

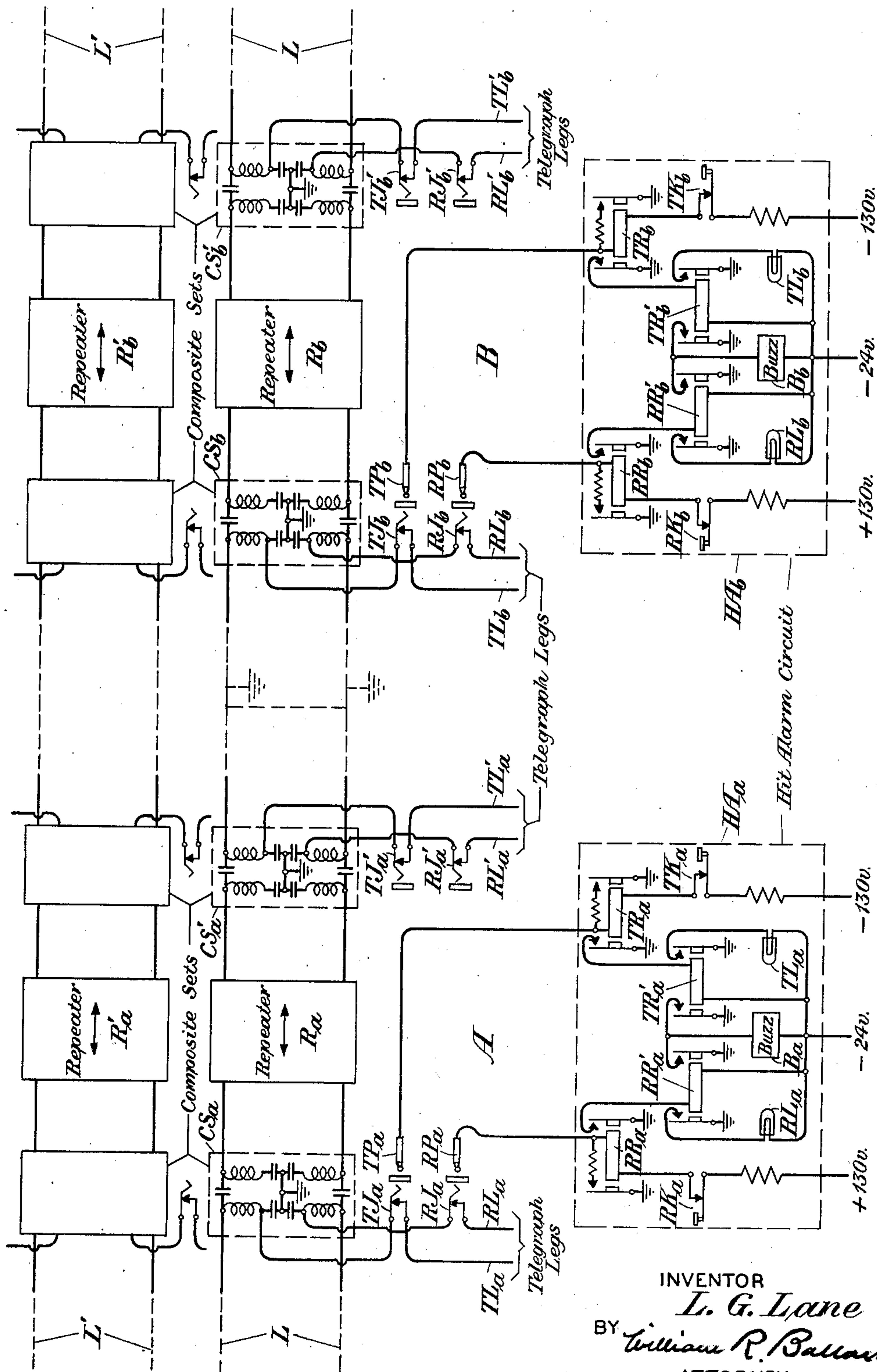
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TESTING CIRCUIT

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TESTING CIRCUIT

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This invention relates to arrangements to test for faults on transmission lines, and particularly to arrangements to test for faults of a temporary or recurrent nature.

Apparatus is well-known in the telephone art capable of testing for faults of a continuous or more or less permanent character, such as permanent grounds, continuously crossed lines or short-circuits, etc. There is, however, a type of fault which is frequently met with, which is not continuous but recurs at infrequent intervals. A common fault of this kind is the condition resulting from so-called "swings." Under these conditions the two wires forming a line sway back and forth with the wind with the result that the two wires occasionally come into contact with each other. This produces a so-called "hit" resulting from a temporary cross or short-circuit which lasts only a brief interval, and may not recur again for many minutes or even for hours.

A hit may also result from one side of a line swing into contact with a wire of an adjacent line. An alternative condition is that existing when one of the wires in swinging makes contact with a grounded element. Here again the condition, while quite deleterious to proper telephone service, may exist only for a brief period and may not recur again until a considerable interval has elapsed.

While existing testing equipment would be capable of locating such faults, if it were possible to watch the indicating instruments continuously, this would necessarily detach employees at all repeater stations from their regular duties to make the necessary observations over a considerable period of time. Moreover, the making of such observations is considerably handicapped by the fact that in a repeatered telephone line it is difficult to determine during the brief existence of a "hit" just what repeatered section is involved.

The present invention makes available a simple and cheap apparatus which may be used to detect and locate the repeater section in which such faults occur without necessitating the continuous supervision or observation of an attendant. This may be accomplished by providing a testing circuit capable of giving a continuous indication as the result of a temporary fault such as a "hit."

The invention will be now more fully understood from the following description when read in connection with the accompanying drawing, the figure of which shows the invention as applied to an ordinary repeatered telephone line which is composited for transmission of superposed telegraph signals.

Referring to the drawing, a telephone transmission line L is shown extending through two repeater stations A and B at which telephone repeaters of the usual type are provided at R_a and R_b . The line sections coming into either side of a repeater are connected on the two sides of the repeater to composite sets, as shown at CS_a , CS'_a , CS_b and CS'_b . These composite sets are connected to so-called Morse or telegraph legs such as are shown at TL_a , RL_a , RL'_a , TL'_a , etc. By means of these composite sets telephone currents may be transmitted over the line L through the repeaters R_a and R_b , but in each line section the telegraph currents, which are separately transmitted over the two sides of the line by means of ground returns, are prevented from entering the repeaters and are diverted into the Morse legs. The Morse legs may be used either for transmitting the telegraph currents around the repeater or for transmitting them to local loops or to telegraph lines terminating at the repeater point.

A circuit arrangement such as above described, when carried over an open wire line, is subject to so-called "swings" which may result in temporarily grounding either side of the line, or in shorting together the two sides of the line, or in putting one side of the line in contact with one of the wires of another line. These effects, while temporary, are recurrent, and render the line unsuitable for telephone and telegraph purposes while the effect is present.

In order to test for faults of the above character, testing circuits or so-called "hit alarm" circuits of the present invention are provided as shown at HA and HA_b for application to the line at the repeater points A and B, respectively. Of course it will be understood that similar hit alarm circuits will be provided for other repeater points not shown in the diagram.

The hit alarm circuit HA_b , for example, terminates in plugs TP_b and RP_b , which may be inserted in jacks TJ_b and RJ_b of the telegraph legs TL_b and RL_b , respectively. The plug TP_b is connected to a relay TR_b in the hit alarm circuit which is connected to a telegraph battery, which in the instance shown supplies a negative voltage of 130 volts. The relay TR_b is of the locking variety and when operated by a "hit" locks up until such time as an attendant may release it by operating key TK_b . One armature of the relay TR_b controls the circuit of a relay TR'_b which at its right-hand contact closes the circuit of an indicating lamp TL_b , and at its

left-hand contact closes the circuit of a buzzer B_b.

Similarly the plug RP_b leads to a locking relay RR_b and through a release RK_b to a plus 130 volt battery. The relay RR_b in turn controls a relay RR'_b, which at its left-hand contact controls the circuit of a signal lamp RL_b, and at its right-hand contact controls the circuit of the buzzer B_b.

The apparatus HA_a shown at repeater station A is similar in all respects to the apparatus HA_b just described and, of course, similar apparatus is provided at all of the repeater points.

If it is found that the transmission line is subject to so-called "hits," the attendant at each repeater station will apply his hit alarm circuits to the telegraph legs on one side of the repeater at his station. For example, at repeater station B the plugs TP_b and RP_b will be inserted in the jacks TJ_b and RJ_b of the telegraph legs TL_b and RL_b. At the same time dead plugs will be inserted in the jacks TJ'_b and RJ'_b on the other side of the repeater to open the telegraph legs incoming from the east.

So also the plugs TP_b and RP_b of the hit alarm HA_a are inserted in the jacks of the telegraph legs TL_a and RL_a at the repeater station A and dead plugs are inserted in the jacks of the telegraph legs RL'_a and TL'_a to open the telegraph legs on the east side of the repeater R_a. A similar action will now take place at each repeater station.

Let us now consider what takes place in connection with the hit alarm circuit at repeater station B. If there are no grounds on the sides of the line, and if there is no cross or short between the two sides of the line, the circuits from the plugs TP_b and RP_b through the relays TR_b and RR_b are open-circuited because the telegraph legs at the right of repeater R_a are open. The result is that no indication will be given on the hit alarm circuit.

If, however, the upper conductor of the line between repeater stations A and B should be grounded temporarily as a result of a "swing," thus giving a so-called "hit," current will flow over the upper conductor through the composite set, jack TJ_b and plug TP_b, through the relay TR_b and the resistances in series therewith to the negative 130 volt battery. Although this hit may be but temporary, the relay TR_b will be operated and locked up and will in turn operate the relay TR'_b to cause the lamp TL_b to glow continuously and the buzzer B_b to give forth an audible signal.

An attendant seeing the lamp or hearing the buzzer will know from the fact the lamp TL_b is operated and the lamp RL_b is not operated that a "hit" is arriving from the section between repeater stations A and B over the upper side of the transmission line. Informed of this fact, the attendant may use a Wheatstone bridge or other known equipment to determine the approximate point in the section at which the fault is located. This will of course involve "watching" the line until a hit capable of being tested occurs. The approximate location being known a repair man will inspect this particular line section to find the cause of the fault. In the meantime the attendant will open the key TK_b to unlock relay TR_b and restore the hit alarm apparatus to normal.

If, on the other hand, the lower conductor of the line should be temporarily grounded as a result of a "swing," the relay RR_b will be oper-

ated, thus actuating the relay RR'_b to cause the lamp RR_b to glow, thereby informing the attendant that a "hit" has occurred on the lower conductor between the line sections A and B. Having ascertained this fact and having by known means approximately located the fault in the section, the attendant may restore the hit alarm apparatus to normal by operating the key RK_b. A repair man may then be sent out to remedy the trouble.

If the "swing" results in temporarily crossing or shorting together the two sides of the line, as indicated by dotted lines between the repeater stations A and B, a momentary circuit will be completed from the positive 130 volt battery, through the resistance and relay RR_b of the alarm circuit, over the plug RP_b and the jack RJ_b, thence through the composite set to the lower conductor of the line to the point at which the cross occurs. From this point the circuit continues over the short circuit connection to the upper line and back through the composite set and telegraph leg to jack TJ_b and plug TP_b, and thence through the relay TR_b and the resistance in the alarm circuit to the negative 130 volt battery.

This results in actuating and locking up both relays TR_b and RR_b. The consequence is that not only the buzzer B_b is set into operation but both lamps TL_b and RL_b are caused to glow, and this latter fact indicates to the attendant that the "hit" was caused by crossing the two sides of the line or bringing them into contact with each other between repeaters A and B. Having ascertained this fact, the attendant may restore the alarm circuit by actuating either key TK_a or TK_b.

It will be noted that a hit occurring between the two repeater stations A and B will not affect a hit alarm circuit to the east of repeater B, because the composite circuit CS_b prevents the hit from passing through its series line condensers to the repeater B. Likewise hits occurring in the line L to the west of repeater station A will not be indicated on the alarm circuit HA_b. The currents resulting from these hits will not pass through the composite sets on either side of the repeater R_a and over the intervening line section to the station B.

It will be apparent that a hit may result from one wire of the line shown in the diagram swinging into contact with a wire of some other line such as the line L. In short a hit occurs when any two wires on the same pole line come into contact. When it is known that the hit involves two wires of different line circuits the hit alarm apparatus may be plugged into the jacks of the two wires involved. When the hit occurs the section in which it occurs will be indicated upon the hit alarm apparatus in a manner similar to a hit involving two wires in the same line. The hit will of course register only on the hit alarm circuit associated with the section in which the swing took place. The exact location of the fault may then be determined by an attendant at the nearest repeater station, who may use a Wheatstone bridge or other known equipment for the purpose. He must of course "watch" the line section which is in trouble until a measurable hit occurs.

It should be understood in connection with hits that although the direct current resulting therefrom will not pass beyond the line section in which it occurs, the hit will impair the usefulness of the line at all points along its length for tele-

phone purposes. This is because the line will be effectively shorted or grounded from an alternating current standpoint during the continuance of the hit.

What is claimed is:

1. Telephone lines each including a plurality of repeaters connected by line sections, apparatus to observe faults at each repeater point, said apparatus including separate indicating devices adapted to be connected to each of a pair of line wires at the repeater point, said indicating devices being arranged to give a continuous indication in response to a temporary but recurrent fault in the line section to which the apparatus is connected.

2. Telephone lines each including a plurality of repeaters connected by line sections, apparatus to observe faults at each repeater point, said apparatus including separate indicating devices adapted to be connected to each of a pair of line wires at the repeater point, said indicating devices being arranged to give a continuous indication in response to a temporary but recurrent fault in the line section to which the apparatus is connected and being unresponsive to faults in other line sections.

3. Telephone lines each including a plurality of repeaters connected by line sections, apparatus to observe faults at each repeater point, said apparatus including separate indicating devices adapted to be connected to each of a pair of line wires at the repeater point, said indicating devices being arranged to give a continuous indication in response to a temporary but recurrent fault in one wire of the line section to which the apparatus is connected.

4. Telephone lines each including a plurality of repeaters connected by line sections, apparatus to observe faults at each repeater point, said apparatus including separate indicating devices adapted to be connected to each of a plurality of wires at the repeater point, said indicating devices being arranged to give a continuous indication in response to a temporary but recurrent fault involving two wires of the line section to which the apparatus is connected.

5. Telephone lines each including a plurality of repeaters connected by line sections, telegraph legs connected to each side of each section of line at each repeater point, apparatus to observe faults at each repeater point, said apparatus including separate indicating devices for each of a

plurality of wires at the repeater point, means to connect said indicating devices separately to the telegraph legs associated with a plurality of wires of the line section, said indicating devices being arranged when so connected to give a continuous indication in response to a temporary but recurrent fault in the line section with which the apparatus is associated.

6. Telephone lines each including a plurality of repeaters connected by line sections, telegraph legs connected to each side of each section of line at each repeater point, apparatus to observe faults at each repeater point, said apparatus including separate indicating devices for each of a plurality of wires at the repeater point, means to connect said indicating devices separately to the telegraph legs associated with a plurality of wires of the line section, said indicating devices being arranged when so connected to give a continuous indication in response to a temporary but recurrent fault in the line section with which the apparatus is associated, and being unresponsive to faults in other line sections.

7. Telephone lines each including a plurality of repeaters connected by line sections, telegraph legs connected to each side of each section of line at each repeater point, apparatus to observe faults at each repeater point, said apparatus including separate indicating devices for each of a plurality of wires at the repeater point, means to connect said indicating devices separately to the telegraph legs associated with a plurality of wires of the line section, said indicating devices being arranged to give a continuous indication in response to a temporary but recurrent fault in one wire of the line section to which the apparatus is connected.

8. Telephone lines each including a plurality of repeaters connected by line sections, telegraph legs connected to each side of each section of line at each repeater point, apparatus to observe faults at each repeater point, said apparatus including separate indicating devices for each of a plurality of wires at the repeater point, means to connect said indicating devices separately to the telegraph legs associated with a plurality of wires of the line section, said indicating devices being arranged to give a continuous indication in response to a temporary but recurrent fault involving two wires of the line section to which the apparatus is connected.

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