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TELEGRAPH SIGNAL REPEATER

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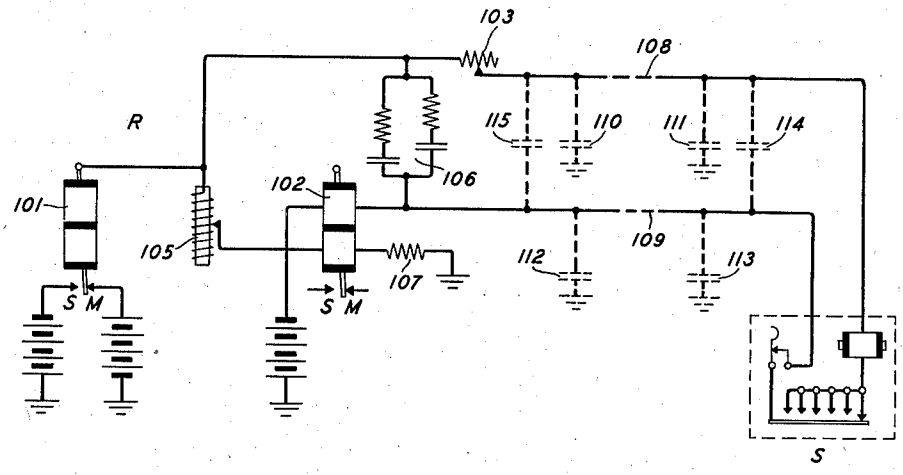

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TELEGRAPH SIGNAL REPEATER

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This invention relates to telegraph repeaters, and more particularly to telegraph repeaters of the balanced loop or differential duplex type in which one relay must be held inoperative while another relay transmits signal impulses through the winding of the inactive relay.

An object of the invention is to prevent the inactive relay from being operated by line discharges when used with long cable line circuits.

Another object is to provide a repeater of simple design which may be effectively operated in conjunction with any one of a plurality of lines of greatly differing characteristics.

Another object is to simplify the switching of repeaters of this type by an arrangement of the parts such that the adjustment of the repeater for operation with lines of different characteristics is confined to a single instrumentality, such as a resistance for adjusting the line current.

The present day tendency is to interconnect telegraph subscribers through switchboards which are equipped with repeaters which are individual to the lines or loops and with other repeaters, such as cord circuit repeaters, which must be adapted for use with lines of greatly differing characteristics. The tendency is, furthermore, to use longer and longer subscribers' loop circuits and to include the conductors for such loops in cables, so that their capacity to ground becomes quite appreciable. The tendency is, furthermore, toward higher speed of transmission.

For these reasons, it is important that repeaters should require as few adjustments as possible for their proper operation with lines of different characteristics. This is, of course, essential particularly with cord circuit repeaters, which may be connected to long cable lines or to open wire lines, but it is also important in connection with repeaters permanently associated with their loops in order to eliminate the continual balance adjustments which hitherto have been necessary in interconnecting subscribers' loops.

It is also important that the tendency of line discharges to kick-off the inactive relay be obviated and, whereas various ways of accomplishing this object have already been proposed, the general objection to those arrangements is that they ordinarily affect the bias and introduce distortion of the signals.

In accordance with a feature of the invention, the sending relay of a telegraph repeater is connected to transmit directly into the line side of the outgoing circuit and the inactive receiving relay has its line winding connected to the return side of the outgoing circuit, thereby practically entirely preventing the line discharges from passing through the inactive relay and eliminating the insertion of anti-kick-off circuit elements.

In accordance with another feature of the invention, phase equalizing means are provided in connection with one or the other, or both, of the line and secondary windings of the receiving relay. The object of this is to compensate for delay of the impulses through the line winding due to their passage over both sides of the line circuit in series and thus prevent the receiving relay from operating during sending. The elements of the phase equalizing means may be standardized and may be given suitable values for any line circuits which may be encountered in commercial operation. This phase equalizing means may be in the form of a resistance capacitance network for advancing the phase of outgoing impulses through the line winding of the receiving relay; or in the form of an inductance for retarding the impulses through the balancing winding of the receiving relay; or it may combine both of these arrangements.

In accordance with still a further feature of the invention, a variable line current control impedance is inserted in the line side of the line circuit and the balancing network is reduced to consist only of a fixed resistance of a value suitable for all line circuits which may be encountered in commercial operations.

The invention will now be described in connection with the attached drawing which shows diagrammatically a circuit arrangement for a telegraph signal repeater embodying the various features of the invention. Only so much of the repeater circuit is shown as is directly associated with a line or loop leading to the distant subscriber's station.

The repeater station R is connected over a pair of line conductors 108 and 109 to a remote subscriber's station S which will include the usual receiving magnet and transmitting contacts of a teletypewriter station. The two-wire line 108 and 109 may be a cable or open wire line or it may be two wires of a cable quad which is being used simultaneously for telephone conversation. In order to clearly bring out the operation of the invention the line will be assumed to be a cable line which consequently will have mutual distributed capacity, represented by condensers 114 and 115, and which will have distributed capacities toward the cable sheath which is grounded, which capacities are represented by condensers 110, 111, 112 and 113.

The repeater station R comprises a transmitting relay 101 which may be operated in any desirable manner either from a local source or from a distant station which may be similar to the station S. Relay 101 has its armature connected directly to the outgoing line conductor 108 and in its marking and spacing positions applies alternately positive and negative potential, respectively, to that conductor. The receiving relay 102 has its armature and contacts connected in any desirable manner for repeating signals into a local circuit or into a line circuit similar to the line 108 and 109. Relay 102 has a line winding connected from the source of negative potential to the return conductor 109 for reception of signals from station S. This relay also has a second or balancing winding connected from the armature of relay 101 through balancing resistance 107 to ground.

With the circuit in normal position as shown in the drawing, current from the source of positive potential is supplied over marking contact of relay 101 directly to conductor 108 maintaining a positive charge on condensers 110 and 111, the current continues through the subscriber's station S over conductor 109 through the line winding of relay 102 to negative potential. The condensers 112 and 113 consequently are normally charged to a negative potential. Condensers 114 and 115 will normally be charged between the positive and negative potentials applied to the two line conductors.

Another circuit may be traced from positive potential over the marking contact of relay 101 through the biasing winding of relay 102 and resistance 107 to ground. The current through the first circuit, and thus in the line winding of relay 102, is in a direction to hold the relay in marking position and is approximately twice the current in the second circuit through the biasing winding of relay 102, which is in a direction to tend to operate the relay 102 to its spacing position. When the line circuit is opened at subscriber's station S for transmission of signals to the repeater station the line circuit including line winding of relay 102 becomes currentless. Relay 102 consequently responds by operating to spacing for the duration of the opening of the line circuit. During such a spacing impulse the charges on line condensers 110, 111, 112, 113, 114 and 115 remain practically unaltered.

Again assuming normal condition of the circuit and that a spacing signal is to be transmitted by operation of relay 101 to its spacing contact, negative or spacing potential will then be applied directly to conductor 108. The subscriber's station consequently will be practically currentless and thus responds to the spacing impulse, and both line conductors will be connected to spacing potential. The condensers 112 and 113 consequently remain practically unaffected, whereas the charge on condensers 110 and 111 will be reversed, with the result that very little charging current will flow through the line winding 102 over conductor 109 due to the grounded capacities, and that a comparatively heavy charging current will flow over the line conductor 108. The charges on condensers 114 and 115 will be reduced to zero, and this small surge will appear in both line conductors, however without appreciable effect on the relay 102 or the receiving equipment at substation S. With relay 101 in spacing position negative potential is also applied to the biasing winding of relay 102 in a direction the reverse of the previous condition and relay 102 remains in marking position during the spacing impulse. When relay 101 returns to its marking position the charges on condensers 110 and 111 will again be reversed and current will again flow through the subscriber's station, which thus responds to the marking impulse. The mutual capacities 114 and 115 will again be charged up to nearly full line potential, but this surge is too small to appreciably affect relay 102. Current will also flow in the line winding of relay 102 and the opposing current in the biasing winding will be reestablished. Thus relay 102 will respond to impulses produced by opening of the line at the subscriber's station, but will not respond to impulses produced by reversing the potentials to the line circuit by transmitting relay 101.

From this description it is clear that the comparatively large current surges due to the ground capacity of the line conductors 108 and 109 do not affect receiving relay 102.

In order that a repeater of this type may be used with different lines, it is necessary to provide means for adjusting the line current. For this purpose variable resistance 103 is inserted in the outgoing line conductor 108. With the line winding of relay 102 in the other conductor the presence of resistance 103 in the outgoing conductor will not delay the decay of current through the line winding of relay 102 when a spacing signal is transmitted from the subscriber's station and thus will cause very little distortion.

Inasmuch as relay 102 is practically unaffected by the static conditions on the line circuit it is evident that the artificial line 107 need not be arranged to balance such static condition; it may therefore be made of a simple resistance of a value which may be suitable for nearly all loop circuits that may be encountered in commercial plants.

In view of the fact that the line impulses from the contacts of relay 101 must first pass through the line circuit and the distant subscriber station before they reach the line winding of relay 102, the impulses through the local circuit including the balancing winding of relay 102 will reach the biasing winding before the line impulses reach the line winding. Whereas this is satisfactory when relay 101 operates to spacing, the reversal of the current in the biasing winding of relay 102 before a marking impulse arrives in the line winding may cause the relay to "kick-off".

This phase relation may be compensated for in different ways; thus by means of a capacitance network 106 connected across the outgoing line a marking impulse may quickly be transmitted to the line winding of the relay 102 and thus prevent the biasing winding from operating the relay to spacing. A similar effect may be obtained by introducing inductance 105 in the local circuit for the biasing winding of relay 102 thereby delaying the arrival of a reverse impulse through that biasing winding sufficiently to permit the marking impulse to arrive first in the line winding of relay 102. It is of course possible to use both of these arrangements simultaneously as shown in the drawing. It will, however, be found that a network comprising a single resistance and capacitance bridge 106 will be sufficient; a capacity of 2 microfarads in series with an 8,000 ohm resistance has been found to give satisfactory average operation. In some cases it may be desirable to add a similar resistance-capacitance bridge of a different time constant for the purpose of improving the wave shape.

It has been found that the phase correcting

means have no distorting effect upon the signals in either direction and the system has the advantage of not requiring devices for preventing kick-off inserted in the line circuit proper, which devices will usually have the effect of introducing bias.

It may be noted that the mutual distributed capacity between conductors **108** and **109** represented by condensers **114** and **115** would aid in correcting the phase relation between the impulses through the two windings of relay **102**.

From the description given above it is apparent that all parts of the repeater circuit may be standardized for permanent use with any line circuit that may be encountered in a commercial plant or for use as a cord circuit repeater for connection with any type of line circuit. The only adjustable device in this arrangement is the line resistance **103**. It is thus possible to standardize the equipment to a high degree and also to obtain the necessary flexibility for switchboard operation.

For a complete system extending from the subscriber's station S to another similar subscriber's station the entire system shown in the drawing, except relays **101** and **102**, may be duplicated. Contacts S and M of relay **102** would constitute sending contacts for the other line circuit corresponding to the contacts of relay **101**; one winding of relay **101** would be connected to the incoming line and the other winding would be included in a biasing circuit similar to that including the lower winding of relay **102** and resistance **107**.

What is claimed is:

1. A two-wire circuit having capacity to ground and having a line side and a return side, signal transmitting means connected to said line side for charging said line side alternately to two different potentials with respect to ground, polar receiving relay means having a winding, and a source of potential permanently connected through said winding to said return side.

2. A telegraph signal repeater operating into an outgoing two-wire line circuit having capacitance to ground, comprising a transmitting relay having contacts for applying alternate potentials to one wire of said line circuit, a receiving relay having an operating winding, a source of potential equal to one of said alternate potentials connected through said winding to the other wire of said line circuit.

3. A two-wire circuit having capacity to ground and having a line side and a return side, signal repeating means comprising transmitting means connected to said line side for charging said line side alternately to positive and negative potentials with respect to ground, a fixed potential connected to said return side, and a polar receiving relay having a winding connected in said return side to be substantially unaffected by charging currents to ground in said two-wire circuit during operation of said transmitting means.

4. A telegraph signaling system including a polar relay having a line winding and a secondary winding, and signal transmitting means for sending signal impulses through both of said windings, and a two-wire line circuit including a remote receiving equipment, both wires of said line circuit being connected to a point between said transmitting means and said line winding.

5. A telegraph signaling system in accordance with claim 2 in which said line circuit is serially connected between said transmitting means and said line winding.

6. A long two-wire line circuit, signal transmitting means including a source of signaling potential at one end of said line circuit, receiving equipment at the other end of said line circuit, a polar relay at said one end of the line circuit having one winding connected over the two wires in series of said line circuit to said transmitting means and having another winding connected through a local circuit to said transmitting means.

7. A telegraph signal repeater operating into an outgoing line circuit and comprising a transmitting relay having contacts, a receiving relay having a line winding and a second winding, a balancing circuit connected through said second winding to said contacts, said contacts being connected to the line side of the outgoing line circuit, and said line winding being connected to the return side of the outgoing line circuit.

8. In a differential telegraph repeater, transmitting contacts connected to the line side of an outgoing circuit, a receiving polar relay having a line winding connected to the return side of said outgoing circuit, and a second winding connected in a balancing circuit from said contacts, circuit means connected to one of said windings to substantially equalize the phase relation of impulses in said windings transmitted by said contacts.

9. A differential telegraph repeater in accordance with claim 8 having a sole regulating means for adjusting said repeater for different operating conditions consisting of an adjustable impedance connected to said line side.

10. A differential telegraph repeater system comprising a polar receiving relay having a line winding and a second winding, signal transmitting means, a balancing circuit connected through said second winding to said transmitting means, a phase controlling network connected between said line winding and said transmitting means, and a two-wire outgoing line circuit connected across said network.

11. A repeater in accordance with claim 7 further comprising a phase correcting capacitance connected in a local circuit between said contacts and said line winding, and a variable resistance connected between said contacts and said line side for adjustment of the line current.

12. A long two-wire line circuit having capacity to ground, transmitting means connected to the line side at one end of said two-wire circuit, receiving relay means having a winding connected in the return side at said one end of said two-wire circuit, a balancing circuit to prevent said relay from responding to the operation of said transmitting means including current regulating and phase correcting means connected to said line winding and a balancing winding on said relay connected to said transmitting means.

13. The combination in accordance with claim 6 further comprising capacitance circuit means in series with said one winding and connected in multiple to said line circuit and inductive circuit means in series with said other winding.

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