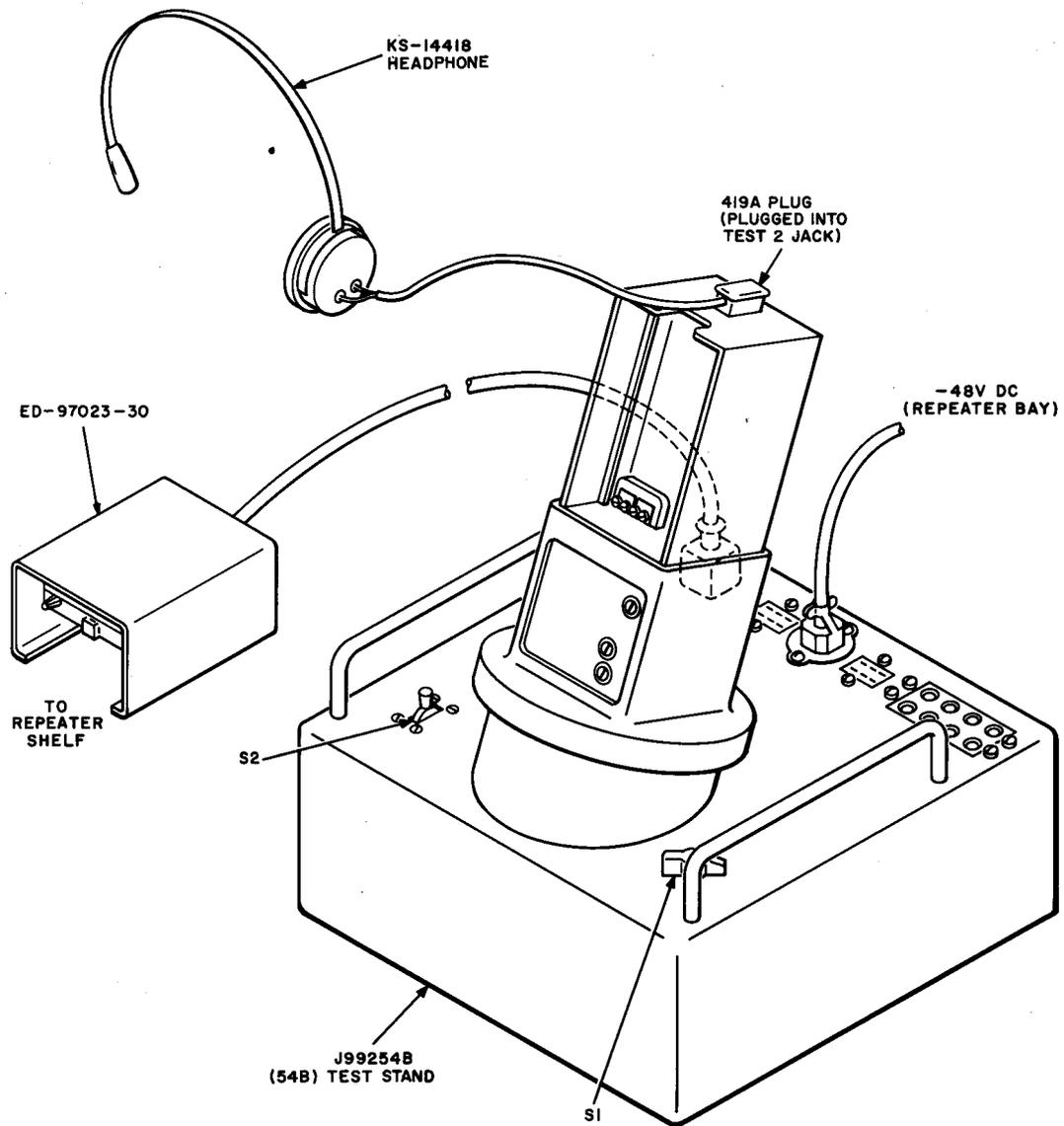


Fig. 9—Stability Test—Test Equipment Connections

STEP	PROCEDURE
3	The open circuit is obtained by placing switch S2 in the neutral position and switch S1 in the RL LINE B position on the 54B test stand.
4	With the headphone connected, no sound other than battery noise should be audible. If the repeater does not sing, refer to Step 7. If the repeater does sing, note whether the tone is of low, medium, or high frequency. If the tone is of relatively low frequency, adjust dial R2 on the 830C network slightly in either direction. If the circuit is not stable, repeat the lineup procedure for the 830C network, but adjust only the R1 and R3 potentiometers.
5	If the tone appears to be 1 kHz or higher in frequency, lower the value of inductance by 0.5 mH and repeat the lineup procedure for the 830C network, adjusting potentiometers R1, R2, and R3. Check again for stability. If the repeater still sings, repeat Step 5. Ensure that the 500- to 2500-Hz return loss is at least 16 dB.
6	If singing persists, decrease the repeater gain by 0.25 dB and repeat the lineup procedure for the 830C network.
7	When the trunk is stable, proceed as follows: <ul style="list-style-type: none"><li data-bbox="228 932 748 961">(a) Remove repeater from 54B test stand.<li data-bbox="228 995 672 1024">(b) Remove plug from shelf socket.<li data-bbox="228 1058 578 1087">(c) Plug repeater into shelf.<li data-bbox="228 1121 659 1150">(d) Have the circuit put in service.