GENERAL TESTS

CONTENTS PAGE

1. GENERAL INFORMATION

Description of Tests

1.01 This section outlines instructions for applying general tests to circuits for which no detailed test methods are provided.

1.02 The functional Regional Installation Engineering Organization should be contacted to provide test information for the following:

(a) Operating Company modifications of standard circuits

(b) Non-standard circuits (ES-schematics)

(c) Manufactured discontinued (MD'D) circuits

1.03 Each of the general tests is explained in Paragraphs 1.09 thru 1.16 to aid in selecting the particular test or tests required to completely verify a circuit. The number of the paragraph containing instructions for applying each test is also indicated.

1.04 The tests outlined in this section satisfy BSP AA630.001 General Performance Requirements. For any additional requirements, such as routine, which might apply to the circuit under test, refer to the individual performance requirements for the system. These are:

(a) BSP 816-007-181 Performance Requirements for No. 1 Crossbar (Handbook 61, Section 10).

(b) BSP 818-010-180 Performance Requirements for 4A and 4M Toll Switching Systems with or without CAMA (Handbook 67, Section 1).

(c) BSP AA636.801 Performance Requirements Toll Testboards No. 4, No. 5, No. 16, No. 17B and No. 18B (Handbook 67, Section 3).

(d) BSP 817-013-180 Performance Requirements for Crossbar Tandem (Handbook 65, Section 0).

(e) BSP 819-010-180 Performance Requirements for No. 5 Crossbar Offices (Handbook 69, Section 0)

Analysis

1.05 All specified features of a circuit, as determined from an analysis of the schematic, circuit description (CD) and wiring list, should be verified using one or more of the applicable tests as specified in Paragraphs 1.09 through 1.16.

1.06 When a circuit contains electronic devices, such as transistors, diodes, etc., refer to Section 0.3 of this handbook for precautions to be observed when testing these devices.

1.07 Normally general tests should be applied in the following sequence, although it is permissible to combine tests where practicable.

(a) Continuity

(b) Voltmeter

(c) Resistance Measurements

(d) Contact Protection and Surge Absorption

(e) Adjustment

(f) Operating

(g) Talking or Transmission

(h) Circuit Induction (Crosstalk)

1.08 Prior to start of test, verify that the equipped circuit apparatus and options agree with the wiring list specifications for the circuit.

General Test Criteria

Continuity Tests (Para. 5)

1.09 All wiring run by the installer, including battery supply leads, shall be verified for continuity to detect opens, reverses and incorrect wiring. As part of this operation, verify that the instructions for pairing, quading or other grouping of leads ("C" wiring for example) as indicated on the schematic have been observed.

Voltmeter Tests (Para. 6 and 12)

1.10 These tests are made to detect crosses or grounds in the circuit. Direct or low resistance crosses and grounds will ordinarily be detected by operating tests. However, a separate test for high resistance crosses and grounds should be made on multiple and cross connections which are used as voice carrying conductors.

Resistance Measurements (Para. 8)

1.11 This test verifies that the correct value of resistances which are used to compensate for cable resistance, external circuit conditions or external ground conditions when these marginal features are not verified by an operating test. Resistance measurements should also be made on all one percent resistances in test circuits, test sets and test desks.

Contact Protection and Surge Absorption (Para. 10 and 11)

1.12 A verification shall be made for correct wiring and proper functioning of installer mounted and connected condensers, resistances (except when part of a shop assembled coil), contact protection networks, retardation coils or a combination of these when used in a circuit for contact protection or surge absorption.

Adjustment (Para. 7)

1.13 Pulsing tests are required on all circuits containing pulse repeating relays when requirements are provided in either the circuit description (CD) or the schematic. A current flow verification, using the schematic circuit requirement tables, should be made of supervisory or tripping relays unless one of the following methods can be applied:

(a) Operating tests to incoming trunk test lines in connecting offices.

(b) Operating tests to incoming trunk test lines in the same office.

(c) Operating tests to test sets which provide marginal tests of these relays.

Operating (Para. 3)

1.14 These tests, using either test sets or test frames, utilize the circuit in the same manner as it is used in service. Using this technique, it is possible to verify a circuit feature, an entire circuit or a combination of circuits to determine whether the equipment involved will satisfactorily perform all its signalling, switching, transmission or other design functions as indicated on the circuit drawings and circuit descriptions.

Talking or Transmission (Para. 4)

1.15 Unless superseded by the individual performance requirements for the system, transmission tests shall be performed on all circuits which contain transmission requirements on the associated schematic or in other supplementary information. Where this requirement does not apply, talking or 1000 cycle tone tests will suffice.

Circuit Induction (Crosstalk) Tests (Para. 9)

1.16 This test is made on all circuits used for transmitting voice currents when the circuits contain repeat coils, induction coils, retardation coils, condensers or transformers and are grouped together on relay racks, desks or switchboards in such a manner that there is a possibility of "crosstalk" between circuits.

2. RECORDS AND REQUIREMENTS

2.01 Forms SD-4-1313 and SD-4-1316 are required for recording the results of general tests.

3. OPERATING TESTS

3.01 Operating tests should, whenever possible, test all features as described in the circuit description (CD) of the circuit under test.

3.02 Normally, the easiest way to implement the operation test of a circuit is to provide the service cross connections and use the circuit in the same manner as it will be used in service.

3.03 ITE-4011, miscellaneous trunk test set, because of its versatility can often be cross connected to provide either an originating or a terminating condition to satisfy unusual circuit layouts. Refer to TMO-4011 for method of operation.

3.04 For testing manufactured discontinued circuits, the handbook tests for the replacing circuit is often applicable.

4. TALKING OR TRANSMISSION TESTS

4.01 Talking tests are best performed in conjunction with the operating test by merely talking over the established connection. Tone may be used for this test if provided in the testing facilities.

4.02 If transmission tests are required to satisfy schematic requirements, refer to Handbook 50, Section 10 for instructions on performing the tests.

5. CONTINUITY TESTS

Description of Test

5.01 Continuity tests are made with the prescribed test sets which provide either an audible or a visual indication when the circuit, including the lead under test, is closed. Occasionally, conditions may necessitate the establishing of a talking circuit when testing between one or more remote points. (See Figure 1 or 2B for method of establishing a talking circuit).

5.02 It must be noted that various conditions will determine the choice of test set to be used. For instance, the R-3311 flashlight test lamp may be used when a lamp signal is desired; the ITE-4002, tone buzzer set should be used when working circuits are involved which cannot be released from service during the interval the continuity tests are made or there is danger of magnetizing repeat coils in trunks, lines or repeaters; and the ITE-4137, AC continuity test set may be used except on vacuum tube circuits, carrier system or telephone repeaters.

> ***Note:*** Before starting continuity tests, the circuit drawings must be checked for grounds or common paths which would cause false continuity. Do not use a ground return on the buzzer when making continuity tests.

Tests Sets and Accessories

AMT.	ITE	DESCRIPTION	WITH KIT	SEE NOTE
1	4002	Tone Buzzer Set	None	2
or				
1	4442	Volt-Ohmmeter	None	
or				
1	4137 4137A	AC Continuity Test Set	102,32	
or				
1	4251	Rapidohm Test Set	None	
1	R3311	Flashlight Test Set		1
or				
1	4490	Assignment Test Set		
1	4511	Whistler Test Set		1
1	4546	Dry Reed Relay Reader		1
As Req.	2260	Call Wire Extension	102	1

Notes:

(1) Available in Crossbar Accessory Set, ITE-4023 or ITE 4250 or may be requisitioned separately.

(2) Used only on working circuits which cannot be released for test.

Cords

(a) Cords are furnished with all sets, however, additional cords may be required depending upon the setup.

(b) Single conductor cords equipped with banana plugs may be extended using the R-2818 connectors.

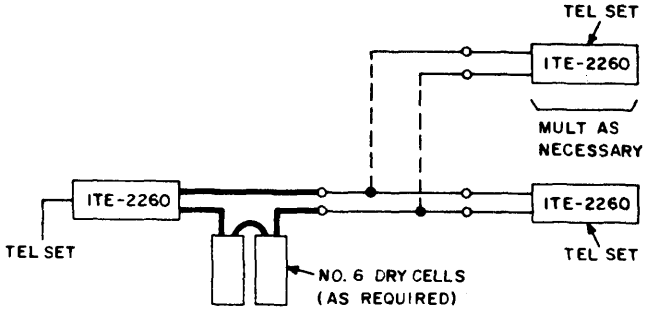


Fig. 1A – Talking Circuit (Par. 5.01)

Tests Using ITE-4137 or ITE-4137A

5.03 The AC continuity test set may be used for making all continuity tests formerly made with a DC buzzer set. It furnishes a source of DC current for use in a talking circuit, and dry tone for use in continuity testing where circuit conditions make it inadvisable to use much current. Refer to TMO-4137, 4137A in Handbook 100 for maintaining the ITE-4137 or ITE-4137A test set.

CAUTION 1: Use only on 105-125V. AC.

CAUTION 2: Disconnect power cord when not in use.

CAUTION 3: Do not use on vacuum tube circuits, carrier systems telephone repeaters.

5.04 Plug the power cord into a convenient 60 cycle 115 volt outlet and prepare the set, using a suitable test setup from those illustrated in Figure 2A, 2B and 2C.

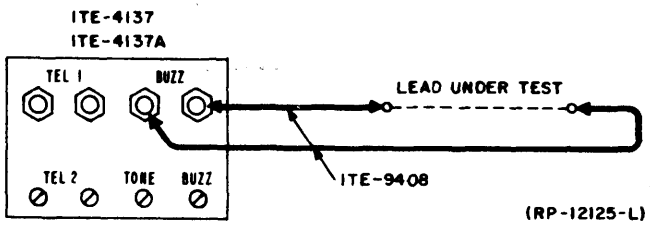


Fig. 2A – Short Lead Test (Par. 5.04)

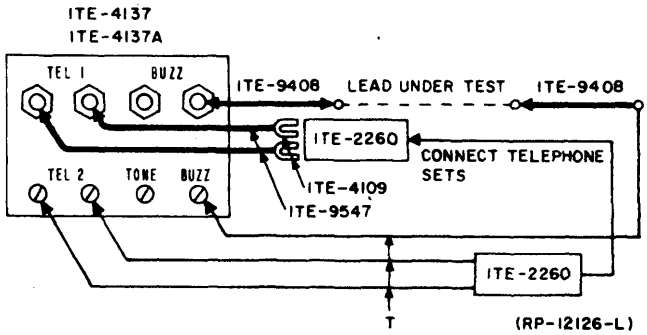
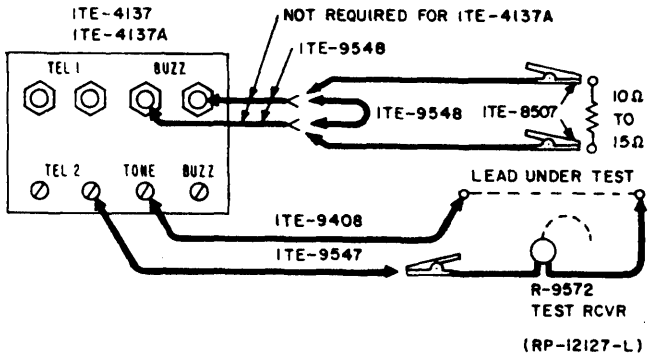


Fig. 2B – Long Leads Test With Talking Circuit (Par. 5.04)



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 2 ITE-9548 cords and 2 ITE-8507 alligator clips to avoid excessive heating of the buzzer.

Fig. 2C – Tone Test (Par. 5.04)

Test of Short Leads (Using ITE-4442)

5.05 The volt-ohmmeter, ITE-4442, can be used for testing very short leads when a talking circuit is not required. It is especially useful for continuity checks made by a single operator. Connect the test leads with the set to + and − connectors. Connect the test leads together and adjust potentiometer OHMS ADJ to cause the meter to indicate "0". Continuity on a wire will then be indicated by an "0" reading on the meter. Readings other than "0" indicate the resistance in the conductor being checked.

Tests of Leads (Using ITE-4002)

5.06 The Tone Buzzer Set may be used for testing leads when the circuit cannot be taken out of service and there is danger of interfering with service or there is danger of magnetizing repeat coils in trunks, lines or repeaters. This set does not provide a direct current path and will not cause interference when it is connected across a circuit as, for example, a tip and ring connection. (This set will check continuity thru a lead having less than 20 ohms; continuity is indicated by an audible signal.) Refer to TMO-4002 in Handbook 100 for information on connecting, adjusting, maintaining and using the ITE-4002 test set.

Tests of Leads (Using R-3311)

5.07 Flashlight test lamp R-3311 can be used for testing continuity of conductors when a talking circuit is not required.

Continuity Test of Battery Supply Leads

5.08 The continuity test of installer connected battery supply leads should be made in the following manner.

CAUTION: Service interruptions have been caused by using a grounded dc buzzer to check leads running to working fuse panels. Do not use a grounded buzzer for such tests.

CAUTION: To eliminate a fire hazard, verify that direct ground is not present on the alarm bar or stud on a fuse panel before installing its feeder fuse.

5.09 Check with a voltmeter or test receiver connected to a grounded battery that all fuse posts are clear of foreign battery or ground.

5.10 Using fuses of correct type as indicated by circuit drawings and fuse panel designations, install the fuses one at a time. Check at one point in the circuit that each fuse is associated with its proper equipment and is free from crosses with other unfused posts on the fuse panel.

Tests of Leads Using Rapidohm ITE-4251

Adjustment

5.11 Refer to Handbook 100 TMO-4251.

Test Operation

5.12 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.

5.13 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 a 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.

Tests of Leads Using Assignment Test Set ITE-4490

Continuity Test

5.14 With 48V battery and ground connected to set, insert test cord into (TEST) jack.

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

Tests of Leads Using Whistler Test Set ITE-4511

Adjustment

5.16 Refer to Handbook 100. TMO-4511.

Whistler Test

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

5.18 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.

5.19 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.

5.20 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.

5.21 While ITE-4511 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.

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

5.23 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.

Crossed Pairs

5.24 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.

5.25 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.

Checking For Crosses With Ground or Battery

5.26 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.

Operation as A Test Headset

5.27 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-ohm 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.)

5.28 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.)

5.29 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.

Use of Dry Reed Relay Reader ITE-4546

5.30 The dry reed relay reader ITE-4546 is used to indicate the operate and nonoperate conditions of the contacts of 293 type relays. This device contains five 2Y switchboard lamps with chuck type terminals which can be pushed on the test terminals of 293 type relays.

6. VOLTMETER TESTS

Description of Tests

6.01 Voltmeter tests are made with the volt-ohmmeter, ITE-4442. When battery and ground cannot be removed by circuit operation, a test should be made to check for the proper polarity.

Test Sets

AMT	ITE	DESCRIPTION
1	4442	Volt-Ohmmeter

Accessories

AMT	CODE	DESCRIPTION
#1	Any	45 Volt Radio B Battery

#Obtain from operating company or purchase locally.

Cross Connections

6.02 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.

Circuits Free of Battery and Ground

Circuit Preparation

6.03 Connect the + terminal jack of ITE-4442 to the POSITIVE terminal of the 45 volt B battery.

6.04 Connect the NEGATIVE terminal of the battery to ground.

6.05 Connect a test lead to the – terminal of ITE-4442.

Test Operations

Note: Before starting the tests touch the test lead referred to in 6.05 to ground and note that voltmeter functions properly.

6.06 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.

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

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

6.09 Remove strapping from the next terminal or 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.

6.10 Repeat operation 6.09 until all the strapping has been removed.

6.11 Resistance of crosses can be determined with ITE-4442 used as an ohmmeter. See Paragraphs 8.25 through 8.31.

Circuits Not Free From Battery or Ground

6.12 When possible perform circuit operations which will remove the battery or ground from circuits under test and perform voltmeter test as described in foregoing Paragraphs 6.03 to 6.11.

6.13 When battery and ground cannot be removed by circuit operation omit test per Paragraph 6.03 to 6.11 and make a test for proper polarity observing that meter reads approximately the same for all circuits of the same type.

7. ADJUSTMENT TESTS

7.01 The requirements and methods for checking relays are covered in Handbook 6. It will not be necessary to make this test if any one of the following conditions has been met.

(a) The electrical requirements for the particular relays have been verified 100% within the supplementary test period specified in the performance requirements.

(b) The "operating" tests have been made over the cable pair to the connecting circuits in the other office.

(c) The "operating" tests have been made with test or adjusting sets to set up loop conditions which provide current flow equivalent to the test current value for the relays.

(d) The "operating" tests have been made with test or adjusting sets to simulate the working limits shown on the schematic drawing.

8. RESISTANCE MEASUREMENTS

General

8.01 This instruction describes the method of measuring resistance using Wheatstone Bridge, ITE-1883, volt-ohmmeter, ITE-4442, rapidohm test set, ITE-4251, or assignment test set, ITE-4490.

8.02 The resistance values of the inductive windings of U and Y type relays are $\pm 10\%$ of rated value unless otherwise specified on the schematic drawing. All other resistance values including noninductive windings of U and Y type relays are $\pm 5\%$ of rated value unless otherwise specified.

8.03 When resistances are measured over a path through one or more switching contacts these contacts may introduce considerable resistance. If a resistance measured over such path exceeds the maximum limit, the contacts should be cleaned and the measurement rechecked. Apparatus should be replaced only when the individual resistances do not meet the limits specified on the drawings.

> ***Note:*** When resistances are measured over the conductors of a switchboard cable these conductors may introduce considerable resistance. If a resistance measured over such a path exceeds the maximum limit, the cable resistance should be considered and the measurement rechecked.

8.04 Resistances cannot be measured when current (other than from the test set) is flowing thru them. The safest procedure is to remove all batteries and ground before making resistance measurements. It is possible, however, to measure resistance connected on ***one side only*** to battery or ground with ITE-1883 or ITE-4442. If such a measurement is to be made test across the resistance with a high resistance voltmeter to insure that there is no voltage drop (current flowing) before connecting the resistance measuring set.

8.05 The most accurate results are obtained by measuring resistances alone and no resistance should be rejected as outside limits until so measured. When resistances are measured in parallel determine that combined resistances as follows:

$$Rc = \frac{R \times R1}{R + R1}$$

For three or more resistances R, R1...Rn in parallel the combined resistance Rc is obtained by substituting the actual resistance values in the formula:

$$Rc = \frac{1}{\frac{1}{R} + \frac{1}{R1} + \ldots \frac{1}{Rn}}$$

Test Sets

AMT		ITE	DESCRIPTION
1		1883	Wheatstone Bridge
	or		
1		4442	Volt-Ohmmeter

Cords

8.06 As Required: Supplied with sets.

Resistance Measurements Using ITE-1883

Precautions to be Observed

8.07 If battery in set fails while in use, a dry cell may be connected to the BA− and BA+ terminals, in which case the BA switch or key should be opened.

8.08 Use 4-1/2 volts external battery except when measuring high resistance (1/2 megohm or more). Never use more than 45 volts external battery.

Preliminary Operation

8.09 Remove all fuses prior to making any resistance measurements in circuit.

8.10 With test receiver, check terminals of resistances to be measured, to insure that they are free from central office battery. It is also desirable to have no ground on the circuit.

8.11 Measure the resistance of leads to be used in connecting the resistances to the test set as outlined in Paragraphs 8.21, 8.22, 8.23 and 8.24. If leads used are #18 wire or heavier and the resistance being measured is large compared to resistance of leads then the resistance of leads may be disregarded.

8.12 On the older sets switch designations are stamped on the knife switches while on the newer sets the designations are on the test set panel. Where designations are on the knife switches, place the switches so that stampings R, RV and BA are exposed to view. Where designations are on the panel operate switches to the R, RV, and BA positions. The sketch in the lid of set shows correct operation of switches.

Setup for Test

8.13 Connect terminals X1 and X2 of ITE-1883 to the resistance to be measured with cords ITE-9501. For greatest accuracy connections should be made directly to the terminals of the resistance to be measured but it is sometimes convenient to connect to other points and include a check of part of the circuit wiring in the measurement.

8.14 All connections must be as nearly electrically perfect as possible. The binding posts must be screwed down tightly, but without undue force, and points of contact with resistance must be cleaned to insure good connection.

Measurement of Known Resistance

8.15 Set ratio dial as specified in following table:

RESISTANCE BEING MEASURED	RATIO DIAL SETTING
Below 10 ohms	0.001
10 ohms to 100 ohms	0.01
100 ohms to 1,000 ohms	0.1
1,000 ohms to 10,000 ohms	1
10,000 ohms to 100,000 ohms	10
100,000 ohms to 1,000,000 ohms	100
1,000,000 ohms to 10,000,000 ohms	1,000

8.16 Using adjusting knob on galvanometer, bring the needle of galvanometer to zero reading.

8.17 Set up on four rheostat dials the reading obtained by dividing the amount of resistance being measured by the setting of ratio dial. For example, when measuring a resistance of 120 ohms, ratio dial setting will be 0.1 and reading of rheostat dials will be 120/0.1 or 1,200.

8.18 Depress B key. With this held operated, a quick tap of G key will cause a moderate deflection of galvanometer in one direction.

8.19 The deflection of the galvanometer needle is noted, and resistance is increased or decreased by adjusting rheostat dials. If deflection of galvanometer needle is to right, more resistance should be added; if to left, resistance should be reduced. By proceeding in this manner, a setting of rheostat is reached which causes no deflection of galvanometer needle.

8.20 From rheostat setting a four digit number may be obtained. By multiplying this number by setting of ratio dial the amount of resistance in circuit is determined. Should rheostat dials read 1,218 and ratio dial 0.1 the resistance will be 121.8 ohms. This will be total resistance in circuit. From this amount subtract resistance of test leads. The result will give actual amount of resistance being measured.

Measurement of an Unknown Resistance

8.21 Set ratio dial to read 1 and four rheostat dials to read 1,000.

8.22 With B key held operated, tap G key and note direction of the deflection of galvanometer needle. If deflection of needle is to right it indicates that resistance is more than 1,000 ohms. Reset ratio dial to read 10 and repeat operation outlined above. If deflection of the galvanometer needle is to left the resistance being measured is more than 1,000 ohms and less than 10,000 ohms.

8.23 Should deflection of the needle be to right when ratio dial is set to read 10, the dial should be advanced to 100 and so on until deflection to left is reached. If needle deflects to left when set at 1 the reading of ratio dial should be reduced until deflection to right is reached.

8.24 Set ratio dial as specified in chart under Paragraphs 8.15 to 8.20 and continue measurements as for known resistance.

Resistance Measurements Using ITE-4442

Note: ITE-1883 is preferable when measurements of an accuracy closer than $\pm 5\%$ are required for resistances less than 100,000 ohms.

Setup for Test

8.25 Observe precautions outlined in Paragraphs 8.09 thru 8.14.

8.26 Insert the connector ends of test cords into the – and + connectors of the volt-ohmmeter and short circuit the other ends of the cords. Turn the OHMS ADJ rheostat until the pointer lines up exactly with the 0 on the green scale.

Measurement of Known Resistance

8.27 Set the switch for the OHMS range in accordance with the following information.

RESISTANCE TO BE MEASURED	RECOMMENDED RANGE
0 - 100 Ohms	X1
50 - 1000 Ohms	X10
500 - 10000 Ohms	X100
5000 - 100000 Ohms	X1000
0.5 - 10 Megohms	X10000

8.28 Connect the test cords to the circuit under test and read the ohms on the green OHMS scale. If the switch is at X1 the OHMS scale indicates resistance in ohms directly. If the switch is at any other OHMS position, add the number of 0's in the switch position to the scale reading to obtain the resistance in ohms.

8.29 For accurate work the 0 ohms adjustment (as described in Paragraph 8.26) should be made every time a different range is used, and also frequently when the lowest range is being used as the battery drain is relatively heavy.

Measurement of Unknown Resistance

8.30 Any resistance scale may be used for the initial check.

8.31 To obtain the most accurate reading rotate the OHM selector switch to the scale giving a resistance reading as close to center scale as possible.

Resistance Measurements Using Rapidohm ITE-4251

Test Operation

8.32 When only a few circuits are to be tested or when the circuits have various values of resistance, the ohmmeter scales can be used in testing for continuity and crosses in the same manner as the relay circuit. (See Paragraph 5.12). It too, will usually operate the magnet at the distant end. Where it does not or where a resistor is used at the distant end, a test for reverses may be made by having an assistant at the end short out the winding or resistor after continuity has been established.

8.33 This instrument is sufficiently accurate for the measurement of resistances having a manufacturing tolerance of 5 percent or greater if care is exercised in estimating half-divisions of the meter scale.

Call Wire

8.34 Connection of terminals CW to a call wire telephone jack, ITE-2260, located at the distant end and connection of Operators' Telephone Sets, ITE-9650, to the TEL jacks at each end provides a call wire to the assistant. Tone from the buzzer is introduced into this circuit so the

assistant can identify an OK test made by the relay circuit.

Resistance Measurements using Assignment Test Set ITE-4490

Test Operation

8.35 With 48V battery and ground connected to set, insert test cord into (TEST) jack. When test pick is applied to terminal under test, meter will read resistance of lead directly with switch set at R. With switch set at R x10, multiply meter reading by 10 to obtain true resistance of lead.

8.36 The test set is sufficiently accurate for the measurement of resistances having a manufacturing tolerance of 2 per cent or greater if care is exercised in estimating half-divisions of the meter scale.

9. CIRCUIT INDUCTION (CROSSTALK) TESTS

Description of Test

9.01 These tests are made by connecting tone to one of a group of circuits and checking for absence of tone in the other circuits. When the level of noise, crosstalk or other interference is to be determined see the procedure in Handbook 80, Sections 103 and 104. Any of the prescribed sets may be used as a source of tone supply.

Test Sets

AMT		ITE	DESCRIPTION
1		2770	Tone Set
1	or	4137 or 4137A	AC Continuity Test Set

Tone Supply

9.02 The tone set, ITE-2770, may be used with either 24 volt or 48 volt battery. A dry tone (free of DC battery or ground) may be obtained by connecting to the T and R terminals with TONE key normal. Grounded tone may be obtained by operating TONE key and connecting to T terminal.

9.03 The AC continuity test set, ITE-4137 or ITE-4137A may be used by utilizing a setup similar to that shown in Figure 2C. Use 2 ITE-9547 cords connected to terminals, TEL 2 and Tone, as a source of tone supply.

General Method of Performing Circuit Induction Tests

9.04 Strap all of the tip conductors together and all of the ring conductors together in all circuits in the group under test and connect the strapped tips and rings to a tone supply. Check for tone across the tip and ring at the other side of each circuit (see Figure 3). Remove the straps from one circuit at a time and note the absence of tone on that circuit.

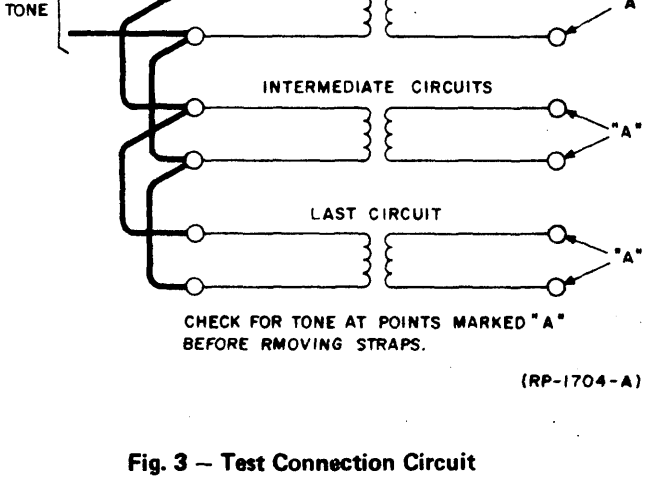


Fig. 3 – Test Connection Circuit Induction Tests (Par. 9.04)

Circuit Induction Test of Key and Plug Ended Trunks

9.05 Connect tone to the tip and ring of one of the trunks. Operate all of the listening or talking keys of the trunks and check for tone in the operator's telephone set. Release the talking or listening key of the trunk to which the tone is connected, and check that no tone is heard in the receiver of the operator's telephone set.

9.06 Repeat the above operations with the tone set connected to each trunk.

10. CONTACT PROTECTION AND SURGE ABSORPTION CIRCUIT TESTS

Description of Test

10.01 This instruction contains information for testing all contact protection circuits which have been provided to eliminate excessive arcing of contacts due to a high voltage discharge at the break of the contacts. A contact protection circuit

may be specified on a drawing as either a network or a capacitor and resistance. This instruction may also be used to test surge absorption circuits where these circuits are of a nature similar to contact protection circuits; otherwise surge absorption circuits should be checked by an operation test. The tests are made by using one of the circuits as a standard and checking the other similar circuits against this standard. Where this method cannot be used, verify the contact protection circuit by observing that excessive sparking at the contacts does not occur during the normal operation of the circuit.

Note 1: In the circuit used for the standard, check the apparatus codes for correctness before proceeding with the test.

Note 2: For method of checking electrolytic capacitors, see BSP 032-110-501.

Test Set

AMT	ITE	DESCRIPTION
1	8253	Contact Protection Circuit Test Set

Contact Protection or Surge Absorption Test Using ITE-8253

10.02 The connections to be made are shown in Figure 4. However, after connecting to the standard and before connecting to the first circuit to be tested, momentarily operate either the B or G key. A heavy click will be heard as a check of proper connection as well as indicating the intensity of click that may be expected as a trouble signal.

Note: Since contact protection or surge absorption circuits are seldom absolutely balanced, a slight click will usually be heard during charge or discharge of the capacitors but will not be of sufficient magnitude to be an indication of trouble. In case of doubt recheck for a trouble signal as in the above paragraph.

10.03 When testing contact protection or surge absorption circuits which are normally charged, either the B or G key is operated several times to discharge the capacitor charge. As the capacitors discharge, the current flow in the standard circuit and the circuit under test should be balanced and no appreciable amount of current will flow through the receiver. If the circuit under test is faulty the circuits will not be balanced thus causing a current flow through the receiver which causes a click in the receiver giving an audible indication of trouble.

10.04 When testing contact protection or surge absorption circuits which are not normally charged, the operation of the set is the same as for normally charged circuits except that the capacitors must be charged and discharged by the operation of the B or G key. A noticeable click during the charging or discharging of the capacitors will indicate trouble.

10.05 When testing networks which are connected across relay windings the resistance of the relay under test must be the same as the resistance of the relay used as standard.

10.06 If necessary block normal the relay under test to eliminate interference from battery or ground.

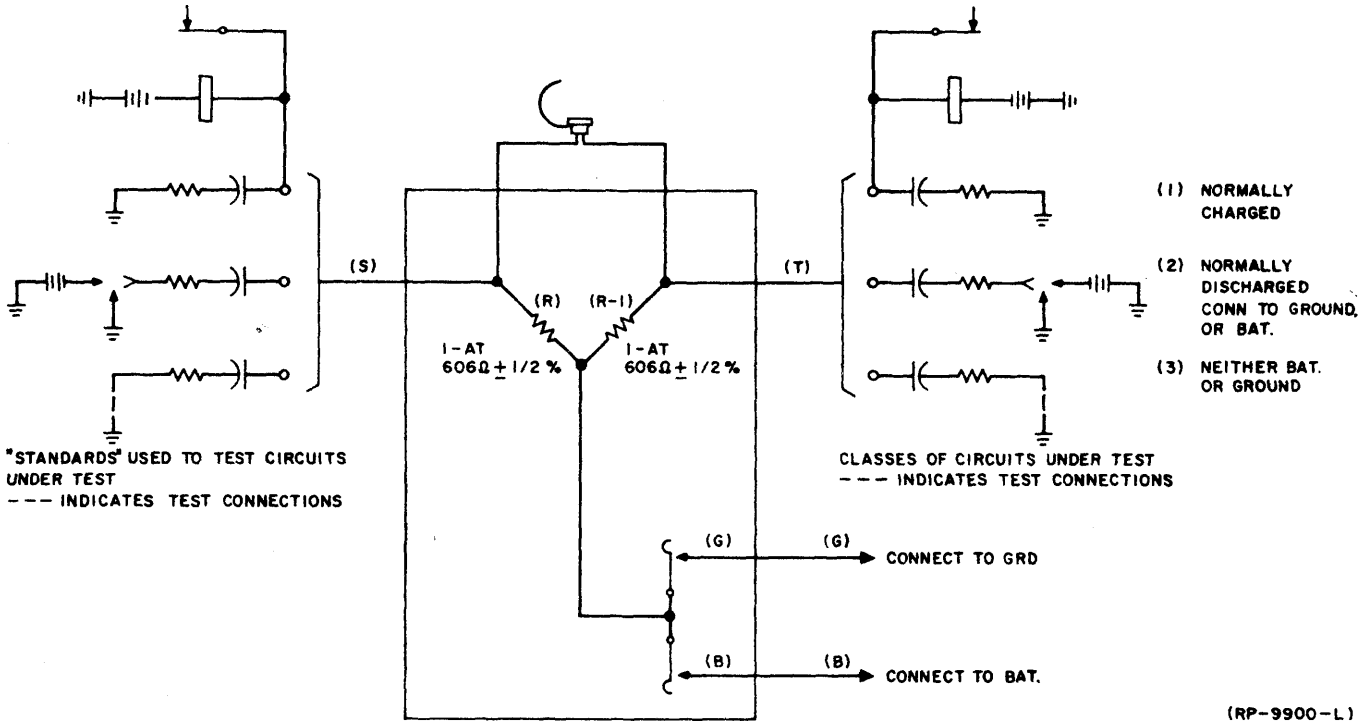
11. COMPARISON CHECK OF IMPEDANCE OR REACTANCE

Description of Test

11.01 This instruction outlines a method of checking circuits by comparing their impedances with the impedance of a circuit which has been carefully checked.

11.02 The general method is similar to that for contact protection except that tone is connected to the contact protection circuit test set. See Figure 5.

11.03 When a single capacitor or a single coil is to be compared with another single capacitor or coil a source of tone similar to that used for circuit induction tests may be used. For networks containing resistance in addition to reactances, or both capacity and inductance, a pure tone, preferably from a milliwatt distributing system or a test oscillator will give the best results. A tone having a frequency of 425 to 1000 cycles and a low harmonic content is the most satisfactory.



Note: Networks may be specified in similar circuits in place of the capacitor and resistance as illustrated. Protection may also be across the relay windings.

Fig. 4 — Contact Protection Test (Par. 10)

11.04 As in all "ear-balance" checks, considerable experience on the part of the operator is required to readily determine when circuits not giving a perfect balance are within limits, since a 5% mismatch in impedance (the usual limit for coils) will give an appreciable reduction in the volume of tone from that heard on an open circuit but will prevent obtaining a real "null" (absence of tone).

11.05 The adjustable shunt resistance shown in Figure 5 is to reduce the level of the tone (with an acceptable balance) to the lowest volume the noise level in the terminal room will permit, in order to preserve the sensitivity of the operator's ear.

Test Set and Accessories

AMT	CODE	DESCRIPTION
1	ITE-4040	DC Adjusting Set
1	ITE-8253	Contact Protection Circuit Test Set
2	Any	Capacitors 1 to 4 mf each

Preparation

11.06 The connections should be made as indicated in Figure 5.

11.07 Ascertain that the source of tone returns to ground and that all circuits to be tested terminate to ground or grounded battery.

Procedure

11.08 With connections made to two circuits known to be satisfactory, operate the key of ITE-8253 to either position. Depress and lock the No. 4 button of the current flow set and adjust the No. 4 slider to reduce the tone to a satisfactory level.

Note: If all circuits available for comparison are new, carefully inspect the apparatus codes and wiring of 3 circuits. Measure any non-inductive resistances with the Wheatstone Bridge or volt-ohmmeter. Connect the contact protection circuit test set to the circuits in

pairs. If a satisfactory balance is found between 1 and 2, 2 and 3 and 1 and 3 they may be regarded as normal circuits and used as standards for checking other circuits.

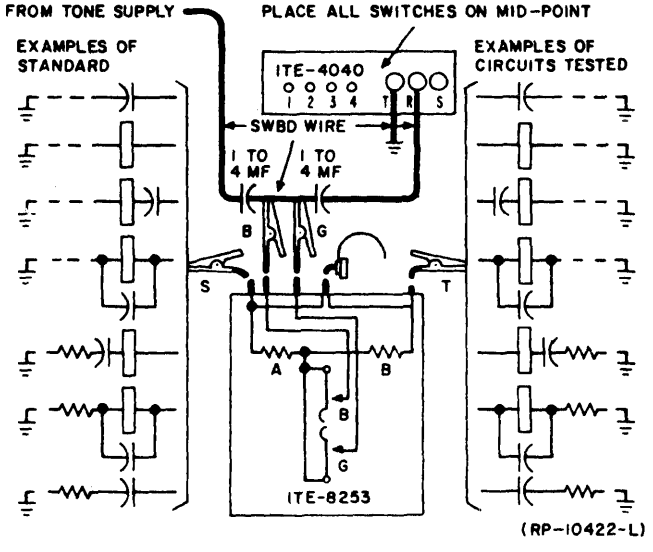


Fig. 5 — Comparison Check of Impedance or Reactance (Par. 11)

11.09 With the S lead connected to a "standard" circuit, hold the key operated and transfer lead T to the corresponding terminal on each circuit to be tested. See Paragraph 11.04.

12. DETECTING AND LOCATING TROUBLES IN MULTIPLE WIRING

Detection of Crosses, Grounds and Opens

Note 1: This method may be used to detect troubles which have developed after the completion of initial multiple tests. It can be used while other tests are being made and will not interfere with operation of equipment under test.

Note 2: Crossed, open or grounded multiple leads may be detected in wiring similar to that of marker multiple wiring at links, connector or block relay frames, multicontact relays and horizontal crossbar switch strapping.

Test Set and Accessories

AMT	ITE	DESCRIPTION
	*4137 or 4137A	AC Continuity Test Set
1	R-9572	Test Receiver

*Cords are furnished with test set.

Setup for Test

12.01 When using the AC continuity test set, plug the power cord into a convenient 60 cycles 115 volt outlet. Make test connections as shown in Figure 2C except that the two middle terminals, Tel 2 and Tone, be connected to ground and a test receiver respectively, using ITE-9547 cords.

Trouble Indications

12.02 ***Note A:*** This method depends upon the comparison of the volume of tone heard with a test receiver and as in all "ear balance" checks, considerable experience on the part on the operator is required to readily determine when leads are crossed.

12.03 ***Note B:*** The tester should not touch the metal part of the test picks during these checks as the body capacity of the tester will effect the volume of the tone heard.

12.04 ***Note C:*** Like leads will have the same distributed capacity to ground and will be indicated by the same volume of tone.

12.05 ***Note D:*** Crossed leads have twice the capacity of single leads and can be detected by an increase in the volume of tone.

12.06 ***Grounded Leads:*** The detection of a ***high volume*** of tone on a lead under test is an indication of a grounded lead.

Example: Touch the tip of the test pick to the grounded framework and notice the high volume of tone heard with the test receiver.

12.07 ***Clear Leads:*** The detection of a ***low volume*** of tone on a lead under test is an indication of clear lead and is the standard for all like multiple leads.

Example: Touch the tip of the test pick to one of the multiple leads and notice the low volume of tone heard with the receiver.

12.08 ***Crossed Leads:*** The detection of a ***slight increase in volume*** of tone on a lead under test is an indication of a crossed lead.

Example: Temporarily cross the lead used in Paragraph 12.03 with another like multiple lead. Touch the tip of the test receiver to one of the crossed leads and note a slight increase in the volume of tone due to the added capacity of the second wire.

12.09 ***Open Leads:*** The detection of an absence or an ***appreciable reduction*** in volume of tone as compared with a clear lead is an indication of an open lead.

Test Operations

Note: The tester should not touch the metal part of the test picks or the grounded framework during this check as the body capacity of the tester will cause a change in the volume of tone heard with the receiver.

12.10 Touch the tip of the test pick to all terminals at one multiple appearance, one at a time, and determine as outlined in Paragraphs 12.02 through 12.09 from the volume of tone heard with the receiver whether the leads are clear, crossed, grounded or open.

12.11 Locate and clear leads in trouble by method outlined in Paragraphs 12.14, 12.15 and 12.16.

AC Continuity Test Set Method

Test Sets

AMT	ITE	DESCRIPTION
*1	4137 or 4137A	AC Continuity Test Set
1	9572	Test Receiver

*Cords are furnished with the test set.

Setup for Test

12.12 Plug the power cord into a convenient 60 cycle 115 volt outlet.

12.13 Connect the two BUZZ jacks of the test set to the multiple leads in trouble, using ITE-9547 cords and observe that the buzzer operates.

Test Operations

12.14 To locate the short circuit connect an R-9572, Test Receiver, to the leads in trouble at the multiple appearance nearest the source of tone. If a low volume of tone and a slight click is heard with the receiver the cross is at some other multiple appearance.

12.15 Continue to check the leads in trouble at the multiple appearances in a direction away from the source of tone until tone or a slight click can no longer be heard with the receiver. Since current and tone are carried on the leads only between the point where the buzzer is connected and the short circuit or ground, the location of the trouble will coincide with the multiple appearance where the tone or the drop of potential can no longer be heard with the test receiver.

12.16 Examine wiring at multiple appearance location found to be in trouble. The buzzer is silenced when the cross is cleared.

Tone Buzzer Method, ITE-4002

Test Sets And Accessories

AMT	ITE	DESCRIPTION
1	4002	Tone Buzzer Set
1	R-9572	Test Receiver
2	4109	Spade Tips
2	9547	1 Conductor Cords
2	8507	Alligator Clips
2	2601	Insulators For Clips

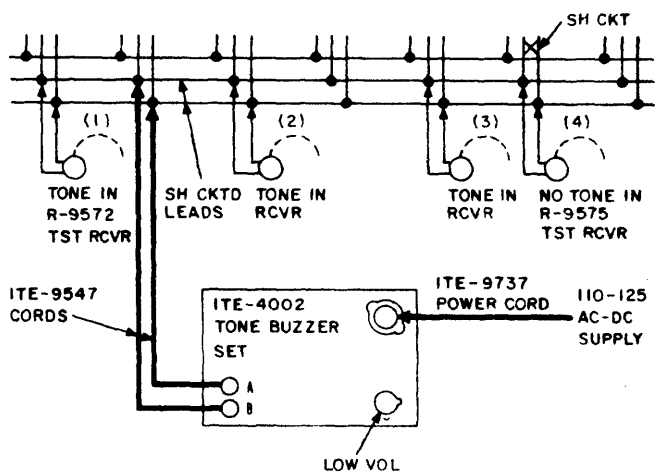


Fig. 6 – Trouble Location Using Tone Buzzer (Pars. 12.20, 12.21, 12.22 and 12.23)

Setup for Test

12.17 Connect the ITE-4002, Tone Buzzer Set, by means of ITE-9737 power cord to a source of 115 Volts AC.

12.18 Connect the A and B terminals of ITE-4002 to the leads in trouble at one of the multiple appearances as shown in Figure 6 and observe that the buzzer operates. If buzzer fails, reverse position of power plug in the receptacle.

12.19 Turn the V control knob to obtain the lowest volume of tone.

Test Operations

12.20 To locate the short circuit connect an R-9572, test receiver to the leads in trouble at the multiple appearance nearest the source of tone as shown by (1) of Figure 6. If a low volume of tone is heard with the receiver the cross is at some other multiple appearance.

12.21 Continue to check the leads in trouble at the multiple appearances in a direction away from the source of tone, as indicated by (2), (3) and (4) of Figure 6 until the tone can no longer be heard with the receiver.

12.22 Since the tone is carried on the leads only between the point where the buzzer is connected and the short circuit or ground, the location of the trouble will coincide with the multiple appearance where tone can no longer be heard with the test receiver.

12.23 Examine wiring at multiple appearance location found to be in trouble. The buzzer is silenced when the cross is cleared.

Fault Finder Kit ITE-4428

12.24 ***Test Equipment:*** The fault finder kit contains an ITE-4261A whistler and ITE-4430 amplifier (147A) and cords required for making trouble location tests.

Setup for Test

12.25 Connect the ITE-4261A whistler to 115 volt ac power outlet and the ground lead on the adapter to grounded framework. Where there is no other convenient ground connection, a receptacle plate mounting screw which has been backed out a few turns may be used. The neon lamp lights.

> ***CAUTION: If the lamp fails to light do not*** continue with the test until the cause for failure has been determined and corrected. The following is a list of possible failures:
>
> (1) Defective ground lead in R-2674 adapter.
>
> (2) Defective neon lamp.
>
> (3) Defective ac power cord.

It may be noted that this lamp is brighter on ac than on dc voltage. The toggle switch should be operated to (T).

12.26 Connect the ITE-9547 cords equipped with ITE-8507 alligator clips to the wires that are crossed and to (W-T) and (TC) or (T) jacks.

12.27 When tracing a single wire for ground or open connect the (W-T) to the wire and (TC) to ground.

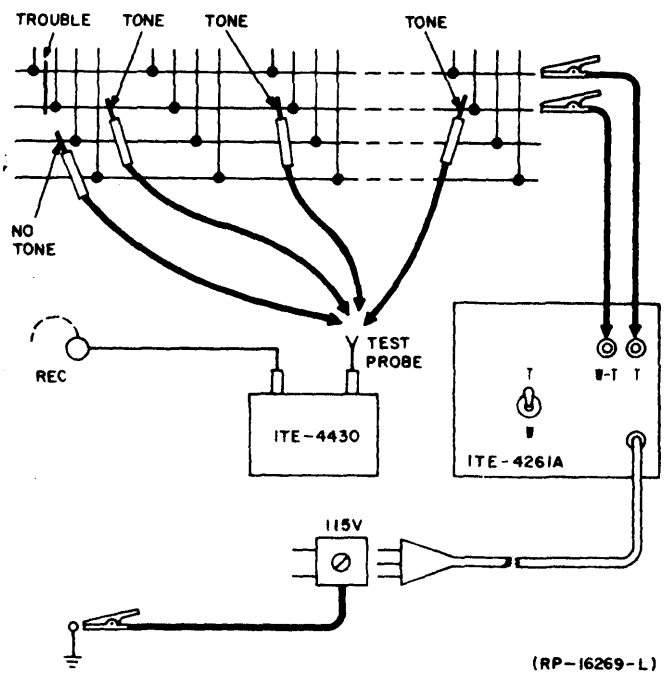


Fig. 7 – Trouble Location Using Fault Finder Kit (Pars. 12.25, 12.26, 12.27, and 12.28)

12.28 Connect the ITE-9378 cord (probe) to the (INPUT) jack of ITE-4430 and ITE-9377 to (REC) jack.

The (PROBE COIL) switch is always used in the (COIL) position when ITE-9378 cord is used.

> ***Note:*** Do not insert a plug into the (REC) jack until actual testing operations are started as this jack is arranged to connect the filament and plate batteries to the amplifier. The life of these batteries is comparatively short unless the plug is removed when the set is not in use.

Test Operations

Switch Wiring

12.29 It is not necessary to touch the probe to the wires being tested. The sensitivity of the amplifier is controlled by the (VOL) potentiometer.

12.30 Trace the tone along the wires in trouble by placing the probe at various appearances as indicated in Figure 11.

12.31 The actual trouble can be located to within one inch. The tone disappears at an appearance past the trouble.

12.32 ***Cable Trouble:*** Tone connected to a cable connector can be traced along cable runs by adjusting the (VOL) potentiometer. It is not necessary to touch the cable with probe unless the trouble is located on the cable run.

Manager, Crossbar Product Engineering Control Center