

GOLDAK Underground Detection Equipment

MODEL 600 POWER CABLE LOCATOR

OPERATING MANUAL


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Locating Since 1933*



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PRODUCTS

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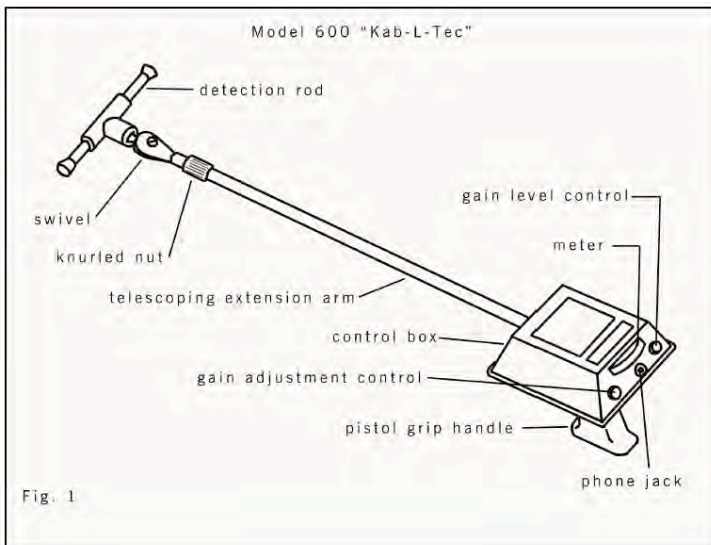


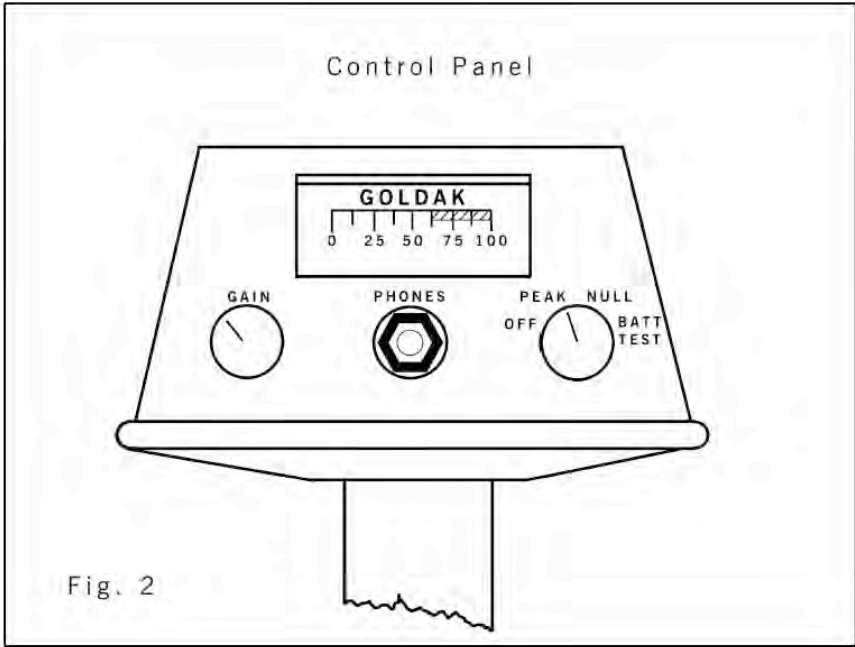
Model 600 Power Cable Locator

1) General Description:

The Model 600 Power Cable Locator is an electronic instrument for locating, tracing, and measuring the depth of energized power cables. It can also be used to locate underground transformers, T-splices, Y-splices, and grounded faults.

Structurally, the “Kab-L-Tec” consists of a high impact plastic control box fastened to a pistol-grip handle and connected through an extension arm to a swivel mounted detection rod (**Fig. 1**). By turning the swivel, the detection rod can be set into detented positions either parallel to the extension arm, perpendicular to it, or inclined at 45 degrees to it (**Fig. 3, 6, and 9**). The control box contains and shields the electronic circuitry; on its face are mounted a gain control, a selector switch, a phone jack, and a meter (**Fig. 2**). The pistol-grip handle not only serves as a means of grasping the instrument but also houses its 9 volt battery in an easily removable clip (**Fig. 13**). A set of high impedance headphones completes the instrument.





Electrically, the detection rod is inductively influenced by the electromagnetic field associated with the current, which is flowing through a cable. The signal thus received by the detection rod is amplified by the circuitry in the control box. With the gain control and the selector switch, the operator can vary the amount of amplification over a wide range, can adjust the degree of meter sensitivity, and can also test the state of the battery at any time. The amplified signal is heard through the headphones and is indicated visually by the meter.

II Operation

A) Functions of the Controls

- 1) **Gain Control** – The gain control (**Fig. 2**) is a multi-turn potentiometer which provides a smooth and continuously variable adjustment of the amplifier's gain and rotating it counterclockwise gradually decreases the gain.
- 2) **Selector Switch** – The selector switch at the right of the panel (**Fig. 2**) has six positions.
 - a) Its first position is “off”. When this switch is set to this position, the battery is disconnected and the entire circuit is turned off.
 - b) Its last position is for testing the state of the battery and is so labeled. When the switch is set to this position, the meter-needle will indicate the condition of the battery: if the meter-needle deflects into the green area at the right of the scale, the battery is good; if the meter-needle falls to the left of the green area, the battery should be replaced.
 - c) The second, third, fourth, and fifth positions of the selector switch adjust the sensitivity of the meter response to signal reception. The second position provides the lowest level of meter sensitivity, the fifth position provides the highest level of meter sensitivity, and the third and fourth positions provide intermediate levels. Because experience proves that the lower levels of meter sensitivity are more useful for operating in the maximizing technique (explained below) while the higher levels of meter sensitivity are more useful for

operation in the minimizing technique, the second and third positions of this switch have been labeled “peak” and the fourth and fifth positions have been labeled “null”.

B) General Operating Principles

- 1) In searching for buried cables, the Model 600 “Kab-L-Tec” is always carried and operated vertically. The operator grasps the instrument by the pistol grip handle and holds it so that the detection rod is close to the earth.
- 2) The signal “sensed” by the detection rod is amplified by the circuitry in the control box. By adjusting the gain control, the operator can regulate the amount of amplification that is imparted to the signal. He should always adjust the gain to produce a response level at the meter and headphones that is strong enough to be observed but not so strong as to saturate the circuit and thereby to render imperceptible the variations that may occur in the “sensed” signal.
- 3) What the detection rod “senses” is the electromagnetic field propagated from the energized cable. The strength of the signal “sensed” at the detection rod, therefore, depends primarily on three factors; (a) the amount of current flowing through the cable, (b) the distance between the detection-rod and the cable, and (c) the position in which the detection rod is oriented with respect to the cable.

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- a) The greater the current through the cable, the stronger will be the signal “sensed” by the detection rod at any point. Conversely, the less the current through the cable, the weaker will be the signal “sensed” by the detection rod at a given point. If we can assume, however, that the amount of current in a given cable will remain fairly constant throughout the duration of the operator’s search for the cable, this factor will not enter into the operating technique.
- b) The distance between the detection rod and the energized cable is a factor that is varied during operation. The farther the detection rod is from the cable, the weaker will be the “sensed” signal; the closer the detection rod is to the cable, the stronger will be the “sensed” signal. In walking toward the cable, in crossing it, and in walking away from it, the operator is varying the distance between the detection rod and the cable (as well as the orientation of the detection rod with respect to the cable -- see below), and the “sensed” signal will vary in accordance with this.
- c) Varying the orientation of the detection rod with respect to the cable at any given distance from the cable will alter the strength of the “sensed” signal at that point. The operator varies this orientation not only by the angle at which he sets the detection rod at its swivel but also by the positions in which he is located as he approaches, crosses, and recedes from the cable. Whenever, at any point, the length of the detection rod is aimed in a line-of-sight at the energized cable, the signal “sensed” by the detection rod will be at an extreme minimal level for that particular point.

Whenever, on the other hand, the detection rod is so oriented that its length is aimed in a direction perpendicular to the run of the cable and that its ends are equidistant from the cable, the signal “sensed” by the detection-rod will be at an extreme maximum level for that particular point.

- 4) The techniques, therefore, of locating or tracing a buried energized cable depend on interpreting variations in response-level for controlled variations in distance from the cable, in orientation of the detection rod with respect to the cable, and in amplifier gain. Two general techniques are possible: the maximizing (or “peaking”) technique and the minimizing (or “nulling”) technique. The maximizing technique requires that the detection rod be so oriented as to have maximum sensitivity when directly over the energized cable. The minimizing technique requires that the detection rod be so oriented as to have minimum sensitivity when directly over the energized cable. In both techniques an initial reference level of signal response is set by adjustment of the gain control, and then variations are observed as the operator carries the instrument into positions that approach the cable, that lie directly above the cable, and that recede from the cable. In the maximizing technique, the variations in the operator’s position as he walks (which are equivalent to variations in the distance and orientation of the detection-rod with respect to the cable) cause the signal response to rise to the maximum value possible when the detection rod is directly over the cable. In the minimizing technique, the variations in the operator’s position as he walks (which are equivalent to changes in orientation of the detection-

rod with respect to the cable) cause the signal-response to fall sharply when the instrument is directly over the cable.

C) Preliminary Procedures

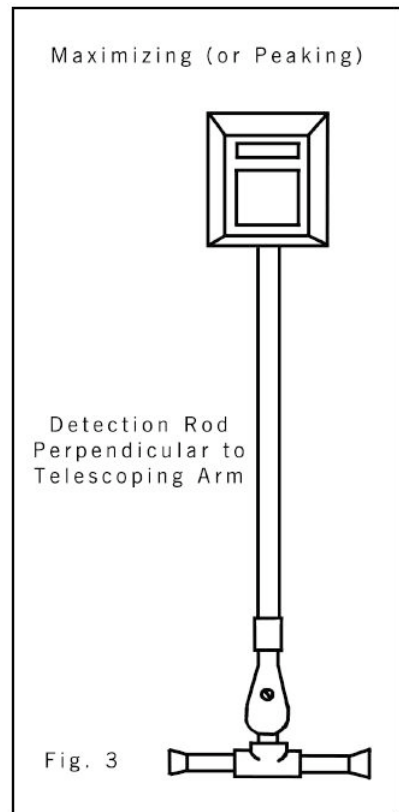
Before attempting to operate the “Kab-L-Tec”, some preliminary procedures are necessary.

- a) Plug the headphones into the phone jack. This, however, is optional. The “Kab-L-Tec” may be operated without headphones; the operator need only observe the meter.
- b) Turn the “Kab-L-Tec” on by rotating the selector switch clockwise out of the “off” position. Allow an interval of a few seconds for the complete charging of the circuit stabilizing capacitors; at the end of this period the meter needle will come to rest.
- c) If desired, the battery may be checked at this point. To do this, turn the selector switch to “battery test” and observe the indication of the meter (--see explanation above, Part II, Section A). When the battery test is completed, return the selector switch either to one of its “peak” or to one of its “null” positions.
- d) Place the detection rod at the desired angle of orientation (perpendicular to the extension arm for the “peaking” or maximizing technique, or parallel to the extension arm for the “nulling” or minimizing technique, as described below and shown in **Fig. 3 and 6**).
- e) Grasp the instrument by the pistol grip handle, and hold it vertically so that the detection rod is within four inches of the surface of the earth. The instrument is now ready for operation.

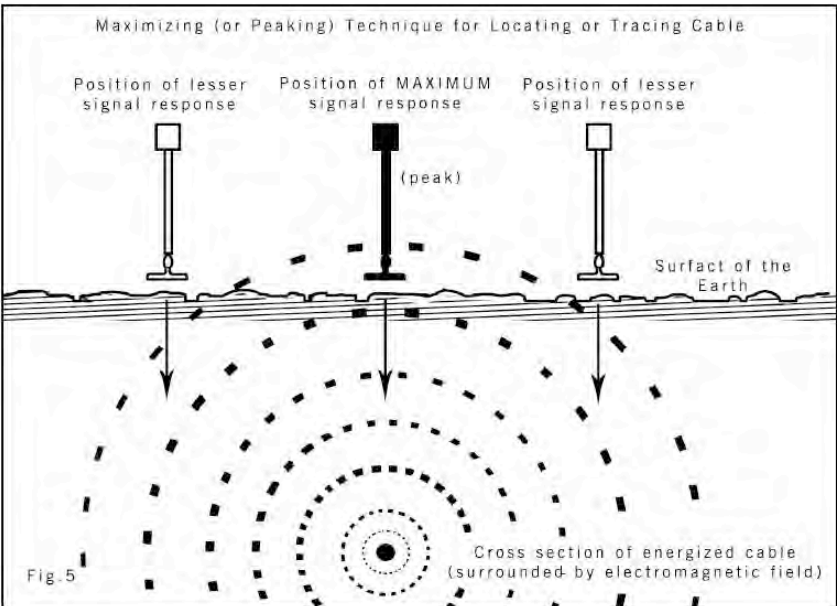
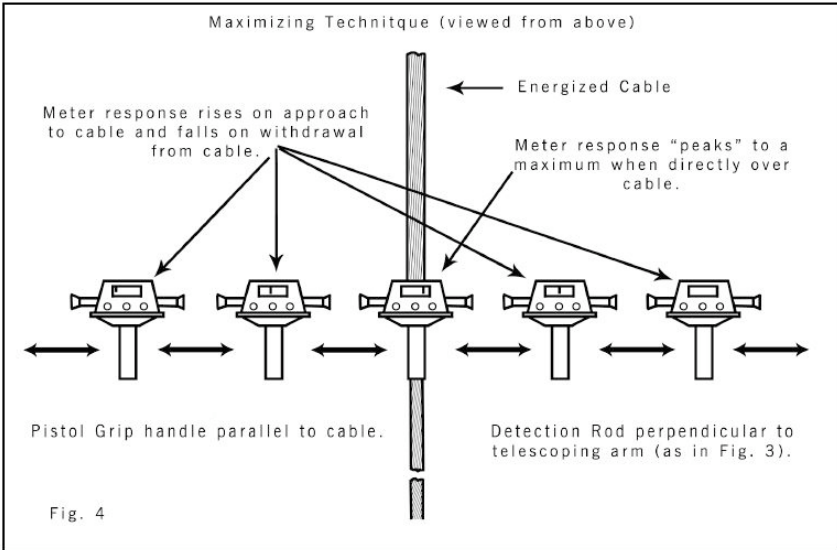
D) Maximizing (or Peaking) Technique

The maximizing technique locates or traces an energized cable by seeking the line of greatest signal response. For this mode of operation, the detection rod is placed in the detented position that sets it at right angles to the extension arm (**Fig. 3**); consequently, as the instrument is held in its normal vertical position, the detection rod is horizontal and parallel to the surface of the earth. The selector switch is set to one of its “peak” positions.

To locate the cable, the operator holds the “Kab-L-Tec” vertically and aligns the pistol grip handle parallel to the expected direction of the cable (**Fig. 4**). He then adjusts the gain control for a signal level that will make the 60Hz. hum audible on the headphones and will deflect the meter needle to approximately half scale (a meter reading of “50”). This will serve as an initial reference level. The operator then scans the earth by walking laterally with the instrument and keeping the pistol-grip handle parallel to the expected run of the cable (**Fig. 4**). If the meter



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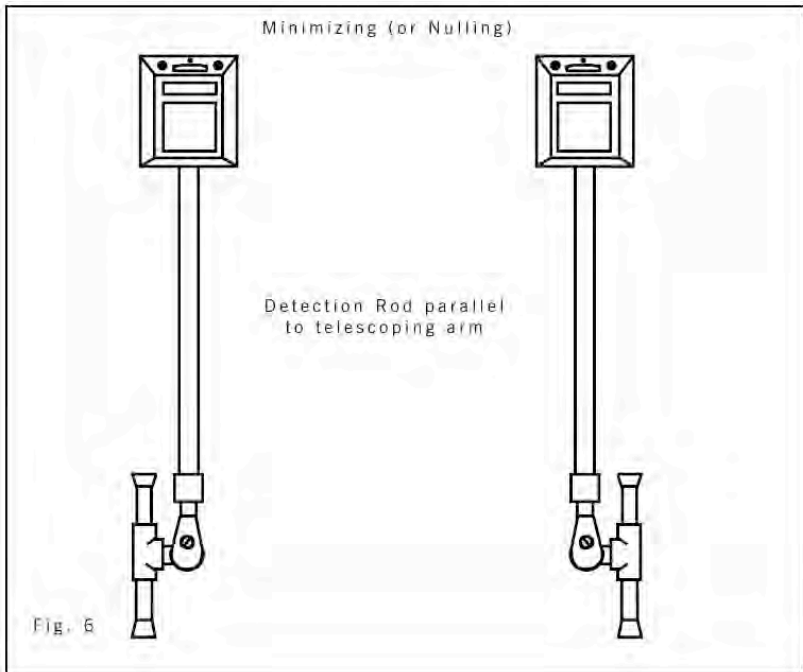


If the meter needle falls as he walks, he is walking in the wrong direction; if it rises, he is walking toward the energized cable. When the meter needle reaches full scale deflection ("100"), the gain of the amplifier must be reduced so as to provide a new reference level of half scale deflection ("50"). Again the operator walks literally toward the cable, and again the meter needle will rise. Each time that the meter needle reaches full scale deflection, the gain must be reduced again to provide another reference level of half scale deflection. This process is repeated until a point is reached where the signal-response no longer rises but begins instead to fall. This point of maximum or "peak" response will be located directly above the energized cable; on either side of the cable the response will fall to lesser levels (**Fig. 4 and 5**). Consequently, by finding the point of maximum response, the energized cable is "located".

The "located" cable may now be "traced" along its entire run by the nonmaximizing technique. The operator maintains the "Kab-L-Tec" in the same orientation, that is, with the pistol-grip handle parallel to the run of the cable. He sets the main control for a reference level of half scale deflection ("50") directly over the cable. he then walks forward and moves the instrument to his right and to his left as he walks. Each time that the detection rod crosses the energized cable, the signal response will peak to a maximum; each time that the detection rod moves to the left or the right of the cable, the signal response will fall to lesser levels. By following the sequence of these points of maximum response, the operator traces out the line under which the cable lies.

E) Minimizing (or Nulling) Technique

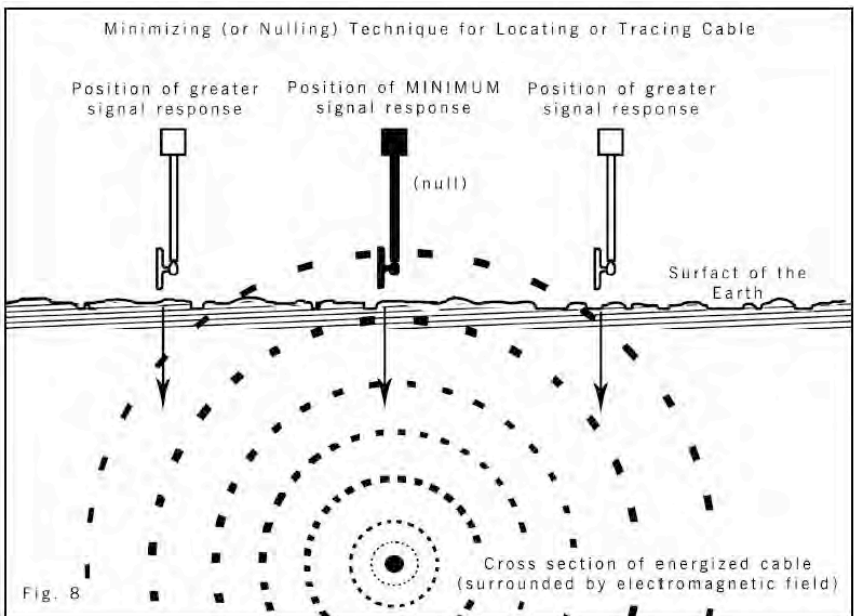
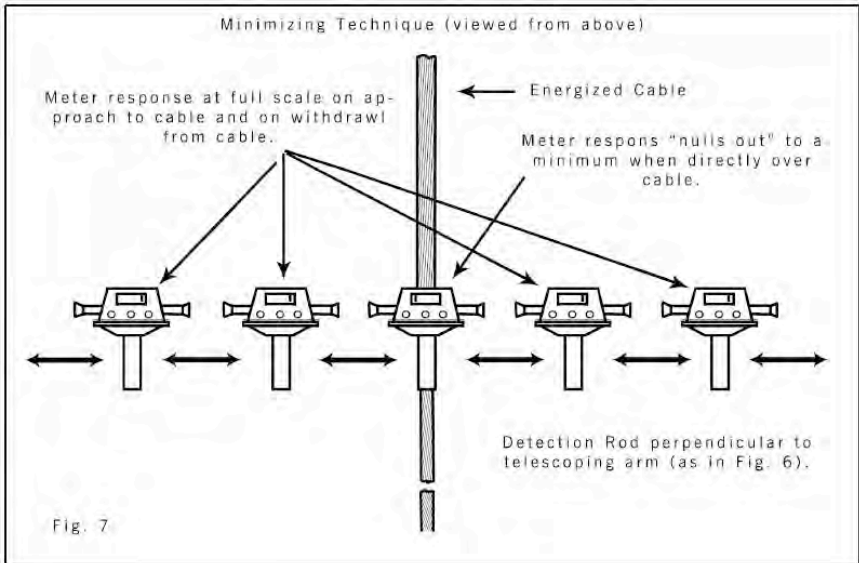
The minimizing technique locates or traces an energized cable by seeking the line of least signal-response. For this mode of operation, the detection-rod is placed in either of the detented positions that sets it parallel to the extension arm (**Fig. 6**). Consequently as the “Kab-L-Tec” is held in its normal vertical position, the detection-rod likewise is vertical, that is, its length is pointing straight up and down. The selector switch is set to one of its “null” positions. To locate an energized cable, the operator holds the instrument vertically and adjusts the gain control for a response level that will make the 60-Hz. hum audible on the headphones and will advance the meter-needle up to a reading of “100” (full scale).



This will serve as an initial reference level. The operator then scans the earth with the instrument, moving it in a direction which will cross over the expected run of the cable. The full scale reference level signal will remain until the instrument crosses over the energized cable. As it crosses to a minimal level, the cable lies directly under the point where the signal response “nulls out” (**Fig. 7 and 8**). (Note -- if the nulling of the signal occurs over an area which is too broad for determining accurately where the cable lies, the amplifier’s gain should be increased; increasing the gain will “sharpen” the response and make the null-area narrow enough to allow precise pinpointing of where the cable lies. Conversely, if the null-area is so “sharp” that it is difficult to detect it at all. The gain of the amplifier must be reduced.) Finding a sharp null-point thus “locates” where the cable lies.

The “located” cable may now be “traced” along its entire run by the same minimizing technique. By finding two null-points, the operator can determine the direction in which the cable runs. He then walks with the “Kab-L-Tec” in the direction of the cable’s run and moves the “Kab-L-Tec” to his left and to his right as he walks. Each time that the detection rod crosses over the energized cable, the signal response will “null out” to a minimum, and each time that the detection rod moves either to the right or to the left of the energized cable, the signal response will rise sharply to a high level. By following the sequence of these null points, the operator traces out the line under which the cable lies.

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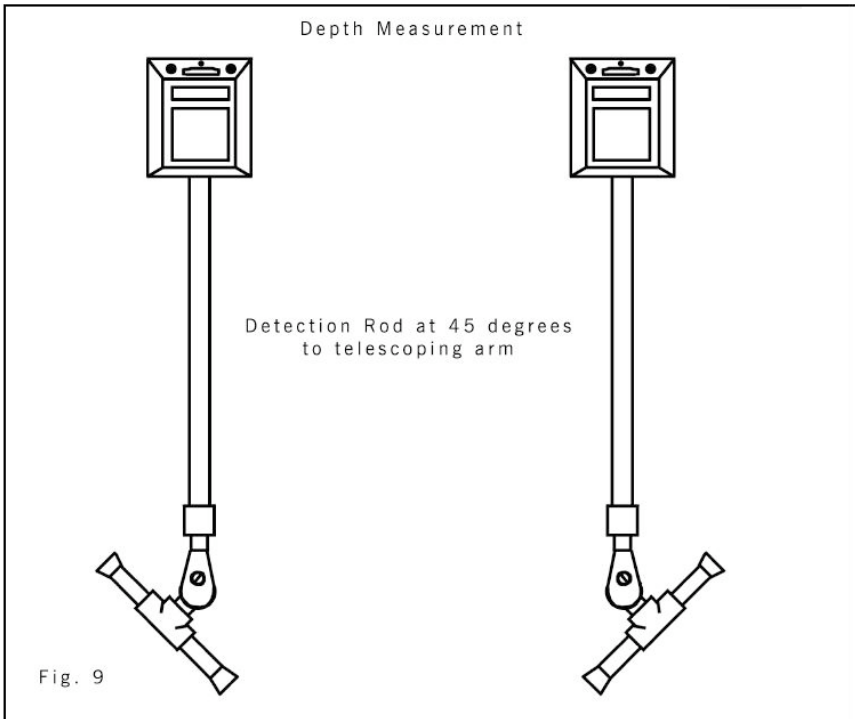
F) Depth Measurement

The technique of measuring the depth of an energized cable is a combination of “nulling” techniques in a precise triangular relationship.

First, the operator must “locate” the line of energized cable by the “nulling” technique as described above (**Part II, Section E, pp. 11**) and shown in **fig. 7 and 8 (p. 13)**. The operator marks the surface of the earth at the point of minimum signal response: this mark will lie directly above the cable.

Secondly, the operator changed the orientation of the detection rod to a 45-degree position; either the left 45-degree detent or the right 45-degree detent may be used (**fig. 9, p. 15**). The operator then holds the instrument so that the pistol-grip handle is aligned parallel to the run of the cable and adjust, if necessary, the gain control for a full-scale reference-level reading (“100”) on the meter (--normally it will not be necessary to readjust the gain control from the setting used previously for “nulling” directly over the cable). The operator then walks laterally to the side on which the high end of the detection rod is situated. (Thus in **fig. 10, p. 16**, the operator is walking toward the left of the page, whereas in **fig. 11, p. 17**, the operator is walking toward the right of the page). The operator continues to walk laterally with the “Kab-L-Tec”, holding the detection rod as close to the ground as possible, until the signal response “nulls out” (**fig. 10 and 11, pp. 16-17**). At this point of minimum signal reception, the length of the detection rod is aimed in a line of sight at the cable. The operator marks the surface of the earth at this point. (Note -- if the nulling of the signal occurs

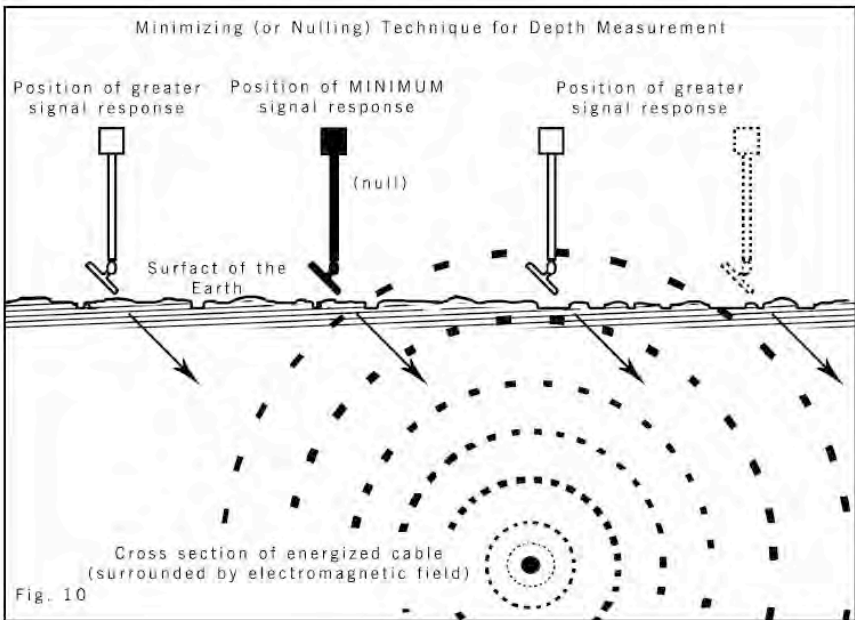
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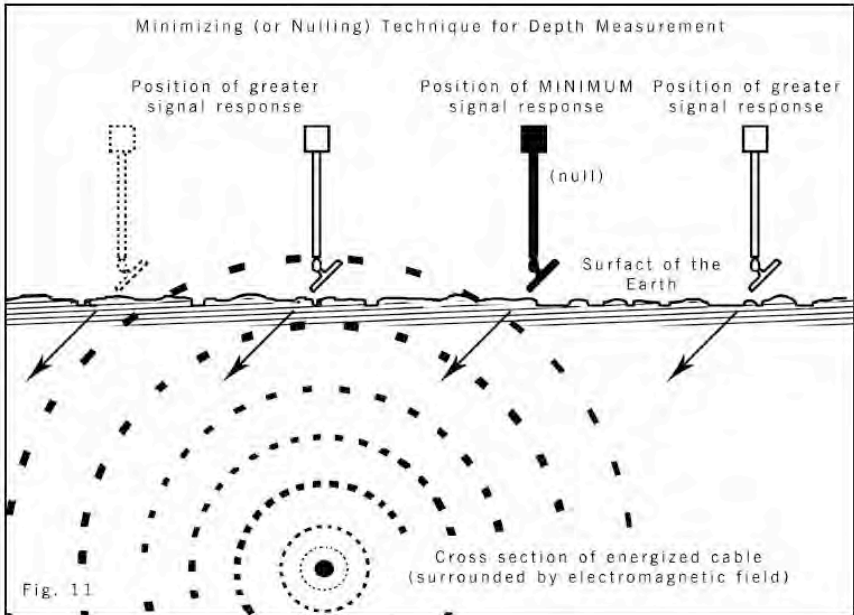


over an area, which is too broad for determining precisely where the earth is to be marked, the amplifier's gain should be increased, increasing the gains will "sharpen" the response and narrow down the null area. Conversely, if the null area is so "sharp" that it is difficult to detect it at all, the gain of the amplifier must be reduced).

Thirdly, the operator measures the surface distance between the two marks which he has made on the surface of the earth. The distance between these two marks will be equal to the distance from the surface of the earth down to the cable (**fig. 12, p. 19**).

When taking depth measurements, it is best to check oneself by taking two measurements, one on one side of the cable and the other on the other side of the cable (as in **fig. 10 and 11, pp. 16-17**), and then to compare the two. Normally, provided these measurements are taken carefully and accurately, they will be equal. When they are not equal, this will be due to distortion of the electromagnetic field caused either by a splice, by a change in the cable's direction, or by an adjacent utility line; in such cases, the cable will lie at a depth which corresponds to the longer of the two surface-measurements.





G) Locating Transformers, Splices, and Faults

1) Underground Transformers

To locate an underground transformer, the operator first locates an energized cable connected to the transformer. He then traces the cable toward the transformer by the maximizing technique described previously. (Note -- the nulling technique cannot be used for locating a transformer). Since the electromagnetic field propagated from a transformer is many times greater than that propagated from the cable, the signal response will rise greatly as the operator walks into the vicinity of the transformer and will continue to rise until the detection rod is directly over the transformer. Each time that the increased signal-response “pegs” the

meter to full scale deflection, the operator must decrease the gain to bring the meter-needle back on the scale. The transformer will be located under the point of maximum response.

2) T-Splices and Y-Splices

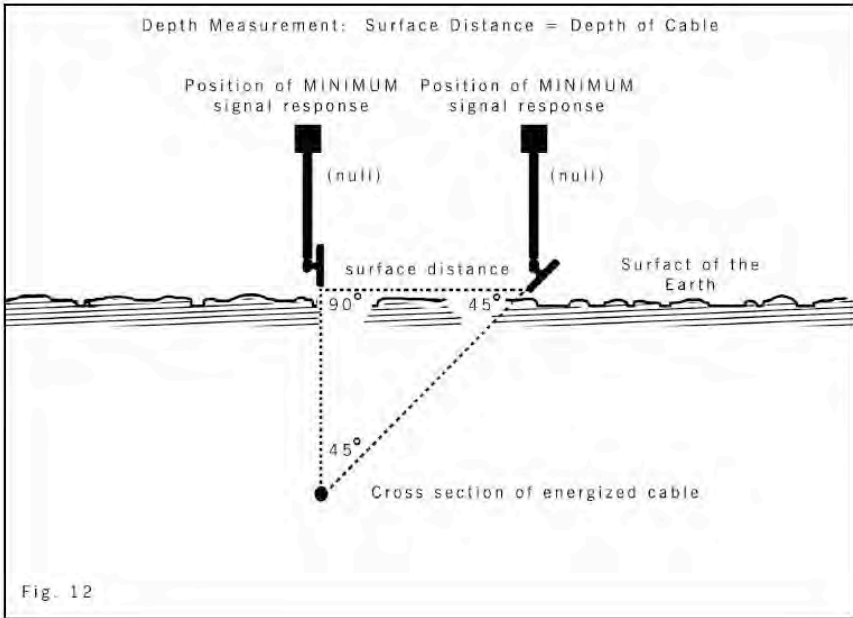
To locate an underground T-splice or Y-splice, each of the three energized cables that join in the splice must first be located at a distance from the splice. Each of these lines is then traced by the maximizing technique to determine the course in which it runs. The splice will be located where the lines converge or intersect.

(Note: Because of the complex patterns of the electromagnetic field near a splice, the nulling technique cannot be used reliably near a splice.) In tracing each of the lines toward the point of convergence, adjustments may have to be made on the gain control in order to compensate for different levels of current in the different lines connected to the splice.

3) Grounded Faults

To locate a fault in which there is current-flow to ground, the energized cable is first located. It is then traced by the maximizing technique as described above. When the instrument passes over a fault, a notable change will be observed in the response-level of the meter; this is due to a change in the line-current and/or to a change in the pattern of the electromagnetic field.

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H) Operating Suggestions and Cautions

- 1) For extreme accuracy in locating a cable (either by the maximizing or by the minimizing technique), the operator must be careful to hold the “Kab-L-Tec” in a perfectly vertical position – that is, the extension-arm must be straight up and down or perpendicular to the surface of the earth.
- 2) For extreme accuracy in depth-measurements, not only must the instrument be held in a perfectly vertical position, but also the detection-rod must be held as close as possible to the earth’s surface. Otherwise the triangular relationship illustrated in **Fig. 12** will not be maintained.

- 3) When using the maximizing technique, it is important to remember that the pistol grip handle must be aligned parallel to the cable. If it is misaligned, the response will fall; if it is misaligned so badly as to be perpendicular to the cable, there will be no response.
- 4) When using the minimizing technique, the operator should distinguish carefully between two different types of decreases in response. When the response “nulls out” quickly and sharply, the detection-rod is crossing over an energized cable; when, however, the response merely falls slowly and gradually, the detection-rod is moving away from the cable at such a distance that the electromagnetic field no longer exerts much influence upon it.
- 5) The maximizing and minimizing techniques can conveniently serve as checks on each other. Locating a cable, for example, by a null-response (minimizing) will verify its location by a peak-response (maximizing).
- 6) Because a null-response is generally “sharper” and more defined than a peak response, it is usually easier and faster to pinpoint the location of a cable by nulling than by peaking.
- 7) In some situations, due to depth, to low current levels, or to three-phase fields, the signal differential can be very small as the operator crosses over the cable on the surface. This will tend to flatten and broaden the response characteristics of signal reception in the “peaking” or maximizing mode. In such cases, the easiest way to achieve precise location of the cable by the maximizing technique is to adjust the gain control

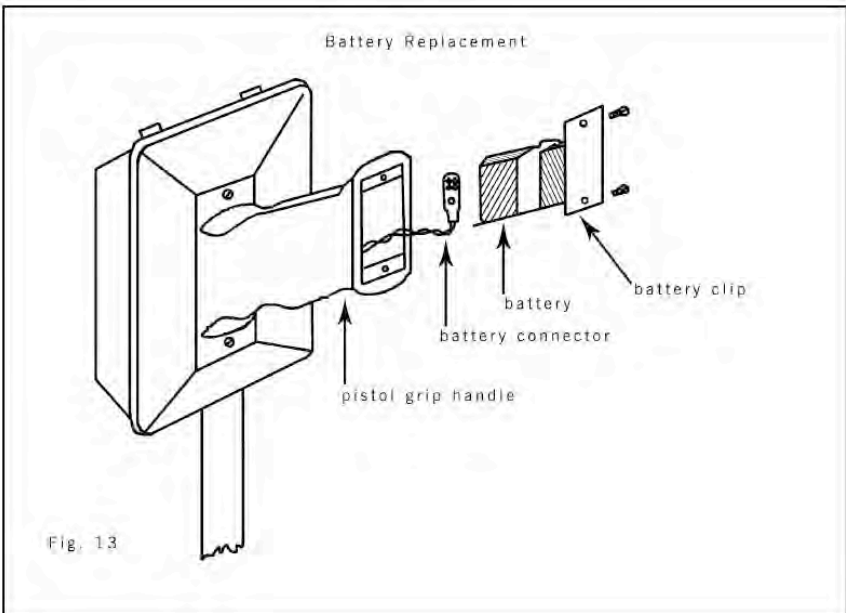
so that the highest peak-response moves the meter-needle to “100” (this will occur in the general area directly above the cable). The operator then moves the instrument laterally to one side of the cable until the response falls to “75”; he marks the ground at that point. He then moves the instrument laterally to the other side of the cable until the response again falls to “75”; he marks the ground at that point also. The cable will be located midway between these two marks.

- 8) When several sources of electromagnetic radiation are present in the same vicinity, the maximizing technique is generally more reliable than the minimizing.
- 9) Whenever possible, current should be raised to a high level in the line which one seeks to locate or trace (for example, by increasing the load on the line). This will strengthen the electromagnetic radiation from the line and will make it easier to locate and trace the line.
- 10) Whenever possible, current should be cut off or reduced in nearby lines which are not to be located or traced. This will eliminate or lessen the possibility of interfering patterns of electromagnetic radiation emanating from them.

III Maintenance

Since the Model 600 “Kab-L-Tec” uses solid state circuitry, nothing needs maintenance or replacement except the battery. the battery is a 9-volt transistor radio type (Eveready S216 or the equivalent). Its life expectancy in the Model 600 “Kab-L-Tec” is approximately 150 hours. the battery should be replaced whenever the battery test procedure (**see Part II, Section A, p. 3**) indicates that its voltage is low.

To replace the battery, the knurled nut at the end of the pistol-grip handle must be loosened and the battery clip must be removed from the handle (**Fig. 13**). The battery connector is then unplugged from the battery and the battery is removed from the battery clip. A new battery is installed by reversing these procedures.



IV Servicing

Should the Model 600 “KAB-L-TEC” Power Cable Locator require repair or servicing aside from normal product maintenance, we suggest that you contact the factory at the following address:

Goldak, Inc.
15835 Monte Street, Unit 104
Sylmar, CA 91342
Phone: 818-367-0149
Fax: 818-833-7694

We will inform you of any local repair stations in your area or advise you to ship the instrument directly to the factory. If you ship the product, we suggest you:

- a) Pack the instrument carefully and secure.
- b) Include any accessory items normally used with the instrument.
- c) Include a note with the instrument stating the nature of the problem(s) you have encountered in using the instrument.
- d) Include a contact name, telephone number, and fax number.

GOLDAK Underground Detection Equipment



GOLDAK PRODUCTS

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