

## E6 REPEATER LINE-UP ON NONLOADED CABLE

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for the adjustable elements to obtain optimum performance. When two or more facilities with the same make-up are to be improved, it is necessary to line up each facility individually in order to obtain maximum benefit from the repeater and networks. In order to attain the unusually high return losses required, and since there are slight variations from pair to pair, each network must be adjusted to the specific pair with which it will operate.

1.05 While the line-up procedure is rather simple, it does require adjustments at both ends of the facility. If a compromise network and short circuit terminations and a 1-kc, 1-mw signal source are available at the nonrepeated end (837C network) of the facility, then the repeater and networks can be lined up by one craftsman.

### 1. GENERAL

1.01 This section provides line-up and installation procedures for the E6 repeater, including an 830C network and an 837C network when the repeater is used on central office-PBX nonloaded trunks. The 837C network is located at the nonrepeated end of the trunk.

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

1.03 The repeater and networks may be used at facilities which are between 2.75 kf and 18 kf in length and which have bridge taps up to 6 kf with any amount being aerial cable.

1.04 Because of the large number of facilities differing in gauge, length, and bridge tap, and the desire to improve return losses and insertion losses, it is necessary to adjust four elements in the 830C and one element in the 837C networks. It is impossible to prescribe the settings

### 2. APPARATUS

2.01 Table A lists the equipment required for the line-up 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. Connect the necessary power to the test equipment.

3.02 Installation and line-up of the E6 repeater for use with a nonloaded cable will require the following *basic* steps.

- (a) Assembling the repeater.
- (b) Initial adjustment of repeater gain unit and 830C network at the central office.
- (c) Installation and line-up of 837C network at the PBX.
- (d) Final adjustment of 830C network.

**TABLE A**  
**APPARATUS REQUIRED FOR E6 REPEATER**  
**LINE-UP 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	1	X	X	—
J99254A, L1 Transmission Loss Measuring Set (54A) with Cords	1	—	—	X	110 to 120 volts, 60 cps, 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 Measuring Set (54C) with Cords	1	1	X	—	
J87241B Power Supply	—	1	X	—	110 to 120 volts, 60 cps
J94021A Transmission Measuring Set (21A) with Cords	1	—	—	X	
J94023A Transmission Measuring Set (23A)	—	1*	—	X	—
KS-14418 Headphones with 419A Plug	1	—	X	—	—
Termination of 900 ohms $\pm 5\%$ in series with 2 $\mu\text{f}$ $\pm 20\%$ , 500 wvdc	—	1	X	—	—
4097A Network	1	—	X	X	—
832A Network	1	—	X	X	—
832B Network	1	—	X	—	—
Circuit Layout Record Card	1	1	X	X	—
J94002AB Auxiliary Transmission Test Set (2AB)	1	—	X	X	—
3 Power Cords with P5F Jones Connectors	3	—	X	X	—
Shorting Plug	—	1	X	—	—

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

(e) Measurement of 1-kc insertion loss and readjustment of repeater gain, if necessary.

(f) Stability test (singing checks).

**3.03** Immediately after the repeater and networks have been lined up, including a stability test, the outdoor temperature and date should be recorded on the circuit layout record card.

**3.04** When properly lined up, the E6 repeater including the 830C network is stable for most any outdoor temperature within a range of  $\pm 50^{\circ}\text{F}$ . If the outdoor temperature is  $80^{\circ}$  or more at line-up time, the repeater may sing at  $30^{\circ}\text{F}$  or less. Also if the temperature at line-up time is  $30^{\circ}\text{F}$  or less, the repeater may sing at  $80^{\circ}\text{F}$ . It is therefore recommended that the 830C network be realigned at or near the average annual temperature. If this recommendation is followed, only one additional line-up will be required for most applications.

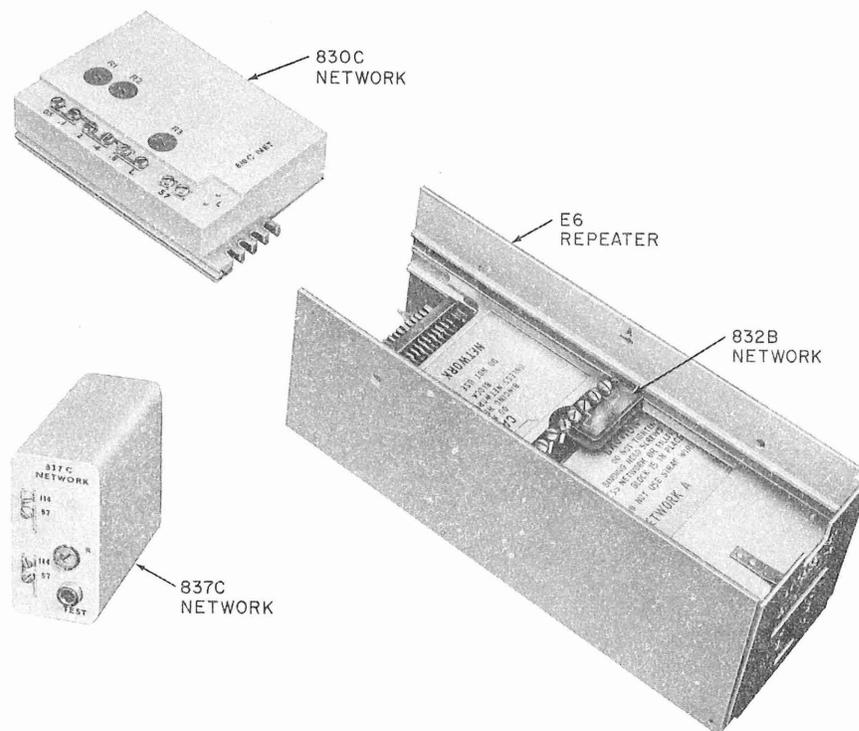
*Note:* This is very applicable to facilities which have a predominant amount of aerial cable, especially near the repeater end.

#### 4. LINE-UP

##### A. Assembling the E6 Repeater

**4.01** The E6 repeater gain unit (831A network) and connector block are mounted in the aluminum chassis prior to shipment. The 832B, 830C, and 837C networks are shipped separately. The 830C network slides into the NETWORK B side of the repeater and is made secure by four screws on the connector block. In addition to securing the network, these screws make the required electrical connections between the gain unit and the network.

**4.02** The 832B network (Section 103-104-110) slides in place on the NETWORK A side of the repeater and is secured by 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 for line-up procedures at the PBX end of the line. A photograph of the E6 repeater, 830C network, and the 837C network is shown in Fig. 1.



**Fig. 1 — E6 Repeater and Networks Used on Nonloaded Cable Between a Central Office and PBX**

**B. Adjustment of Repeater Gain**

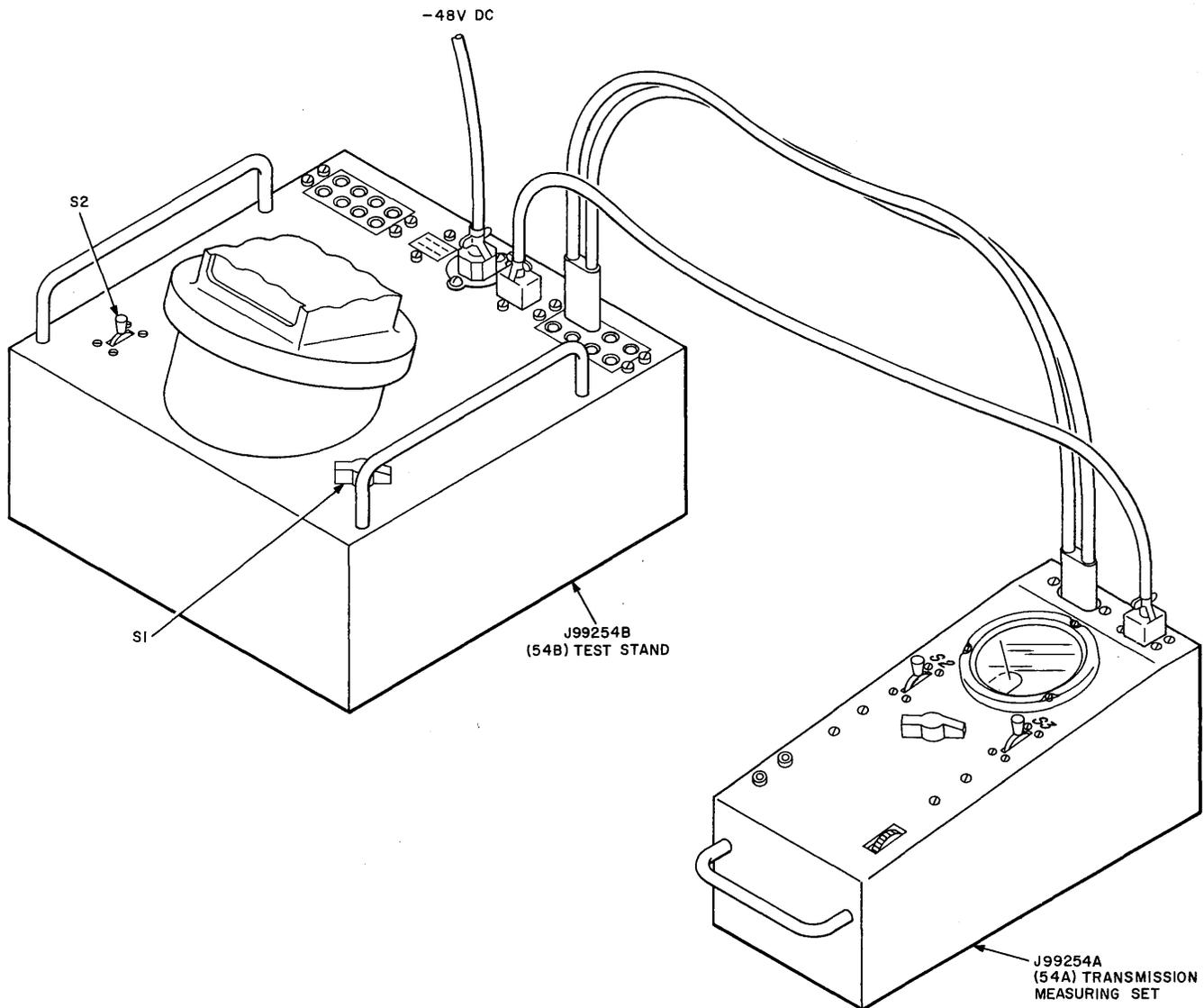
**4.03** Gain adjustment of the E6 repeater consists of setting the adjusting screws of the 831A gain network to the gain required on the circuit layout card.

**4.04** Place the printed wiring-board side of the 831A 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. Contact with the printed wiring-board conductors is made by the

washers under the screwheads. Therefore, the screwheads should be fully down on, or fully clear of, the printed wiring board.

**4.05** Set the 54B test stand and 54A transmission measuring set near the -48 volt power distribution outlet which is provided on bays equipped with E6 repeaters.

**4.06** Connect -48 volt power to the 54B test stand and connect the test stand to the 54A transmission measuring set as shown in Fig. 2.



**Fig. 2 — Converter Gain — Test Equipment Connections**

**Note:** The 54A set has no switch to apply power, nor is there a pilot light. No warm-up period is necessary. No connection to the cable pairs is required for the gain adjustment of the 831A network.

**4.07** Carefully insert the repeater into the 54B test stand. Lower (*do not drop or force*) 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 head of the 54B set so that the 831A gain-unit side of the repeater is easily accessible.

**4.08** All screws on the gain-unit side should have been loosened as in 4.04. Consult the circuit layout card for the specified gain adjustment. Refer to the 831A network adjustment card (P-30C109) in the 54B test stand pocket to determine the necessary screw settings for this specified gain value. These values are also shown in Table B. For example, in the row corresponding to 12-db gain are listed screws A, B, E, H, and 1, 2, 4, 5, 7, 9, to be turned down. Tighten these firmly, but not excessively, and leave all other screws raised.

**Caution:** *Excessive tightening may strip threads.*

**4.09** Measure the converter unit gains separately as follows.

(1) On 54B test stand, set switch S2 to a neutral position and switch S1 to GAIN position.

(2) Throw S2 on the 54A set to CAL, and adjust the knurled knob CAL ADJ to give a 0-db reading. Then set S2 to MEAS position. The position of other keys and knobs on the 54A set does not affect this reading.

(3) Rotate gain db knob S1 to 12 db. Make certain that screw K on the 831A network is loosened. Operate 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 plus the meter reading. Note this value.

(4) Throw switch S3 from SERIES to SHUNT. Measure and note this gain.

(5) Compare the two measured gain values with the value given on the 831A network adjustment card in the 54B set pocket for individual converter gains, both sides of which are shown in Table B. For 12-db total gain, the separate converters should measure 7.9-db gain as shown. If both series and shunt gain measurements fall within  $\pm 0.2$  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 4.12. If not, adjust the gain of either the series or shunt converter or both as follows.

**4.10** Check to see that the proper screws are turned down and that all others are clear of the printed wiring. If no error can be found and the series-converter gain measurement deviates by more than  $\pm 0.2$  db from the listed value, throw S3 to SERIES. Recalibrate as in 4.09(2) and then restore S2 to MEAS. Adjust screws A through J on the 831A network to give the tabulated gain for a single converter to within  $\pm 0.1$  db. 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; raising a screw raises the gain.

**4.11** If the shunt-converter gain measurement deviates by more than  $\pm 0.2$  db from the listed value, throw S3 to SHUNT and adjust the measured gain to within  $\pm 0.1$  db of the listed value, using screws 1 through 9 on the 831A network. Screws 1, 2, etc. are the fine-gain adjustment. Raising a screw on this converter lowers the gain; tightening a screw raises the gain.

**4.12** The gains of the individual converters must agree with each other within 0.2 db before combined gain can be measured.

**4.13** Tighten screw K on the 831A network and leave it in this position. (This screw connects series and shunt converter units together in the operating position.)

**4.14** Recalibrate the 54A set.

**4.15** Throw S3 to SH & SER and measure combined gain. This should check specified gain to within  $\pm 0.3$  db. Record the measured gain in pencil in the rectangular recess on the front face of the repeater after the word GAIN.

**TABLE B**  
**831A NETWORK ADJUSTMENTS FOR 900-OHM IMAGE IMPEDANCE**

TOTAL GAIN (DB)	SERIES OR SHUNT CONVERTER GAIN (DB)	SERIES SCREWS DOWN	SHUNT SCREWS DOWN	TOTAL GAIN (DB)	SERIES OR SHUNT CONVERTER GAIN (DB)	SERIES SCREWS DOWN	SHUNT SCREWS DOWN
1.0	0.5	ADEFHJ	36	8.2	5.1	A EFGH	1345678
1.1	0.6	CEFHJ	146	8.4	5.2	ACDFGH	9
1.3	0.7	ABCDFHJ	12346	8.6	5.3	ADFGH	129
1.5	0.8	BDFHJ	356	8.7	5.4	BCFGH	1239
1.7	0.9	ACFHJ	1456	8.8	5.5	BFGH	249
1.9	1.0	FHJ	123456	9.0	5.6	ABCDEFGH	2349
2.1	1.1	ABDEHJ	137	9.1	5.7	ABDEGH	159
2.2	1.2	BCEHJ	1247	9.2	5.8	ABCEGH	1359
2.4	1.3	BEHJ	157	9.4	5.9	CEGH	1459
2.6	1.4	ACDHJ	2357	9.5	6.0	AEGH	3459
2.8	1.5	DHJ	12457	9.6	6.1	ACDGH	69
3.0	1.6	CHJ	167	9.8	6.2	BDGH	369
3.1	1.7	ABCDEFGJ	2367	9.9	6.3	BCGH	12369
3.3	1.8	ABDEFGJ	12467	10.0	6.4	ABGH	12469
3.4	1.9	ABCEFGJ	567	10.2	6.5	ABCDEFH	23469
3.6	2.0	BEFGJ	13567	10.3	6.6	CDEFH	1569
3.8	2.1	ACDFGJ	124567	10.4	6.7	ADEFH	13569
4.0	2.2	ADFGJ	8	10.6	6.8	BCEFH	4569
4.1	2.3	ACFGJ	138	10.7	6.9	BEFH	124569
4.3	2.4	FGJ	148	10.8	7.0	ABCDFH	1234569
4.4	2.5	CDEGJ	2348	11.0	7.1	CDFH	279
4.6	2.6	DEGJ	1258	11.1	7.2	ADFH	1379
4.8	2.7	ABEGJ	12358	11.2	7.3	BCFH	479
4.9	2.8	ABCDGJ	3458	11.3	7.4	ABFH	12479
5.1	2.9	BDGJ	168	11.5	7.5	FH	123479
5.3	3.0	BCGJ	2368	11.6	7.6	ACDEH	2579
5.4	3.1	BGJ	2468	11.7	7.7	BDEH	13579
5.6	3.2	BCDEFJ	123468	11.8	7.8	ABCEH	4579
5.7	3.3	BDEFJ	12568	12.0	7.9	ABEH	124579
5.8	3.4	ACEFJ	4568	12.1	8.0	AEH	234579
6.0	3.5	AEFJ	34568	12.2	8.1	BCDH	1679
6.1	3.6	ACDFJ	178	12.3	8.2	ABDH	3679
6.3	3.7	ADFJ	1378	12.5	8.3	DH	123679
6.5	3.8	ACFJ	1478	12.6	8.4	ACH	24679
6.6	3.9	AFJ	23478	12.7	8.5	BH	234679
6.7	4.0	CDEJ	2578	12.8	8.6	H	15679
6.9	4.1	DEJ	23578	13.0	8.7	ACDEFG	35679
7.0	4.2	CEJ	24578	13.1	8.8	BDEFG	1235679
7.2	4.3	EJ	234578	13.2	8.9	ABCEFG	245679
7.3	4.4	CDJ	12678	13.3	9.0	CEFG	1345679
7.5	4.5	DJ	23678				
7.6	4.6	CJ	24678				
7.7	4.7	J	234678				
7.9	4.8	CDEFGH	25678				
8.0	4.9	ADEFGH	135678				
8.1	5.0	ACEFGH	145678				

**4.16** With S3 on SH & SER, operate S1 to LOAD MEAS; the meter reading will decrease slightly. If this decrease is less than 0.4 db, record both gain measurements on the repeater face. This data will be valuable for future maintenance checks on the repeater.

**4.17** Repeaters which 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.

#### C. Initial Adjustment of Impedance Matching Network

**4.18** Initial adjustment of the 830C network consists of setting the impedance and response of the network to an approximate value suitable for line-up of the 837C network at the PBX end of the line.

**4.19** Set the dials of adjustable resistors R1, R2, and R3 on the 830C network to the center of their range. This is done by setting the arrows on the dials to the white dot or black line on the network case. Set the inductance value of the network 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 in.

**4.20** Remove the repeater from the 54B test set and 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 line-up. Ensure that the repeater is powered and that disabling plugs have been removed from the jack strip.

**4.21** The circuit is now ready to have the 837C network installed and aligned at the PBX end of the line.

#### D. Installation and Line-Up of 837C Network

**4.22** At the PBX end of the line, install the 837C network. Using the circuit layout card for reference, connect terminals 1 and 2 of the network to the proper line, and connect terminals 3 and 4 to the proper tip and ring terminals of the trunk circuit.

**4.23** Set the adjusting screws labeled 57 and 114 on the face of the 837C network to the build-out resistance required on the circuit layout card. If build-out is not required, the screws should be tightened, or turned into the network. Build-out resistance is added to the circuit for those cases where insufficient loop resistance allows false dial pulsing.

**Caution:** Set both 57 screws or both 114 screws to the same position to avoid severe circuit unbalance.

**4.24** Connect the 54C return-loss measuring set, the J87241B power supply, and the 837C network as shown in Fig. 3. Set the switches on the 54C measuring set as follows:

S1 to 500 — 2500~

S2 to SEND LEVEL CAL

S3 to 900Ω 2 MF

DB to RETURN-LOSS scale

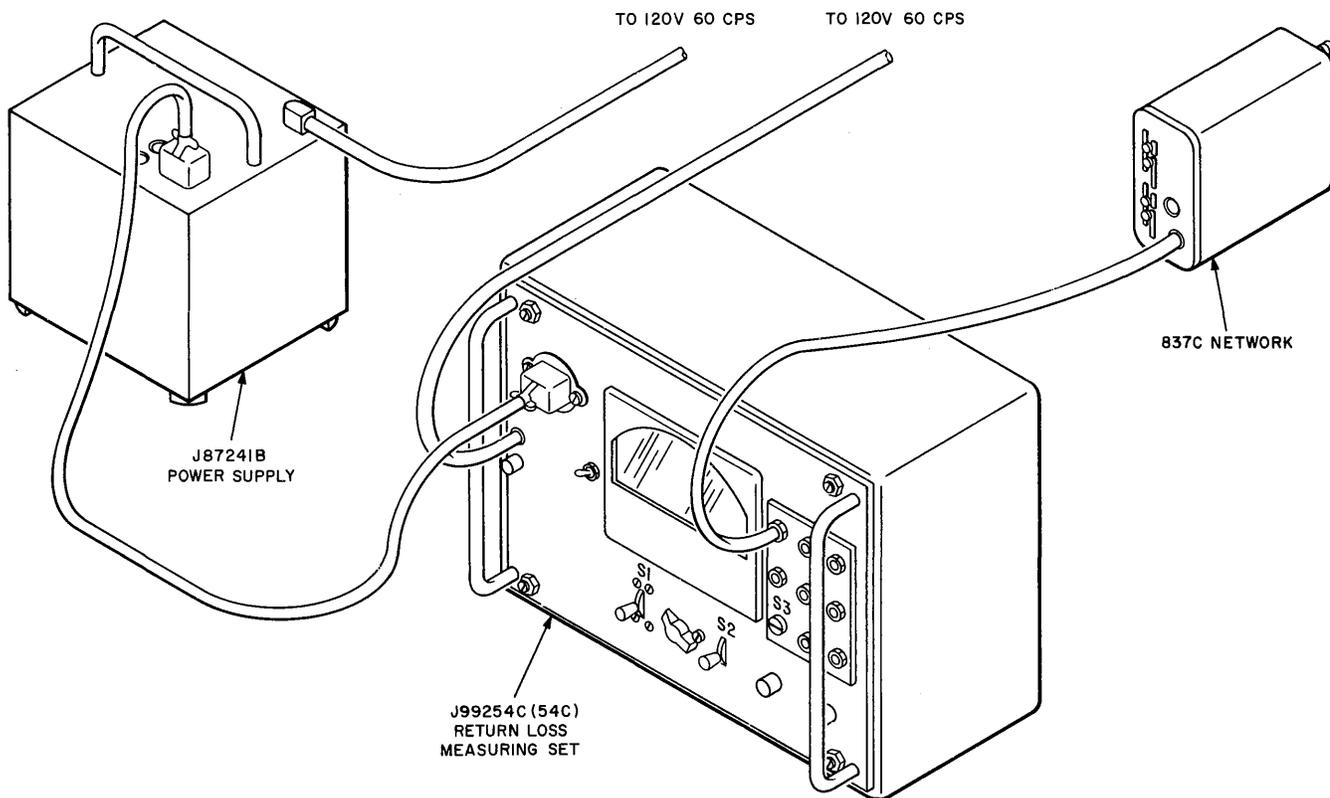
**4.25** Calibrate the 500- to 2500-cps range of the 54C set to 0 db and then throw switch S2 to MEAS.

**4.26** Adjust R dial on the 837C network for a maximum return-loss reading on the 54C measuring set. A loss of 22 db should be obtained, although 18 to 22 db is acceptable. If return-loss readings are within limits, refer to 4.28. If more than 22 db is obtained, rotate the R dial in a *clockwise* direction until the 54C measuring set indicates exactly 22 db.

**Caution:** Do not obtain 22 db by rotating R dial counterclockwise as this will increase the transmission loss of the line, which is objectionable.

**4.27** If a minimum reading of 18 db cannot be obtained in 4.26, check the cable connections between the 837C network and the 54C measuring set. Then make the following checks in order:

- (1) Check 837C network terminal connections.
- (2) Ensure that the E6 repeater is firmly in place on the shelf and that dc power has been applied.
- (3) Install a new 837C network and repeat the line-up procedure.



**Fig. 3 — Return-Loss Adjustment of 837C Network — Test Equipment Connections**

**4.28** If a satisfactory return loss was obtained in 4.26, disconnect the 54C measuring set and the power supply from the 837C network. This completes the line-up of the 837C network.

**4.29** To complete the line-up of the 830C network, and to check net insertion loss, the assistance of another craftsman or the PBX operator is required. The assistance is needed at the PBX to terminate the trunk with a 900-ohm resistor in series with a 2-microfarad capacitor, for final adjustments on the 830C network, and to apply a 1-kc source at 1 milliwatt to check net insertion loss.

#### **E. Final Adjustment of 830C Network**

**4.30** Request the craftsman or operator at the PBX to place the 900-ohm, 2-microfarad termination on the trunk.

**4.31** 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 network and insert the repeater into the 54B test stand as instructed in 4.07. Set the mode switch (S1) on the 54B stand to NORM. Rotate the head of the 54B test stand so that the adjustable resistors on the 830C network are easily accessible. Set S2 to neutral.

**4.32** Connect the 54B test stand to the repeater shelf, to the 54C measuring set, and to the 4097A network (Section 103-104-100) as shown in Fig. 4. The 4097A network 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 4097A network to the 830C network.

**4.33** When connecting the 4097A network to the 830C network, the screw labeled L on the 830C should be loosened. This removes the internal inductance of the 830C network from the circuit and replaces it with the inductance of the 4097A network. Set the 4097A network to .8 mh.

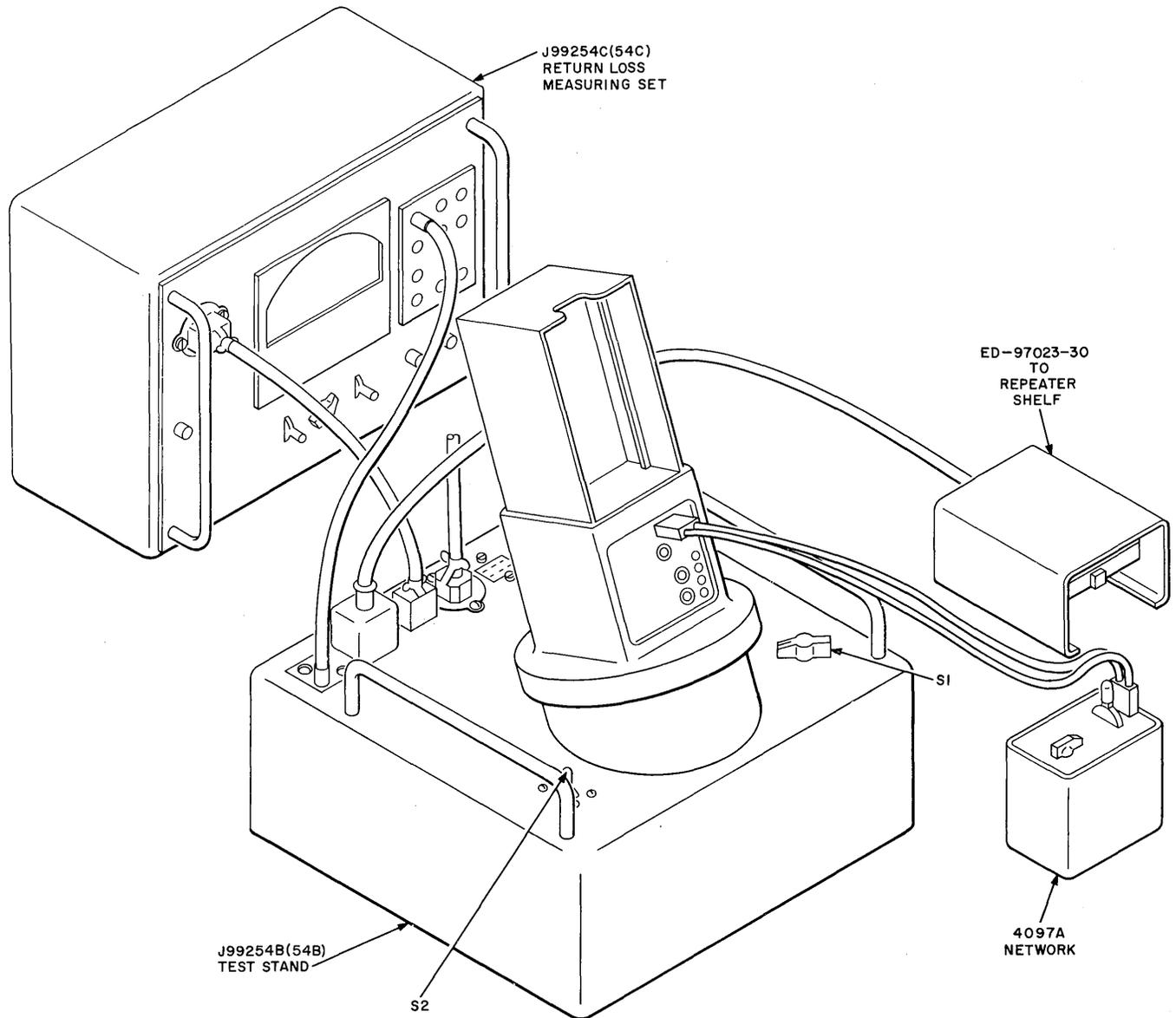


Fig. 4 — Return-Loss Adjustment of E6 Repeater — Test Equipment Connections

**4.34** Calibrate both frequency ranges (500 to 2500 cps and 2000 to 3000 cps) of the 54C measuring set to 10-db return loss on the meter, rather than to 0 db. This will prevent overloading the E6 repeater.

*Caution: Subsequent readings will have to be reduced by 10 db to give the true return loss.*

**4.35** The objective in the next part of the line-up procedure is to obtain the maxi-

mum return loss. The 830C network contains four adjustable elements which must be adjusted to compensate for deviations in the gain unit and for the large variety of differences in trunk layouts. This adjustment procedure enables the craftsman to obtain not only satisfactory return losses in the 500- to 2500-cps range and 2000- to 3000-cps range, but also at frequencies below 200 and above 3000 cps. This is necessary in order to prevent repeater singing in the idle or switching conditions. To ensure satisfactory operation, it is also necessary to have the return loss in the 500- to 2500-cps range at least as large as in the

**TABLE C**  
**TRANSCRIBING INDUCTANCE FROM 4097A NETWORK**  
**TO 830C NETWORK**

INDUCTANCE* (4097A NETWORK)	SCREW TERMINALS** (830C NETWORK)				
	.8	.4	.2	.1	.05
0	X	X	X	X	X
.05	X	X	X	X	-
.10	X	X	X	-	X
.15	X	X	X	-	-
.20	X	X	-	X	X
.25	X	X	-	X	-
.30	X	X	-	-	X
.35	X	X	-	-	-
.40	X	-	X	X	X
.45	X	-	X	X	-
.50	X	-	X	-	X
.55	X	-	X	-	-
.60	X	-	-	X	X
.65	X	-	-	X	-
.70	X	-	-	-	X
.75	X	-	-	-	-
.80	-	X	X	X	X
.85	-	X	X	X	-
.90	-	X	X	-	X
.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 network.

\*\*X indicates screws which should be tightened down to obtain equivalent inductance on 830C network.

2000- to 3000-cps range. To meet these requirements, a lengthy but simple series of steps must be performed. After the craftsman has adjusted several networks, the time required to perform this procedure should be less than one minute.

**4.36** Perform the following steps.

- (1) Set switches on the 54C measuring set as follows:
  - S1 to 500 — 2500~
  - S2 to MEAS
  - S3 to 900Ω 2 MF
- (2) Adjust R2 for maximum return-loss indication on the 54C measuring set.
- (3) Adjust R3 for maximum return loss.
- (4) Increase or decrease the value of inductance (L) by operating the switch and key on the 4097A network until maximum return loss is obtained.
- (5) Readjust R3 for maximum return loss.
- (6) Readjust R2 for maximum return loss.
- (7) Repeat Step 4. If a significant increase in return loss is indicated (i.e., 0.5 db), repeat Steps 5, 6, and 7 until additional return loss cannot be obtained.
- (8) Throw switch S1 on the 54C measuring set to the 2000—3000~ position.
- (9) Adjust R1 for maximum return loss.
- (10) Readjust the value of inductance as instructed in Step 4.
- (11) Readjust R1 for maximum return loss.
- (12) Throw switch S1 on the 54C measuring set to the 500—2500~ position.
- (13) Readjust the value of inductance as instructed in Step 4.
- (14) Readjust R1 for maximum return loss.
- (15) Readjust R2 for maximum return loss.
- (16) Readjust R3 for maximum return loss.
- (17) If indicated return loss in the 2000- to 3000-cps range is greater than at the 500- to 2500-cps range, decrease the value of inductance in 0.05-mh steps until the return loss in the 500- to 2500-cps range is greater. Repeat Steps 15 and 16 for optimum results.

**4.37** The foregoing steps should enable the craftsman to obtain a maximum return loss (500 to 2500 cps) in excess of 18 db (28 db on meter). Maximum return loss in the 2000- to 3000-cps range should exceed 14 db. The minimum acceptable values are as follows:

500 to 2500 cps — 16.0 db

2000 to 3000 cps — 11.0 db

**4.38** If minimum values cannot be obtained, re-adjust R2, R3, and the inductance. If requirements still cannot be met, replace the 830C network with a new network and repeat the entire line-up procedure (refer to 4.01 through 4.41).

**4.39** If acceptable values of return loss are obtained in the line-up procedure, tighten the L screw on the 830C network and set in the amount of inductance (L) that was obtained with the 4097A network (see Table C).

**4.40** Disconnect the 4097A 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 measuring set in the 500- to 2500-cps range.

**4.41** Request the craftsman or operator at the PBX to remove the 900-ohm 2-microfarad termination. This completes the line-up of the 830C network.

**F. Measurement of 1-KC Insertion Loss**

**4.42** Two methods of measuring 1-kc insertion loss are available if the PBX operator can furnish 1 mw of power at 1 kc. Fig. 5 shows necessary connections when the operator *cannot* furnish 1 mw at 1 kc. This procedure requires two craftsmen. If the operator *can* furnish 1 mw at 1 kc, the 23A TMS is not required, and the TMS terminals on the 2AB test set must connect to the DET jacks on the 21A TMS. (The 21A TMS oscillator is not used, and insertion loss may be read directly on the meter of the 21A TMS.) In addition, the TEST switch on the 2AB test set must be set to REC 900Ω. This measurement includes PBX loss.

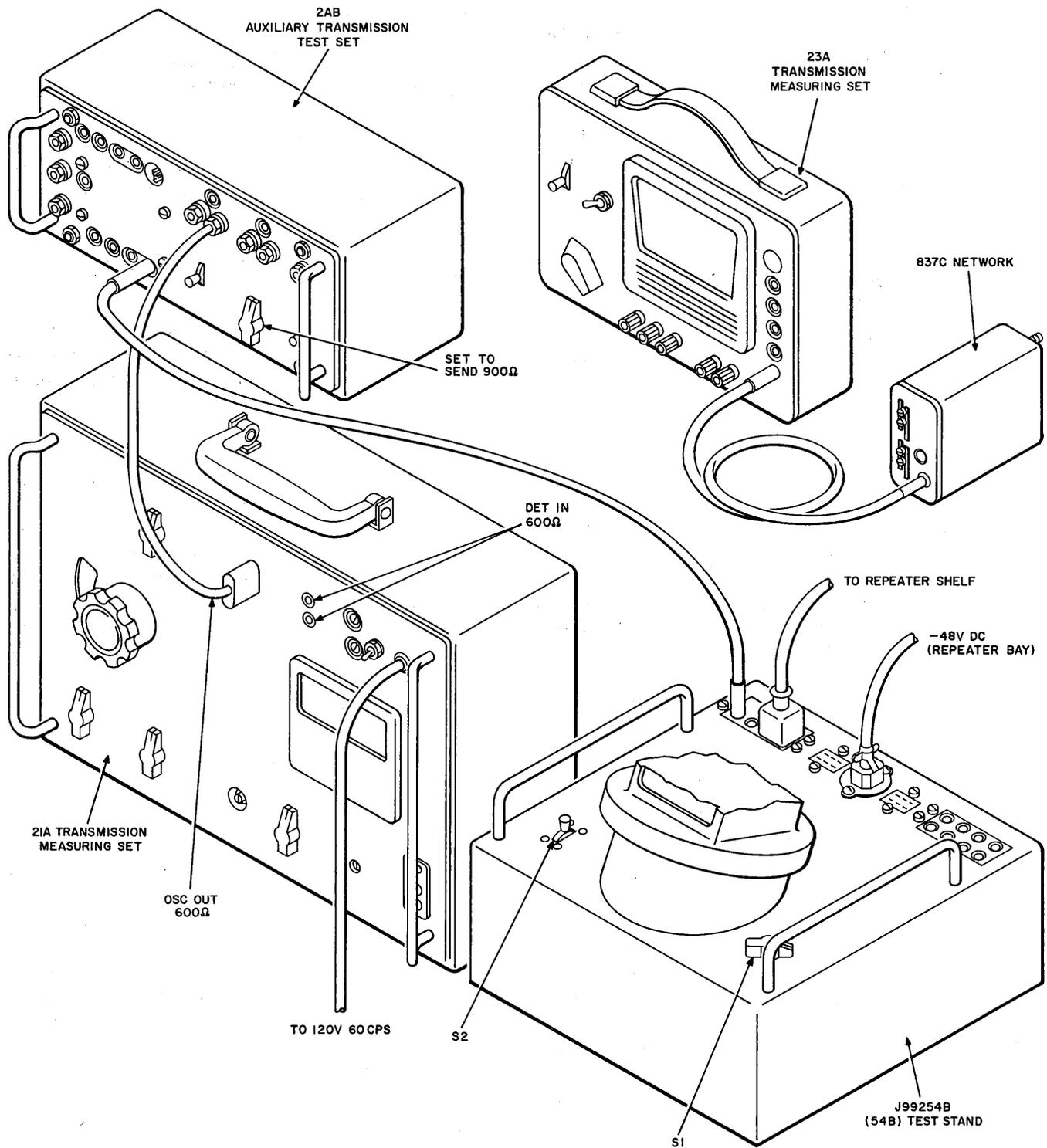


Fig. 5 — Measurement of 1-KC Insertion Loss — Test Equipment Connections

**4.43** If the operator cannot furnish 1 mw at 1 kc, refer to Fig. 5 and set switches on the 23A set as follows: INPUT to 900; mode to MEAS; ADD DBM to +5. At the central office end of the line, connect the 21A transmission measuring set, the 2AB auxiliary transmission test set, and the 54B test stand as shown in Fig. 5. Set the OSC OUTPUT smooth control (on the right) of the 21A set to +0.5 db. Set the OSC OUTPUT step control (on the left) to 0 db. Set the FREQ control to 1 kc. Refer to Section 103-202-100 for calibration of the 2AB set and associated test equipment. Set S2 to neutral and S1 to normal.

**4.44** If the measured insertion loss on the 23A measuring set at the PBX end of the line is not within  $\pm 0.2$  db of the desired net loss (noted on circuit layout card), it will be necessary to change the gain of the E6 repeater as described in 4.03 through 4.14.

**4.45** If the gain of the repeater requires a change in excess of 1 db, it will be necessary to recheck the 500- to 2500-cps and 2000- to 3000-cps return loss. If return-loss requirements are not within limits, repeat the line-up procedure as described in 4.30 through 4.41.

**4.46** This completes the insertion-loss measurement.

#### **G. Stability Tests (Singing Check)**

**4.47** The E6 repeater is designed to be stable under all operating conditions (idle condition, dial pulsing, etc.). However, when lining up the circuit it is desirable to have at least a minimum margin of safety for singing. This margin of safety is assured 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. If singing does occur during this test, changing the adjustments slightly, while still meeting return-loss requirements, will provide adequate singing margins under all operating conditions.

**4.48** Connect the 54B test stand, repeater, and KS-14418 headphone equipped with a 419A plug as shown in Fig. 6. The 419A plug

connects into the TST 2 jacks on the front of the repeater.

**Caution:** Do not plug headphone into the TST 1 jacks as it may make the repeater sing.

**4.49** The short circuit mentioned in 4.47 can be obtained by two methods. Method 1 is to insert the shorting plug into the TEST jack of the 837C network; method 2 is to operate the attendant dial at the PBX when connected to the trunk under test.

**4.50** The open circuit mentioned in 4.47 is obtained by placing switch S2 in neutral position and switch S1 in the RL LINE B position on the 54B test stand.

**4.51** With the headphone connected as in 4.48, no sound other than battery noise should be audible. If the repeater does not sing, refer to 4.55. 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 now stable, repeat the line-up procedure for the 830C network, but adjust only the R1 and R3 potentiometers.

**4.52** If the tone appears to be 1 kc or higher in frequency, lower the value of inductance by 0.5 mh and repeat the line-up procedure for the 830C network, adjusting potentiometers R1, R2, and R3.

**4.53** Check again for stability. If the repeater still sings, repeat 4.52. Ensure that the 500- to 2500-cps return loss is at least 16 db.

**4.54** If singing persists, decrease the repeater gain by .25 db and repeat the line-up procedure for the 830C network.

**4.55** When the trunk is stable, proceed as follows:

- (1) Remove repeater from 54B test stand.
- (2) Remove plug from shelf socket.
- (3) Plug repeater into shelf.
- (4) Have the circuit put in service.

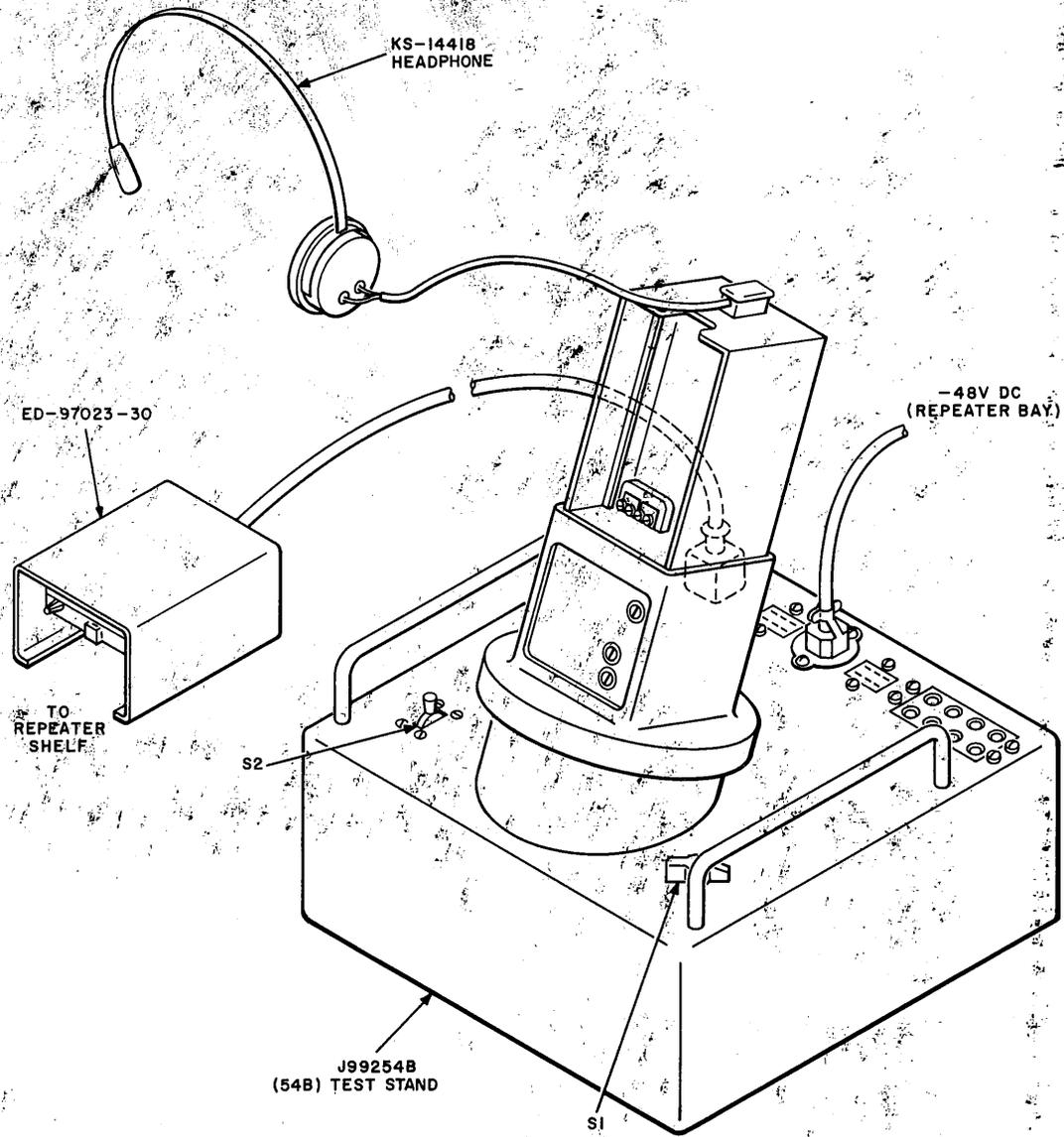


Fig. 6 — Stability Test — Test Equipment Connections