E6 REPEATER

ALIGNMENT PROCEDURE

CONTENTS PAGE

1. GENERAL

1.01 This section contains the installation and lineup procedures for the E6 repeater. It includes the gain settings of the 831-type networks (gain units) and the procedure for the lineup of the 830-type line building-out (LBO) networks. Prescription settings and values are contained in other sections of this series.

1.02 This section is reissued to change Table A to include actual as well as measured gain of the 831-type gain unit.

1.03 Alignment of the E6 repeater will require some or all of the following steps:

(a) Assembly of the repeater.

(b) Adjustment of the gain unit, check of the gain, and a high-level gain measurement.

(c) LBO network adjustment to fit the line pairs and measurement of the return loss after adjustment.

(d) Check for singing with the repeater connected to the lines and with various terminations connected at the terminals of the circuit.

1.04 Before placing the repeater in service, a cable completion test, including an echo structural return-loss measurement, should have been made. The cable must meet transmission requirements. Elimination of faulty pairs will assure quick installation, thereby avoiding difficulties due to missing loading coils or other large unsuspected line irregularities.

1.05 Defective units should not be repaired in the field. The plug-in module should be returned to the local Western Electric Service Center for testing and repair.

2. ASSEMBLING THE E6 REPEATER

2.01 The E6 repeater gain-unit and connector block are mounted in the aluminum cover before shipment. The LBO networks are shipped separately and mounted in the covers by the telephone company. For terminal use, one LBO (830-type) network and one dummy LBO (832A) network are needed. For intermediate use, two LBOs (830-type) are used. The 830-type network slides into the cover and is secured by four screws on the connector block. These screws also make the required electrical connections between the gain unit and the LBOs. The dummy LBO is relatively small and is secured entirely by the four connecting screws. An exploded view of the repeater is shown in Fig. 1.

INTERMEDIATE REPEATERS

2.02 For intermediate repeaters, an 830-type network of the type specified for the line A side should be inserted over the NETWORK A printing in the repeater cavity. The four screws that make electrical connection to the 830 network and hold it in the repeater should be tightened firmly, but not excessively.

Caution: Excessive tightening may strip threads.

2.03 An 830 network of the type specified for the line B side should be inserted and the four screws that hold the network in place over the marking NETWORK B should be tightened.

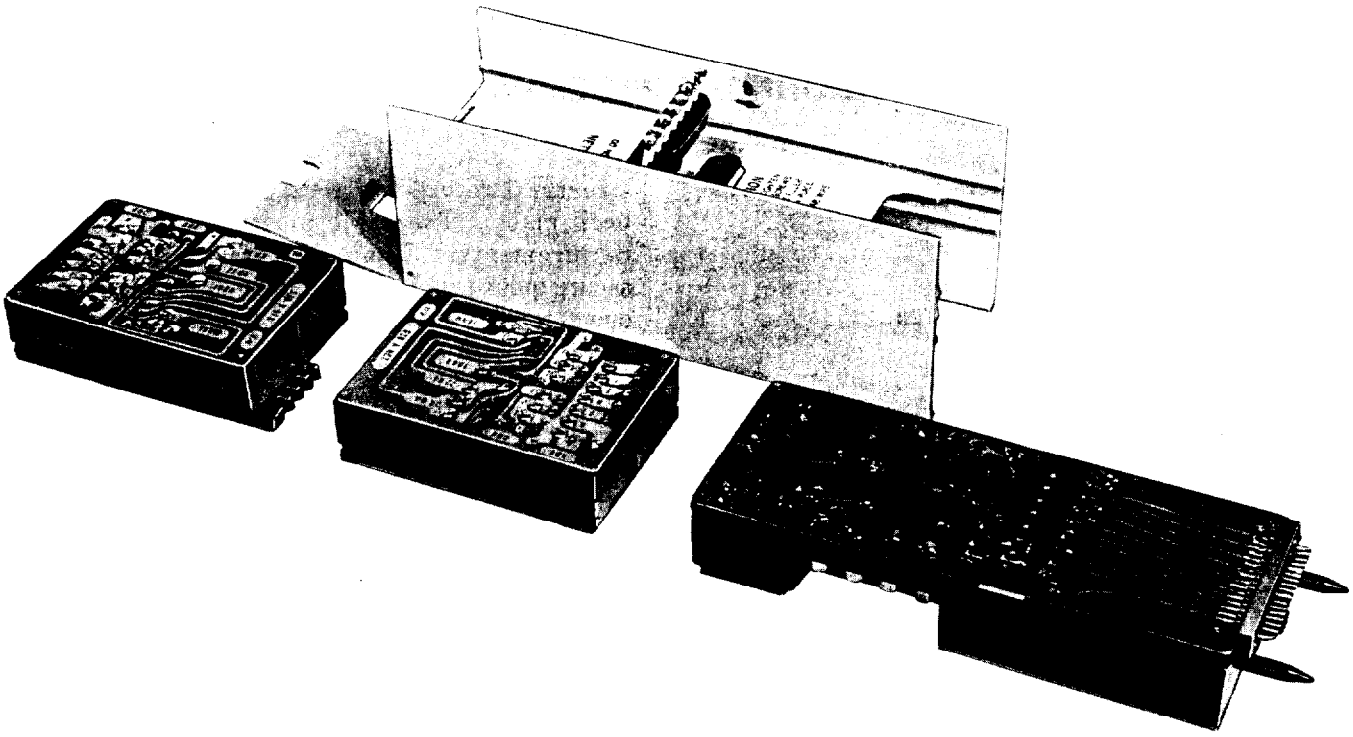

Fig. 1—Exploded View of E6 Repeater

TERMINAL REPEATERS

2.04 For terminal repeaters, an 830-type network of the type specified for the line B side should be inserted and the four screws that hold the network should be tightened. An 832A (dummy) network should be inserted on the line A side of the repeater and these four screws should be tightened. The terminal repeater assembly is shown in Fig. 2.

Caution: Do not attempt to strap the terminals by using wire in place of the use of the 832A dummy network. The screws cannot be driven down with a clearance less than 1/4 inch between the head of the screw and the 831-type network without causing internal damage.

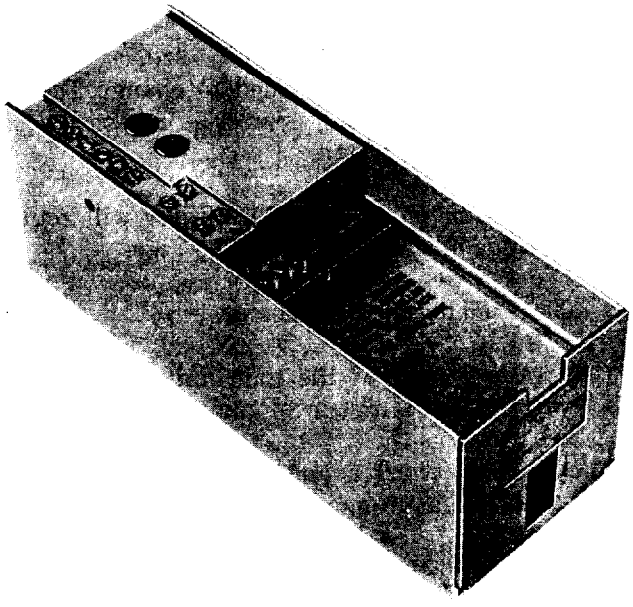

Fig. 2—E6 Terminal Repeater Assembly

ALL REPEATERS

2.05 The repeater should be turned over and all screws on the 831-type network should be loosened three turns. These will be labeled A through K and 1 through 9 (see Fig. 3).

Note: Certain bus bar connections of the printed wiring of the 831-type network adjacent to screw A may appear broken. This is a factory adjustment of individual networks. These gaps should not be closed.

3. MEASURING APPARATUS

The following listed test apparatus or equivalent may be required for E6 repeater lineup:

1—Line Extension Cord, ED-97023-30

1—J99354A (54A), L1 Transmission Measuring Set (TMS) with Cords

1—J99254B (54B) Test Stand

1—J99254C (54C) or KS-20501 Return Loss Measuring Set (RLMS) with Cords (Required only if LBO networks are adjusted)

3—Power Cords with P5F Jones Connectors

1—4125A or 4125B Network or termination of 900 ohms or 600 ohms ±5% in series with 2 μF ±20%, 500 wVdc

1—4066H Network

1—4097B Network

1—832A Network

1—Circuit Layout Record (CLR)

1—Shorting Plug

1—KS-14418 Headset equipped with 419A plug.

Where available, the KS-20501 RLMS (103-106-115) may be used as an alternative to the 54C set. Where this section specifies using the 500- to 2500-Hz sweep of the 54C set, the echo range ◗(ERL)◖ of the KS set may be used. Where this section specifies using the 2000- to 3000-Hz sweep, the high range ◗(SRL-HI)◖ of the KS set may be used. Although the readings of the 54C and the KS sets usually differ a little from each other, the same numerical requirements should be used for the readings of the KS set and the 54C set.

4. ADJUSTMENT OF THE REPEATER

GENERAL

4.01 If the trunk is to be equipped with an impedance compensator (at a nonrepeatered terminal), the compensator should be adjusted and connected before E6 repeaters are adjusted (332-205-500).

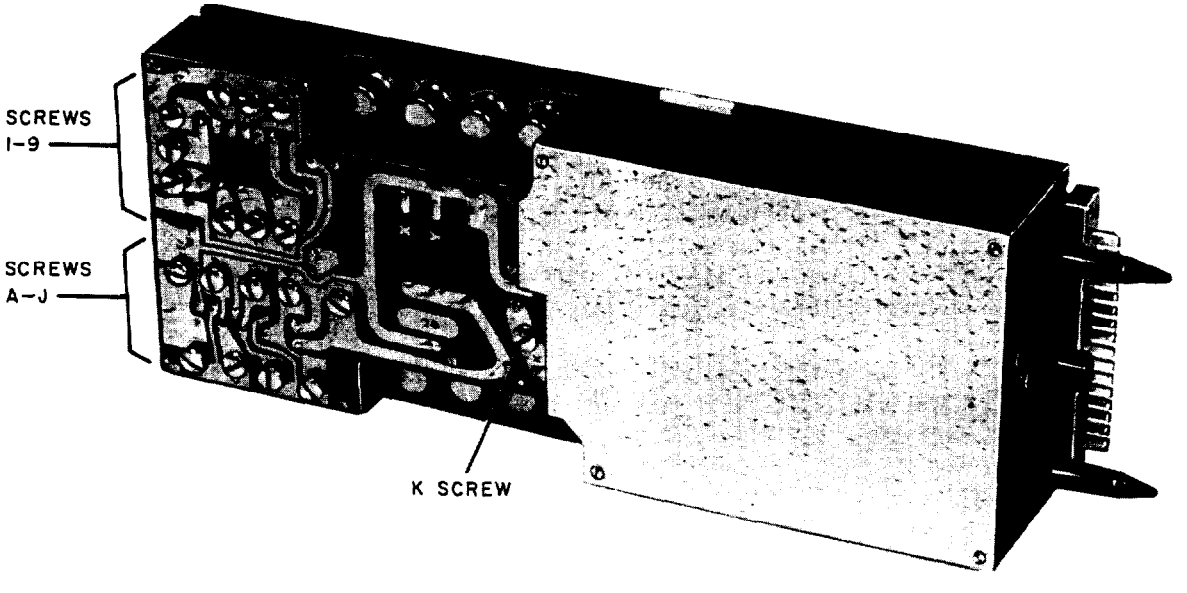

Fig. 3—831-Type Network

4.02 Adjustment of the repeater consists of setting the adjusting screws of the gain unit (831-type network), the adjusting screws of the LBO (830-type network), and checking both units for performance.

4.03 All adjustments on the 831-type gain unit and 830-type LBO networks are made by tightening or loosening the screws on the face of the networks. Contact with the printed wiring board conductors is made under the screwheads. The screwheads should, therefore, be fully down on or fully clear of the exposed wiring on the face of the boards.

4.04 Adjustment of the gain unit by means of the 54A TMS consists of:

(a) Setting screws on the gain unit in accordance with desired gain

(b) Checking gain of series and shunt converters separately

(c) Measuring combined gain of the gain-unit converters

(d) Making a high-level check of the operation of the gain unit.

4.05 The final adjustments of the LBO network are made with the 54C RLMS and consist of:

(a) Setting the LBO screws to preliminary settings based on the gauge of cable, length of endsection, and other line characteristics

(b) Optimizing these adjustments to give maximum return loss.

ADJUSTMENT OF THE 831-TYPE NETWORK (GAIN UNIT)

4.06 The repeater gain may be adjusted by using the procedure in the following steps.

STEP	PROCEDURE
1	Consult the CLR to determine gain settings of the 831-type network in the E6 repeater. *Note:* Under certain circumstances, the gain of a single repeater will be used to supply gain for two adjacent links. The gain on the CLR for those cases will be higher than that ordinarily required. The single repeater would also contain the proper LBO for the adjacent link. If a repeater disabler is used on this link, it must be removed from the disabler socket located directly below the repeater.
2	Place the printed wiring-board side of the 831-type network face up. Loosen screws A through K and 1 through 9. All adjustments on the gain network are now made by tightening some of these screws. 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.
3	Set the 54B test stand and 54A TMS near the −48 volt power distribution outlet, which is provided on bays equipped with E6 repeaters.
4	Connect −48 volt power from the repeater bay to the 54B TEST STAND—TST PWR jack and patch the TMS TST PWR jack of the 54B test stand to the TEST PWR jack of the 54A TMS by using the P5F cords. Patch the TMS A and B jack of the 54B test stand to the A and B jack of the 54A TMS by using ▶a 6P1A cord E/W 425A plugs or equivalent (Fig. 4).◀ *Note:* The 54A TMS has neither a switch to apply power nor a pilot light. No connection to the cable pairs is required for the gain adjustment of the 831-type network.

STEP	PROCEDURE

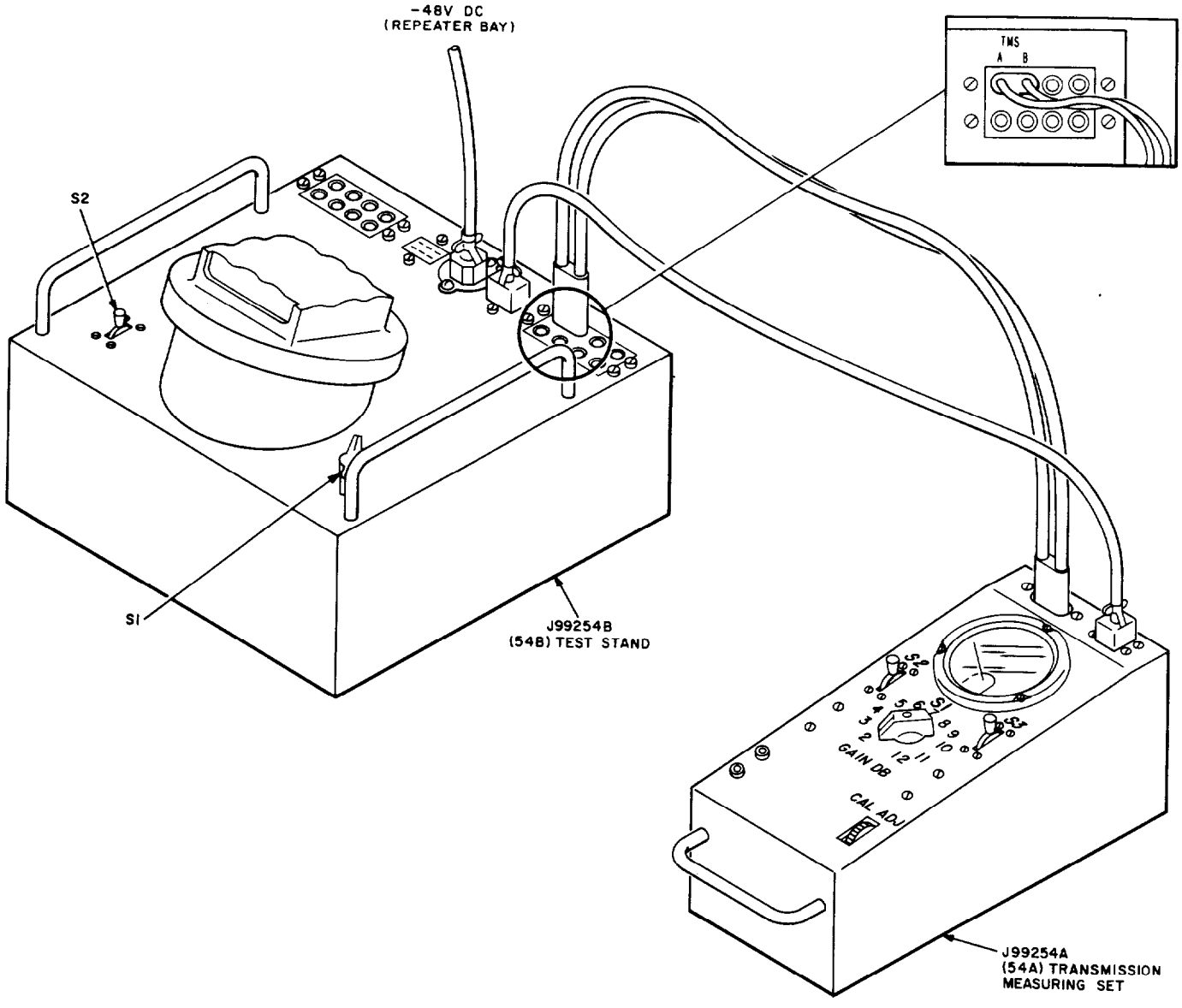

Fig. 4—Converter Gain—Test Equipment Connections

STEP	PROCEDURE

5 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 turret of the 54B test stand so that the 831-type gain unit side of the repeater is easily accessible.

6 All screws on the gain unit side should have been loosened as in Step 2. Consult the CLR for the specified gain adjustment. Refer to Table A to determine the necessary screw settings for this specified gain value.

Example: In the row corresponding to 12-dB gain, screws A, B, C, E, H, 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.

Caution: Excessive tightening may strip threads.

Converter Unit Gains

7 On the 54B test stand, set switch S2 to a neutral position and switch S1 to GAIN position.

8 Throw S2 on the 54A TMS to CAL and adjust the knurled knob CAL ADJ to give a 0-dB reading on the meter. Then set S2 to MEAS position. The position of other keys and knobs on the 54A set does not affect this reading.

9 Rotate GAIN DB knob S1 to the specified gain. Make certain that screw K on the 831-type 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 reading. Note this value.

10 Throw switch S3 from SERIES to SHUNT. Measure and note this gain.

11 Compare the two measured gain values with the value given for the 831-type network adjustment shown in Table A.

Example: For 12-dB total gain, the separate converters should measure 7.9-dB gain as shown in Table A. 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 Step 14. If not, adjust the gain of either the series or shunt converter or both as in the following steps.

12 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 $\pm$0.2 dB from the listed value, throw S3 to SERIES. Recalibrate as in Step 8 and then restore S2 to MEAS. Adjust screws A through J on the 831-type network to give the tabulated gain for a single converter to within $\pm$0.1 dB.

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.

◆ TABLE A ◆

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
ACTUAL*	MEASURED†				ACTUAL*	MEASURED				ACTUAL*	MEASURED				ACTUAL*	MEASURED			
Same as measured	0.0	0.0	BCDGHJK	123	Same as measured	3.4	1.8+	ADEFGJK	13467	6.9	6.8	4.0	CDEJK	1578	10.4	10.1	6.3+	DGHK	469
	0.1	0.0	ABDGHJK	14		3.5	1.9	BCEFGJK	567	7.1	6.9	4.0+	BDEJK	3578	10.5	10.2	6.4	BCGHK	12469
	0.2	0.1	ADGHJK	134		3.6	2.0	CEFGJK	12567	7.2	7.0	4.1	ABCEJK	123578	10.6	10.3	6.5	ABGHK	13469
	0.3	0.1+	BCGHJK	5		3.7	2.0+	AEFGJK	23567	7.3	7.1	4.2	CEJK	24578	10.8	10.4	6.5+	AGHK	123469
	0.4	0.2	ABGHJK	35		3.8	2.1	ABCDFGJK	24567	7.4	7.2	4.3	AEJK	134578	10.9	10.5	6.6	BCDEFHK	2569
	0.5	0.2+	GHJK	235		3.9	2.1+	CDFGJK	134567	7.5	7.3	4.4	ABCDJK	1234578	11.0	10.6	6.7	ABDEFHK	3569
	0.6	0.3	BCDEFHJK	145		4.0	2.2	ADFGJK	8	7.6	7.4	4.5	CDJK	2678	11.1	10.7	6.8	DEFHK	4569
	0.7	0.3+	CDEFHJK	345		4.1	2.3	ABCFGJK	128	7.7	7.5	4.5+	ADJK	13678	11.2	10.8	6.9	BCEFHK	124569
	0.8	0.4	BDEFHJK	2345		4.2	2.3+	CFGJK	238	7.8	7.6	4.6	ABCJK	123678	11.3	10.9	7.0	CEFHK	234569
	0.9	0.4+	DEFHJK	16		4.3	2.4	AFGJK	148	7.9	7.7	4.7	CJK	24678	11.4	11.0	7.1	AEFHK	179
	1.0	0.5	BCEFHJK	36		4.4	2.5	BCDEGJK	348	8.0	7.8	4.7+	AJK	134678	11.5	11.1	7.2	BCDFHK	1279
	1.1	0.6	ABEFHJK	1236		4.5	2.5+	ABDEGJK	12348	8.1	7.9	4.8	ABCDEFGHK	1234678	11.6	11.2	7.2+	CDFHK	2379
	1.2	0.6+	AEFHJK	246		4.6	2.6	DEGJK	258	8.2	8.0	4.8+	CDEFGHK	25678	11.8	11.3	7.3	ADFHK	1479
	1.3	0.7	BCDFHJK	1346		4.7	2.6+	ACEGJK	1358	8.3	8.1	4.9	ADEFGHK	135678	11.9	11.4	7.4	ABCFHK	12479
	1.4	0.7	ABDFHJK	56		4.8	2.7	BEGJK	458	8.5	8.2	5.0	ABCEFGHK	1235678	12.0	11.5	7.5	CFHK	23479
	1.5	0.7+	ADFHJK	1256		4.9	2.8	ABCDGJK	12458	8.6	8.3	5.1	CEFGHK	245678	12.1	11.6	7.5+	BFHK	579
	1.6	0.8	BCFHJK	2356		5.0	2.8+	CDGJK	23458	8.7	8.4	5.1+	AEFGHK	345678	12.2	11.7	7.6	ABCDEHK	2579
	1.7	0.9	CFHJK	1456		5.1	2.9	ADGJK	168	8.8	8.5	5.2	BCDFGHK	12345678	12.3	11.8	7.7	CDEHK	13579
	1.8	0.9+	AFHJK	3456		5.2	2.9+	BCGJK	368	8.9	8.6	5.3	CDFGHK	9	12.4	11.9	7.8	BDEHK	4579
	1.9	1.0	ABCDEHJK	123456		5.3	3.0	CGJK	12368	9.0	8.7	5.4	ADFGHK	129	12.5	12.0	7.9	ABCEHK	124579
	2.0	1.0	CDEHJK	27		5.4	3.1	AGJK	2468	9.1	8.8	5.5	ABCFGHK	239	12.6	12.1	8.0	ACEHK	134579
	2.1	1.1	BDEHJK	137		5.5	3.2	ABCDEFJK	13468	9.2	8.9	5.5+	CFGHK	149	12.7	12.2	8.0+	BEHK	1234579
	2.2	1.2	ABCEHJK	47		5.6	3.2+	CDEFJK	568	9.3	9.0	5.6	AFGHK	349	12.8	12.3	8.1	EHK	2679
	2.3	1.2	ACEHJK	1247		5.7	3.3	ADEFJK	12568	9.4	9.1	5.6+	ABCDEGHK	12349	12.9	12.4	8.1+	BCDHK	3679
	2.4	1.3	BEHJK	2347		5.8	3.4	ABCEFJK	23568	9.5	9.2	5.7	ACDEGHK	159	13.0	12.5	8.2	CDHK	23679
	2.5	1.3	ABCDHJK	157		5.9	3.5	CEFJK	14568	9.6	9.3	5.8	ABDEGHK	1259	13.1	12.6	8.2+	BDHK	14679
	2.6	1.4	ACDHJK	357	6.1	6.0	3.5	AEFJK	34568	9.7	9.4	5.9	DEGHK	2359	13.2	12.7	8.3	DHK	124679
	2.7	1.4+	BDHJK	12357	6.2	6.1	3.6	ABCDFJK	234568	9.8	9.5	6.0	BCEGHK	1459	13.4	12.8	8.4	BCHK	134679
	2.8	1.5	DHJK	2457	6.3	6.2	3.6+	CDFJK	178	9.9	9.6	6.1	CEGHK	12459	13.5	12.9	8.5	CHK	5679
	2.9	1.5+	ACHJK	13457	6.4	6.3	3.7	ADFJK	378	10.0	9.7	6.1+	BEGHK	23459	13.6	13.0	8.6	BHK	125679
	3.0	1.6	BHJK	167	6.5	6.4	3.8	ABCFJK	12378	10.1	9.8	6.2	ABCDGHK	169	13.7	13.1	8.7	HK	135679
	3.1	1.7	HJK	367	6.6	6.5	3.8+	CFJK	2478	10.2	9.9	6.2+	ACDGHK	1269	13.9	13.2	8.8	BCDEFGK	1235679
	3.2	1.7+	BCDEFGJK	12367	6.7	6.6	3.9	BFJK	3478	10.3	10.0	6.3	ABDGHK	1369	14.0	13.3	8.9	CDEFGK	145679
↓	3.3	1.8	ABDEFGJK	2467	6.8	6.7	3.9+	ABCDEJK	123478										

Notes:

* With the LFC screws of an 830A or B LBO set to the TERM position, the actual 1 KHz gain is greater than the gain measured with the 54A TMS. When an 830A or B is used with any other LBO in special service applications, the actual gain value should be used. When the LFC screws for any LBO are in the INT position or the gain is below 6 dB, the actual and measured gains are the same.

† 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
13	If the shunt converter gain measurement deviates by more than ±0.2 dB from the listed value, throw 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. *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.
14	The gains of the individual converters must agree with each other within 0.2 dB before combined gain can be measured.
15	Tighten screw K on the 831-type network and leave it in this position. (This screw connects series and shunt converter units together in the operating position.)
16	Recalibrate the 54A TMS.
17	Throw S3 to SH and 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.
18	With S3 on SH and SER, operate S2 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.
19	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.

ADJUSTMENT OF THE LINE BUILDING-OUT NETWORKS

4.07 The following adjustment procedures are for the 830-type networks. Where 830A, 830B, and 830G networks are used, the prescription settings are usually satisfactory. Touch-up is required only for trouble conditions or where circuit requirements are not met. The procedure for intermediate repeaters is similar except where noted.

STEP	PROCEDURE
	A. 830A, 830B, and 830G Networks—Adjustments (For Touch-Up Only)
1	Patch from the TST PWR jack of the 54C RLMS to RLMS TST PWR jacks of the 54B test stand. Patch from the RL jack of the 54B test stand to MEAS RL jack of the 54C RLMS by using a 3P7B cord. These connections are shown in Fig. 5.
2	Have the circuit to be measured turned down at the originating end or at both ends if the circuit is a 2-way link.

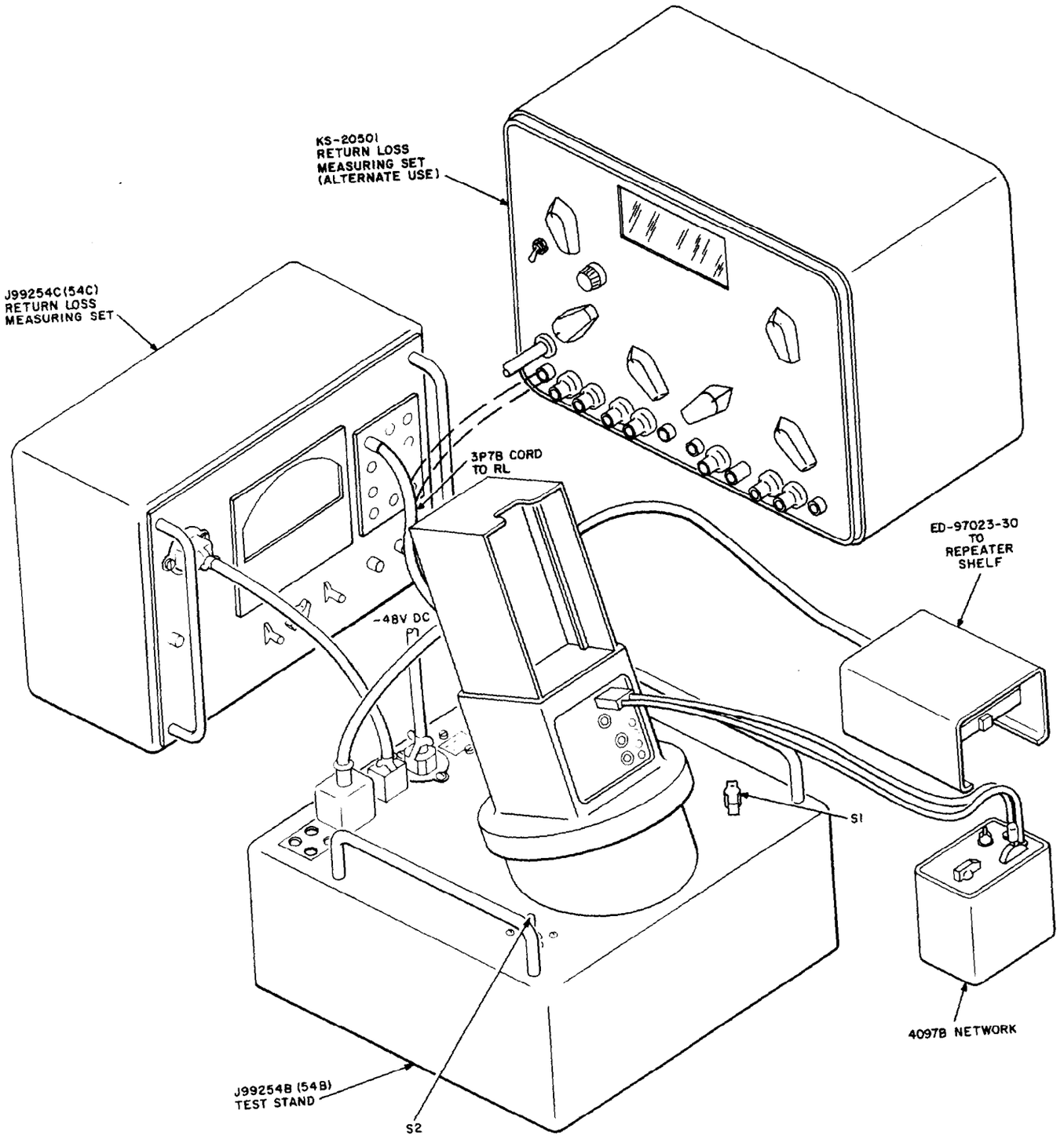

Fig. 5—Return Loss Adjustment of E6 Repeater

STEP	PROCEDURE

3 Patch from the vacant position on the repeater shelf where the E6 repeater will be installed to the 54B test stand LINE EXT A and B jacks by using the ED-97023-30, Group 2 cord as shown in Fig. 6. Insert the plug gently in order not to damage the shelf-connector spring contacts. Rotate the turret of the 54B test stand to bring the 830-type networks forward for easy accessibility. The network connected to line A is uppermost.

Building-Out Capacitor (BOC) and LATTICE Adjustments

4 If the LBO network on line B is to be adjusted, have the line busied out but not terminated at the distant end on line B. If the LBO network is on line A (intermediate repeater) have the far end of line A terminated.

5 Set switch S1 on the 54B test stand to RL LINE B (RL LINE A for intermediate repeater). Set switch S1 on the 54C RLMS to 2000—3000 ~ . If the 54A TMF is also plugged into the 54B test stand, operate switch S3 to SH and SER. This is required only on early models of the 54B test stand.

6 Plug in the power cord of the 54C RLMS to a 120-volt 60-Hz ac outlet and turn the PWR switch on. A 10-minute warm-up period is required. On the 54C RLMS, set S2 to SEND LEVEL CAL, S3 to 900Ω 2 μF, and gain knob AT1 to 0 on the RETURN-LOSS scale. Calibrate the 2000—3000 ~ range of the 54C RLMS to 0 dB by adjusting the SEND LEVEL ADJ knob for 2000—3000 ~ . Release S2 to MEAS.

7 Adjust gain knob AT1 on the 54C RLMS until the meter reads on scale.

8 Set the line B LBO network screws to the preliminary screw settings given on the CLR by tightening the specified screws and loosening all others. If the network being adjusted is an 830A or 830B network and no screw settings are given, start with A, C, E, F, 1, 2, and 1, 2 for 22-gauge cable, and TERM for both terminal repeater and intermediate repeaters assigned to special service circuits.* These suggested initial settings correspond to those for a 22-gauge cable with a 3000-foot end section. If the network being adjusted is an 830G and no screw settings are given, start with A, E, F, and Y, Y. This initial setting corresponds to that of a 26-gauge cable with a 3000-foot end section. Only the X, X or Y, Y screws of the LATTICE section should be turned down in an 830G network. ***Never*** should both X, X and both Y, Y screws be turned down concurrently.

*For POTS, the TERM screw should be tightened for a terminal repeater and loosened for an intermediate repeater.

9 Bring the meter on scale by rotating AT1 on the 54C RLMS.

10 Request a termination at the distant end of line B and observe the meter of the 54C RLMS for a change indicating that the termination has actually been connected to the line being used. This termination is to be 900 ohms in series with 2.14 μF for a 900-ohm impedance terminal or 600 ohms in series with 2.14 μF for a 600-ohm impedance terminal.

STEP	PROCEDURE

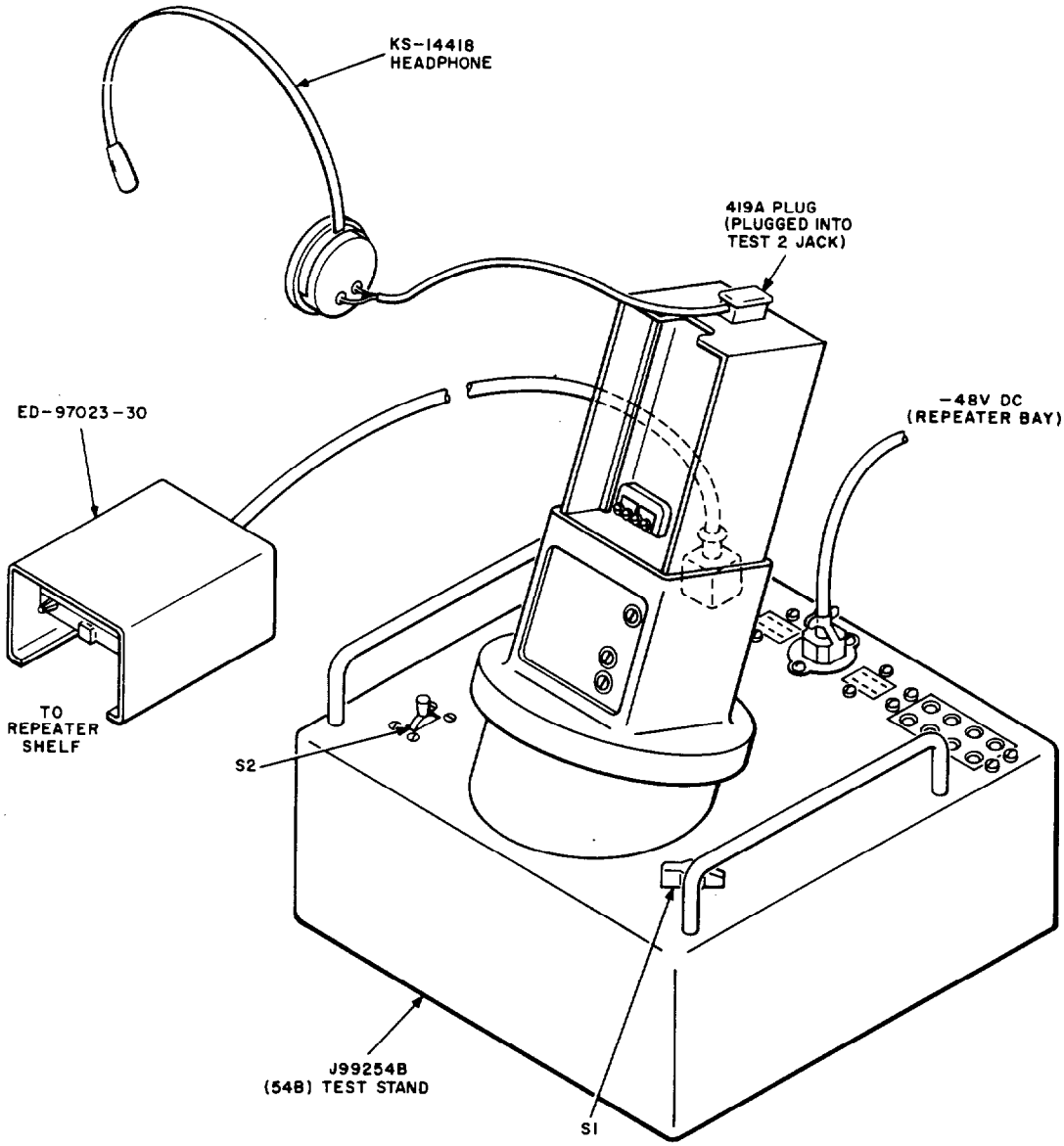

Fig. 6—Stability Test—Test Equipment Connections

11 The 54B test stand includes a balanced inductor of 400-ohm resistance to permit holding dialed-up terminations while testing. For this purpose the tester operates a key, ◗S2, to the HOLD LINE position to insert◖ the two balanced windings of the inductor in series with the tip and ring wires of the cable pair. A patch is thus provided for direct current from one end of the link to the other through the test location. At the same time, the

STEP	PROCEDURE

two parts of the link are isolated at voice frequencies so that neither part affects tests made on the other.

12 Optimize the return loss by adjusting BOC screws A through G to obtain the highest return loss. Do this by increasing the BOC in 0.004-μF steps; if this causes the return loss to rise, increase the capacitance still further until a maximum is reached. If no maximum is found by increasing the BOC, decrease the capacitance in 0.004-μF steps and follow up until a maximum return loss is obtained. If the adjustment is critical, repeat with 0.002-μF steps.

Note 1: In some cases the adjustment may not be critical. In such cases, use the average of the two settings where a decrease in return loss is just noticeable.

Note 2: If there are two BOC settings that give the same average meter reading, choose the setting for which the meter needle wavers less.

Note 3: Negative values of return loss sometimes occur.

Note 4: Remove screwdriver from screwheads when observing 54C RLMS readings.

Note 5: If the network being adjusted is an 830G network, the BOC should not exceed 0.039 μF when both Y, Y screws are down. Should the optimization procedure indicate that more BOC is necessary, use screws X, X; turn down screws 1, 2, 3 and 1, 2, 3; and add BOC in the above described manner.

13 The values of the BOC screws are as follows:

CAPACITANCE OF BOC SCREWS OF NETWORK ±2%

A 0.001 μF	D 0.007 μF	F 0.025 μF
B 0.002 μF	E 0.013 μF	G 0.049 μF
C 0.004 μF		

Example: Tightening a screw adds capacitance. Thus, when the A, E, and F screws are down, they equal 0.001 plus 0.013 plus 0.025, or 0.039 μF. In this case, 0.004 μF could be added by tightening screw C. To remove 0.004 μF, the screws would be A, B, D, and F down.

830A and 830B Networks—Low-Frequency (LF) Adjustment

14 Set S1 on the 54C RLMS to 500—2500 ~ . Set S2 to SEND LEVEL CAL. Calibrate the 500—2500 ~ range of the 54C RLMS to 0 dB by adjusting the SEND LEVEL ADJ knob for 500—2500 ~ . Release S2 to MEAS. Bring the reading of the meter on scale by rotating gain knob AT1. Turn out LBO screw(s) for the cable gauge originally selected. Turn LBO screw(s) in for one of the other gauges.

STEP	PROCEDURE

Note 1: The screw setting that gives the greater return loss value is the better setting, but screw(s) for one gauge only shall be left down.

Note 2: If the setting for two different gauges gives the same results, use the one for coarser wire, ie, set for 19 gauge when the same results within 0.5 dB are obtained on 19 and 22 gauges.

830A, 830B, and 830G Networks—Building-Out Resistor (BOR) Adjustment

15 Set S1 on the 54C RLMS to 500—2500~sweep. Reduce the initial BOR value on the LBO to the next lower value to verify that the return loss is increased. If it is not, increase the BOR value.

Note 1: The condition that gives the greater return loss value is the better setting. If the same results are obtained for two different values of BOR, set for the lower value of resistance. Be sure that the same value of resistance is used in the tip and ring side of line, ie, 1 + 1, 2 + 2, 3 + 3 screws must be in a corresponding position. When different values are used, the circuit becomes unbalanced and is susceptible to noise.

Note 2: The resistance values that can be obtained are as follows:

	NETWORK	
	830A & 830B	830G
All screws down	0 ohms	0 ohms
1, 2 and 1, 2 down	28 ohms	33 ohms
1, 3 and 1, 3 down	56 ohms	66 ohms
1 and 1 down	84 ohms	99 ohms
2, 3 and 2, 3 down	112 ohms	132 ohms
2 and 2 down	140 ohms	165 ohms
3 and 3 down	168 ohms	198 ohms
No screws down	196 ohms	231 ohms

B. 830C Network Adjustment

1 At the distant end of the circuit, request that a 900-ohm or 600-ohm 2-μF termination be placed on the drop side of the ▶837-type◀ network (impedance may be obtained from the CLR; a 4125A [600-ohm] or 4125B [900-ohm] termination may be used to terminate the circuit).

2 Insert the repeater into the 54B test stand as instructed in ▶4.06,◀ Step 5. Set the mode switch (S1) on the 54B test stand to the designations listed below.* Rotate the turret of

STEP	PROCEDURE

the 54B test stand so that the adjustable resistors R1, R2, and R3 on the 830C network are easily accessible. Set S2 to neutral.

*RL LINE A if the network is in side A.

RL LINE B if the network is in side B.

3 Connect the 54B test stand to the repeater shelf, to the 54C RLMS, and to the 4097-type network ◗(Section 103-104-10Z)◖ as shown in Fig. 6. Table B provides data for transcribing the value of inductance obtained with the 4097-type network to the 830C network.

Note: If a 4097-type network is not available, the following method utilizing the inductance screws on the 830C network must be used to obtain the proper inductance setting:

(a) Tighten down the L screw on the 830C network. This enables the internal inductance of the network.

(b) Set the inductance to the prescription value or, if the prescription setting is not supplied, to 0.8 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.

(c) To increase or decrease network inductance, use combinations of screws as shown in Table B.

4 When connecting the 4097-type network to the 830C network, the screw labeled L on the 830C network should be loosened. This removes the internal inductance of the 830C network from the circuit and replaces it with the inductance of the 4097-type network. Set the 4097-type network as prescribed on the CLR.

5 Set the dials of adjustable resistors R1, R2, and R3 on the 830C network to the approximate center of their adjustable range or to the midrange mark if the network has one.

6 Calibrate both frequency ranges (500—2500 ~ and 2000—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.

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

7 The objective in the next part of the lineup procedure is to obtain the maximum return loss for the specific facilities assigned to the link. A high return loss assures adequate margin against echo and singing. Measure return loss with the 54C RLMS by performing the following steps in sequence:

(a) Set switches on the 54C RLMS as follows:

S1 to 500—2500 ~

TABLE B

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

INDUCTANCE* (4097A or 4097B NETWORK)	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: *Sum of inductance indicated on rotary and key switches on 4097B network.

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

STEP	PROCEDURE

S2 to MEAS

S3 to 900Ω 2 MF.

(b) Adjust R3 for maximum return loss indication on the 54C RLMS.

(c) Adjust R2 for maximum return loss.

(d) Adjust R1 for maximum return loss.

(e) 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.

(f) Repeat Steps (b), (c), and (d).

(g) Repeat Step (e). If a significant increase in return loss is indicated (ie, 0.5 dB), repeat Steps (b), (c), and (d) at least twice or until additional return loss cannot be obtained.

(h) Throw switch S1 on the 54C RLMS to the 2000—3000~ position.

(i) Adjust R1 for maximum return loss.

(j) Readjust the value of inductance as instructed in Step (e).

(k) Readjust R1 for maximum return loss.

(l) Throw switch S1 on the 54C RLMS to the 500—2500~ position.

(m) Readjust the value of inductance as instructed in Step (e).

(m) Readjust R1 for maximum return loss.

(o) Readjust R2 for maximum return loss.

(p) Readjust R3 for maximum return loss.

(q) If indicated return loss in the 2000—3000~ range is greater than the 500—2500 range, decrease the value of inductance in 0.05-mH steps until the return loss in the 500—2500~ range is greater. Repeat Steps (o) and (p) for optimum results.

Requirement: The return loss measurement obtained should be equal to or greater than the value specified on the CLR.

8 If the requirement in Step 8 cannot be met, readjust R1, R2, R3, and the inductance. If requirements still cannot be met, replace the 830C network and repeat the entire lineup procedure. If requirements still cannot be met, refer to the responsible engineering department.

STEP	PROCEDURE

9 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 B).

10 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—2500~ range.

11 Request that the termination be removed at the distant end.

C. 830E Network Adjustment

1 Mount the 832A network on the NETWORK A side of the repeater and secure it by all four screws.

2 Slide the 830E network into the NETWORK B side of the repeater and secure it with all four screws on the connector block.

Caution: ▶If the 830E network must be mounted in the A side of the repeater housing, the housing should have a plastic door to prevent grounding of the ring conductor.◀

Note: All four screws are needed since they also make the required electrical connections between the gain unit and the networks.

3 Request the distant end to connect a "live" telephone or place a 4066H network adjusted per Table C or a 600-ohm termination on the trunk. See Section ▶332-206-225◀ for further detail.

4 Set the mode switch (S1) on the 54B test stand to RL LINE B. Rotate the head of the 54B test stand so that the adjustable resistors on the 830E network are easily accessible. Set S2 to neutral.

5 Connect the 54B test stand to the repeater shelf, to the 54C RLMS, and to the 4097B network (Section 103-104-101), as shown in Fig. 5. The 4097B network ▶contains◀ an easily adjusted inductance for determining the proper setting of inductance in the 830E network. Operate the key on the 4097B to 830E; dial readings will correspond to the inductance settings on the network (ie, if the dial reads 0.4 as optimum setting, the 0.4 screw on the network should be loosened; all others should be tightened).

Note: If a 4097B network is not available, the following method utilizing the inductance screws on the 830E network must be used to obtain the proper inductance setting. This may be done as follows:

(a) Tighten down the L screw on the 830E network. This enables the internal inductance of the network.

(b) Set the inductance initially to 0.0 mH by tightening down all screws. Tightening down a screw removes the particular value of inductance from the network circuit.

STEP	PROCEDURE

TABLE C

ADJUSTMENTS OF 4066H NETWORK

RANGE OF DIRECT CURRENT SUPPLIED TO 500-TYPE TELEPHONE SET WITH HANDSET OFF THE CRADLE (MILLIAMPERES)	SCREW SWITCH TO BE CLOSED (TURNED IN); ALL OTHERS TO BE OPEN (TURNED OUT)
36 or less	A
37—50	B
51—61	C
62 or more	D

Note: Only one adjusting screw should be in the turned-in position for any of the dc ranges of current supplied to the 500-type set being balanced by the network. All others should be turned out two complete turns.

(c) Network inductance may be increased by loosening or turning out screws marked .05, .1, .2, .4, .8.

6 Loosen the screw labeled L on the 830E network. This removes the internal inductance of the 830E network from the circuit and replaces it with the inductance of the 4097B network. Set the 4097B network to 0.0 mH and connect the network to the L pin jacks on the 830E network as shown in Fig. 6.

7 On the 830E network, set the dials of adjustable resistors R1 to 1/4 range (90° clockwise) and R2 to zero (fully counterclockwise).

8 Set the 830E network BOR screws, L screws, and C screws per Table D.

The BOR screws must be set the same (both tightened or both loosened) to prevent circuit unbalance.

9 Calibrate both frequency ranges (500—2500~ and 2000—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.

STEP | PROCEDURE

TABLE D

830E NETWORK
INITIAL SETTINGS

BOR REQUIRED FOR VARIOUS LOOP RESISTANCES		
LOOP RESISTANCE* OF CABLE PAIR	SCREWS	POSITION
≤ 400 ohms	BOR	UP
	R	DOWN
> 400 ohms	BOR	DOWN
	R	UP
L SCREWS		
Start† with either all L-value screws (including the L screw) down, or when using the external 4097B network (with L screw up on 830E), start with knob set to 0.		
POTENTIOMETERS		
Start† the potentiometers R1 set to 1/4 range (90° clockwise) and R2 set to 0 (fully counter-clockwise).		
C SCREW		
Total BT < 3 kft.		UP‡
Total BT between 3 and 6 kft and most located closer than 3 kft from repeater		UP‡
Total BT between 3 and 6 kft and most beyond 2 kft from repeater.		DOWN‡

Notes:

* Average temperature.

† Initial settings are for starting only. Final settings must be obtained by optimizing with a 54C RLMS or a KS-20501 RLMS.

‡ If >20 dB ERL and >12 dB for the 2 to 3 kHz RL (with 4066H network termination) are not met, try other condition of C screw. If results are about the same, use C in UP condition.

STEP	PROCEDURE

Caution: On subsequent readings, subtract 10 dB from the sum of the AT-1 dial and meter reading to obtain the true return loss.

Maximum Return Loss

Note: The objective in the next part of the lineup procedure is to obtain the maximum return loss for the specific facilities assigned to the trunk. A high return loss assures adequate margin against echo and singing.

1 Set switches on the 54C measuring set as follows:

S1 to 500—2500~

S2 to MEAS

S3 to 900Ω 2 MF.

2 Increase the value of inductance (L) by operating the switch and key on the 4097B network until maximum return loss is obtained.

3 Adjust R1 for maximum return loss indication on the 54C measuring set.

4 Set switch S1 to 2000—3000~ and adjust R2 for maximum RL.

5 Set switch S1 to 500—2500~ and repeat Steps 2 and 3.

6 Repeat Step 4. ***If a significant increase in return loss is indicated (ie, 0.5 dB), repeat Steps 2 and 3 at least twice or until additional return loss cannot be obtained. If an increase or decrease of 0.05 in L improves the RL in the SP (2000—3000 Hz) band, use that value.***

7 Repeat Steps 5, 6, and 7 until optimum adjustments are obtained.

8 The foregoing steps should lead to a maximum return loss (500 to 2500 Hz) in excess of 20 dB (30-dB meter reading since the set was calibrated at 10 dB). If the ERL (500 to 2500 Hz) is less than 20 dB or the SP (2000 to 3000 Hz) is less than 12 dB, change the position of the C screw and repeat lineup procedure. Use the C screw position that gives the better values for ERL and SP. If the results are almost equal for both conditions, use C in the UP position for better high-frequency response.

9 If the maximum return loss cannot be obtained, make sure the termination is on the circuit and the B side of the repeater is connected to the cable pair. If requirements still cannot be met, replace the 830E network with a new network and repeat the entire lineup procedure.

Note: Removing the termination should always reduce the return loss. It is possible to ***misalign*** the repeater without a termination at the PBX and obtain return losses in the order of 11 dB, but the circuit would be unstable.

STEP	PROCEDURE
10	If acceptable values of return loss are obtained, tighten the L screw on the 830E network and set the amount of inductance (L) that was obtained with the 4097B network.
11	Disconnect the 4097B network from the 830E network and, if there has been more than a 1-dB reduction from the previous indication, readjust R1 and R2 for maximum return loss. This completes the lineup of the 830E network. *Note:* Record the measured return loss (meter reading −10 dB) on the CLR for future reference.
12	Request that the termination at the distant end be removed.

5. STABILITY TESTS (SINGING CHECKS)

5.01 The extent of these tests will depend on whether the circuit is equipped with idle circuit terminations at neither end, at one end, or at both ends, or whether it is equipped with a repeater disabler. The CLR will specify whether the stability checks are to be made from frame to frame or on an overall basis, including office equipment at both ends.

5.02 The tests can be made either with the repeater in the 54B test stand or with the repeater on the shelf. If a test stand is used, set the right-hand switch of the 54B set to NORM.

STEP	PROCEDURE
1	Connect the 54B test stand, repeater, and KS-14418 headset 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.
2	Monitor the repeater for singing with the KS-14418 head set with the following combinations of terminations:

STEP	PROCEDURE

	ORIGINATING END	TERMINATING END
	Circuit not equipped with idle-circuit terminations or repeater disabler	
(1)	900 (600) ohms	900 (600) ohms
(2)	Open circuit	Open circuit
(3)	Open circuit	Short circuit
(4)	Short circuit	Open circuit
(5)	Short circuit	Short circuit
	Circuit equipped with idle-circuit terminations at both ends or repeater disabler	
(1)	900 (600) ohms	900 (600) ohms
(2)*	Idle condition	Idle condition
(3)	900 (600) ohms	Open circuit

* For circuit with idle-circuit terminations.

	Circuit with idle-circuit terminations at one end	
(1)	900 (600) ohms	900 (600) ohms
(2)*	Idle condition	Idle condition
(3)	900 (600) ohms	Open circuit

* Either open circuit or with idle-circuit termination at end equipped with idle-circuit termination.

Note 1: With the headphone connected as shown in Fig. 6, no sound other than battery noise should be audible. If the repeater does not sing, refer to Part 6.

Note 2: If a low-level 1-kHz tone is heard, it may be coming from the 54A TMS, which is still connected to the 54B test stand. Disconnect the power plug from the test stand.

3 If the repeater sings the possible troubles are:

(a) Improper test connections.

(b) The insertion loss has been incorrectly measured and is less than permissible.

(c) The 830-type network is defective.

STEP	PROCEDURE
	(d) The makeup of the facility is outside limits.

6. PUTTING THE REPEATER IN SERVICE

6.01 When a trunk is stable, proceed as follows:

STEP	PROCEDURE
1	Remove repeater from 54B test stand.
2	Remove plug from shelf socket.
3	Plug repeater into proper shelf position.
4	Have the circuit put in service.