

March 3, 1942.

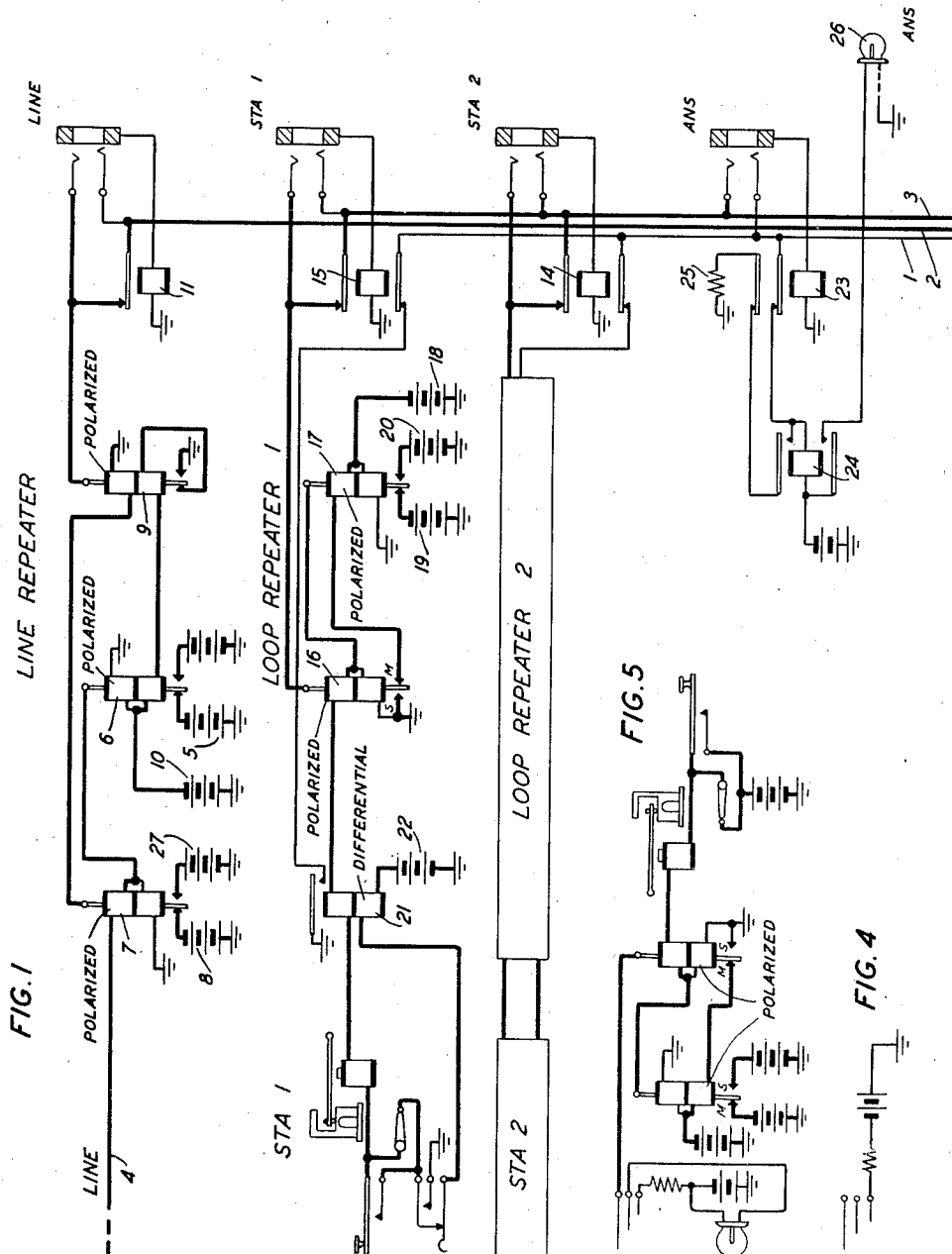
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2,275,126

TELEGRAPH ALARM CIRCUIT

Filed Feb. 8, 1940

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

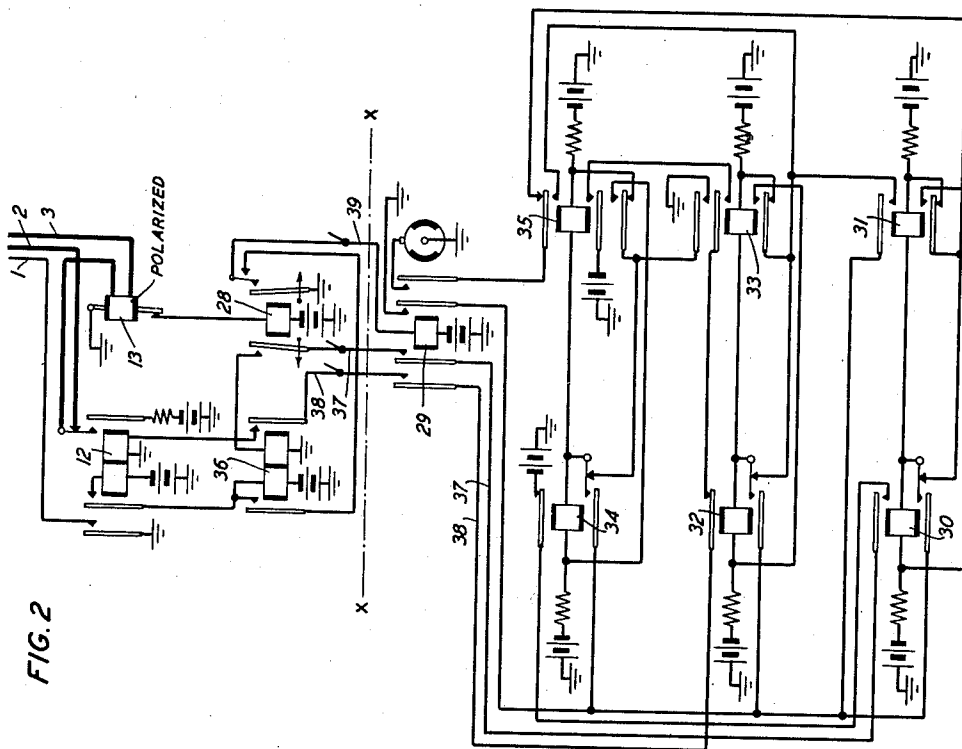


FIG. 2

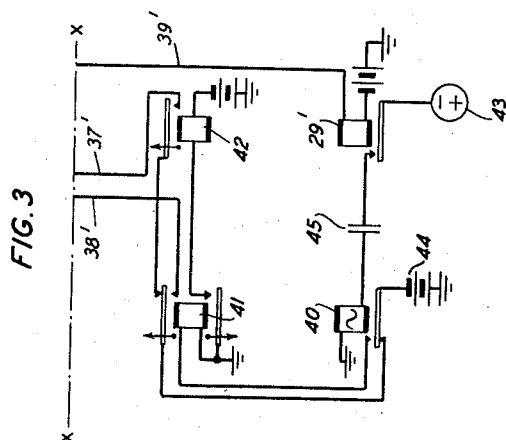


FIG. 3

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TELEGRAPH ALARM CIRCUIT

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12 Claims. (Cl. 178—74)

This invention relates to telegraph circuits, and more particularly to the inverse neutral or hub concentration circuits described in Patent 2,056,277 issued October 6, 1936, to Fullerton S. Kinkead et al. Specifically, it is an alarm circuit for indicating that one or more of the circuits connected into and forming part of the inverse neutral or hub concentration circuit is transmitting a particular telegraph signaling condition for an excessive interval, thereby rendering the whole hub circuit inoperative. Such a condition could arise, for example, if one of the local loop circuits forming part of the hub concentration were permanently opened for any reason, such as a conductor being broken or a transmitting contact of a station being left open.

In the operation of hub circuits, as is generally known, the various line conductors and customers' loop conductors terminate in line and loop repeaters respectively. The local or leg side of these repeaters are interconnected into a system in a manner resembling the spokes of a wheel, the legs being interconnected through a common point or hub. A signal transmitted from any leg passes through the hub and is transmitted to each of the other legs simultaneously. Normally all of the repeaters are in the unoperated or marking condition. For this condition all of the legs of the hub circuit are terminated at the winding of a send relay connected to battery of the same polarity. When a spacing signal is to be transmitted from one of the legs to all of the others, battery of the opposite polarity or ground is connected, at the repeater, to the transmitting leg, operating the send relay in each of the other legs which repeats or sends the signal to the line or loop conductors. If trouble develops so as to cause the transmission of a permanent spacing signal into the hub over one leg, the send relay in each of the other legs will respond and remain in the spacing condition as long as the trouble persists. Since the signal received by each leg is the same as for an ordinary spacing signal, it is necessary to distinguish between the ordinary spacing signal and the protracted spacing signal, indicating trouble, on the basis of the duration of the signal.

Experience with existing private wire service has indicated that the majority of protracted spacing signals are caused by troubles in the customers' loop conductors in the form of opens or by the station attendant at the customer's premises leaving the transmitting key open. Since this results in the entire private wire network being placed in a spacing condition, other

station attendants in the same and in other cities will "call in" to their respective telegraph test-board attendants who thereupon attempt to locate and isolate the source of trouble. It is an object of this invention to restrict this work only to the test-board attendant in the office which directly serves the station in trouble.

It is a more specific object of the invention herein to distinguish between ordinary spacing signals and protracted spacing signals transmitted in a hub circuit.

A feature of the invention is means connected to the hub of an inverse neutral telegraph circuit for indicating that a particular signaling transmission condition has persisted for longer than a permissible interval.

Another feature of the invention resides in the association of the said trouble detecting means with a particular leg or a group of legs which, experience indicates, are responsible for most of the troubles and further, an additional means whereby the said particular leg or said group of legs are automatically disconnected from the remainder of the hub circuit when the trouble is detected.

These and other features will become apparent from the following detailed description when read with reference to the associated drawings.

In Fig. 1 a telegraph line is shown connected by means of its associated line repeater to two station circuits through their respective individual loop repeaters to form a hub circuit. The telegraph line is shown in the upper left portion of the drawing extending from left to right and connecting to the line repeater. Station No. 1 is shown in the left-hand middle portion of the figure connected to its individual repeater, loop repeater No. 1, in the middle of Fig. 1. Station No. 2 and loop repeater No. 2 in the lower left and lower middle portion of Fig. 1, respectively, are represented as blocks. It is to be understood that they each include wiring and apparatus identical with that in station No. 1 and loop repeater No. 1, respectively. Only one line and two stations are shown connected through their respective repeaters to form a hub circuit. It is to be understood that in commercial practice many hub circuits will contain more stations grouped together and frequently more than one line. Each line and each station has associated with it a jack and a sleeve relay. These are indicated at the right of Fig. 1. The answering lamp and jack shown at the lower right of Fig. 1 are to provide the usual calling-in and answering facilities, respectively, for a hub circuit. In addi-

tion, in accordance with the invention herein, these facilities provide means for indicating a permanent spacing signal received from one of the loops associated in a hub circuit and means for responding thereto to initiate steps in locating the faulty loop.

In Fig. 2 the upper portion of the figure, or that above the line XX, shows the alarm circuit relay equipment of the invention herein. The lower portion of the figure, or that below the line XX, shows the timing circuit which may be common to a plurality of hub circuits. This is a form of delay circuit arranged to prevent the registering of a trouble indication for every spacing signal. It prevents the signal lamp from lighting until the spacing condition has persisted for longer than a definite interval, which is measured by the aid of the timing circuit, before the trouble signal is operated to indicate a permanent spacing condition. This particular timing circuit per se is well known in the art. However, its associations with a hub circuit for the purposes of the present invention is believed to be novel.

Fig. 3 is a second timing or delay circuit which may be used instead of the circuit in the lower portion of Fig. 2. It, too, is well known in the art but its association with a hub circuit for the purposes of the present invention is believed to be novel.

Fig. 4 is a splitting cord circuit used in cooperation with the top three jacks of Fig. 1 for disconnecting the associated circuit from the hub circuit.

Fig. 5 is an answering cord used in cooperation with the ANS jack of Fig. 1.

Both Fig. 4 and Fig. 5 are well known in the art.

The figures are to be arranged so that the three leads 1, 2 and 3 of Fig. 1 connect with leads 1, 2 and 3 of Fig. 2.

The circuits as shown are in the marking condition. For this condition a circuit may be traced from battery 10 through the top winding of polar send relay 6, to ground. The effect of this current is to actuate the armature of send relay 6 to the left to engage its marking contact. The line 4 is terminated at a similar repeater at the distant telegraph office so that the effect of current flowing from battery 5 through the left-hand or marking contact and armature of send relay 6, through the top winding of polar receive relay 7 and over the line 4 to the distant office, tends to actuate the armature of receive relay 7 to engage with its left-hand or marking contact. This effect preponderates over the effect of current from battery 5 flowing through the bottom winding of receive relay 7, which tends to actuate the armature of receive relay 7 to the right or spacing contact. The armature of receive relay 7 is therefore maintained in engagement with its left-hand or marking contact.

With receive relay 7 on its left-hand or marking contact current is supplied from battery 8 through the left-hand contact and armature of receive relay 7, through the top winding of polar break relay 9 to ground. The effect of this current is to tend to operate the armature of break relay 9 to engage its left-hand or marking contact. The path interconnecting the local or leg side of the line repeater with the loop repeaters may be traced from negative battery 10 through the bottom winding of polar relay 6, bottom winding, left-hand or marking contact and armature of polar relay 9, through the break contact

and armature of relay 11, to conductor 2. Conductor 2 may be considered as the common hub. Each leg of additional line repeaters, if provided, would also be connected to conductor 2 over a path similar to that described for the line repeater shown in Fig. 1. The path continues from conductor 2, right break contact of relay 12, the winding of polar relay 13, over conductor 3 to a parallel circuit extending through the top armatures and break contacts of relays 14 and 15. The upper branch of the parallel circuit is the leg of loop repeater No. 1 and extends through the armature and right-hand or marking contact of polar receive relay 16, and through the top winding of polar send relay 17 to negative battery 18. The lower branch of the parallel circuit is the leg of loop repeater No. 2 and extends from the top break contact of relay 14 into loop repeater 2 and through a circuit corresponding to that traced for loop repeater No. 1. It should be observed that for the marking condition the line repeater and the loop repeaters are interconnected by means of conductors, all of which are terminated in battery of the same polarity, namely, in batteries each having their positive poles grounded. No current flows, therefore, in the legs of the hub circuit for the marking condition. For the marking condition, therefore, no current flows through the windings of the relays included in the aforetraced leg paths nor through the winding of relay 13.

The armature of polar send relay 17 is held in engagement with its left-hand contact, during the marking condition, by current flowing from battery 18 through its bottom winding. The armature of polar relay 16 is held in engagement with its right-hand contact during the marking condition of station No. 1 loop by the effect of current flowing over a circuit which may be traced from negative battery 19, through the left-hand contact and armature of polar send relay 17, through the top winding of polar receive relay 16 and neutral relay 21, through the station No. 1 sounder, transmitting key and calling-in key and the bottom winding of neutral relay 21 to positive battery 22. It should be observed that batteries 19 and 22 are in series-aiding relationship for the marking condition. The effect of the current flowing from battery 19 through the bottom winding of receive relay 16, which tends to operate the armature of relay 16 to the left to engage its left-hand or spacing contact, opposes the effect of the marking current in the top winding, but is insufficient and during marking the armature of receive relay 16 is held to its right-hand or marking contact.

The effect of current flowing through the top winding of neutral relay 21 balances the effect of current through the bottom winding of relay 21 and the relay remains unoperated. This relay is differentially connected and responds only to the operation of the station calling-in key which grounds the loop conductor connected to the top winding and opens the loop conductor connected to the bottom winding of relay 21. Under this condition relay 21 operates and establishes a circuit from ground through its front contact, through the bottom break contact of relay 15, the top inner break contact of relay 23 to battery through the winding of relay 24. This operates relay 24 which locks through its upper make contact, top outer back contact of relay 23 and resistance 25 to ground. The operation of relay 24 also closes an obvious circuit through its bot-

tom front contact to light lamp 26 as a calling-in signal for the loop.

While the loops and line are interconnected as shown for the marking condition, the various relays will all be in the condition indicated. If a spacing signal is transmitted by any repeater to the associated leg, it will operate a relay in each of the other repeaters to transmit a spacing signal to its associated line or station loop. Thus, a spacing signal transmitted from the distant telegraph office connected to line 4 will permit the armature of receive relay 7 to be operated to engage its right-hand or spacing contact. Positive battery 27 connected to the top winding of relay 9 will operate the armature of relay 9 to the right. This connects ground to the armature of relay 9 and therefore to the leg of this repeater, and since all other legs common to the hub are terminated in battery of the same polarity, a relay having a winding in series in each of the other legs is operated to transmit a spacing signal. In the case of loop repeater No. 1, send relay 17 responds, its armature being actuated to the right to engage its right-hand or spacing contact, connecting positive battery 20 to one end of the station No. 1 loop. Since the opposite end of loop 1 is also terminated in positive battery 22, the current normally flowing in the loop ceases. The station sounder which was in an operated condition during the marking condition, while batteries of opposite polarities were connected to the ends of the loop, is released to indicate a spacing signal. In the same manner a relay corresponding to send relay 17 will be actuated in each of the other loop repeaters in response to the line spacing signal, to transmit a spacing signal in each instance to its associated station where a sounder will be actuated.

When the repeater (not shown) at the distant telegraph office again transmits a marking signal, the receive relay 7 opens its right-hand or spacing contact and again closes its left-hand or marking contact. Relay 9 is then caused to do the same, thus removing ground from the line repeater leg. Send relays in the loop repeaters, such as send relay 17, open their right-hand or spacing contacts and close their left-hand or marking contacts, thus closing the respective loop conductors between batteries of opposite polarity and operating the senders to their down or marking positions.

If the sending key at any local station, such as station 1, is opened the loop circuit is broken. Current ceases to flow through the top winding of receive relay 16. The armature of relay 16 will respond to current through its bottom winding to engage its left-hand or spacing contact, thereby connecting ground to the loop repeater leg, transmitting a spacing signal to the line repeater and to each loop repeater associated together in the particular hub.

From the foregoing it should be apparent that should a loop be left open or should a trouble condition arise resulting in the transmission of a permanent spacing signal from any loop repeater, it will connect ground on its associated leg in the circuit, thereby transmitting a permanent spacing signal to each of the associated hub legs, both line and loop, and the whole hub circuit is rendered inoperative.

The manner in which a permanent spacing signal received from any loop repeater leg will operate calling-in signal lamp 26 after a definite interval to indicate the trouble condition and the manner in which the particular leg which is

defective may be located and cut off from the hub will now be described.

The path interconnecting the line repeater and the loop repeaters traced above, which passed through the actual hub of the circuit, included the winding of polar relay 13. This winding is connected to the line repeater through conductor 2 and to all of the loop repeater legs in parallel through conductor 3. The armature of relay 13 is normally in engagement with its left-hand contact which maintains relay 28 operated over an obvious circuit. If a ground is connected from any of the loop repeater legs to conductor 2, the armature of relay 13 is actuated to the right releasing relay 28. This will happen whenever a spacing signal or a break signal is transmitted from a loop repeater but not from a line repeater. In order to discriminate between such signals and a permanent spacing signal indicating a trouble condition, it is necessary to introduce the timing or delay circuit to measure a definite allowable interval before a signal indicating the trouble condition is registered.

Any of a number of time measuring or delay circuits, which excludes dash-pot relays, which are all well known in the art, would be satisfactory to delay the registering of the trouble signal. The circuit shown in the lower portion of Fig. 2, below the line XX, is a well-known circuit which is suitable for this purpose. It comprises three pairs of relays, such as 30 and 31, corresponding to the W and Z relays in the patent to O. Cesareo 1,751,263 of March 18, 1930. Its operation will therefore be described briefly.

When relay 28 is released ground is connected through its right-hand armature and inner make contact to a circuit extending through the winding of the timing circuit start relay 29, operating relay 29. Relay 29 operated connects both interrupted and steady ground to the delay circuit through its right-hand outer and inner contacts respectively. Relay 30 is operated at the beginning of the first pulse of interrupted ground through its continuity contacts and is immediately locked to steady ground from relay 29. The operation of relay 30 connects battery from the contacts of relay 34, through the contacts of relays 30, 29 and 28 to the right-hand winding of relay 36. Relay 36 operates and locks through its left-hand winding and contacts to ground from relay 28. Steady ground is at the same time connected from the right-hand inner contacts of relay 29, to the right-hand terminal of the winding of relay 31 in parallel with relay 30. Relay 31, however, cannot operate during the interval while the first pulse of interrupted ground is connected, because this interrupted ground is connected to the right-hand terminal of the winding of relay 31, through the break contact of relay 31, which short-circuits the steady ground. At the end of the first pulse of interrupted ground, however, the path through the interrupter is momentarily open-circuited, removing the short circuit, and relay 31 immediately operates from the steady ground connected to the left-hand terminal of its winding. The operation of relay 31 connects the same steady ground from relay 29 into the second pair of relays, relays 32 and 33. Relay 32 operates. This connects steady ground to the left-hand terminal of the winding of relay 33. Relay 33 cannot operate, however, as the ground connected to its left-hand terminal is short-circuited by the same ground connected to the right-hand

terminal of its winding, through the top make contact of relay 31 and the bottom break contact of relay 33.

The operation of relay 31 transferred the lead connected to the interrupter from its lower break to its lower make contact. At the beginning of the second pulse of ground from the interrupter ground is connected to the left-hand terminal of the winding of relay 30. This short-circuits the steady ground and relay 30 releases. However, relay 31 is maintained operated by the second ground pulse from the interrupter through the continuity contacts of relay 30. At the end of the second ground pulse from the interrupter relay 31 releases. The release of relay 31 disconnects the short-circuiting ground from the right-hand terminal of the winding of relay 33 and permits it to operate from the steady ground connected to the left-hand terminal of its winding.

The operation of relay 33 connects ground in parallel to the right-hand terminal of the winding of relay 34, operating relay 34 and to the right-hand terminal of the winding of relay 35, which is thereby prevented from operating from ground connected to the left-hand terminal of its winding when relay 34 operates.

At this juncture, therefore, at the end of two pulses of interrupted ground relays 30 and 31 have gone through one cycle of operation, each operating and releasing once, and are again in their original release condition. Relay 36 has operated and locked. In response to the single operation and release of relay 31 during the first cycle, relays 32 and 33 have operated and relay 34 has operated in response to the operation of relay 33 and these relays, namely 32, 33 and 34, are in an operated condition at the end of the first cycle of operations of relays 30 and 31. Relay 35 has not yet been operated.

Relays 30 and 31 respond to the second pair of pulses, pulses three and four, in the same manner as for the first pair of pulses. When relay 31 operates during the second cycle, however, relays 32 and 33 are in an operated condition. The ground supplied from relay 31, through the make contact of relay 33 to the left-hand terminal of the winding of relay 32, short-circuits the ground supplied to the right-hand terminal of the same winding and relay 32 releases. Relay 33 remains operated while relay 31 is operated and releases after the ground supplied from relay 31 through the continuity contacts of relay 32 is removed from relay 31 releases.

The release of relay 33 removes the ground short-circuiting the ground connected to the left-hand terminal of the winding of relay 35 and relay 35 operates. The operation of relay 35 transfers the lead from the interrupter from relays 30 and 31 to relays 32 and 33.

This may be considered to be the end of the second cycle. During this cycle relays 30 and 31 have operated and released once more. Relays 32 and 33 which were held operated at the end of the first cycle have been released. Relay 34, which was operated during the first cycle of two interrupted ground pulses, continues operated at the end of the second cycle.

Relay 35 operated for the first time during the second cycle and remains in an operated condition at the end of the cycle. Relays 30 and 31 play no further part in the operation of the timing circuit.

At the start of the fifth ground pulse from the interrupter relay 32 operates and when the fifth

pulse has ended, relay 33 operates. At the beginning of the sixth pulse relay 32 releases. The manner of operation is identical with that described for corresponding steps in the case of relays 30 and 31. When the relays are in this condition during the sixth interrupter pulse, namely, with relays 35 operated, 33 operated and 32 released, battery is supplied from the lower inner make contact of relay 35, through the top inner make contact of relay 33, the top break contact of relay 32, the left-hand outer make contact of relay 29, the right-hand inner make contact of relay 36 and through the right-hand winding of relay 12, operating relay 12. Relay 12 locks through its left-hand inner make contact and armature, the left-hand make contacts and armature of relay 36 to ground through the right-hand make contacts of relay 28. The operation of relay 12 connects ground through its left-hand outer make contact and the top inner armature and back contact of relay 23, through the winding of relay 24 to battery, operating relay 24 which lights lamp 26. Relay 24 operated locks through its top make contacts and the back contact and armature of relay 23 to ground through resistance 26.

To return to the timing circuit, the operation of relay 33 at the beginning of the sixth pulse connects ground through the top outer make contact of relay 33 and the bottom outer make contacts of relay 35 to the left-hand terminal of the winding of relay 34, releasing relay 34. Relay 35 remains operated as long as relay 33 is operated. Relay 33 releases at the end of the sixth ground pulse from the interrupter, disconnecting ground from the path through the continuity contacts of relay 34 to the right-hand terminal of the winding of relay 35. Relay 35 releases and the timing circuit is restored to normal.

Attention is called to the fact that the timing circuit may be, and generally is, common to a large number of hub concentrations such as is shown in Fig. 1. It was shown above that after the start relay 29 is operated, battery is connected to conductor 37 in the timing circuit at the start of the first ground pulse from the interrupter to operate relay 36. Battery is connected to conductor 38 in the timing circuit at the start of the sixth ground pulse from the interrupter to operate relay 12 and ultimately to bring in lamp 26.

If the timing circuit is not already in use serving any of the other hub concentrations to which it is common, the lamp 26, connected to a particular hub on which a loop circuit is sending a continuous spacing signal, will be lighted during the sixth interrupted ground pulse after relay 29 operates, counting the first pulse whether partial or full. If the timing circuit is in use, however, and has progressed in its operation beyond the point where the first battery pulse is connected to lead 37, the measured interval will be protracted during the operation of the remaining portion of a complete cycle of operation of the timing circuit and will continue during a succeeding complete cycle. A full cycle of the timing circuit means, in this sense, six interrupted ground pulses requiring six seconds. Thus, for an interrupter supplying closed and open impulses of one-half second duration each, sixty times per minute, the interval required to bring in a lamp may vary from a minimum of four and one-half seconds, in cases where the start relay 29 is operated near the extreme end of the

first ground pulse, to a maximum of ten and one-half seconds, in cases where relay 28 for a particular hub concentration is not released until immediately after the first interrupted ground pulse has been transmitted into the timing circuit which is functioning with another hub concentration which has been connected to it earlier.

Attention is called to the fact that unless the loop spacing condition persists, relay 13 will be released, in turn reoperating relay 28. This will prevent the battery pulses from being transmitted into the particular hub circuit involved and prevent the lighting of lamp 26 therein. If but one hub is connected to a timing circuit at the time, relay 29 will be released. Relay 29 in turn disconnects both the interrupted and steady ground from the timing circuit restoring relays 30 to 35, inclusive, to normal. However, if more than one hub concentration is connected to the timing circuit and a loop permanent spacing signal persists on any one or more of them, relay 28, associated with each hub concentration in such condition, will remain released. Start relay 29 in the timing circuit will remain operated and the timing circuit will function to bring in lamp 26 in each hub concentration circuit so conditioned.

The manner in which the particular loop which is defective is located will now be described.

In addition to operating relay 28 the operation of relay 12, at its right-hand make-before-break contacts, disconnected the line repeater or repeaters associated with the hub from the loop repeaters and connected negative battery to the line repeater side of relay 13 to take the place of negative battery which had formerly been supplied by the line repeater in the marking condition.

At this point attention is called to the fact that, since the armature of polar relay 13 operates to the right to release relay 28 only in response to ground connected to conductor 3 from any one of the loop repeaters, the lighting of the lamp is an indication of trouble in some one of the loop facilities. The substitution of negative battery from the right-hand armature of relay 12 for negative battery on conductor 2 from the line repeater releases the line facilities and maintains relay 13 operated.

In response to the lighted lamp the attendant inserts the answering plug of any of a number of well-known cord circuits, such as Fig. 5, into the bottom jack of Fig. 1. A permanent ground will be supplied from the left-hand contact and armature of the relay 16 in the particular loop repeater which is in trouble, over conductor 3, through the tip of the bottom jack and into the tip of the connected cord, maintaining the sounder in the attendant's telegraph set in a permanent spacing condition. The ground from the left outer make contact of relay 12 is supplied over conductor 1 through the ring of the bottom jack and the ring of the plug of Fig. 5 to light the lamp in Fig. 5. At the same time battery will be supplied from the sleeve of the plug of Fig. 5, through the bottom jack to the winding of relay 23, operating relay 23. The operation of relay 23 breaks both the operating and holding path to relay 24 which releases, extinguishing lamp 26.

The operator will thereupon insert the plug of a testing cord in turn into each of the jacks associated with a particular loop and station circuit. This testing cord may be any of a number of well-known testing cords, such as Fig. 4.

Each one of the sleeve relays, such as 14 and 15, will be operated in turn in response to the insertion of the jack, from battery supplied over the sleeve circuit. The top and bottom break contacts of each of these relays will be opened momentarily.

When the relay such as 14 or 15 associated with the loop circuit which is in trouble is operated, the permanent ground connected to conductor 3 is removed, allowing the attendant's sounder in Fig. 5 to move to the marking position. Relay 13 is released. Relay 28 reoperates. Relays 36 and 12 which were locked to ground through the right-hand contacts of relay 28 are released when relay 28 reoperates. The release of relay 12 reconnects the loops which are not in trouble to the line leg by reconnecting conductor 2 through the right-hand make contacts of relay 12 and the winding of relay 13 to conductor 3. The release of relay 12 also removes the ground connected to the ring of jack ANS, causing the lamp in Fig. 5 to be extinguished.

When the trouble in the particular loop is cleared and the permanent ground from its repeater has been removed, its relay corresponding to either 14 or 15 may be released by withdrawing the testing plug per Fig. 4 from the associated jack, thereby disconnecting battery from the jack sleeve and releasing the relay. This reconnects the loop which was formerly in trouble to the hub.

The timing circuit per Fig. 3 may be substituted for the timing circuit per Fig. 2. In such case conductors 37, 38 and 39, extending from the timing circuit per Fig. 2, will be disconnected from the upper portion of Fig. 2 at line XX of Fig. 2, and the three conductors 37, 38 and 39, extending from the portion of Fig. 2 above the line XX, will be connected to conductors 37', 38' and 39', respectively, of Fig. 3.

Under this arrangement, when relay 28 releases and connects ground to conductor 39, a circuit will be extended through conductor 39' and through the winding of start relay 29', operating relay 29'. The armature of relay 29' is connected to a ringing interrupter indicated at 43. This ringing interrupter is a part of the well-known ringing machine used in telephone offices for impressing a single two second pulse of alternating current on a line, for ringing a telephone subscriber's bell, followed by a four second silent interval. It connects alternating potential between ground and the armature of relay 29' for two seconds, followed by an open circuit for four seconds. After relay 29' is operated, alternating current relay 40 is operated from source 43 through the armature and front contact of relay 29', through condenser 45 and the winding of relay 40 to ground.

The operation of relay 40 connects battery 44 through the armature and make contact of relay 40 and the winding of relay 41 to ground, operating relay 41. The operation of relay 41 transfers its upper armature from its back contact to its front contact, extending a path over conductor 38' into Fig. 2 over conductor 38 to the right-hand armature of relay 36, which is open at this time. Thus the transfer of the upper armature of relay 41 is ineffectual at this time as the path through its make contact is open at each end.

The operation of relay 41 also closes ground through the bottom armature and make contact of relay 41, through the winding of relay 42 to battery, operating relay 42. The operation of relay 42 is also ineffectual at this time, as the

circuit extending from ground through the right-hand winding of relay 36 in Fig. 2, the left-hand back contact of relay 28, over conductor 37, into Fig. 3 through conductor 37' and through the make contacts of relay 42 is open, while relay 41 is operated, at the top back contact of relay 41.

Relay 40 is released at the start of the four second open circuit intervals of ringing interrupter 43. The release of relay 40 transfers battery 44 from the front to the back contact of relay 40. When battery is removed from the connection through the winding of relay 41, relay 41 does not release immediately as it is a slow-to-release relay. During the interval that it remains operated, the battery 44 is connected through the armature and back contact of relay 40 and through the armature and still closed top front contact of relay 41 to conductor 38' and into Fig. 2 over conductor 38 to the right-hand armature of relay 36 which is still open as relay 36 has not yet operated. When relay 41 does release, ground is removed from the winding of relay 42 at the bottom armature and front contact of relay 41, but relay 42 is also a slow-to-release relay. During the interval that it remains operated, battery 44 is connected from the armature and back contact of relay 40, through the top armature and back contact of relay 41 and the make contacts of relay 42, to lead 37', operating relay 36, which locks as heretofore described. Then relay 42 releases.

On the succeeding cycle relays 40, 41 and 42 will operate as described for the first cycle. When relay 40 releases during the second cycle, battery 44 will be connected to lead 38' during the interval that slow-to-release relay 41 remains operated, after relay 40 has released. This time, since relay 36 is operated, battery will be supplied to the right-hand winding of relay 12 which will operate. Lamp 26 will ultimately be lighted in the same manner as heretofore described.

The timing circuit of Fig. 3, like the timing circuit of Fig. 2, is connected so as to serve a number of hub concentrations such as Fig. 1. The shortest delay interval that may be obtained from Fig. 3, that is to say, the shortest interval during which it will first transmit a pulse of battery over conductor 37' to operate relay 36, followed by a pulse of battery over conductor 38' to operate relay 12, will be of approximately six seconds duration. This will occur when relay 29' is operated just long enough before the end of the two second alternating current interval of ringing interrupter 43 to permit relays 40, 41 and 42 to operate. On this basis the battery pulse on the lead 37' will be connected as soon after the end of the alternating voltage interval as may be required for relays 40 and 41 to release. The battery pulse over conductor 38 will be transmitted approximately six seconds later when relay 40 releases and before relay 41 releases.

The longest interval will be obtained when relay 29' is operated just at the end of the period of alternating voltage, when there is not sufficient alternating voltage time remaining to operate relay 40. On this basis slightly more than six seconds will elapse before the battery pulse is transmitted over conductor 37' and six more will elapse before the battery pulse is transmitted over conductor 38', a total of slightly more than twelve seconds.

The variation in the elapsed time between six and twelve seconds before a battery pulse is transmitted over each of the two conductors is

the same whether one or more hub concentrations are connected to the timing circuit of Fig. 3. In this respect the circuit per Fig. 3 differs from the timing circuit of Fig. 2.

5 What is claimed is:

1. In a telegraph system, a telegraph line circuit, a telegraph repeater connected thereto, a plurality of telegraph loop circuits, a telegraph repeater connected to each of said loop circuits, means for interconnecting all of said repeaters through a common electrical point, means connected to said repeaters for operating one of said repeaters in such manner as to transmit electrical current through said point so as to operate all of said other repeaters in response to one telegraph signaling condition, means connected to said repeaters for preventing the transmission of electrical current through said point so that all of said repeaters remain unoperated in response to another telegraph signaling condition, and alarm signal means responsive to time measuring control means, both connected to said system, for indicating that one of said conditions has endured for longer than a permissible interval.

2. In combination in a telegraph system, a plurality of telegraph station circuits each interconnected through an individual hub type repeater to form a hub telegraph circuit, an alarm signal connected to said hub telegraph circuit, a timing circuit connected to said hub telegraph circuit, and means for operating said alarm signal after said timing circuit has measured an interval to indicate a spacing signal of excessive duration received from one of said repeater circuits.

3. In combination in a telegraph system, a plurality of telegraph circuits each interconnected through an individual repeater associated therewith to form a telegraph hub circuit, and an alarm signal connected to said hub circuit for indicating a spacing signal received from one of said repeaters enduring longer than a permissible measured time interval.

4. In combination in a telegraph system, at least three telegraph circuits each having a telegraph repeater termination and each operatively interconnected to all of the others through a single electrical junction, common to all of said repeaters, means for transmitting either one of two telegraph signaling conditions from any one of said repeaters to each of the other repeaters simultaneously, and alarm means connected to said junction, responsive to timing means connected to said alarm means for indicating that one of said signaling conditions has persisted for longer than a permissible interval.

5. In a telegraph system, a plurality of telegraph loop circuits, each connected through an individual repeater to a single electrical conductor forming a common junction for said repeaters, an electrical conductor extending from said junction through the winding of an alarm control relay to a telegraph line circuit repeater, means for operating said relay in response to one of two telegraph signaling conditions imposed on said junction, and alarm signal timing means connected to said relay for operating an alarm signal when said condition has prevailed for longer than a permissible interval.

6. In a telegraph system, a plurality of telegraph loop circuits each connected through an individual repeater to a single electrical conductor forming a common junction for said repeaters, a plurality of telegraph line circuits each

connected through an individual repeater to a single electrical conductor forming a common junction for said line circuit repeaters, alarm signal control means interconnecting each of said junctions for controlling means indicating that a telegraph circuit connected to one of said junctions is defective, and means included in said control means for preventing the operation of said control means when a telegraph circuit connected to the other of said junctions is defective.

7. In a telegraph system, at least three telegraph repeaters comprising two groups, including a first group connected individually directly to telegraph lines and a second group connected individually directly to telegraph local stations, each of said repeaters being operatively connected to all of the others through a single common electrical junction comprising an electrical conductor, means for transmitting either one of two telegraph signaling conditions from any one of said repeaters to all of the others of said repeaters simultaneously through said junction, a first means in said junction, responsive to the transmission of one of said signaling conditions from a repeater in a particular one of said groups for an excessive interval, for operating an alarm

connected to said first means, and means also connected to said junction for preventing the operation of said first means in response to the transmission of either of said signaling conditions from a repeater in the other of said groups.

8. A system in accordance with claim 7, including means for determining the particular repeater transmitting the signaling condition for an excessive interval.

9. A system in accordance with claim 7, including means for automatically disconnecting from the system the repeater transmitting the signaling condition for an excessive interval.

10. A system in accordance with claim 7 in which a timing circuit is automatically connected to said junction to measure said interval.

11. A system in accordance with claim 7 including means for disconnecting one of said groups from the other of said groups.

12. A system in accordance with claim 7 including means for disconnecting one of said groups from the other of said groups, and means for subdividing a group containing a plurality of repeaters so as to localize the trouble.

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