MULTIPLE WIRE

FAULT LOCATING

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1. GENERAL

1.01 This section covers the methods to be used in locating and clearing troubles in multiple wire and the precautions necessary to ensure the safety of the work operations.

1.02 This section is reissued to include the use of the 114A Test Set, whose output is equivalent to the low output of the 76-type test set.

1.03 Most troubles in multiple wire are man-made and could be prevented by a little additional care during the manufacturing, handling, shipping, and placing operations. The major causes of trouble are:

(a) Cuts, tears or abrasion to the insulation during placing.

(b) Faulty splices where bare copper conductors are exposed beyond the end of a splice sleeve.

(c) Not permanently repairing punctured insulation resulting from the use of test picks.

(d) Damage to insulation from rubbing against tree limbs or other foreign objects.

(e) Lightning strokes or power contacts.

2. PRECAUTIONS

2.01 ***Repair Work in a Span:*** Where repair work in a span is necessary, lower the wire to the ground or use a truck-mounted platform ladder or an aerial lift. DO NOT ATTEMPT TO RIDE MULTIPLE WIRES IN A CABLE CAR. DO NOT PLACE A LADDER AGAINST MULTIPLE WIRE.

2.02 ***Lowering or Raising Multiple Wire:*** To avoid accidents and to prevent damage to the wire when lowering or raising multiple wire under tension:

(1) Do not drop the wire to the ground from its position on a pole or crossarm, use a handline to lower it gently, preferably while standing on the ground.

(2) Obtain assistance if conditions are such that one man cannot perform the work safely.

(3) Place warning flags to warn the public where a possible safety hazard exists.

2.03 Do not make temporary repairs unless absolutely necessary. Where temporary repairs are unavoidable, arrange to have permanent repairs made as soon as possible.

2.04 ***Nonstandard Power Conditions***

(a) ***Contact with Power:*** Contacts with power lines, with street light circuits or with pole-mounted equipment associated with them, should be reported for the power company to correct in accordance with local instructions. If there is any indication or suspicion that telephone circuits may be in contact with power wires:

(1) Make a visual inspection of the route to try to locate the contact.

(2) Inspect all open wire circuits which serve from the multiple wire for the contact.

(3) Inspect for burns in bridle, block, or drop wires connected to multiple wire or for the operation of protectors connected to such wires. These are strong indications of contact with power wires.

Where inspection finds an actual contact, do not attempt to locate trouble until the power company corrects this contact. Where inspection does not find any power contacts but tests at the testboard or with a B Voltage Tester still indicate the presence of foreign potentials, notify your supervisor.

(b) ***Substandard Clearances:*** Substandard clearances from power lines, from street light circuits, or from pole-mounted equipment associated with them, located during inspections or trouble locating work should be reported for correction in accordance with local instructions.

2.05 Plan the work before climbing, and take all precautions necessary to perform the work safely, including wearing of Insulating Gloves when joint use or power crossings are involved.

2.06 Never place wire guards over multiple wire if the insulation is abraded. Repair the insulation permanently before placing the wire guards.

2.07 DO NOT USE TEST PICKS, TEST CLIPS, OR OTHER DEVICES WHICH PUNCTURE THE INSULATION OF MULTIPLE WIRE. Such punctures lead to rapid corrosion of the conductor, and temporary repairs only defer the corrosion. Holes that are found or must be made in locating faults shall be repaired by cutting the conductor and splicing it with the proper size splice sleeve.

2.08 ***The 111A Test Set must be returned annually for electrical tests to ensure the set will withstand 10,000 volts.***

3. GENERAL TROUBLE LOCATING

3.01 The objective of trouble location in multiple wire is to restore service to the subscribers in the shortest practical time. A careful analysis and a systematic approach can save considerable time and effort. A visual inspection of the wires will usually reveal external evidence of certain kinds of trouble. Other causes of trouble, not so readily apparent, will require electrical tests to determine their location.

3.02 Thorough knowledge of conditions along the route of the multiple wire will greatly assist in locating trouble. Undesirable plant conditions such as unfavorable locations in trees, inadequate clearance from buildings, roofs, etc, which have not as yet been corrected, frequently suggest the first place to look for trouble. Knowledge of building operations or other construction work in the vicinity that might damage this wire will assist, in many cases, in quickly locating the cause of the trouble.

3.03 To proceed in a logical and efficient way to locate the cause of the trouble, obtain the following information from the test desk:

(a) Location and route of line—especially important if the terrain over which the line passes requires special equipment or assistance during periods of bad weather.

(b) Any indication that foreign current may be on the line such as the operation of central office heat coils or presence of 60-cycle hum (see 2.04).

(c) Cable number, terminal, and the cable pairs to which the circuits in trouble are assigned.

(d) If available, pole numbers where branch leads or subscriber drops are terminated.

(e) Nature of trouble revealed by testing or trouble report.

(f) If some or all stations on a line are out of service and if one or more lines are involved include the identity of the lines and stations.

3.04 After obtaining the information covered in 3.03 from the test desk, establish by appropriate preliminary tests that the trouble is located in the multiple wire. Then, test to determine the nature and magnitude of the trouble. If the conditions covered in 3.02 are not applicable, isolate the trouble in accordance with approved procedures as follows:

(a) Select convenient points such as wire terminals at junction poles or load points where circuits are terminated and can be read-

ily identified and opened. Proper utilization of the hand test set will help to quickly locate or isolate many faults without making other tests or without assistance from the test desk or the operator.

(b) Trace the fault to a specific section of the wire by making successive tests at different points with the hand test set.

(c) After the fault has been localized to a specific section, it may be pinpointed by the appropriate method described below depending upon the type of fault. As this test progresses from pole to pole, make a careful visual inspection for any external evidence of the fault.

3.05 Opens can be traced from the ground with the 111A Test Set. The 114A Test Set should be used as a source of tone for this purpose. Shorts, crosses and grounds can be traced from the ground with the 105-type test set. The 76-type test set (high output) is recommended as a source of tone. Although the 114A Test Set has a lower output, it can be used effectively if the fault resistance is low and the tone can be applied relatively close to the fault. The detailed procedures for locating the various types of faults in multiple wire are covered in Parts 4 to 7. After a fault has been located and cleared, make permanent repairs as covered in Part 8.

4. LOCATING OPENS

4.01 Opens are of three classes, as follows:

(a) ***Complete:*** Usually caused by a break in one or both conductors of a circuit, by a wire being disconnected from a binding post, or by an improper or split pair connection at a terminal or load point.

(b) ***Intermittent:*** Most commonly caused by loose connections on binding posts of terminals or load points, improperly made splices, wires corroded through at locations where abrasion has occurred on the wire, or damage incurred during placing, etc.

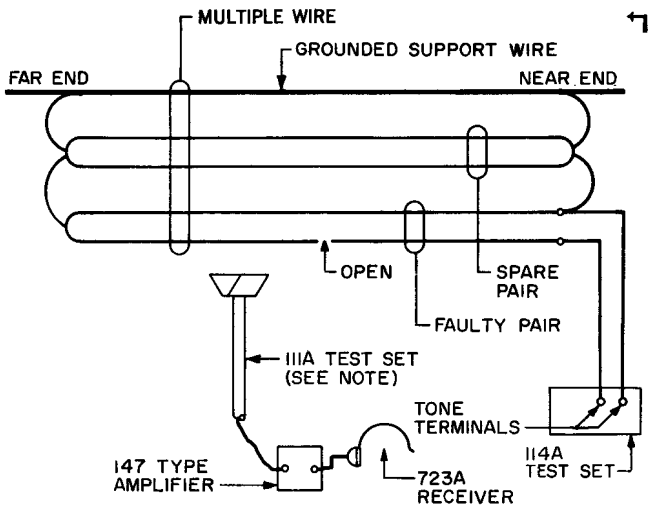
(c) ***High Resistance Connections:*** Ordinarily caused by improper cleaning of wires before attaching them to binding posts, or by the formation of corrosion on wires, binding posts, nuts and washers. High resistance connections are not often identified as opens since they usually cause only poor transmission and noise, and not cutouts.

4.02 Unlike opens in cable where location is difficult because of the sheath acting as an electrostatic shield, opens in multiple wire can be readily located in either wet or dry weather. After isolating the fault to a particular section, refer to Fig. 1 and proceed as follows:

(1) At the far end, short and ground to the support wire the pair in trouble and all spare pairs.

(2) At the near end, ground all spare pairs and the good side of the open pair to the support wire.

(3) At the near end, apply 500-cycle voltage between the open conductor and ground using the 114A Test Set or the 76-type test set for the voltage source. If a 76-type test set is used connect to the low tone output. If the general location of the open is known or suspected, place the voltage source at the end which is closest to the open.



NOTE: 513A TOOL (CAPACITANCE PROBE) CAN BE USED IN PLACE OF 111A TEST SET TO PINPOINT THE OPEN.

Fig. 1 — Locating Opens

(4) Use a 147-type amplifier (switch in probe position), a 723A Receiver, and the 111A Test Set attached to a suitable number of tree pruner handle extensions. Starting at the voltage source end, lift the probe end of the 111A Test Set and align the "V" shaped guide along the wire. With the probe in contact with the

wire, move the probe along the wire until the loudest tone is heard. Adjust the volume to a comfortable listening level. This particular volume setting serves as a reference and should not be changed for the rest of the test.

(5) Follow the multiple wire toward the open in the faulty conductor. The probe should be held in contact with the multiple wire and moved over a short distance when listening for tone, because the tone will vary in volume as a result of the lay of the wire. Check for tone at intervals along the span to determine whether tone is present. In long sections of wire, check for tone every few spans instead of checking every span.

(6) If the tone cannot be heard in a particular span, or portion of a span, backtrack until the tone is heard. The location of the open will be indicated by tone on one side of the open and a drop off of tone on the other.

(7) If the location of the open is not obvious after access is gained to the approximate location of the fault, it may be necessary to pinpoint the open. In this case, use the 513A Tool in place of the 111A Test Set (see note to Fig. 1). If power noise tends to mask out the signal, wrap the lead of the test clip (ground lead) for the 513A Tool around the multiple wire about ten times and make no metallic connection to this test clip.

4.03 Intermittent opens in multiple wire are frequently difficult to locate. When tracing voltage along the wire, it may be necessary to move or shake the wire in the span toward the voltage source in order to make the open appear.

5. LOCATING SHORTS

5.01 Methods used in locating shorts, crosses, and grounds in cables also apply in the case of multiple wire. The following paragraphs describe these types of faults and the methods to be used in their location.

5.02 Short circuits are of two classes, namely:

(a) ***Low Resistance:*** Due to a complete breakdown of the insulation between the two wires of a circuit and the establishment of a low resistance path from one wire to the other. Frequent causes are injury to insulation at supporting attachments on crossarms or poles, abrasion from contacts with trees, buildings, etc., where proper protective measures were not used, damage from gun shots, and injury by foreign workmen or construction operations.

(b) ***High Resistance:*** A high resistance path between the two wires of a circuit may be caused by either a partial breakdown of the insulation or a complete breakdown of the insulation which has resulted in only a poor contact between the wires. The usual causes for this type of short are similar to those given for the first type differing only in the degree of injury to the insulation.

5.03 After the short has been isolated to a reasonably short section of wire, refer to Fig. 2 and proceed as follows:

(1) At the far end of the section, open the affected pair at an accessible point. Working circuits should remain connected in the normal manner.

(2) At the near end, apply tone between sides of the faulty pair using the high tone output of the 76-type test set or its equivalent. The 114A Test Set can be used effectively if the fault resistance is low and the tone can be applied relatively close to the fault.

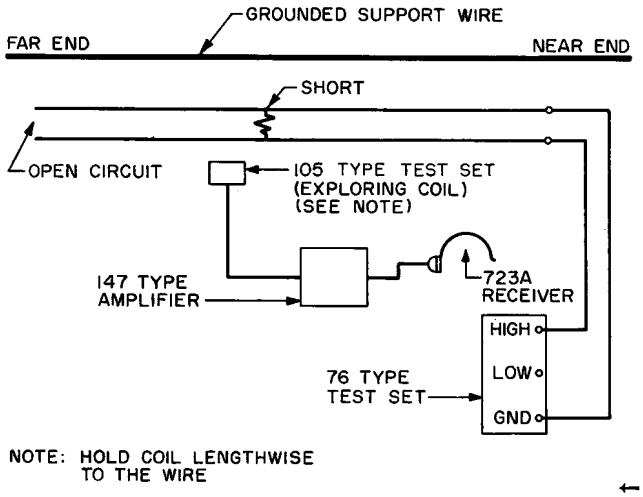


Fig. 2 — Locating Shorts

(3) Trace the tone along the wire using the test equipment as illustrated in Fig. 2.

(4) A definite change in the level of tone in the headset will indicate that the fault was passed.

6. LOCATING CROSSES

6.01 Crosses result from the establishment of an electrical contact between one conductor of one circuit and a conductor of one or more other circuits. A common cause, in addition to those mentioned for the other types of faults, is found at terminating points such as cable or wire terminals and load points where improper dressing and connecting permits the ends of wires to touch adjacent binding posts of other circuits.

6.02 When sides of two or more pairs are crossed, isolate the fault to a particular section of wire, refer to Fig. 3 and proceed as follows:

(1) Select a convenient point at the far end of the section and open the affected pairs. Leave working circuits working in their normal manner.

(2) At the near end apply tone to the crossed wires at an accessible point using the high tone output of the 76-type test set or its equivalent. The 114A Test Set can be used effectively if the fault resistance is low and the tone can be applied relatively close to the fault.

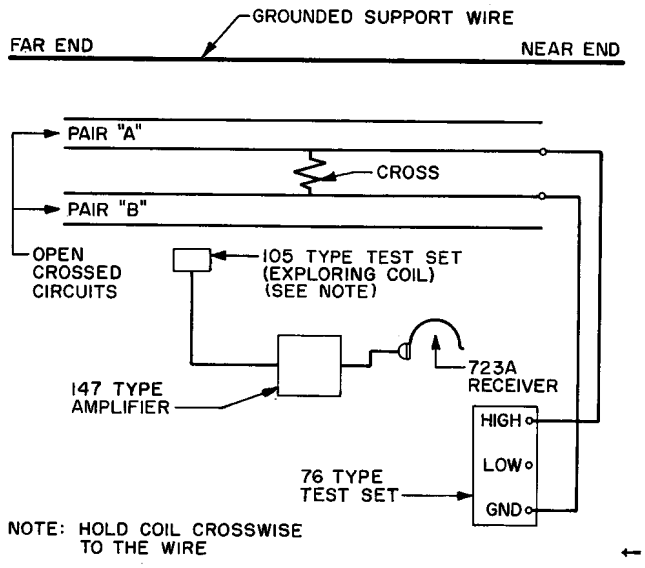


Fig. 3 — Locating Crosses

(3) Use the 105-type test set (exploring coil) to locate the fault in the same way as when locating a short.

7. LOCATING GROUNDS

7.01 Grounds may appear in either of two different types:

(a) ***Low Resistance:*** This type of ground usually results from a complete breakdown of the insulation on a conductor due to damage or abrasion and contact with grounded objects such as the support wire, guys, ground wires, etc., establishing a low resistance path to ground.

(b) ***High Resistance:*** This type of ground may be caused by complete or partial breakdown of the insulation on a conductor and the establishment of a poor contact with grounded objects so that the path to ground is of high resistance except in wet weather. It may also be caused by complete breakdown of the insulation on a conductor and contact with objects such as wood poles, trees, buildings, etc, that do not afford a low resistance path to ground. Troubles of the latter class are frequently of varying intensity, appearing usually during wet weather and usually must be located either under wet weather conditions or by a visual inspection for the point where the insulation is faulty.

7.02 In most cases where a conductor is grounded, it will show a low resistance to ground at the test desk. It is impossible for the test desk to determine whether the conductor is grounded to the support wire or grounded through contact with a tree or other objects exclusive of the support wire.

7.03 In order to determine the path to ground and locate the trouble, isolate the fault to a reasonably short section of wire, refer to Fig. 4 and proceed as follows:

(1) Open the affected pair at the far end of the section. Other circuits continue to work normally.

(2) At an accessible point at the near end, apply tone between the grounded side of the circuit and the support wire using the high tone output of the 76-type test set or its equiv-

alent. The 114A Test Set can be used effectively if the fault resistance is low and the tone can be applied relatively close to the fault.

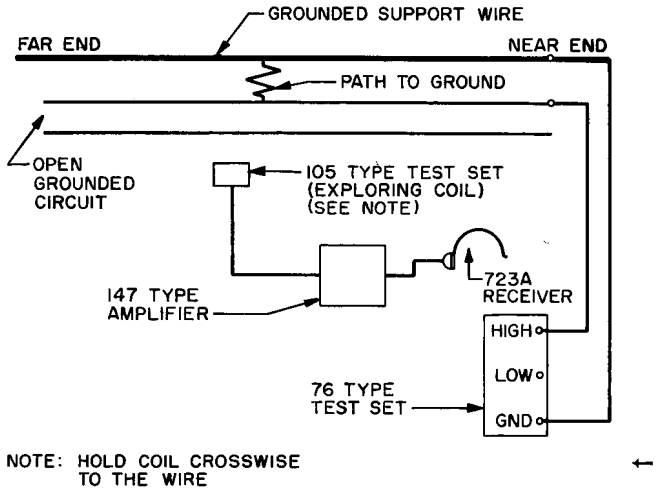


Fig. 4 — Locating Grounds

(3) Trace the tone along the wire with the exploring coil. When the level of tone drops off, the fault is passed indicating that the path to ground is through the grounded support wire. If the tone continues and appears at the far end of the section, the path to ground is through some other object exclusive of the support wire.

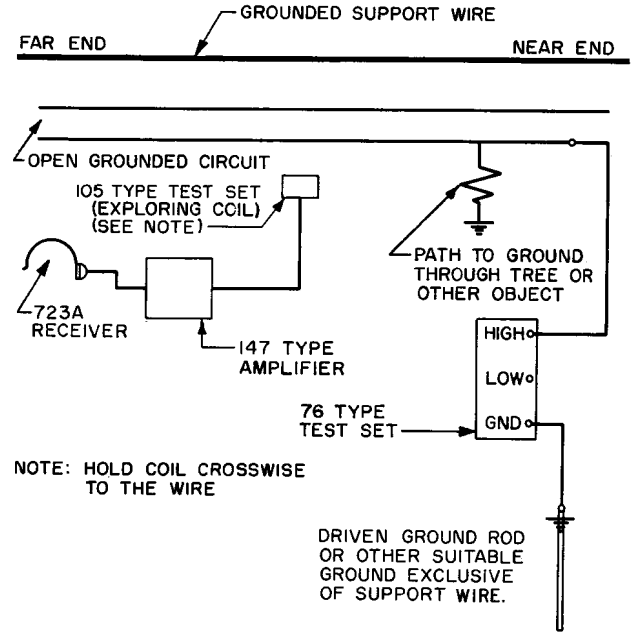


Fig. 5 — Locating Ground Paths

(4) To locate the ground path, in cases when it is not through the support wire, return to the tone source and connect the ground terminal of the 76-type test set to a ground rod driven for this purpose or to some other suitable ground that is not directly connected to the support wire. The exploring coil is again used as shown in Fig. 5 to trace the tone. When the tone level drops, the path to ground has been passed.

8. CLEARING TROUBLE

8.01 If necessary to repair a conductor to clear trouble in multiple wire, cut the conductor and splice it with the appropriate size of splice sleeve as covered in Section 624-220-200. Where there is insufficient slack, the conductor can be spliced out. Care should be taken to replace the conductor in the same relative position in the stranded group, and to maintain the color code of the conductor.

8.02 When the location of grounds, shorts, or crosses is known exactly, remove sufficient insulation to inspect the conductor for corrosion, nicks, or other injuries. If the conductors are not damaged, repair the insulation on each conductor as covered in 8.01.

8.03 If the inspection at the point of trouble indicates that the conductor is corroded or damaged to such an extent that a potential case of trouble is apparent, cut out the defective piece and complete repairs as covered in 8.01.

8.04 If the damage to all conductors and the support wire is extensive over a section of considerable length or if the insulation has been damaged at several points in a span, it may be necessary to replace the section or the entire span. The work should be done in accordance with the sections covering placing and splicing.

8.05 Where abrasion has caused the trouble, the cause should be removed, if possible, or suitable protection should be placed on the multiple wire so that further abrasion will be avoided (see 2.06).

8.06 While at the location of the trouble, the remainder of the multiple wire which is accessible should be inspected for indications of damage to insulation which might result in future cases of trouble. Such conditions should also be cleared while the wire is accessible.

8.07 After a fault has been located and cleared, the condition which caused the trouble should be corrected. The work should be done in such a manner as to prevent a recurrence of trouble at the same location and from the same cause, and to eliminate, as far as practical, any unsatisfactory conditions that might result in a recurrence of the trouble.