

BELL SYSTEM PRACTICES
Outside Plant Construction
and Maintenance

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B RURAL AND B URBAN WIRES
FAULT LOCATING

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1. GENERAL

1.01 This section, covering the maintenance of B Rural and B Urban Wires, sets forth methods to be used in locating and clearing various types of trouble and the precautions necessary to insure safety in the performance of all work operations. In addition to the methods outlined in this section, a workman should be familiar with approved construction methods as covered in other sections of this group of practices.

1.02 Damaged insulation, lightning strokes, and power contacts are the conditions most likely to produce trouble. Periodic inspection and associated preventive maintenance, when planned and carried out, will detect and eliminate many potential sources of trouble.

2. PRECAUTIONS

2.01 The detailed precautions in this section, together with all applicable safety precautions as covered in other sections of these practices, should be observed. Those which apply particularly to this type of plant are contained in the sections on Precautions—General and Precautions—Aerial Work.

2.02 Do not work on B Rural or B Urban Wire if there is any indication or suspicion that the wire may be in contact with power wires. Before doing any work in such cases,

a visual inspection for such contacts must be made, and any dangerous conditions corrected. If inspection does not reveal any unsatisfactory power conditions and tests at the test board still indicate the presence of foreign potentials, any work done in the field to locate such trouble, such as opening a pair at a cable terminal, etc., must be done while wearing rubber gloves.

2.03 Avoid making temporary repairs whenever possible.

When unable to repair defects permanently because of lack of proper equipment or material or due to the nature of the work involved, the workman shall be governed by local practices or by special instructions relative to making temporary repairs.

2.04 **B Rural or B Urban Wire shall not be ridden in a cable car nor worked on by placing a ladder against it.** When it is necessary to perform repair work in the span, either a truck mounted platform ladder should be used or the wire should be lowered to the ground.

2.05 The lowering or raising of a taut B Rural or B Urban Wire requires that precautions be taken to insure that the work is done safely. The wire shall not be dropped free to the ground from its position on the pole or crossarm. Use a handline to avoid the possibility of accidents and to prevent damage to the wire by the sudden drop while under tension. Obtain assistance to lower or raise the wire when it is determined that traffic, corners, trees, power, or other conditions are such that one man can not do the work in a safe manner.

2.06 Wire guards should never be placed over sections of the wire on which the insulation is abraded and has not been repaired.

2.07 Splice wires only in accordance with standard practices by using approved splices.

2.08 It is highly undesirable to use test picks, test clips, or other devices that puncture the insulation; such holes lead to rapid corrosion of the conductor. Where holes have been made, they shall be covered with a double layer of D Vinyl Tape, extending at least 1/2 inch beyond hole.

3. LOCATING TROUBLE

3.01 In common with other types of plant, the objective of trouble location in B Rural or B Urban Wire is to restore service to the subscribers in the shortest practicable time. By careful analysis and a systematic approach, a workman can save considerable time and effort. A visual inspection of the wire will usually reveal external evidence of certain kinds of trouble; others, not so readily apparent, will require electrical tests to determine their location.

3.02 A thorough knowledge of conditions along the route of the B Rural or B Urban Wire greatly assists a workman 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 In order to proceed in a logical and efficient way to locate the cause of the trouble, the workman should secure the following information from the test desk:

- (a) Location and route of line—especially important if the terrain over which the line passes is such as to require special equipment or assistance during periods of bad weather.
- (b) Any indication such as the operation of central office heat coils or presence of 60-cycle hum that there may be foreign current on the line.
- (c) Cable number, terminal, and the cable pairs to which the circuits in trouble are assigned.
- (d) Pole numbers, if available, where branch leads or subscriber drops are terminated.
- (e) Nature of trouble as diagnosed by the test deskman or as indicated by trouble report.
- (f) Whether or not some or all stations on a line are out of service and whether or not one or more lines are involved. This information should include, of course, the identity of these lines and stations.
- (g) Whether or not trouble of a similar nature has recently occurred on the line or lines.

3.04 Burns in bridle wires or drop wires connected to B Rural or B Urban Wire, or operation of protectors connected to such wires strongly indicate contact with power wires. When such indications are found, the entire line should be inspected to locate such sources of trouble, and if contacts or other unsafe conditions are found no trouble locating work should be done until such conditions have been corrected.

3.05 After securing all available information as listed above, the workman should determine by appropriate preliminary tests that the trouble is located in the B Rural or B Urban Wire. When this fact is established, he should test to determine the nature and magnitude of the trouble. If the workman is aware of conditions such as those mentioned in Paragraph 3.02 which might have caused the trouble, his investigation should

begin by a visit to the points where these conditions are known to exist. If nothing is found at these points then further tests, in accordance with approved methods, should be made to isolate the trouble.

3.06 Proper utilization of the hand test set will enable the workman to quickly locate or isolate many faults without making other tests or without assistance from the test deskman or the operator.

3.07 Select convenient points such as wire terminals at junction poles or load points where circuits are accessible and can be readily identified and opened. Make successive tests with the hand test set at different points until the fault has been isolated into the shortest possible section of the wire. After the fault has been localized in this manner, it may then be located by placing tone at one end of the section and tracing it along the wire using appropriate test sets, depending upon the type of fault. Generally, it will be necessary to check for tone at poles unless a ladder truck is used or conditions permit the wire to be lowered to the ground. Shorts, crosses, and grounds can be traced from the ground with the 105B Test Set. As this check progresses from pole to pole, a careful visual inspection should be made for any external evidence of the fault.

3.08 The detailed procedures to be employed in locating various types of faults in B Rural or B Urban Wire are outlined and illustrated in Parts 4 and 5. After a fault has been located and cleared, all repairs should be made in accordance with instructions given in Part 6.

4. LOCATING OPENS

4.01 Opens are of three classes, as follows:

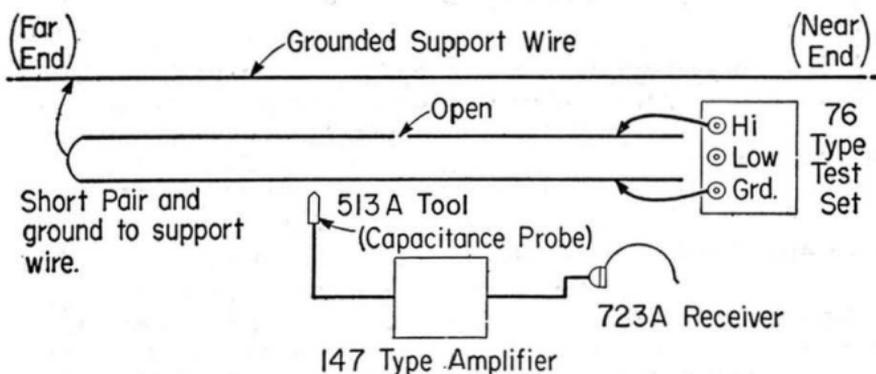
(a) **Complete:** Usually caused by a break in one or both conductors of a circuit, by a wire being disconnected from a binding post, or by an improper or split pair connection at a terminal or load point.

(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 B Rural or B Urban Wire can be readily located in either wet or dry weather. After isolating the fault to a particular section, proceed as follows:

- (1) At the far end, short and connect the pair in trouble to the grounded support wire.
- (2) At the near end, apply tone between the "open" wire and ground using the 76-Type Test Set for a tone source as shown below.
- (3) Use a 91A Test Set, consisting of a 513A Tool (capacitance probe), a 147 Type Amplifier, and a 723A Receiver, to trace tone along wire. **The 513A Tool must not be used on tree pruner handles or other improvised extensions to locate opens from the ground. Accidental contact of the 513A Tool with power wires could result in electric shock.**
- (4) When the fault is passed, a definite change in the level of tone in the headset will be evident.



Short and ground all nonworking pairs to support wire at near end. Other circuits to continue working normally

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

5. LOCATING SHORTS, CROSSES AND GROUNDS

5.01 Methods used in locating shorts, crosses, and grounds in cables also apply in the case of B Rural or B Urban Wire. The following paragraphs describe these types of faults and set forth methods to be used in their location.

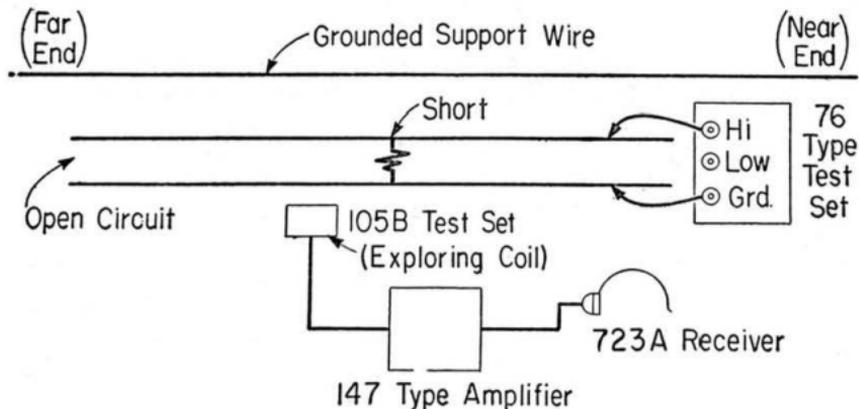
Shorts

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, 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 76-Type Test Set as illustrated below:



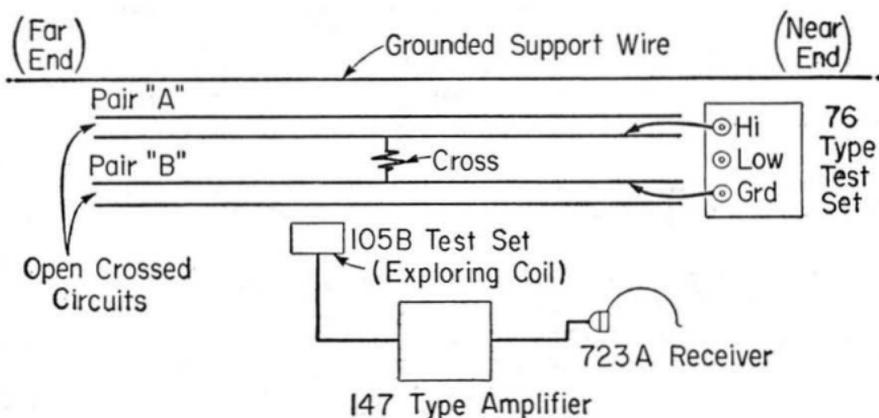
- (3) Trace the tone along the wire using the test equipment shown in the above sketch.
- (4) A definite change in the level of tone in the headset will indicate that the fault was passed.

Crosses

5.04 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.

5.05 When sides of two or more pairs are crossed, isolate the fault to a particular section of wire 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) As illustrated below, apply tone to the crossed wires at an accessible point at the near end using the 76-Type Test Set for a tone source.



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

Grounds

5.06 Grounds may appear in either of two different types.

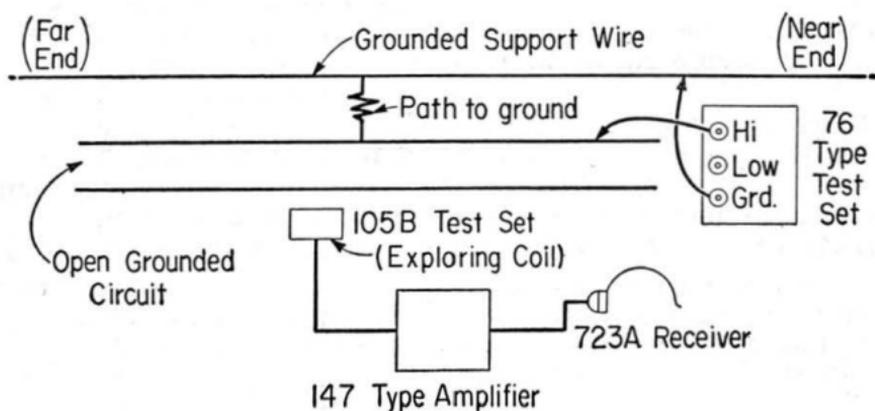
- (a) **Low Resistance:** This type of ground usually results from a complete breakdown of the insulation on a conductor due to damage or abrasion and contact with grounded objects such as the support wire, guys, ground wires, etc., establishing a low resistance path to ground.

(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.

5.07 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 deskman 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.

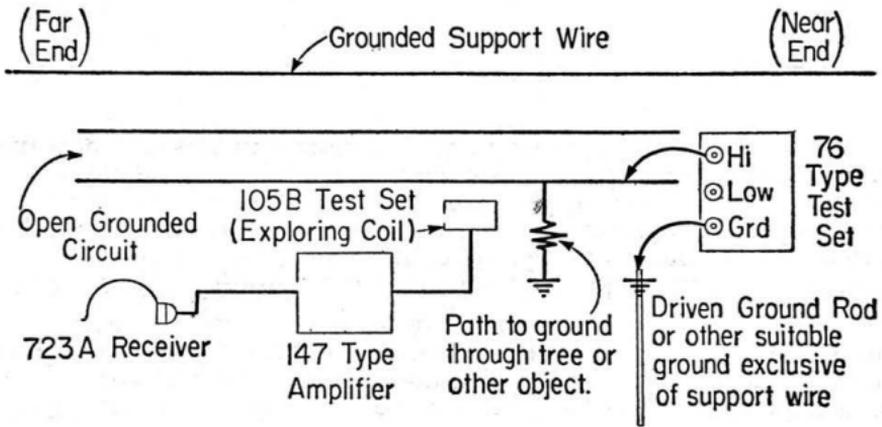
5.08 In order to determine the path to ground and locate the trouble, isolate the fault to a reasonably short section of wire and proceed as follows:

- (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, place tone between the grounded side of the circuit and the support wire using the 76-Type Test Set as shown below:



(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.

(4) To locate the ground path in such case, 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 some other suitable ground that is not directly connected to the support wire. The exploring coil is again used as shown below to trace the tone. When the tone level drops, the path to ground has been passed.



6. CLEARING TROUBLE

6.01 When it is necessary to restore insulation to clear and repair trouble in B Rural, each conductor from which the insulation has been removed shall be covered with two half lapped layers of 3/4-inch DR tape followed by two half lapped layers of friction tape. Start the tapes at the middle of the sleeve or opening in the insulation and extend them over the insulation for 1/4-inch beyond each end. Tapes may be cut to 1/2 inch wide to improve handling. Use only D Vinyl Tape on B Urban Wire, placing 2 half lapped layers.

6.02 Where opens are located in B Rural Wire, repairs may often be made by splicing with an F Splice Sleeve for each open conductor (use G Splice Sleeves on B Urban Wire). If sufficient slack is not available, the wire may be spliced out. Care should be taken to replace the section in the same relative position in the stranded group.

6.03 When the location of grounds, shorts, or crosses is exactly known, remove sufficient insulation to inspect the conductor for corrosion, nicks or other injuries. If the conductors are not damaged, restore the insulation on each conductor with tapes applied in the manner described in Paragraph 6.01.

6.04 If the inspection at the point of trouble indicates that a 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 in the manner outlined for opens in Paragraph 6.02.

6.05 In cases where the damage to all conductors and the support wire is extensive over a section of considerable length or where 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 practices outlined in the Placing and Splicing Sections.

6.06 In those cases where the trouble was caused by abrasion, the cause should be removed if possible or suitable protection should be placed on the B Rural or B Urban Wire so that further abrasion will be avoided.

6.07 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 practicable, any unsatisfactory conditions that might result in a similar case of trouble in the future.