Jan. 3, 1939. R. B. CUMMINGS 2,142,304

TROUBLE FINDER

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Fig. 1.

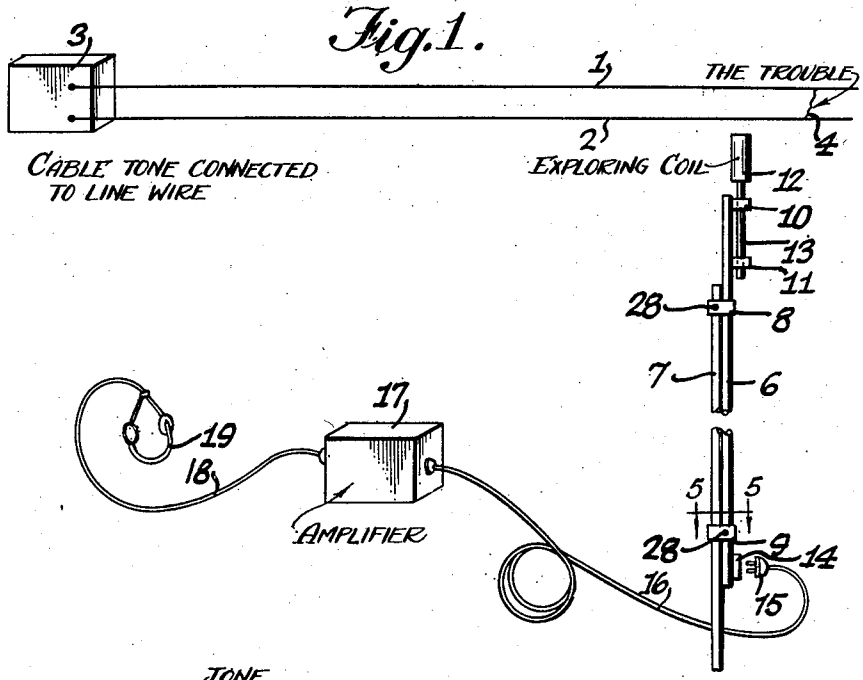


Fig. 2.

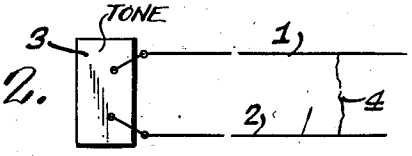


Fig. 3.

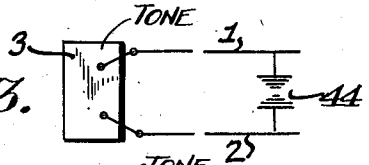


Fig. 4.

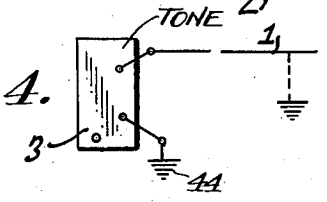


Fig. 5.

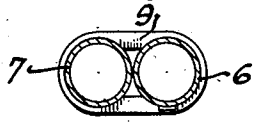
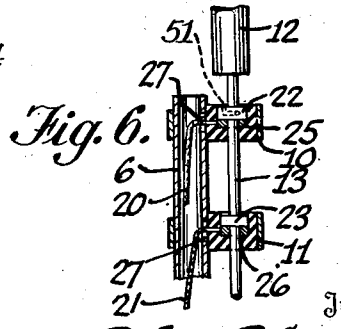


Fig. 6.



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TROUBLE FINDER

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Fig. 7.

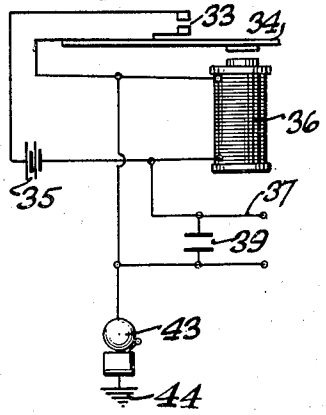


Fig. 8.

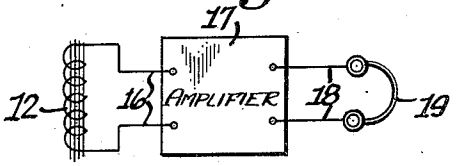


Fig. 9.

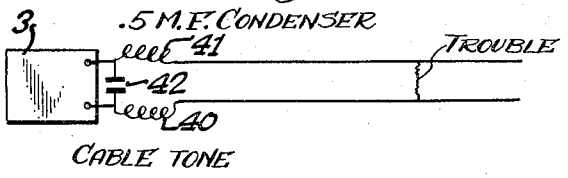


Fig. 10.

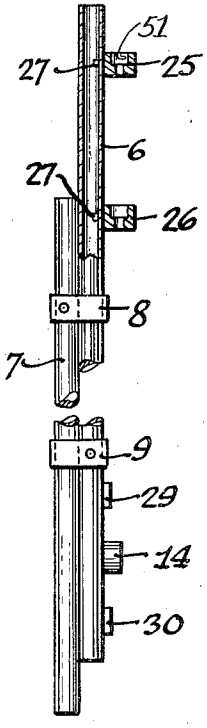


Fig. 11.

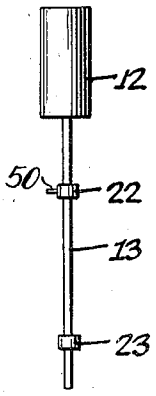
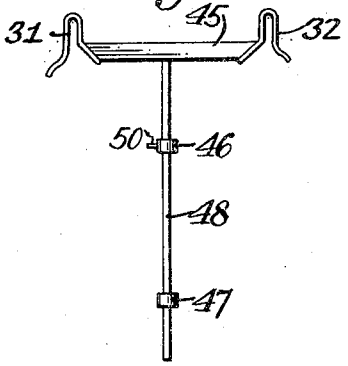


Fig. 12.



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UNITED STATES PATENT OFFICE

2,142,304

TROUBLE FINDER

Rodney B. Cummings, Forest Grove, Oreg.

Application April 6, 1936, Serial No. 73,005

4 Claims. (Cl. 175—183)

This invention relates to an improved method for locating trouble such as accidental grounds or short circuits in alternating current light and power systems, or telephone lines, and comprises portable equipment and its use as will hereinafter appear from the specification.

Heretofore, sundry methods and apparatus have been employed by repair men for locating faults in line wires. Usually an exploring coil was used in combination with an ordinary hand generator, the test man shifting the exploring coil from one side of the test lead to the other or else the leads were shifted on the wires. By this invention such shifting is not necessary and the generator is not used. Instead a device hereinafter referred to as a cable tone is connected to the line wires and cooperates with the exploring coil.

The object of the invention is to provide simple and positive means for the location of faults in circuits, principally those carrying telephone or telegraph circuits.

A further object is the provision of apparatus, which is portable, sensitive and reliable in action for locating line troubles.

A further object of the invention is the provision of means for temporarily connecting a telephone set to the lines.

With the foregoing and other objects in view, as will hereinafter appear, this invention comprises the constructions, combinations and arrangement of parts, hereinafter set forth as described and shown.

In the drawings wherein similar numerals indicate similar parts:

Figure 1 is a view of a pair of lines, to which the detecting and testing device in accordance with the invention is associated.

Fig. 2 illustrates the method of connecting a cable tone to line wires where the wires are short circuited.

Fig. 3 illustrates a similar connection where two lines are grounded.

Fig. 4 illustrates another application of the cable tone.

Fig. 5 illustrates a view of the support rod taken on line 5—5 of Fig. 1 in the direction of the arrows.

Fig. 6 illustrates the exploring coil mounting means in the support rod.

Fig. 7 shows a schematic arrangement of the cable tone.

Fig. 8 shows a schematic arrangement of the impulse receiving apparatus.

Fig. 9 is a showing of the cable tone connected to the line.

Fig. 10 shows the support rod alone.

Fig. 11 shows the exploring coil mounting.

Fig. 12 shows a line connector.

In the broad aspect of the invention an oscillating current is transmitted from the cable tone through the lines to be tested and back to the cable tone. An exploring coil when shifted along the wires but out of contact therewith will pick up by induction a small amount of current when in the path of the current emanating from the cable tone. The exploring coil is mounted on a support rod and connects with an amplifier and a sound transmitter and constitutes the pick-up device. As is readily apparent an amplified signal will be received at the transmitter wherever the cable tone current is flowing, so that the operator may easily trace the path of the current to the trouble source.

Referring to Figure 1 the transmission lines 1 and 2 are shown connected to a source 3 of alternating current for testing purposes, this source being hereinafter referred to as a cable tone.

Out of physical contact but inductively coupled to these tested lines is an exploring coil 12 mounted on a telescoping type of support rod 6. Electrical connections from the exploring coil extend through the rod 6 to a socket 14, through a plug 15, line 16, to an amplifier 17, through line 18 to a sound transmitter 19, in this case a head set being illustrated.

The cable tone is more particularly illustrated in Fig. 7 wherein an electromagnetic coil 36 is connected across a D. C. source of E. M. F. 35 and vibrating contacts 33. An armature 34 acted on by the coil 36 intermittently makes and breaks the contacts 33. Terminal leads 37 and 38 are connected across the coil 36 and are joined to the lines 1 and 2 as shown in Fig. 1. A bell 43 is connected to the terminal lead 38 and to ground at 44. A blocking condenser 39 of 0.5 mmf. is placed across terminal leads 37 and 38. This condenser acts as a by-pass for undesirable high frequency currents that would tend to pass from the cable tones into the lines.

In the modified form of the cable tone in Fig. 9 a wave trap comprising inductances 40 and 41 and condenser 42 is interposed between the cable tone and lines to eliminate undesirable frequencies from reaching the lines. The condenser may be located at either end of the inductances.

An exploring coil 12 found to produce very good results is one made from a model T-Ford ignition coil. In this instance the two secondary

coils are connected in series. However, such exploring coil may also be made by other methods well known in the art. The coil 12 is supported by a hollow insulating rod 13 having two longitudinally displaced electrical contacts 22 and 23 which are connected to the wires of the coil. Contact 22 is of larger diameter than 23 to facilitate insertion into the support hood. In contact 22 is a bayonet pin 50 to engage a bayonet slot 51 (see Fig. 10).

The support rod comprises two tubular elements 6 and 7 preferably of insulation and mounted in adjustable telescoping relation by sleeves 8 and 9 (see also Fig. 5). Sleeve 8 is secured at 28 to rod member 7 and slides over element 6. Sleeve 9 is similarly secured to the element 6. A set screw in one or both sleeves 8 and 9 serves to hold elements 6 and 7 in fixed position.

In Fig. 6 contacts 25 and 26 are set in insulating bases as shown at 10 and 11 respectively of the support rod 6 and electrically contact the conducting elements 22 and 23 of the exploring coil. Contact 25 has a larger diameter than contact 26 to correspond with the enlarged contacts 22 and 23 or 46 and 47 of the detachable elements. Contact 25 has a bayonet slot 51 to receive bayonet pins 50 for locking engagement. The detachable element Fig. 11 or 12 is inserted vertically then rotated for locking movement or engagement.

Wires 20 and 21 lead from contacts 25 and 26 through openings 27 into the tubular element 6 to contacts in socket 14 at the lower end. The electrical contacts in socket 14 may each, as illustrated in Fig. 10, be connected respectively with one of the contacts at 29 and 30 for a purpose to be later described.

Plug 15 connects the exploring coil with an amplifier device through conductor cord 16. The exploring coil may be coupled to any efficient amplifier with as many stages of amplification as desired, and may be resistance coupled or transformer coupled. The output of the amplifier feeds into a receiver 19 such as high impedance headphones or a loud speaker.

Fig. 8 illustrates the wiring scheme from the exploring coil to the headphones corresponding to Fig. 1.

In Fig. 2 the lines are shown short circuited at 4 while in Fig. 3, both lines are shown grounded.

In Fig. 4 is shown the cable tone connected to one of the lines 1 and the bell connected to ground 44. This bell is thus in the tone circuit so that a lineman out in the line somewhere may signal an attendant at the cable tone by connecting an ordinary lineman's portable telephone (magneto type) from one side of the line to the ground; and by turning the generator, the bell will ring if the trouble in the line is cleared or is of such a nature that a circuit can be completed to the bell through ground and one side of the line. The bell used is of the ordinary telephone type and has at least the impedance of such type bell to avoid interference with the proper operation of the tone circuit.

With the cable tone thus connected to the transmission lines the bell is connected to ground from the side of the line I am testing, I may call in on this side of the line, even with the tone connected to signal an attendant at the office. This method does not tie up the circuit when the cable tone is connected.

In Fig. 10 the support rod is shown disconnected from the exploring coil and amplifier. It also illustrates better the contacts 25 and 26, the insulating elements 10 and 11 being purposely omitted for this reason. The openings 27 for the wires from the contacts to the tube interior is also clearly shown without the wires.

At times it is desirable to tap into the lines to make telephone connection with the telephone exchange. My apparatus takes care of such situation in the manner now set forth. In Fig. 12 is shown a line tapper device comprising a hollow insulating spacer and supporting member 45 with two spring clip electrical contacts 31 and 32 at the ends. An insulating hollow support 48 extends at right angles and centrally of spacer 45. On this support 48 are longitudinally displaced contacts 46 and 47 similarly arranged and constructed at 22 and 23 in the exploring coil unit. Wires concealed in parts 45 and 48 connect contacts 31 to 47 and 32 to 46. It can be readily seen that either the line tapper or the exploring coil may be quickly mounted or dismounted from the support rod.

Where the line tapper is applied to the support rod a telephone set well known in the art may be connected with electrical contacts 29 and 30 in the support rod and electrically connect with lines 1 and 2 through spring clip contacts 31 and 32.

When trouble appears in the lines the cable tone 3 is connected with the lines and an oscillating current sent therefrom over the lines. Such current will travel in the paths shown in any of the Figures 2 to 4 and 9.

The detecting equipment including the exploring coil, amplifier, speaker or headphones, and the connections may all be carried in an automobile or other vehicle. The exploring coil may be placed any reasonable distance from the lines and moved by the vehicle along the direction of the lines. The amplifier serves to amplify considerably the signal receiver from the lines. When the coil is moved along the lines a point will be reached where no signal or a faint signal is obtained, the indication that the end of the current path has been reached. At such point it will be found that the wires are short circuited, or one or both wires are grounded.

For carrying on a conversation the line tapper 30 is inserted in the support rod and a telephone is connected at 29 and 30.

Having thus described my invention, I claim:

1. In an inductive coupler for testing transmission lines the combination of an exploring coil, an amplifier and signal receiver, of a supporting rod interposed between the exploring coil and amplifier, said rod comprising two longitudinally adjustable members at least one of which is hollow, means for holding the members in adjusted relation, two insulated contacts on one of the members adapted to detachably receive complementary contacts of the exploring coil, socket contacts for connection with a detachable plug to the amplifier and wire connections between the socket contacts and the first mentioned insulated contacts.

2. An exploring coil comprising a coil, an insulated closure therefor, an insulating support extending from the enclosure, longitudinally displaced contacts on said support of similar configuration but of dissimilar cross-sectional area and connection means between each contact and coil within the support.

3. A support for an exploring coil comprising relatively longitudinally adjustable rod members, adjustable clamping means thereon, insulating contacts at the upper end of one rod member, there being two sets of contacts at the lower end

of the rod member and means within the rod for rendering parallel connections with said contacts.

4. A line tapper for transmission lines comprising a line bridge and a detachable adjustable support, said bridge including a spacer bar of insulating material, a spring contact at each end of the bar, an insulating extension centrally of the bar, longitudinally spaced insulated contacts on said extensions and connecting means between the respective extension contacts and the spring contacts, said adjustable support including relatively longitudinally adjustable tubular members, longitudinally spaced insulated contacts on one member to receive those on the extension, and conductors extending into the tubular member from the support contacts.

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