

WIRING VERIFICATION

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1. GENERAL

1.1 This section outlines instructions for electrical verification of Installer wiring. This section may be used to test wiring where no detailed methods are provided.

1.2 Precautions

1.21 No action may be taken in a working office which may cause service interruptions. Since the Telephone Company's personnel is responsible for the status of an operational office at all times, it is necessary for Western Electric personnel to coordinate all testing with the Telephone Company to insure continuous service of the office as outlined in the related MOP.

1.22 General precautions to be taken against personal injury, equipment damage, and service interruptions are covered in Handbook 0 and are to be observed at all times as they apply to the operations being performed.

1.3 If necessary, the appropriate Regional Installation Engineering Organization should be contacted to provide continuity verification information for the following:

- (A) Operating Company modifications of standard circuits.
- (B) Non-standard circuits.
- (C) Manufacture Discontinued circuits.

1.4 Wiring verification tests are made with the prescribed test sets to verify wiring for continuity and to detect and analyze opens, shorts, reversals and incorrect wiring. Conditions may necessitate the establishing of a talking circuit when testing between one or more remote points. When a test set has a provision for a talking circuit, it will be discussed in the section which describes the individual test set.

1.5 This section describes in detail the operation and optimum applications of available continuity test sets listed in the table below:

Table of Test Sets

<u>ITE</u>	<u>Name</u>
1886	Continuity Test Set, 3 Conductor
2095	Battery Supply Set, Voltmeter
2175	Voltmeter
4002	Tone Buzzer
4137	AC Continuity Test Set
4137A/B/C	AC Continuity Test Set
4251	Rapidohm Test Set
4251A	Rapidohm Test Set
4261	Whistler
4261A	Whistler
4490	Assignment Test Set
4511	Whistler
4525	Tone Buzzer
4525A	Tone Buzzer
5256	Connectorized Cable Test Set
5421	Electronic Lead Verification System (ELVS) Analyzer
5422	ELVS Master Test Encoder
5423	ELVS 200 Circuit Encoder
5424	ELVS 1000 Circuit Encoder
5609	Multiple Lead Verification System
5717	Cable Locator
5718	Modular Continuity Verification Set

1.6 It must be noted that various conditions will determine the choice of test set to be used. For instance, a VOM may be used to verify short leads; the ITE-4525A Tone Buzzer should be used when there is a danger of magnetizing repeat coils in trunk lines or repeaters, and is generally used for continuity testing in Electronics Switching Systems; the ITE-4137A,B,C AC Buzzer is generally used for single lead continuity testing as directed. The ITE-4511 or ITE-4261A Whistlers may be used to verify continuity and check for shorts. The ITE-2175 Voltmeter Set is available to verify multiple wiring. The ITE-5718 Modular Continuity Verification Set is available to verify wiring which is associated with plug-in modules. The ITE-5421 ELVS may be used to verify wiring for certain bulk wiring verification operations. Not all of the various wiring verification test sets are mentioned here, but all are covered in detail in the following paragraphs.

1.7 Recommended applications are given in the description of each set along with information as to what the set will check for and what it will not check with respect to the general requirements.

1.8 General Requirements.

Refer to the particular system handbook for the recommended wiring verification test set. In the absence of this information, select the set which will best verify the wiring in the most efficient manner.

1.9 Before starting continuity tests, the circuit drawing must be checked for grounds or common paths which would cause false continuity. Do not use a ground return on the AC Buzzer when making continuity tests.

2. RECORDS AND REQUIREMENTS

2.1 Records

2.11 Wiring - verification test results are to be recorded on form SD-97-1313 Test Trouble Record and summarized on form SD-97-1315 and SD-97-1334. For detailed information on test record forms, refer to Handbook 3, Section 6B.

2.2 Requirements

2.21 All wiring run by the Installer shall be verified for continuity to detect and analyze opens, shorts, reversals and incorrect wiring. When pairs, quads or other groupings are indicated, the grouping shall be verified.

2.22 Conductor colors should not be employed during verification operations. Continuity verification must be performed as a terminal-to-terminal check irrespective of the associated lead color information also listed on the Cable Connect Sheet (CCS). Terminal-to-terminal checking not only provides for continuity checking of the leads, but verifies the integrity of functional lead assignments within a circuit. This type of checking thereby eliminates the chance of missing slipped terminals that can readily occur when checking by color codes.

2.23 The test equipment used to make continuity tests on circuits containing transistors, diodes, dry-reed relays, electrolytic capacitors, etc., should not have an open circuit voltage or short circuit current exceeding the rated voltage or current of the component under test. Refer to the particular system installation handbook for a specified test set.

2.24 Care should be exercised when testing circuits or apparatus containing coils, mercury contact relays, square loop cores, ferrite sheets, etc., which may be permanently injured through magnetization by direct or excessive alternating current. Ordinary direct current buzzers and similar testing equipment shall not be used for making continuity tests on these equipments. Refer to the particular system installation handbook for specified test sets.

3. CONTINUITY TESTS OF LEADS

3.1 General - Continuity tests, using the test sets discussed below, will assure the uses of point-to-point continuity, but will not economically reflect problems associated with shorts or grounds.

3.2 Tests Using ITE-4137 or ITE-4137A,B,C

3.21 The AC Continuity Test Set may be used for making continuity tests usually limited to electromechanical systems. It furnishes a source of DC current for use as a talking circuit and a dry tone for use in continuity testing.

3.22 The test will verify continuity in the wiring, but will not test for shorts or analyze other defects.

3.23 Operation

PRECAUTION: DO NOT USE THE SET ON VACUUM TUBE CIRCUITS, CARRIER SYSTEMS, TELEPHONE REPEATERS, ELECTRONIC SWITCHING SYSTEMS, ETC.

3.231 Plug the power cord into a convenient 60 Cycle 115 Volt outlet and prepare the set, using a suitable test set up from those illustrated in FIG. 1A, 1B, 1C, 1D, 1E, 1F, 1G, 1H, or 1J.

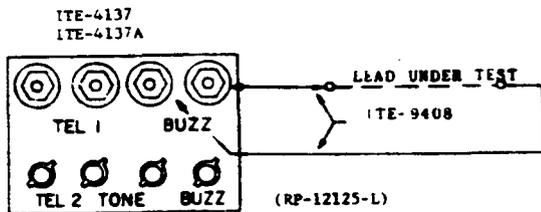
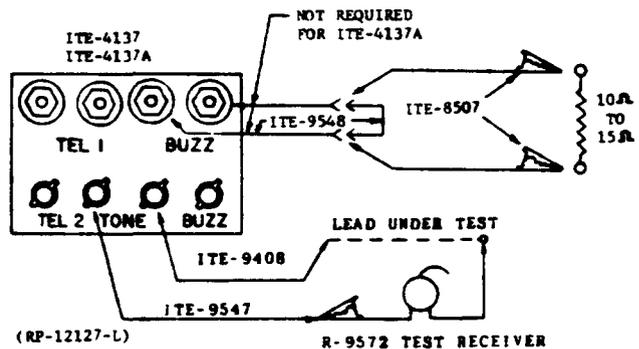


FIG. 1A SHORT LEAD TEST (PAR. 3.2)



NOTE: ITE-4137 only. If the tone circuit is to be used for a considerable time, short the BUZZ jacks through 10 to 15 ohms using two ITE-9548 Cords and two ITE-8507 Alligator Clips to avoid excessive heating of the buzzer.

FIG. 1C TONE TEST (PAR. 3.2)

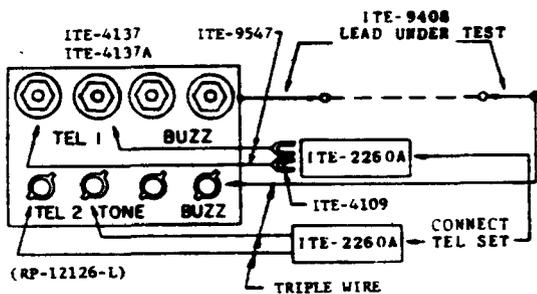


FIG. 1B LONG LEADS TEST WITH TALKING CIRCUIT (PAR. 3.2)

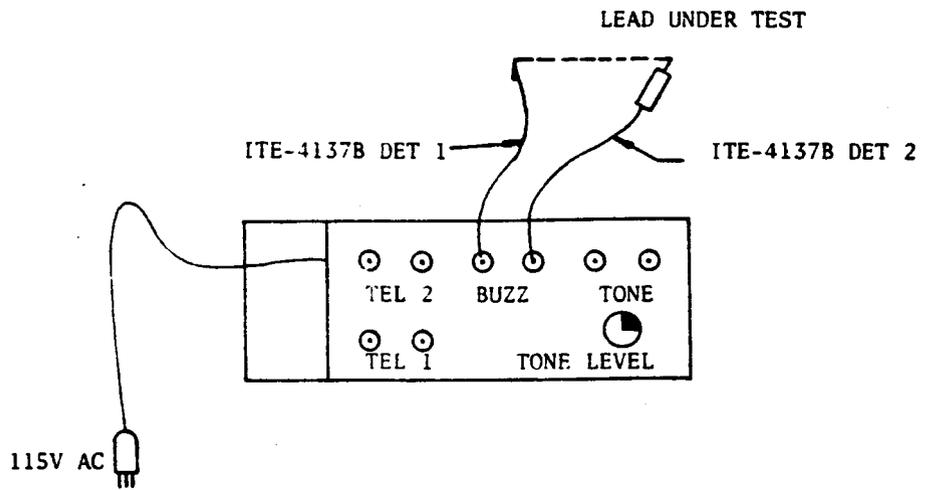


FIG 1D SHORT LEAD TEST
(PAR. 3.2)

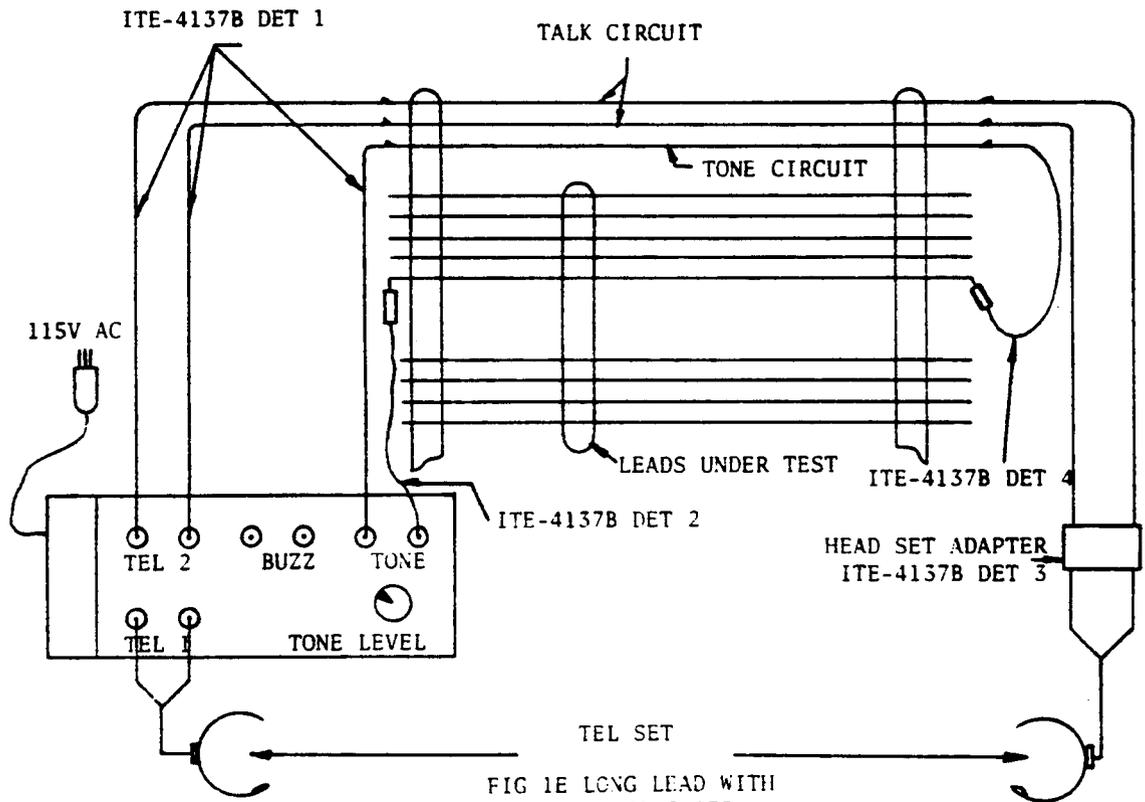


FIG 1E LONG LEAD WITH
TALKING CIRCUITS
(PAR. 3.2)

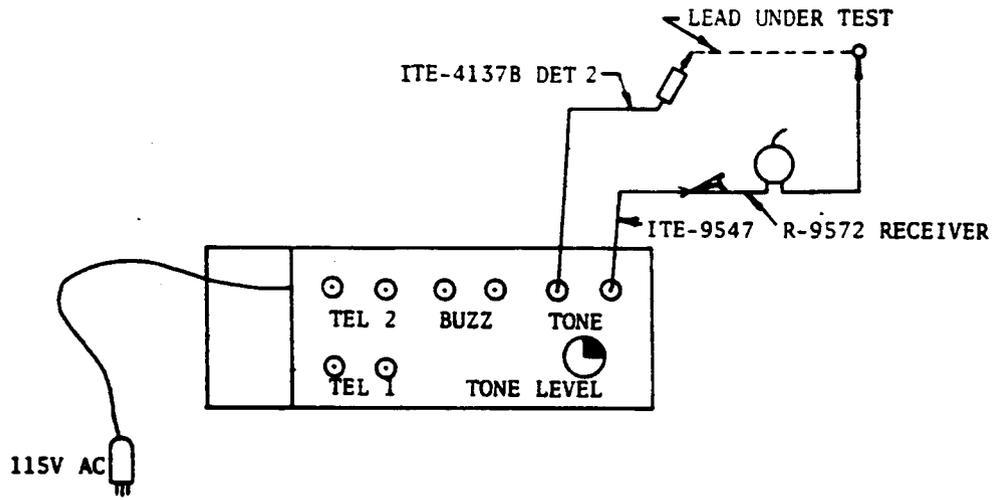


FIG 1F TONE TEST
(PAR. 3.2)

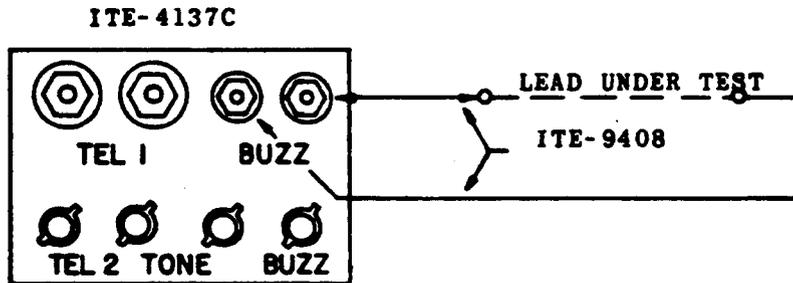


FIG.1G SHORT LEAD TEST
(PAR. 3.2)

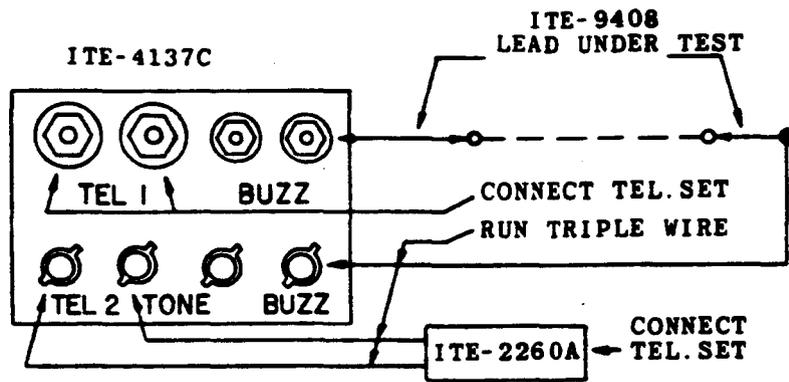


FIG. 1H LONG LEAD TEST WITH TALKING CIRCUITS
(PAR. 3.2)

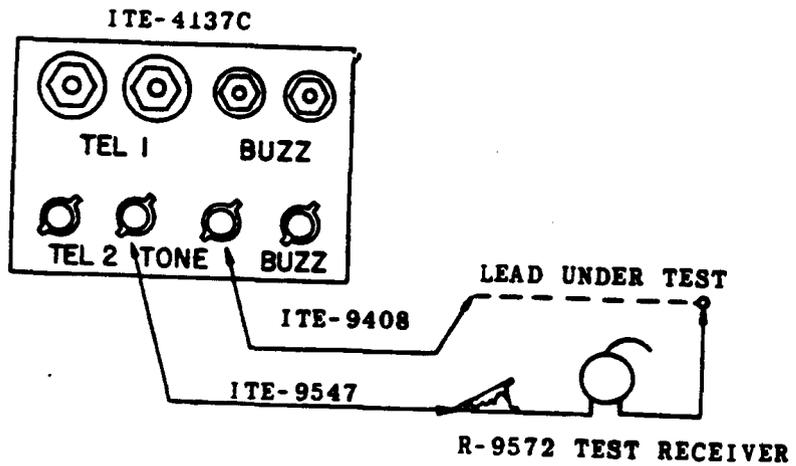


FIG 1J TONE TEST

(PAR. 3.2)

3.3 Tests Using ITE-4002

3.31 The Tone Buzzer may be used for making continuity tests and is usually specified for use in transmission products. The Tone Buzzer may be used for testing leads where coils might be magnetized or sensitive apparatus might be damaged by other types of test sets. This set will check continuity through a lead having less than 20 Ohms resistance; continuity is indicated by an audible signal.

3.32 The test set will verify continuity, but will not test for shorts or other defects.

3.33 Operation

3.331 Connect the female plug of the power cord into the power receptacle in the set and connect the other end of the power cord to a 115 Volt, 60 Cycle power outlet. The test is made by connecting two circuit points to terminals A and B on the set by using the leads provided with the set. An audible tone will result if the circuit connected between A and B has a total impedance less than 20 Ohms.

3.4 Tests Using ITE-4525 or ITE-4525A

3.41 The Tone Buzzer Test Set may be used for making continuity tests usually specified for use in Electronic Switching Systems. This set will check continuity through a lead having resistance less than 20 Ohms; continuity is indicated by an audible signal.

3.42 The test will only verify continuity, but will not test for shorts or other defects.

3.43 Operation (ITE-4525)

3.431 Turn the ON OFF switch to the ON position. Connect the pin end of the test cords into jacks A and B on the test set. Using a narrow blade screwdriver, turn SENS potentiometer to the extreme counterclockwise position. Insert the test probes into the 20W jacks. Slowly turn the SENS potentiometer clockwise until an audible tone is heard. Then turn slightly counterclockwise until the tone is barely audible. If no tone is heard, check the conditions of the batteries. Remove the test probes from the 20W jacks and touch the probes together. A louder tone should be heard at a slightly lower frequency. This adjustment will check continuity up to 20 Ohms on the lead under test and will not yield a tone for any resistance over 20 Ohms.

Locate the tone buzzer at a convenient point between the frames containing the leads under test. Touch the test probes to each end of the conductor. A tone will indicate continuity. Turn the ON OFF switch to OFF when the set is not in use.

3.44 Operation (ITE-4525A)

3.441 The operation of the ITE-4525A is slightly different than the ITE-4525. Turn the REF, OFF, TEST switch to the REF position. If the LED does not light, check or replace the battery. Turn the thumbwheel potentiometer until the tone is barely audible. This adjustment will enable the buzzer to check continuity through up to 20 Ohms and will not yield tone for a resistance greater than 20 Ohms. Turn the REF, OFF, TEST switch to the TEST position. Touch the test probes to each end of the conductor. A tone will indicate continuity.

3.5 Tests Using ITE-4442 or ITE-4442A

3.51 The volt ohm meter may be used for testing short leads when a talking circuit is not required. It is especially useful for continuity checks made by a single operator.

3.52 The test will verify continuity, but will not check for shorts or other defects.

3.53 Operation

3.531 Connect the leads with the set to the jacks marked + and -. Connect the test leads together and adjust the potentiometer OHMS ADJ to cause the meter to indicate 0. Continuity will then be indicated by an 0 reading on the meter. Readings other than 0 indicate the resistance in the conductor being checked.

4. WIRING VERIFICATION TESTS OF LEADS

4.1 General

4.11 Wiring verification tests using the test sets discussed below will assure the user of point to point continuity and will reflect problems associated with crosses, shorts and grounds.

4.2 Tests Using ITE-4261 and ITE-4261A

4.21 The Whistler may be used for verifying wiring where the wiring is predominantly of the same length.

4.22 The test will verify continuity as well as give an indication of shorts, foreign grounds, and other defects.

4.23 Set Up ITE-4261

4.231 Volume Adjustment

4.2311 Connect the set to a 115 Volt outlet. Observe that the neon lamp lights. If the lamp does not light, reverse the plug in the power outlet. This applies to AC voltage only. If the power supply is DC make the test in the next paragraph and disregard the neon lamp.

NOTE: R-3184 Adapter may be required on some sets. ITE-9421 Cord should be connected only after power cord is connected properly and neon lamp is lit.

4.232 Connect an ITE-9421 Cord to the test terminal on the set and touch the test pick to ground. A click should be heard in the loudspeaker. If this click is not heard when using DC power, reverse the power plug adapter at the power outlet.

4.233 Touch the test pick to one of the conductors under test. Adjust the VOLUME control to obtain a whistle of suitable volume. When the test pick is removed from the conductor under test, the test set may still produce a whistle, but of a much higher pitch. This condition is normal and is caused by the capacity introduced by the test cord.

4.24 Set up ITE-4261A

4.241 Connect the power cord of the set to 115 Volt power outlet. The set is equipped with a R-3184 Adapter which may be removed if power outlets are arranged for a 3-wire connector. When the adapter is used, connect the grounding connection to ground and observe that the neon lamp on the set panel lights. If the lamp does not light, reverse the plug in the power outlet. When the power supply is DC current the lamp may or may not light. Make the test in PAR. 4.242 and 4.243 and connect the plug so the click is heard in the loudspeaker.

4.242 Connect an ITE-9421 Cord to the (W-T) jack on the set and after about one minute warm up time the set should be ready to operate. Operate the toggle switch to W.

4.243 Connect the ITE-9421 Test Pick to ground and listen for a click in the loudspeaker as the ground connector is made and broken.

4.244 Touch the test pick to the wire to be tested and adjust the (VOL) potentiometer until a whistle of suitable volume is obtained. In some cases a high tone may be heard in the speaker with the pick removed. This is due to the capacity of the test cord.

4.245 If the volume is run high the whistler will be audible without touching a capacity, however, when the test pick is touched to a wire the change in tone is clearly discernible.

4.25 Test Operation

4.251 Touch the test pick to each of the wires or terminals to be tested. Each wire or terminal should produce the same audible signal if the wires have similar capacities and no trouble is encountered.

4.252 Changes in tone or no tone would indicate a change in capacity and may be caused on one of the following:

(A) A cross with battery or ground will cause a click in the speaker. This may be direct or through resistances which could be several thousand ohms.

(B) A condenser to battery or ground will stop the tone if the capacity is large enough. This set is designed to work on cables up to 1000 feet. Some sets may operate on lengths in excess of 1000 feet, which means that the exact capacity of the cable cannot be computed.

(C) A cross with any conductor outside of the cable under test will lower the pitch by an amount that depends on the relative length of the two conductors. If the second conductor is at least half as long as the conductor under test, the change in pitch will be great enough to be readily noticed. If the second conductor is shorter than this, the cross may or may not be detected depending upon the acuity of the tester, but when the second conductor is tested later, the change caused by being crossed with a longer conductor will be readily detected.

(D) An open in a conductor will cause it to have less capacity to ground than the trouble-free conductors so it will produce a higher pitched whistle than the others. This is not recommended, however, as a test for continuity.

4.253 The pitch of the whistle is different for every different length of cable. A satisfactory whistle will be obtained on a single conductor in a cable five feet long, if the conductors terminate in relay, jack or switch terminals. A satisfactory whistle will also be obtained when two conductors are crossed in a cable 1000 feet long. Capacity to ground beyond the values represented by these extreme conditions may or may not cause a whistle depending on manufacturing variations in the set.

4.254 The whistler is not recommended for cross tests in local forms where different wires have different lengths.

4.26 Crossed Pairs

(A) When the Whistler Test has disclosed two or more crossed conductors in a cable, the Whistler may be used to determine which is crossed with which.

(B) Connect the Whistler to one crossed conductor. Touch a grounded test pick to each of the other conductors that showed a cross. The one that stops the whistle is crossed with the conductor connected to the test set.

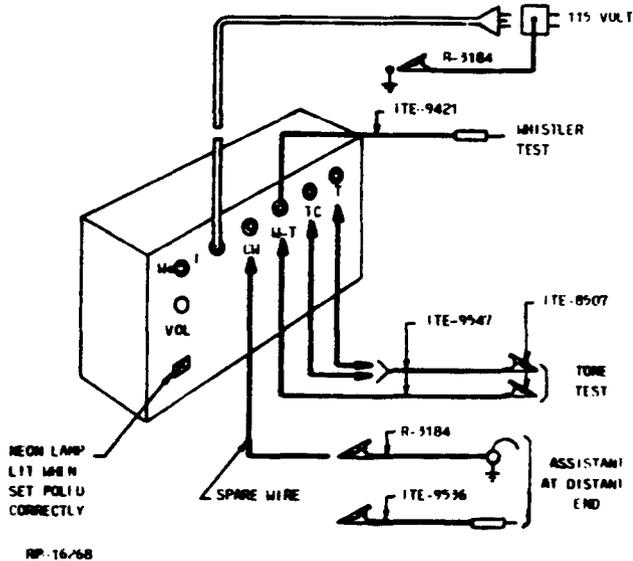


FIG. 2 WHISTLER TEST SET CONNECTION (PAR. 4.272)

4.27 Continuity Test

4.271 The continuity test is performed in the same manner as the Test Operation except that an assistant is located at the other end of the wire being tested. As each wire is whistled, the assistant applies solid ground to the wire which stops the whistle.

4.272 The assistant can obtain an OK signal by connecting a spare wire in the cable to the ITE-4261A (CW) Jack and connecting the other end of the spare wire through a test receiver to ground. See FIG. 2.

4.28 Tone Operation

4.281 Operate the toggle switch to (T) and connect a test receiver to the (W-T) and (T) or (TC) jacks. A tone of approximately 500 cycles should be heard in the receiver.

4.282 The volume of the tone is controlled by the (VOL) potentiometer and should be adjusted to work with the detector being used. Avoid working the set at too high volume as it may interfere with working circuits.

4.3 Tests Using ITE-4511

4.31 The whistler may be used for verifying wiring where the wiring is predominantly of the same lengths.

4.32 The test will verify continuity as well as give an indication of shorts, foreign grounds and other defects.

4.33 Set-Up ITE-4511

4.331 Operate slide switch to W position.

4.332 With the probe held so that the probe pick points away from the operator, rotate the knurled disk projecting through the probe case away from the OFF mark engraved on the case (counter-clockwise rotation). This operation closes a switch in the whistler battery supply.

4.333 Touch the grounding cord clip to the test set probe. A low pitched buzz should be heard in the test set receiver. As the knurled control disk is rotated further in a counter-clockwise direction, the intensity and, to some extent, the frequency of the tone in the receiver will increase.

4.334 Connect the grounding cord clip to relay rack ground near the termination of the conductors to be tested for crosses.

4.335 Touch the probe pick to one of the conductors under test. Adjust the knurled disk, if necessary, to obtain a whistle of suitable pitch. With conductors of short length it may be necessary to rotate the disk almost fully counter-clockwise.

4.34 Operation

4.341 Touch the probe to each of the conductors under test. Each should produce a whistle of the same pitch and volume.

4.342 Any fault in the conductor under test will cause a whistle of different pitch than that produced by trouble-free conductors.

(A) A cross with battery or ground, directly or through apparatus will produce a low pitched whistle or buzz of about the same pitch as if the test probe were connected to ground directly.

(B) A cross with any other conductor in the same cable will lower the pitch of the whistle by about one-half an octave.

(C) A cross with any conductor outside of the cable under test will lower the pitch by an amount that depends on the relative length of the two conductors. If the second conductor is at least half as long as the conductor under test, the change in pitch will be great enough to be readily noticed. If the second conductor is shorter than this, the cross may or may not be detected depending upon the acuteness of the tester but when the second conductor is tested later, the change caused by being crossed with a longer conductor will be readily detected.

(D) An open in a conductor will cause it to have less capacity to ground than the trouble free conductors so it will produce a higher pitched whistle than the others. This is not recommended, however, as a test for continuity.

4.343 From the foregoing, it may be seen that the Whistler will detect crosses in any cable where there are enough trouble-free conductors to establish a normal pitch for the whistle. It is not necessary to strap conductors to ground to detect crosses.

4.344 The pitch of the whistle is different for every different length of cable. A satisfactory whistle will be obtained on a single conductor in a cable five feet long, if the conductors terminate in relay, jack or switch terminals. A satisfactory whistle will also be obtained when two conductors are crossed in a cable 500 feet long.

4.345 While ITE-451 will not perform satisfactorily on cable conductors less than 5 feet in length, it can be used to detect crosses in the banjo wiring of individual crossbar switches.

4.346 The whistler is not recommended for cross tests in local forms where different wires have different lengths.

4.347 A cross between two conductors can be proved as follows: Both of the suspected conductors will "whistle" at the same pitch. Actually cross the two conductors either with the probe pick or a piece of wire at the test location. There should be no change in the pitch of the whistle if a cross exists between the conductors at some other point.

4.35 Crossed Pairs

4.351 When the whistler test has disclosed two or more crossed conductors in a cable, the whistler may be used to determine which is crossed with which.

4.352 Connect the whistler to one crossed conductor. Touch a grounded test probe to each of the other conductors that showed a cross. The one that produces a tone of about the same pitch as if the whistler probe were directly grounded is crossed with the conductor connected to the test set.

4.36 Checking For Crossed With Ground or Battery

4.361 While the whistler test can determine that a conductor is crossed with battery or ground, it cannot determine which one of the conditions it is crossed with. Once it is determined that such a cross exists, the whistler may be switched to test headset operation and a test for battery or ground can then be made. The following paragraph describes the use of ITE-4511 as a test headset.

4.37 Operation as a Test Headset

4.371 Operate the slide switch to REC position. This operation partially opens the battery supply to the whistler circuit and connects the test set receiver to the grounding cord and probe tip. A 10,000 Ohms resistor is also connected in series with the receiver and probe tip.

NOTE: If the set is used as a test headset for only short intervals between whistler operations, the whistler battery circuit need not be opened by rotating the knurled disk to OFF. If the set is used mainly as a test headset for long periods of time or when the set is not in use, the knurled disk should be rotated to OFF. (Fully clockwise - until the battery switch is felt to operate.)

4.372 The 10,000 Ohm resistor in series with the receiver and probe can be shunted out by holding the LR switch operated. With the 10,000 Ohm resistor shunted out the receiver resistance becomes approximately 300 Ohms. (Receiver resistance of 70 Ohms plus two 415 Ohm resistors connected in parallel.)

4.373 With the LR switch nonoperated current through the receiver is limited to approximately 5 milliamperes (assuming a 48 Volt battery supply). Currents of this order should not damage equipment, such as dry reed relay contacts.

5. TESTS OF MULTIPLE WIRING

5.1 General

5.11 Continuity tests, using the test sets discussed below, will assure the user of point-to-point continuity and will reflect other wiring problems as noted.

5.2 Tests Using ITE-1886

5.21 The Three Conductor Continuity Test Set may be used for testing the continuity of the tip, ring, and sleeve wire, and has a busy line feature to detect ring and sleeve or ring and tip reverses on busy lines. It is designed to make continuity tests on extensions of No. 1 or No. 11 type switchboards jack-per-line multiple in offices where high wound line relays, 34 Ohm cut-off relays, and cord and trunk circuits having a sleeve battery through a maximum resistance of 310 Ohms, are installed.

It should not be used on extension of OGT multiple, jack-per-station multiple, low resistance line relay circuits, or any type of multiple extensions other than those described above. It may be used for continuity tests on any type of un-cross-connected multiple where the Automatic Multiple Test Set is not available, and on un-cross-connected OGT and subscribers multiple having ground through a resistance or message register on the sleeve.

5.22 The set is designed to test continuity of the tip, ring, and sleeve wire, and can detect ring and sleeve or ring and tip reverses on busy lines.

5.23 Connections

5.231 24V and GRD

5.2311 Direct 24 Volt Central Office battery and ground are connected to the test set. This is conveniently done by connecting battery to the ring, and ground to the tip of a spare line in the multiple, and using a test cord to connect the 24V and GRD terminals of the test set to this line at any point where the set is to be used. Use only wire and test cords in good condition for battery and ground connections. Solder and tape all splices between wire and cord terminals.

5.232 Dry Cells

5.2321 Six dry cells are connected to the DC-1 and DC-2 jacks in such a manner that each conductor of the DC-1 jack is connected to the corresponding conductor of the DC-2 jack through two dry cells in series. This is conveniently done by connecting the dry cells between corresponding conductors of two spare lines in the multiple at one end of the switchboard or at the distributing frame, and patching these spare lines to the DC-1 and DC-2 jacks with two ITE-9604 Cords at any point where it is desired to use the set. Two sizes of DC-1 and DC-2 jacks are provided in order that the ITE-9604 Cord, which has a No. 109 plug (109 replaced by 309) on one end and a No. 110 plug (110 replaced by 310) on the other, may be used to connect to either No. 92 or No. 49 multiple jacks. For testing exceptionally long runs it may be necessary to use three dry cells instead of two for each conductor.

5.233 Helper's Signal

5.2331 If both tester and helper cannot hear the buzzer, or if the buzzer is not used, an additional signal for the helper may be obtained by making one of the following connections:

5.234 Receiver

5.2341 When the buzzer is used, the REC terminal is extended to one terminal of a test receiver worn by the helper and the other terminal of the receiver is connected to ground.

5.235 Lamp

5.2351 When the buzzer is not used, the LAMP terminal is extended to one terminal of a 2G lamp located near the helper and the other terminal of the lamp is connected to 24 volt battery. If desired, a

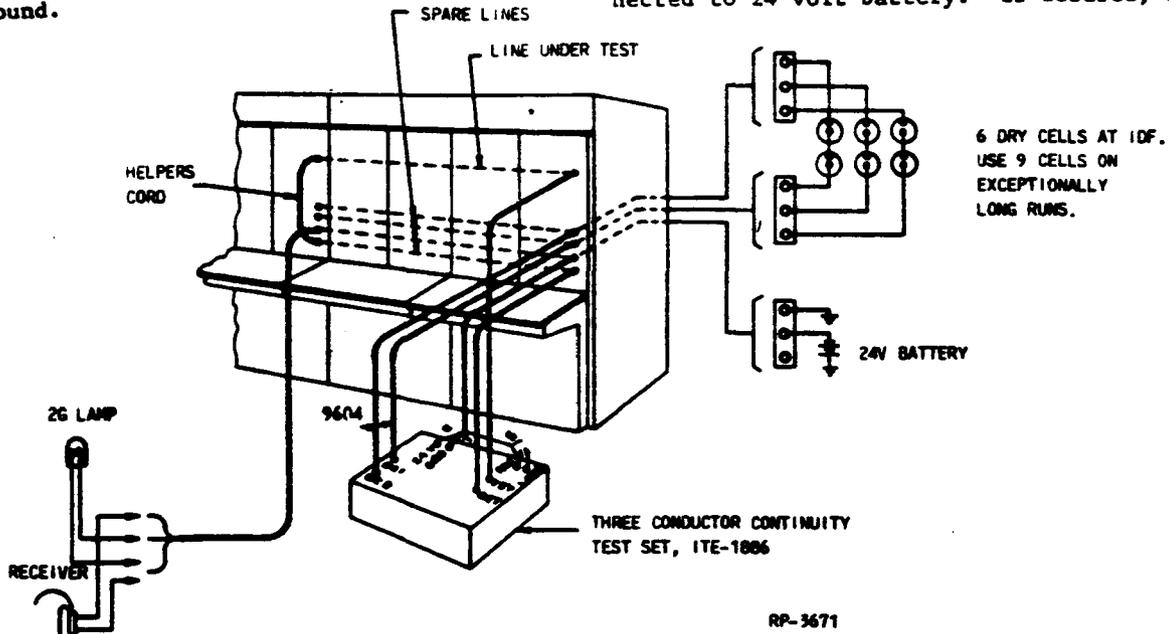


FIG. 3 TYPICAL CONNECTIONS FOR THREE CONDUCTOR CONTINUITY TEST SET (PAR. 5.2361)

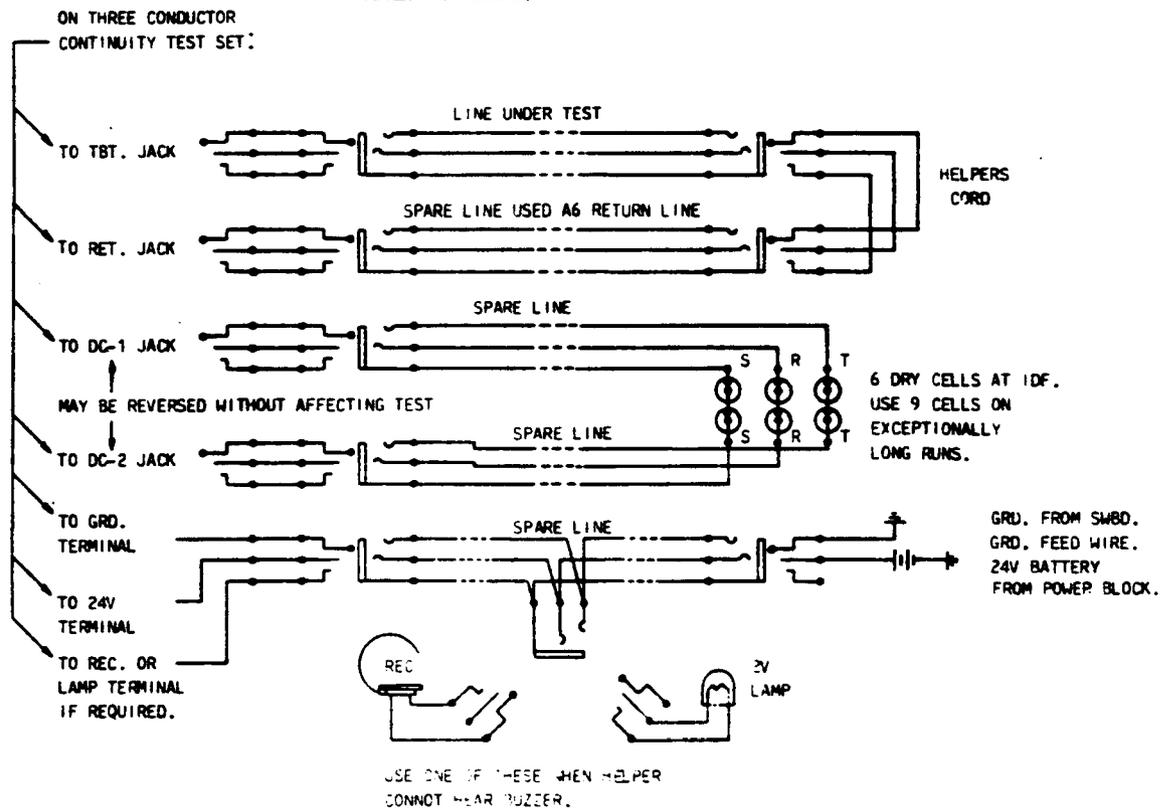


FIG. 4 TYPICAL CONNECTIONS FOR THREE CONDUCTOR CONTINUITY TEST SET (PAR. 5.2361)

trunk lamp may be used as a signal by connecting the LAMP terminal to the sleeve of a blank line and plugging a trunk in this line at the helper's position.

5.236 TST and RET Jacks

5.2361 The TST and RET jacks are connected to the two jacks between which continuity is being tested. Two sizes of jacks are provided in the test set in order that either No. 92 or No. 49 multiple jacks may be tested with ITE-9604 Cords.

NOTE: The foregoing connections are shown graphically in FIGS. 3 and 4.

5.24 Circuit Operation

5.241 Idle Line Free From Trouble

5.2411 The set contains a chain of three dry cell circuits which operates the R, S, and T relays over the corresponding conductors of the line under test, these circuits being so arranged that the R relay operates as soon as the plug of both test cords are completely inserted in the jacks. The ring is placed first in the chain, to prevent tapping of subscribers' bells, flashing of line lamps and other troubles which would be caused if the tip and ring were bridged during the process of inserting the two test plugs. The R relay operated lights the R lamp and completes the dry cell circuit for operating the S relay, thereby lighting the S lamp, and completing the dry cell circuit for operating the T relay. The BL relay does not operate on an idle line.

5.2412 The operation of the T relay lights the T lamp and closes a circuit from ground on the normal contact of the BL-1 relay to the SIG lamp, the LAMP terminal, and to the buzzer, if the BUZ key is operated.

5.242 Idle Line in Trouble

5.2421 If the ring, sleeve or tip is open, the corresponding relay will not operate, the operation described above will stop at that point, and the R, S, and T lamps will indicate the point at which the test was blocked. If these lamps indicate that only the tip is open, no key operations are required, but if the ring, sleeve or both are open, the R or S key is operated to complete the test.

5.2422 These keys close local dry cell circuits in the set for operating the corresponding relays, permitting the set to test the remaining conductors of the line and to give an O.K. signal if the remaining conductors are not open.

If the conductor which blocked the test is reversed with one of the conductors of the same line, the two corresponding relays will lock up over the reverse path when the key is operated, and the signal will remain operated after the key is released. In the case of a ring and sleeve reverse this locking circuit may be traced from the ring of the TST jack through the ring dry cells, normal contact of the BL key, R relay winding, ring of the RET jack and helper's cord, reversed wire in multiple, sleeve of TST jack, make contact of R relay (operated by R key), sleeve dry cells, normal contact of BL key, S relay winding, sleeve of RET jack and helper's cord, and reversed wire in multiple back to the ring of the TST jack. A similar path exists in the case of a sleeve and tip or ring and tip reverse. Since this locking path does not exist unless both ends of both reversed wires are connected to the test set, the signal will stop when the key is released in the case of one or two opens or a reverse with a conductor of another line.

5.243 Busy Line

5.2431 When a busy line is encountered the BL relay operates from battery on the sleeve of the subscriber's cord or trunk circuit and closes the circuit for operating the BL-1 relay. The BL-1 relay operated, opens the circuit for the SIG lamp and buzzer and causes the BL lamp to light as an indication that the line is busy. The R, S and T relays function as described for an idle line.

5.2432 After noting that the R, S and T lamps are lit the tester operates the BL key, which opens the three dry cell circuits and connects the R relay between the rings of the two test cords. The purpose of this key is to determine whether the R relay was operated by the dry cells over the ring circuit, or by Central Office battery and ground over a ring and sleeve or ring and tip reverse. In the latter case it will remain operated after the BL key is operated keeping the R lamp lit as a trouble signal.

5.2433 A reverse of any kind in cross-connected multiple sets up a central office battery circuit through one or more of the relays in the test set which will operate these relays when the resistance and battery conditions permit. In the case of an idle line this central office battery current is negligible and reverses are indicated as opens, as described in PAR. 5.242 but on busy lines the current from Central Office battery over a ring and sleeve or ring and tip reverse is quite heavy, and these reverses are usually detected by the lighting of the R lamp when the BL key is operated.

5.2433 (cont'd)

A tip and sleeve reverse of a busy line or between two busy lines will usually be detected as an open on one or both lines, but under certain circuit conditions will operate the S and T relays and give a false O.K. signal.

5.2434 In the case of a reverse between two conductors of a busy line, if the relay associated with the first conductor of the reverse is operated by the central office battery, the dry cell locking circuit described in PAR. 5.242 is set up. If the dry cells are aiding the central office battery the relays will lock up and the reverse will be detected by the lighting of the R lamp after the BL key is operated, but if the dry cells oppose the central office battery the relays will chatter when the plugs are first inserted.

5.244 Helper's Signal

5.2441 If a receiver is connected between the REC terminal and ground the sound of the buzzer will be transmitted to this receiver through the C-1 condenser.

5.2442 The operating ground for the SIG lamp and buzzer is also connected to the LAMP terminal and may be used to light a lamp at the helper's position.

5.245 SIG Key

5.2451 The operation of the SIG key connects ground to the SIG lamp, LAMP terminal and buzzer. It is used by the tester to signal the helper to advance to the next line.

5.25 Reason for Working Limits

5.251 The use of the set is restricted to the standard type of multiple described under "General Description" for the following reasons:

(A) There must be sufficient current through the BL relay when connected to the sleeve of a busy line to operate this relay, or certain reverses will not be detected on busy lines. A maximum cord and trunk sleeve resistance of 310 Ohms and a 3/4 Ohm cut-off relay will permit the BL relay to operate satisfactorily.

(B) There must be sufficient resistance in the tip and ring circuits on idle lines to prevent false operation of the test set relays by line relay battery and ground in the case of reverses.

High wound line relays meet this requirement, but the old type 60 Ohm line relays do not.

(C) The sleeve circuits in the office must be such that the 2250 Ohm ground placed on the sleeve by the test set will not interfere with the proper operation of any marginal relays in working circuits, such as ringing selection relays in jack-per-station trunk circuits.

(D) Since a tip and sleeve reverse on a busy line may not be detected by this set under certain conditions, the multiple must be such that this tip and sleeve reverse will be detected by the voltmeter test.

5.3 Tests Using ITE-2175

5.31 The Voltmeter Set is designed to detect high resistance crosses between conductors such as paralleled tip, ring and sleeve wires of jack ended circuits, to detect grounds and to provide a means for making DC voltage measurements.

NOTE: Detailed methods for Multiple Testing of Local, Toll and Teletypewriter Switchboards are contained in Handbooks 70, 72, and 83. Tests of Dial Multiples are given in Handbooks 51, 52, 53, 61, 62, 63, 91, and 93.

5.32 The voltmeter was developed to detect crosses and grounds, especially those having a high resistance, between any one conductor and the surrounding conductors.

5.33 General

5.331 Voltmeter tests are made with the Voltmeter Set, ITE-2175, or with Volt Ohmmeter, ITE-4442. ITE-2175 is preferable for use in jack multiple as ITE-4442 is not arranged for rapid manipulation when patched to a jack. When battery and ground cannot be removed by circuit operation, a test should be made to check for the proper polarity.

5.332 Test Sets

Amount	ITE	Description
1	2175	Voltmeter Test Set
or		
1	4442	Volt Ohmmeter
1	2095	Voltmeter Battery Supply Set

ITE-2095 is ordinarily supplied to manual and toll offices only.

5.333 Accessories

Amount	Code	Description
1	Any	45 Volt Radio B Battery

Purchase locally for dial offices and for manual or toll offices where ITE-2095 is not available.

5.334 Cross Connections

As far as possible, all cross connections should be installed before performing voltmeter tests in order that they may be tested with the leads under test.

5.34 Circuits Free of Battery and Ground

5.341 Connect the + BAT terminal of ITE-2175 or - terminal jack of ITE-4442 to the POSITIVE terminal of the 45 Volt B battery, or to the + terminal of ITE-2095.

5.342 Connect the NEGATIVE terminal of the battery or the GRD terminal of ITE-2095 to ground.

NOTE: When ITE-2095 is used in connection with ITE-2175 (see FIG. 5) connect either 24 Volt or 48 Volt battery to the 24V or 48V terminal of ITE-2095 and connect the SIG terminal of ITE-2095 to the SIG terminal of ITE-2175; also connect either 24 Volt or 48 Volt battery to the 24V or 48V terminal of ITE-2175 and ground to GRD terminals of ITE-2175 and ITE-2095. If 24 Volt battery is used, note that knife switch on ITE-2175 is in position so that designation 24V is showing. If 48 Volt battery is used, designation 48V should be used.

5.343 Connect a test lead to the R-BAT terminal of ITE-2175, or the terminal of ITE-4442.

NOTE: Before starting the tests, touch the test lead referred to in PAR. 5.343 to ground and note that voltmeter functions properly.

5.344 Using strap wire, strap the terminals of the multiple or cross connections under test at the terminal block or terminating point and connect to ground.

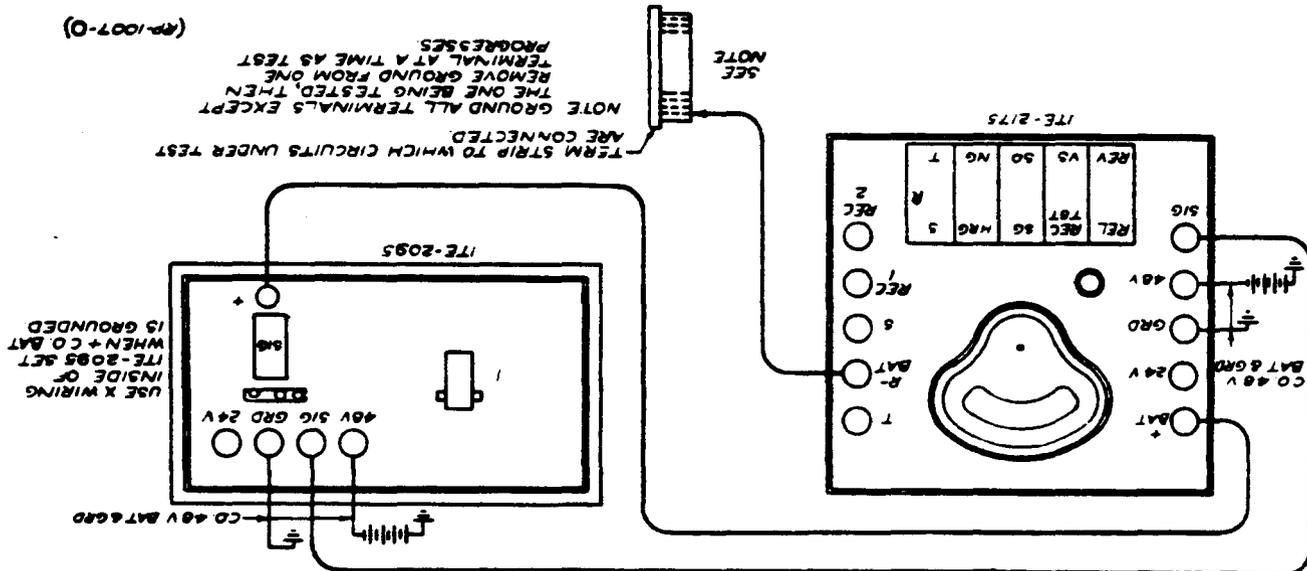


FIG. 5 TEST CONNECTIONS VOLTMETER TEST (PAR. 5.342)

5.345 Check each terminal or wire to make sure that all are grounded.

5.346 Remove the strapping from one of the terminals or wires and connect the test lead from the Voltmeter Set to this terminal. There should be no deflection of the voltmeter, showing that this lead is free from ground or crosses.

NOTE: If ITE-2095 is used, the buzzer will operate when trouble is encountered provided the SIG key on ITE-2095 is operated.

5.347 Remove strapping from the next terminal of wire and connect the test lead to that terminal. There should be no deflection of the voltmeter, showing that the terminal or wire is free from ground or crosses.

5.348 Repeat PAR. 5.347 until all the strapping has been removed.

5.349 The resistance of a cross may be roughly estimated by operating the VS key momentarily to avoid burning out shunt or overloading battery in ITE-2175 or ITE-2095, and noting change of voltmeter reading. If voltmeter reading is greatly reduced, the resistance of cross is high. If reduction of voltmeter reading is slight, the resistance of the cross is low. Resistance of crosses can be determined with ITE-4442 used as an ohmmeter. See PAR. 3.5

5.35 Circuits Not Free From Battery or Ground

5.351 When possible, perform circuit operations which will remove the battery or ground from circuits under test and perform voltmeter test as described in foregoing PAR. 5.341 to 5.349.

5.352 When battery and ground cannot be removed by circuit operation, omit test per PAR. 5.341 to 5.349 and make a test for proper polarity observing that meter reads approximately the same for all circuits of the same type.

6. TESTS OF LEADS WITH POTENTIAL OR GROUND

6.1 General

6.11 Tests using the sets discussed below will assure the user of continuity and will reflect other wiring problems as noted.

6.2 Tests Using ITE-4490

6.21 The assignment test set was designed to indicate on a direct reading meter resistance in ohms to battery or ground in a 48 Volt circuit. The set consists of the meter portion of the Rapidohm Test Set ITE-4251 with components of closer tolerance to obtain readings of greater accuracy. A 10X multiplier switch is provided to read values above 2000 Ohms conveniently. The zero center-scale meter reads directly in ohms.

6.22 The set was developed to furnish a device for testing trunk assignments when varying conditions of battery or ground appear on the different trunk conductors.

6.23 Set Up ITE-4490

6.231 If the meter pointer is not at center-scale (infinity), adjust the setting using a screwdriver in the slot of the centering screw.

6.232 Connect 48V battery and ground to the set with ITE-9408 Cord. Meter reading remains at infinity.

6.233 With the switch set at position connect ground to jack (Test) with any single conductor test cord. The meter should read zero at +GRD end of the scale. If the pointer is off reading turn (ADJ) knob until reading is correct. Turn switch to position RX10. Meter reading may change slightly. Set (ADJ) knob for the best balance in readings. Disconnect ground from (TEST) jack.

6.234 Repeat PAR. 6.233 with 48V battery connected to jack (TEST). The meter should read zero at -48V end of scale. Set (ADJ) knob for the best balance in reading at both ends of scale for both switch positions.

6.24 Continuity Test

6.241 With 48V Battery and ground connected to the set, insert the test cord into (TEST) jack.

6.242 Signal assistant to apply ground to the other end of the lead under test. Meter will read 0 at + GRD end of scale.

6.3 Tests Using ITE-4251 or 4251A

6.31 The Rapidohm Test Set was developed to test for continuity and crosses in cabling and multiple wiring that is connected to battery or ground through resistance or magnet winding. In addition to the above, this set may be used to verify continuity and crosses on leads isolated by diodes or diode matrix networks.

6.32 Calibration (ITE-4251)

6.321 Connect jack A of the test set to jack A of a frame.

6.322 Turn the SELECTOR switch to position R. Set the meter at exactly midscale by means of the adjusting screw on the meter.

6.323 Connect jack TEST to jack 48V. Adjust the ADJ knob to obtain a meter deflection of exactly zero.

6.33 Adjustment to Circuit Under Test

6.331 Connect jack TEST to the terminal of the circuit under test. Use the SELECTOR switch in position R or RX10, whichever gives the better meter deflection and observe by the deflection of the meter to the left or right that the terminal is connected to battery or ground. Also observe by the amount of the deflection that the circuit includes the proper value of resistance. When the switch is in position RX10, the indication of the meter must be multiplied by 10 to obtain the resistance of the circuit in ohms.

6.332 Operate the toggle switch to TB when the circuit under test is connected to battery or to TG when it is connected to ground. Where the external resistance involved is 200 Ohms or less, operate the (LR) key. This adds 300 Ohms in parallel with the P1 windings of the (L) and (H) relays to reduce the current flow through these windings. Turn the H and L rheostats to their extreme clockwise position. With jack TEST connected to the circuit under test, turn the SELECTOR switch counter-clockwise to the first position that lights lamp L. This will be position L when the resistance in the circuit is under 1400 Ohms.

6.333 Turn rheostat L counter-clockwise until lamp L just goes out, lamp OK lights and the buzzer sounds.

6.334 Turn rheostat H counter-clockwise until lamp OK goes out and H lights. Then turn it back until H just goes out and OK relights.

6.335 The foregoing adjustment of rheostats H and L is approximate because it does not take into account the heavy negative soak applied to the relays by the biasing circuits while the test lead is open. Repeatedly open and close the test lead and trim the adjustments of rheostats H and L so that lamp OK just lights when the lead is closed.

6.34 Calibration (ITE-4251A)

6.341 Connect jack A of the test set to jack A of a frame.

6.342 Turn the SELECTOR switch to position R. Set the meter at exactly midscale by means of the adjusting screw on the meter.

6.343 Connect jack TEST to jack 48V. Adjust the ADJ knob to obtain a meter deflection of exactly zero.

6.344 Remove jack TEST from jack 48V.

6.35 Adjustment to Circuit Under Test

6.351 Connect +130 jack of test set to +130 jack of a frame, if the test set is to be used to check resistances isolated by diodes needing positive voltage in order to be forward biased. If the test set is not going to be used on isolated resistances, do not make +130 connection.

6.352 Connect jack TEST to the terminal of the circuit under test. Use the SELECTOR switch in position R or RX10, whichever gives the better meter deflection, and observe by the deflection of the meter to the left or right that the terminal is connected to battery or ground. If jack +130 of test set is used the meter deflection will be read on -48V side. Also observe the amount of the deflection that the circuit includes the proper value of resistance. When the switch is in position RX10 the indication of the meter must be multiplied by 10 to obtain the resistance of the circuit in ohms.

WARNING: Do not connect jack test to -48 Volt power with +130 Connected to Test Set.

6.353 Operate the toggle switch to TB when the circuit under test is connected to battery or when +130 connection is used. Set toggle switch in TG position when the circuit under test is connected to ground and +130 is not being used. Where the external resistance involved is 200 Ohms or less, operate the (LR) key. This adds 300 Ohms in parallel with the P1 windings of the (L) and (H) relays to reduce the current flow through these windings. Turn the H and L rheostats to their extreme clockwise position. With jack TEST connected to the circuit under test, turn the SELECTOR switch counter-clockwise to the first position that lights lamp L. This will be position L when the resistance in the circuit is under 1400 Ohms.

6.354 Turn rheostat L counter-clockwise until lamp L just goes out. Lamp OK lights and buzzer sounds.

6.355 Turn rheostat H counter-clockwise until lamp OK goes out and H lights. Then turn it back until H just goes out and OK relights.

6.356 The foregoing adjustment of rheostats H and L is approximate because it does not take into account the heavy negative soak applied to the relays by the biasing circuits while the test lead is open. Repeatedly open and close the test lead and trim the adjustments of rheostats H and L so that lamp OK just lights when the lead is closed.

6.4 Test Operation

6.41 Connect jack TEST to the terminals of each of the circuits under test. Each should cause the buzzer to sound. This verifies that each of the leads tested has the correct resistance to battery or ground, that it is therefore, continuous and not crossed with any other lead connected to battery or ground.

6.42 If it is necessary to also check the circuits for reverses, and if the apparatus at the distant end consists of magnet windings, the magnets will be operated by the current over the test lead and an observer can watch that they operate in predetermined sequence. If resistors are used at the distant end, the assistant can short circuit them after continuity has been established. This will stop the buzzer unless a reverse is encountered.

7. TESTS OF WIRING ASSOCIATED WITH PLUG-IN BAYS USING ITE-5718

7.1 General

7.11 Modularized Continuity Verification
Set was developed to enable the staller to verify the wiring between plug-type bays and distributing frames. The set consists of a family of plug-in boards each of which is designed for a specific application.

7.2 Tests Using ITE-5718

7.21 Wiring Verification Tests using ITE-5718 will assure the user of point-to-point continuity as well as detecting and analyzing opens, reversals, shorts and miswiring.

7.22 The Light-Box (List 1) may be plugged directly to the face of any one of the plug-in extender boards. The appropriate designation plate should be attached to the Light-Box. This will provide the correct nomenclature for the wiring for the system under test.

NOTE: Some extender boards have built-in display lights on the face plates and do not require a light box.

7.23 The Installer, at the bay under test, plugs the appropriate extender board into the channel(s) of the bank.

7.24 The Installer at the distributing frame connects the test probe (ITE-9539) to Central Office battery for appropriate potential. The Installer then proceeds to probe the leads on the proper terminal block(s) at the distributing frame.

7.25 The Installer at the frame under test, verifies that the lamps operate in the proper sequence.

7.26 Continue the procedure until the complete frame is verified.

7.27 Error Indication:

(A) If no lamp lights, there is an open or a miswire.

(B) If the wrong lamp lights, there is a miswire or reversal.

(C) If two lamps light at the same time there is a short between the two terminals.

(D) If any lamps remain lit (without probing) there is a short to battery.

(E) If no lamp lights in the light-box and the lamp in the probe lights, there is a short to ground.

7.28 Refer to other 900 Series Sections for more information on specific applications of the ITE-5718.

8. WIRING VERIFICATION USING ITE-5420 TO ITE-5424 (ELVS)

8.1 General

8.11 The Electronic Lead Verification System (ELVS) is a portable automatic test system designed for Central Office bulk wiring verification. It can be used in Electromechanical and Electronic Switching Systems. Although the system does not furnish a source of DC current for use as a talking circuit, the spare jack provision on each encoder eliminates running a pair of leads between frames under test. This is applicable only when the ELVS is used on the automatic mode.

8.2 Requirements

8.21 The test set will verify lead continuity and will identify opens, shorts, reversals and grounding conditions. It also has the capability of specific wire identification and search, if required. The system is most efficiently used in bulk wiring operations when a pattern is maintained on the wiring (e.g., wiring between the protector and cosmic distributing frames).

8.3 Tests Using ELVS

8.31 The ELVS can operate in two modes; a manual mode and in automatic mode. FIGS. 6 and 7 show the basic elements in each mode.

8.32 The ITE-5420-L1 Test Accessory Set contains inter-connect codes which are always required when using the system. The other lists contain test codes required for a particular application. Interconnect cords are 50 conductor connectorized cables or cordage used to carry power, communication, control, and coded information between the components of the System.

8.33 Test cords are those which interface from an Encoder to the apparatus or terminal strip which terminates the leads under test.

8.34 The ITE-5421 Analyzer contains the power supply and rechargeable batteries, test signal generators, audible alarm controls, cold cathode ("Nixie" type) display, and a set of switches used to analyze the display information.

8.35 The ITE-5422 Master Test Encoder selects one end of a lead and applies a test signal to it.

8.36 Encoders (ITE-5423 or ITE-5424) receive the test signal at the other end of the lead on one input connector contact (or several, if many leads are connected or shorted together). A diode matrix in the Encoder routes the signal to 4 of the 50 information leads representing the lead location code.

- 1 "End A" or "End B"
- 2 Hundreds Digit
- 3 Tens Digit
- 4 Units Digit

8.37 The Analyzer receives information about each lead from the Encoder and Master Test Encoder, and compares this "origin-destination" data to determine whether any wiring trouble conditions exist.

8.38 The lead location code is decoded and displayed by the Analyzer, which then signals the Master Test Encoder whether to continue ("Pass") or stop ("Fail").

8.39 Refer to Section 910 of this Handbook for information on the operation of these test sets. Other 900 Series Sections provide information on applications and use of the test cords.

9. CABLING VERIFICATION

9.1 General

9.11 The test sets discussed below may be used in various cabling operations and in some instances may be adapted to wiring tests.

9.2 Tests Using ITE-5609

9.21 The Multiple Lead Verification System (MLVS) may be used for verifying power cable and switchboard cable runs in Electromechanical and Electronic Switching Systems. List 1 and List 2 also require an ITE-4442A VOM for making tests, but the List 3 contains all items required to perform the tests.

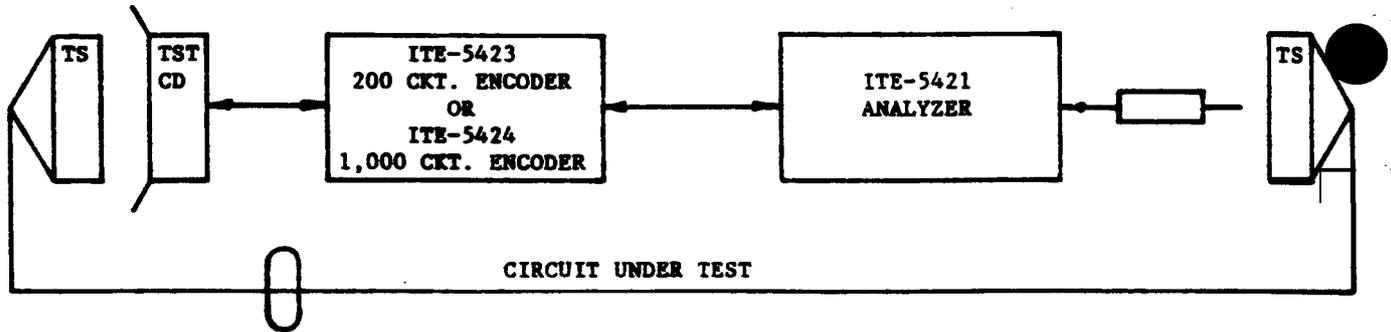


FIG. 6 MANUAL PROBING SETUP
(PAR. 8.31)

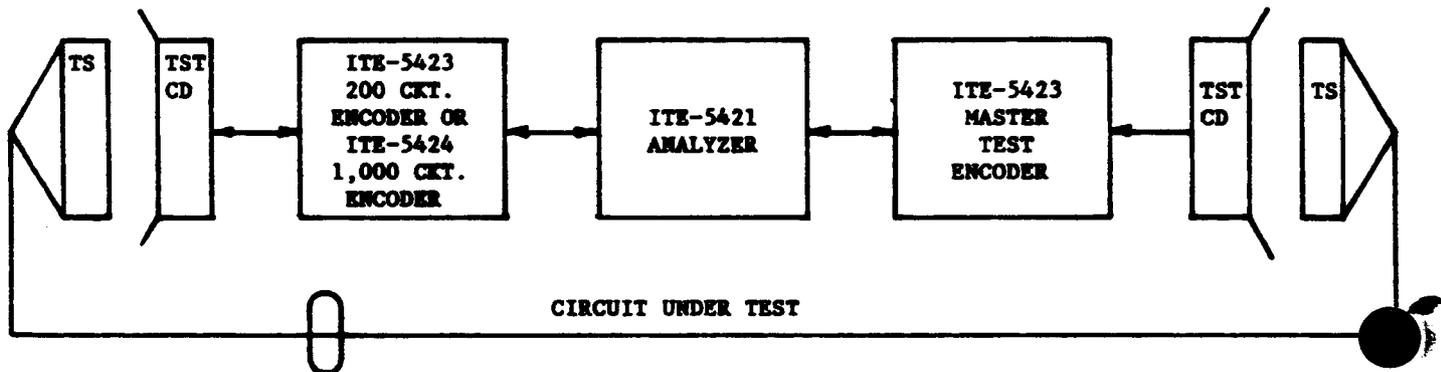


FIG. 7 AUTOMATIC SCAN SETUP
(PAR. 8.31)

9.22 Test with the List 1 or List 3 will allow the operator to verify cable runs or allow the operator to correctly tag cables. The List 2 may be used to verify continuity of leads or multiples at the time of wire wrapping. The system will only allow the user of point-to-point continuity, but will not check for shorts or analyze other defects.

9.23 Operation

9.231 Whenever feasible ground should not be used as a common return.

9.232 If found to be necessary, a special wire identification scale may be made by taping a 1" transparent Cellophane tape across the face of ITE-4442A VOM. This tape can be marked with a grease pencil and easily changed to identify specific leads. Be sure to remove the tape after testing.

9.233 Before testing calibrate the ITE-4442A VOM by placing the range switch on "XIK" and connect "+" and "-" meter leads. Zero adjust the VOM using the " " adjustment.

9.234 Before testing, calibrate the meter (List 3) by connecting the red and black leads together and adjusting the screw on the meter face until the needle is directly on the calibrate line.

9.235 When using the List 1 or 2, if a common return path, ground, etc., does not exist, connect the yellow and the "GRND" resistance box lead to any two wires of the cable. Take the VOM to the other end of the cable and search for any two leads that make the VOM indicate between 2 and 10 on the black AC-DC meter scale. The lead that connects to the "-" VOM probe is the "GRND" lead of the resistance box and can be marked at both cable ends and used as a common return for the testing.

9.236 Connect the resistance box leads, 1 through 12, to the cable leads under identification. Use the VOM or meter and identify leads 1 through 12 at the remote cable end, using the meter scale marked 1 through 12. Repeat in groups of 12 or less until all leads have been identified (FIG. 8).

9.24 Switchboard Cable, Surface Wiring, Etc., Testing

9.241 Repeat PARS. 9.231, 9.232, 9.233, 9.234, and 9.235 where they apply.

9.242 If a wire-wrap gun is to be used, use List 2 and connect the extension probe bracket to the gun tip, as per FIG. 9, using the wrench provided.

WARNING: A Metal wire-wrap gun tip sleeve must be used. A plastic tip sleeve will not work.

9.243 Wire-wrap 12 leads at one cable end and connect the resistance box leads, 1 through 12, to the wire-wrap terminals.

9.244 Connect the extension bracket to the VOM, and insert the cable lead to be identified into the gun tip. Identify the lead end using the VOM, and connect it to the proper terminal.

9.3 Tests Using ITE-5256

9.31 The ITE-5256 Connectorized Cable Test Set was developed to detect single wiring faults in the connectorized cables of No. 2 ESS. The test set can verify cables using 72, 64, 50 or 48 per connectors either in or out of the cable rack.

9.32 The test set will verify continuity in the wiring and will indicate a fault, but will not determine the cause of the fault.

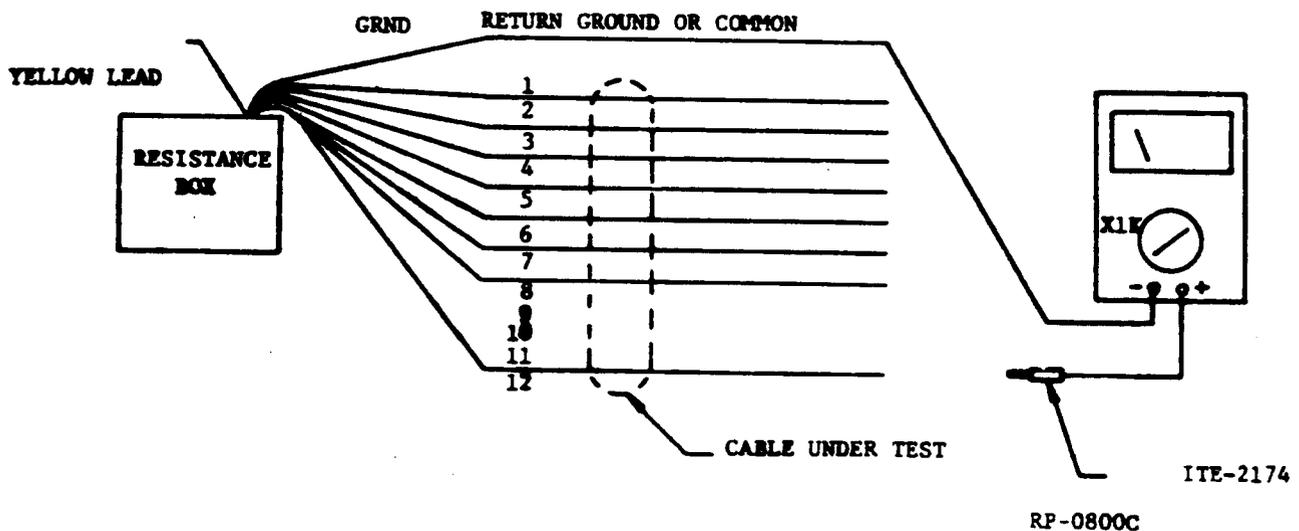


FIG. 8

(PAR. 9.236)

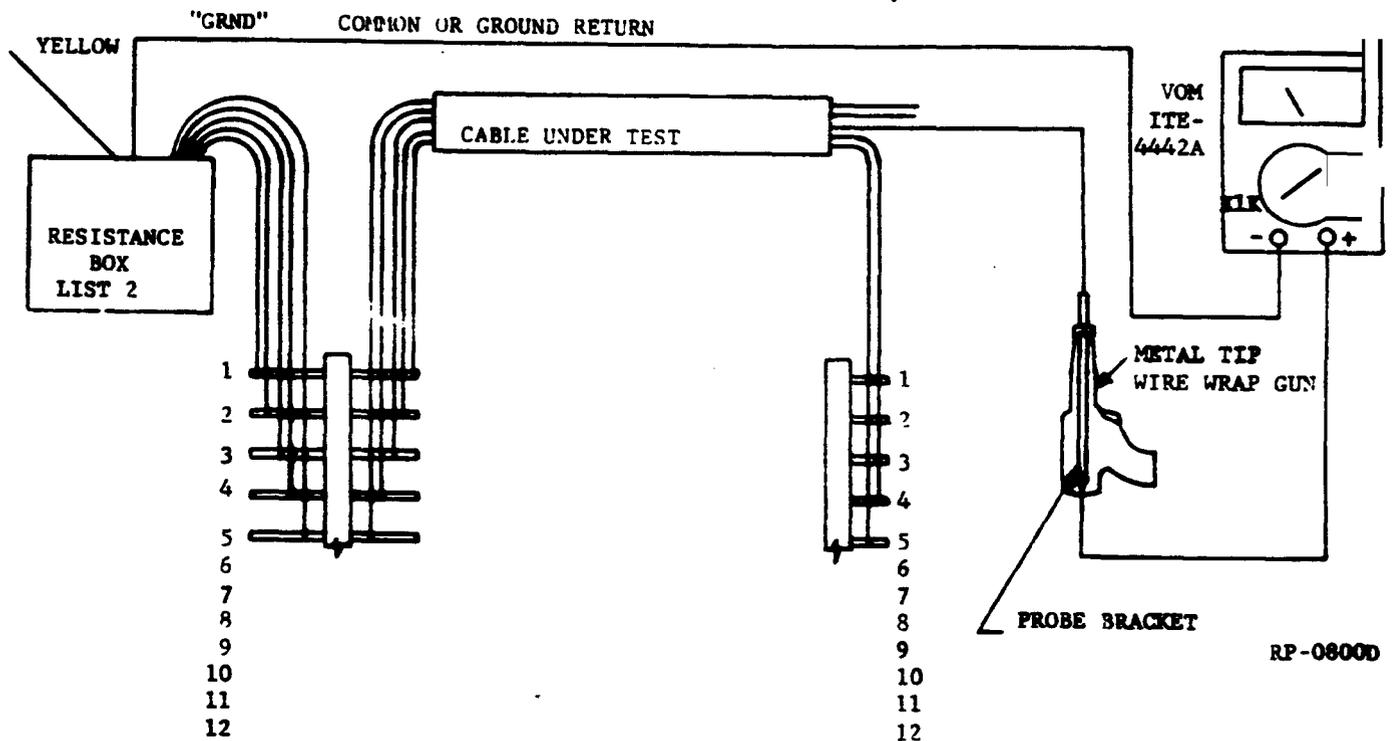


FIG. 9
(PAR. 9.242)

9.33 Calibration

9.331 Calibration of test set can be checked by removing connectorized cables from the local end of the test set. Place the FUNCTION switch in the TST LO position, note FAULT lamp is out. Press LIMIT TEST button and note FAULT lamp lights. Switch FUNCTION switch to TST HI position. FAULT lamp should light. Press LIMIT TEST switch again and lamp extinguishes. This verifies calibration of test set.

9.332 To calibrate test set turn the SENS potentiometer inside the local box to the center of rotation. Place the FUNCTION switch in the TST LO position.

9.333 Turn REF potentiometer full counter-clockwise and turn back until FAULT lamp extinguishes. Perform the test in PAR. 9.331. If this test passes, the set is properly calibrated. If this test fails turn the SENS potentiometer approximately one turn counter-clockwise and repeat PAR. 9.333 until set passes.

9.334 If proper calibration cannot be attained, replace the battery and repeat the calibration adjustments.

9.34 Operation

9.341 Groups of six leads (five in the 50-pin connector) are selected by the GROUP switch. See TMO-5256 for lead assignments. This switch is rotated through the required number of positions to test all the groups in the cable.

9.342 If the **FAULT** lamp is lit for a group of leads under test and the **FUNCTION SWITCH** is in the proper position a short, open or miswire exists in that group.

9.4 Tests Using ITE-5717

9.41 The cable locator system was developed to aid the Installer in the location of cables in conjunction with the 710 Connector program. The set is primarily intended to be used on voice frequency pairs in exchange cables where the possibility of interference with service must be reduced to minimum.

→ Indicated new or changed information.

Reason for Reissue
Revised Paragraph 7.

9.42 The test set can be used to identify cables in the cable rack. The set may be used for continuity verification in certain applications.

9.43 The set consists of two basic units: a transmitter which produces a high frequency signal and an audio signal; and a receiver which detects and amplifies the signals. Both units are battery powered. For detailed instructions concerning the operation of the set, refer to Section 911 of this Handbook.

Engineering Planning Manager
(Installation)