

E-TYPE TELEPHONE REPEATERS
GENERAL INFORMATION ON PLACING REPEATERS IN SERVICE

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1. GENERAL

1.01 This and associated sections describe the methods for placing E-type telephone repeaters in service when inserted in trunks, loops, or combinations of the two.

1.02 The associated sections are as follows:

332-200-300 — Placing E1 or E13 Repeaters in Service — Using E-Repeater Test Set

332-200-301 — Placing E2 or E23 Repeaters in Service — Using E-Repeater Test Set

332-200-302 — Placing E1 or E13 Repeaters in Service — Using 2G Repeater Test Set

332-200-303 — Placing Repeaters in Service — Without the Use of a Repeater Test Set

1.03 Each of the associated sections includes a flow diagram for the convenience of persons familiar with the test procedure.

1.04 In most cases, the procedures of this section and other sections will be used in conjunction with the network strapping charts of Section 332-200-107 for the E1 and E2 repeaters and Section 332-200-106 for the E13 and E23 repeaters.

1.05 The block diagram of Fig. 1 shows a typical arrangement of an E13 or E23 repeater at an intermediate location in an interoffice line. An intermediate E1 or E2 repeater would appear as shown in Fig. 1 except with the E3 repeater and its distributing frame connections omitted.

1.06 Simplified schematics of the repeaters, repeater network internal components, and network terminal arrangement are shown in Section 332-200-500. The circuit drawings are listed in that section for reference.

1.07 The term "Design Group" as used in the associated sections and diagrams refers to the persons or person in the Operating Company Plant Department responsible for the work involved.

2. APPARATUS

2.01 In each of the associated sections, the apparatus required for that particular test procedure is listed or indicated by reference to other sections. Block diagrams showing interconnections of the test apparatus and equipment under test are included in the sections.

2.02 Where test terminations as described in 4.13 and 4.14 are to be applied manually, the following apparatus is required for the conditions indicated in the attached Figs. 5 and 6:

- 2 — Resistors 600 ohms ± 5 per cent (145C or equivalent)
- 2 — Resistors 909 ohms ± 5 per cent (145C or equivalent)
- 1 — Resistor 100 ohms or as specified (145-type or equivalent)
- 4 — WIU Cords

2.03 Where E2 or E3 repeaters are to be lined up for short periods of time prior to cut-over, as described in 4.22, the following apparatus is required for each repeater involved:

- 1 — 354A Plug equipped locally with
- 1 — Resistor, 0.5 watt, 1800 ohms ± 5 per cent (KS-13490, List 1 or equivalent) bridging the plug terminals.

2.04 The test apparatus should be calibrated immediately before any series of tests.

3. BUILDING-OUT CAPACITORS

3.01 Where building-out capacitors are required it is important that they be connected at the specified side of the repeater.

E1 or E13 Repeater

3.02 Building-out capacitors, where required for the E1 or E13 repeater, should be connected at the E1 repeater panel across the line, either at terminals 1 and 4 on the LINE A side or at terminals 2 and 3 on the LINE B side. In some cases, building-out capacitors are specified on both sides.

E2 or E23 Repeater

3.03 One 0.01 mf and two 0.02 mf capacitors are built into the E2 repeater. One terminal of each capacitor is permanently connected to terminal 42 on the repeater network strapping board. The other terminals of the capacitors are permanently connected to terminals 43, 44, and 45, respectively, on the strapping board. The capacitors may be used in any parallel combination to add from 0.01 to 0.05 mf to the end-section, on either side but not on both sides of the repeater. For convenience in making the connec-

tions at the network strapping board, terminals 40 and 41 provide for connecting the capacitors to LINE A side of the repeater and terminals 46 and 47 provide for connecting the capacitors to the LINE B side.

3.04 Where building-out capacitors are required on both sides of the repeater, supplementary capacitors must be added externally on the network strapping board. The added capacitors should be connected either to terminals 40 and 41, or 46 and 47. The bare leads of the capacitors should be covered with insulated sleeving. The capacitors and their leads should be arranged so that they do not extend beyond the tips of the network terminals.

3.05 Building-out capacitors identical to those in the E2 repeaters are provided in the E-repeater test set. The capacitors and line terminations are connected to test set network patch jacks numbered to correspond with terminal numbers on the repeater network strapping board. The capacitors in the repeater and those in the test set may be used simultaneously for trial purposes. The test set is not arranged to disassociate the capacitors from the line by key or switch operation; therefore, when checking the extent of improvement obtained by using the capacitors, they must be removed for the "reference" condition and added for the "measure" condition.

4. TEST PROCEDURES

A. General

4.01 Four procedures are described for placing the repeaters in service, as listed in 1.03.

4.02 Generally, the procedure without a test set may be followed where experience with other identical circuits has proven the assigned network strappings to be satisfactory for the particular type of facilities involved and *all* of the following conditions exist:

- (1) The same general type of loading is used on all of the lines.
- (2) No repeating coil equipment is connected between the repeaters and the lines.
- (3) The required gain is equal to or less than the allowable gain.
- (4) Gain measurements are not specifically called for.

4.03 A procedure with test set should be used when any of the conditions in 4.02 do not exist, where trouble has been experienced in the procedure without a test set, or where an unusual line condition is encountered. Use of the E-repeater test set is preferable since it is applicable to all E-type repeaters and contains trial networks for them. The 2G repeater test set is limited in use to the E1 and E13 repeaters and contains a trial network for the E1 repeater only.

4.04 The placing of E-type repeatered lines in service is based on the premise that the lines have had acceptance tests made on them and that any troubles have been cleared. A general outline of the procedures follows:

- (1) In a group of five or more identical facilities, five lines are chosen as typical of the group.
- (2) The five lines, with their repeaters connected and strapped, are terminated as shown in Fig. 5 or 6. Four of the lines are tested for repeater stability, and repeater gain measurements are made on the fifth line.
- (3) With the proved strapping arrangement on the repeater network, each repeatered line of the group is terminated, a single measurement of repeater gain is made, and, if desired, the circuit net loss is determined. The procedure is continued with a test call monitored for stability and performance. The repeatered line is then placed in service.
- (4) In the event of only one line in the group, as would be the case of a replacement repeater, for example, the one repeater should be tested for the five termination conditions (Figs. 5 and 6) described for five typical repeaters of a line group.

4.05 Where two or more repeaters are operated in tandem on the same line, effective gain measurements and stability tests must be made for each repeater.

B. Network Strapping

4.06 Predetermined strapping arrangements for the gain adjusting networks of the repeaters for the different types and combinations of plant facilities most commonly encountered comprise other sections as stated in 1.04.

4.07 Specified or trial network strapping arrangements may be set up on the test set patching boards where it is considered likely that changes or adjustments may be necessary during the course of the tests. Network strapping arrangements for the E1 or E2 and the E3 repeaters may be patched up on the E-repeater test set; however, the 2G repeater test set is arranged for network patches for only the E1 repeater. The repeater networks should be strapped in the manner outlined in 4.08 and 4.09 where a trial arrangement is not required, when the final arrangement has been determined by patches and is to be transferred to the repeaters, or where a test set is not used.

4.08 Procedure for strapping the network of the E1 repeater:

- (1) Disconnect the 130-volt supply from the E1 repeater by removing the cord tip of the flexible plate lead from jack P+ at the rear of the repeater.
- (2) Remove the cover from the front of the network unit.
- (3) Remove all straps from the network terminals.

Caution: Avoid unnecessary heating of the network terminals. Eyes should be protected against possible spurts of rosin and solder from the hollow terminals.

- (4) Strap the network as specified, using 22 gauge type "M," "K," or "BG" wire for nonadjacent terminals and 22 gauge bare strap wire for adjacent terminals.

Caution: See Caution in (3) above. Avoid the use of excessive amounts of solder.

- (5) After soldering, carefully examine all strapping to make certain that it agrees with the specified arrangement and that there are no faulty connections such as short-circuits between wires and terminals.
- (6) Arrange the strap wires so they do not extend beyond the tips of the terminals.
- (7) Restore the cover plate to the network unit.
- (8) Reconnect the 130-volt supply to the E1 repeater by reinserting the cord tip of the flexible plate lead into jack P+.

4.09 Procedure for removing the E2 or E3 repeater from the mounting shelf or test set, strapping the network, and restoring the repeater to the shelf or test set:

- (1) Remove the repeater from the mounting shelf or E-repeater test set.

Notes

1. Where the repeater is removed from the mounting shelf, readjust the heater voltage, if required, as stated in 4.12.
2. A 680A tool should be used for disengaging the repeater from its mounting shelf socket in order to prevent possible injury to personnel and damage to equipment.
3. Do not touch any terminal on the repeater network strapping board while the repeater is engaged in a shelf socket or in a test set with power connected, since 130 volts potential is then present between some of the terminals and ground.

Caution: No removal, addition, or change of strapping shall be made on the repeater network terminals while the repeater is plugged into the test set.

- (2) Remove the plastic shield from the repeater network strapping board, where provided.
- (3) Remove all straps from E2 repeater network terminals. Remove all straps from E3 repeater network terminals except strap between terminals 36 and 37, where provided.

Note: On an E3 repeater having network terminal 37, a strap is required between terminals 36 and 37 when the repeater is plugged into a mounting shelf socket, unless a disabler circuit is used with the repeater.

Caution: Avoid unnecessary heating of the network terminals.

- (4) Strap the network as specified, using 22 gauge type "M," "K," or "BG" wire from nonadjacent terminals and 22 gauge bare strap wire for adjacent terminals.

Caution: Use portions of the network terminals not occupied by internal wiring. Avoid unnecessary heating of the network terminals and avoid the use of excessive amounts of solder.

- (5) After soldering, carefully examine all strapping to make certain that it agrees with the specified arrangement and that there are no faulty connections such as short-circuits between wires and terminals.

- (6) Arrange the strap wires so that they do not extend beyond the tips of the terminals.

- (7) Restore the plastic shield where it was removed in (2) above.

- (8) Plug the repeater into the mounting shelf socket of the test set.

Notes

1. Where the repeater is restored to the mounting shelf socket, readjust the heater voltage, if required, as stated in 4.12.
2. Each time the repeater is to be plugged into the test set, *carefully* align the guide pins of the connector-plug on the E2 or E3 repeater with the test set connector-socket E2 REPEATER or E3 REPEATER, respectively, and plug the repeater into the test set. *Fasten the repeater securely by clamping it in place.*

C. Electron Tubes and Applied Voltages

4.10 The electron tubes are checked, applied voltages are adjusted, and reject values for cathode voltages are established for the space current history method of tube testing in accordance with Section 332-200-501.

4.11 The 130-volt supply to the E1 repeater must be disconnected before, and reconnected after, making any change in connections to the repeater, or any addition, change, or removal of straps on the gain adjusting network terminals on the repeater. Removing the cord tip of the flexible plate lead from the E1 repeater P+ jack disconnects the 130-volt supply from the repeater, and restoring the cord tip to the jack reconnects the supply.

Caution 1: When the cord tip of the flexible lead is removed from the P+ jack, the lead should be looped upon itself (loose knot) in order to prevent the cord tip from touching terminals on other repeaters.

Caution 2: To avoid considerable decrease in the life of a tube, the 130-volt potential should not be disconnected from the tube,

while the heater potential is applied, for any longer period of time than required by the test procedure.

4.12 Whenever E2 or E3 repeaters are to be removed from the repeater mounting shelf sockets, in order to avoid damage to the tube heaters of repeaters remaining on the shelf, the heater voltage should be reduced before:

- (a) One or more repeaters are removed from a shelf of four or less repeaters, or
- (b) Two or more repeaters are removed from a shelf of more than four repeaters.

The heater voltage should be adjusted immediately after the repeaters are removed and again after the repeaters are restored to the shelf sockets.

D. Test Terminations

4.13 Test terminations are required at each end of lines on which E-type repeaters are being tested. The terminations may be applied either by dialing test line circuits where available or manually.

4.14 On all lines except those from step-by-step offices and lines handling special services, the test terminations consist of open- and short-circuits across the lines to simulate idle-line and signaling conditions for stability tests, and resistances to simulate nominal office impedances for gain measurements. Five recommended conditions are opens at both ends, shorts at both ends, open at one end and short at the opposite end, vice versa, and resistance at both ends. The different conditions are tabulated on the attached Figs. 5 and 6. These figures illustrate the terminations as applied manually. Similar terminations are applied by means of the test line circuits. In the associated point sections, references to test terminations on specific lines allude to the test termination conditions of correspondingly numbered lines in the tables on Figs. 5 and 6. In some instances in the point sections, the different test termination conditions are specified for application, one at a time, on a single line. Heat coils must be removed from lines which are to be terminated manually and must be restored when the terminations are moved.

E. Stability Tests

4.15 The purpose of the stability test is to check that there is adequate margin in the circuit to prevent singing. The test is made by listening to a monitoring headset connected to the C1 and P- or C2 and P- jacks on the front of the E1 or E2 repeater. During the stability test, the test power is reduced to minimum. The various test terminations impose more severe conditions than are normally encountered for signaling and talking, and the use of the monitoring headset connected to the repeater during the test further reduces the margin against singing. When singing is not heard under the test conditions, the required margin against singing is assured and the repeater is considered *stable*; when singing is heard, the repeater is considered *unstable*. An unstable repeater should be removed from the line except during the test period, in order to avoid the possibility of inducing interference into other circuits.

4.16 In the event that an unstable repeater is found in any one of the five typical repeatered lines, and accuracy of the network strapping arrangement is confirmed by re-examination, alterations of the network arrangement are permissible within certain limitations or rules of installation practices. These limitations or rules are given in the procedures.

F. Gain Tests

4.17 In each procedure utilizing a repeater test set for placing the repeatered line in service, any one of three methods is employed for determining the effective gain on one of the five typical lines and later in measuring the reference or "single-shot" gain on each repeatered line in the group. The three methods are: by averaging gains measured at seven specified frequencies, by a single measurement with a noise generator as the source of test power, and by averaging four gains derived from a mid-point curve plotted from adjacent peak and valley gain points measured throughout the voice-frequency range.

4.18 In the procedure without a repeater test set, the gain test is applicable to E13 and E23 repeaters only and consists merely of determining whether the E3 repeater is active, and therefore producing gain.

4.19 Where the E1 repeater is to be connected to the test set, the P11A cord should be positioned so that the cord will not overturn the test set or place undue strain on the TEST connector of the repeater when the proper connections have been made. The cord should be placed to avoid interference with rolling ladders, with other telephone apparatus, or with the work operations of other personnel.

Caution: At any time when the P11A cord is connected to the test set and the two single-conductor plugs are not inserted into jacks NET 1 and 3 on the repeater, in order to prevent the blowing of fuses, the two plugs should be secured so that the plugs cannot accidentally touch any terminals on the repeater.

G. Circuit Net Loss

4.20 Determination of the circuit net loss is not a requirement with respect to placing the repeated lines in service and may be omitted where desired.

4.21 The circuit net loss is determined by overall transmission measurements of the line equipped with the repeater, or with two or more repeaters operating in tandem. Either of two methods may be used, the choice depending upon whether the test power is to be supplied by oscillator or noise generator.

H. Method for Maintaining Stability of Lined-up Repeater for Short Period Prior to Cutover

4.22 E2 and E3 repeaters which are lined up prior to cutover may be held stable for a short time until the cable pairs are connected, by inserting disabler plugs into pin jacks at the right of pin jacks P- and C2 on the front of the repeaters. The pin jacks at the right of pin jacks P- and C2 are designated 2 and 3, respectively, inside of the repeater but are not designated outside of the repeater.

Caution: In order to avoid shortening tube life, use of the disabler plug in an E3 repeater should ordinarily be limited to a few days.

4.23 E2 and E3 repeaters manufactured prior to late 1956 were provided with dummy plugs in the pin jacks at the right of pin jacks P- and C2. In such repeaters, the dummy plugs must be removed to make the pin jacks accessible. Dummy plugs which are removed need not be restored to the jacks.

I. Test Call

4.24 Before the line is placed in service, a test call should be made by the originating or control office to a station in the terminating office. The man placing the call should observe that the talking connection is satisfactory, and that the repeater does not sing during dialing, ringing, and switchhook flashing.

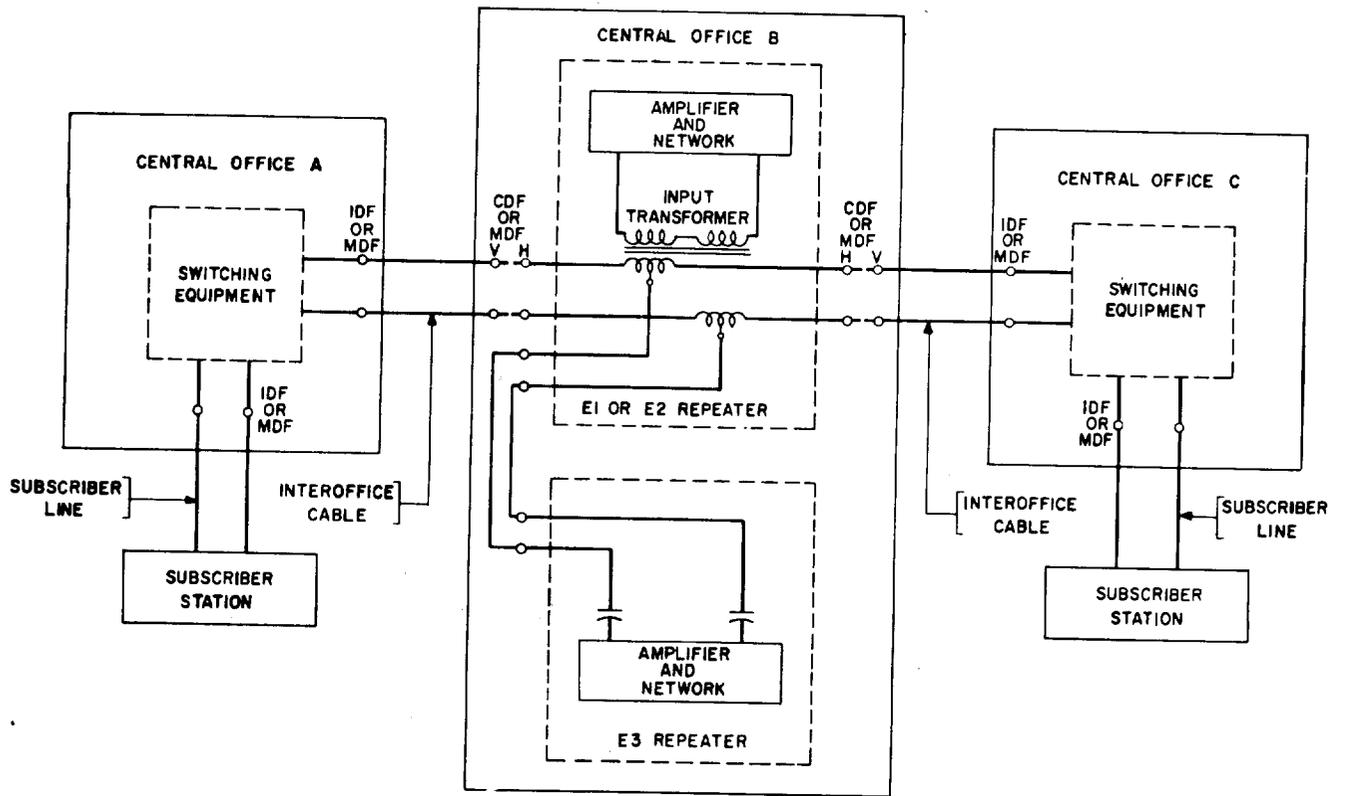


Fig. 1 — Typical Application of an Intermediate E13 or E23 Repeater

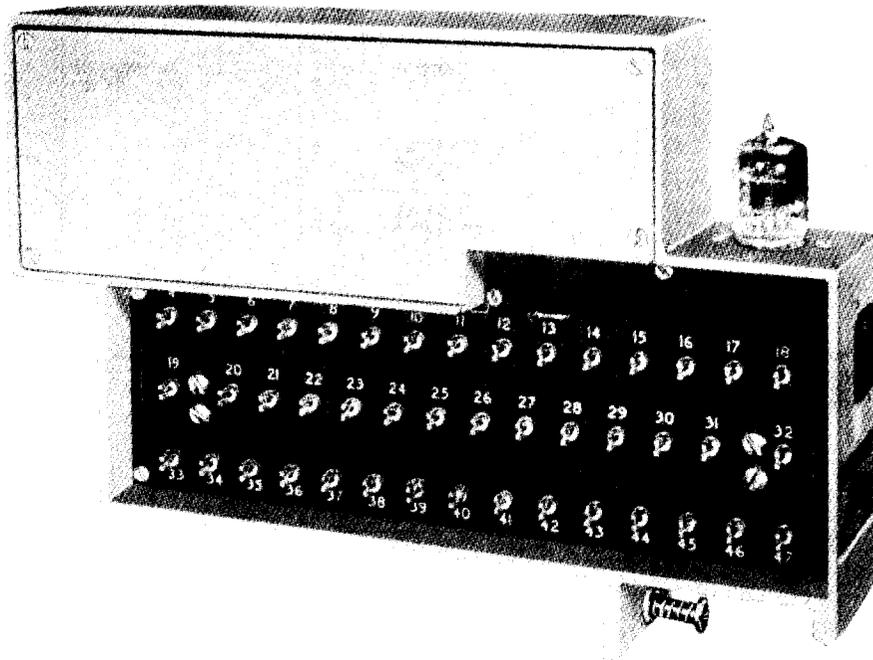
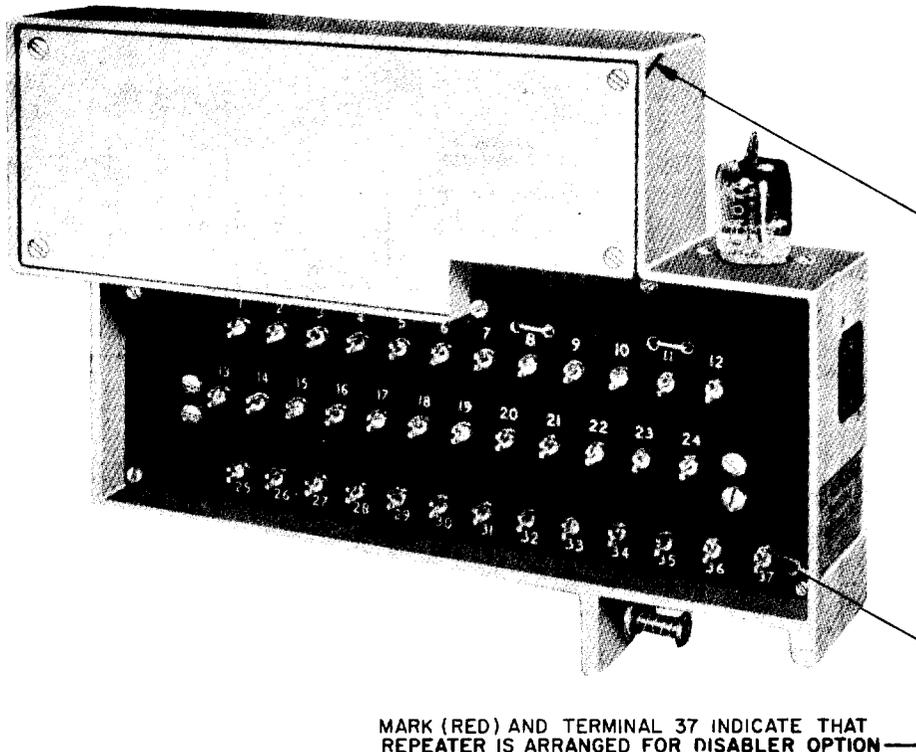


Fig. 3 — E2 Repeater (Left Front View)



MARK (RED) AND TERMINAL 37 INDICATE THAT REPEATER IS ARRANGED FOR DISABLER OPTION

Fig. 4 — E3 Repeater (Left Front View)

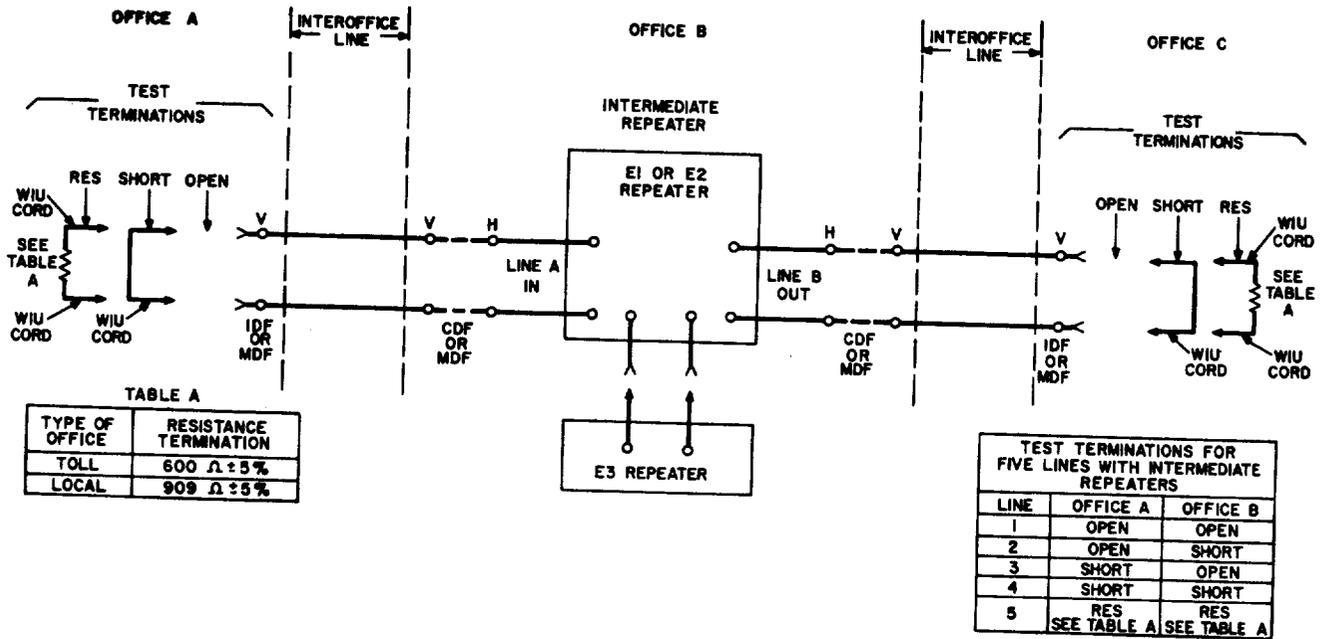


Fig. 5 — Test Terminations for Lines with Intermediate Repeaters — Manual Application Shown

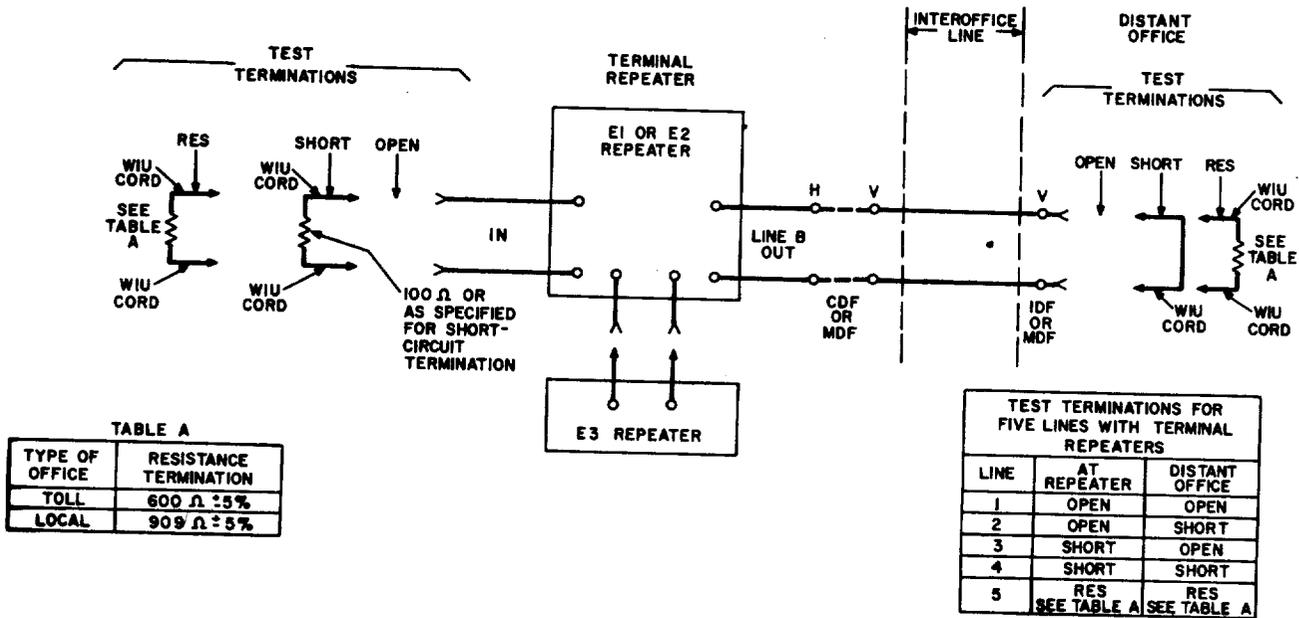


Fig. 6 — Test Terminations for Lines and Terminal Repeaters — Manual Application Shown