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TELEGRAPH SIGNALING REPEATER

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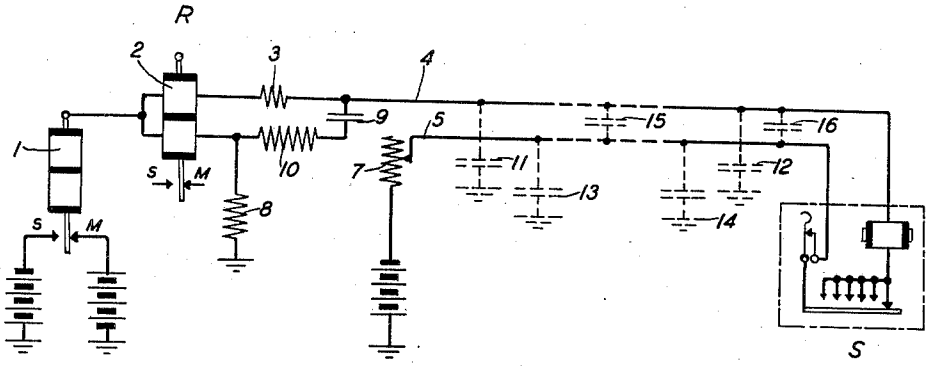

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TELEGRAPH SIGNALING REPEATER

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This invention relates to telegraph repeaters and more particularly to telegraph repeaters of the balanced loop or differential 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.

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 different characteristics.

Another object is to simplify the operation of repeaters of this type by an arrangement of 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.

The present day tendency is to interconnect telegraph subscribers through switchboards which are equipped with repeaters individual to the lines. For the sake of economy the tendency is, therefore, to standardize such repeaters so that they may be installed for use on lines of greatly differing characteristics without the cumbersome balance adjustments which hitherto have been necessary. The tendency is, furthermore, to use longer and longer subscribers' loop circuits and to include the line conductors for such loops in cables; thus their capacity to ground becomes quite appreciable. The tendency is also toward greater speed of transmission.

For these reasons it is important that repeaters should require as few adjustments as possible for their proper operation on lines of different characteristics; in fact it is desirable that the adjustments should be limited to adjustment of the line current.

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

In accordance with a feature of the invention a network is provided for distributing the line discharges substantially proportionately between the line winding and the balancing winding of the inactive receiving relay at a repeater station, so that the relay will not kick off due to such discharges, the arrangement being such that the signals will not be biased or otherwise distorted.

More specifically the invention provides for a capacitance path from the outgoing line to a point between the balancing winding and the balancing network for carrying a portion of the line discharge through the balancing winding to the source of line discharging potential at the contacts of the transmitter relay, especially during a spacing impulse.

For the purpose of properly apportioning the line discharge between the line winding and the balancing winding a small fixed resistance is serially connected in the line circuit without an appreciable effect upon the signals.

In accordance with a more specific feature of the invention the main resistance for adjusting the line current is inserted in the return conductor from the distant station. By a combination of these arrangements the wave shape of the signals transmitted in either direction may be improved and the bias of signals from the distant station reduced. It will furthermore, be possible to use a balancing network or artificial line which consists merely of a fixed resistance, since it no longer will be necessary to out-balance the transient characteristics of the line.

The features of the invention may be used with special advantage in cord circuit repeaters, such as are used at switchboards for interconnection of line or loop circuits. The reduction to a single operation of the adjustment of a repeater to each line circuit with which it is connected is an important factor in speeding up the switchboard service.

The invention will now be described as applied to a specific preferred embodiment, and reference will be made to the attached drawing which shows a signal repeater arranged to include the various features of the invention and connected over a two-wire line circuit for two-way communication with a distant station, such as a teletypewriter station. In the drawing only such parts of a repeater are shown as are directly associated with the illustrated line circuit, it being understood that the circuit for another line circuit either may be made substantially like the circuit shown in the drawing, or may be of any well-known design. This application of the invention to the embodiment shown in the drawing is by way of example and is made to facilitate the study and understanding of the invention by one skilled in the art. It should, however, be understood that the invention may be successfully applied in different manners and to circuits of different types other than that described and illustrated.

Referring now to the drawing, the repeater

station R is connected over line conductors 4 and 5 for two-way communication with the distant teletypewriter station S, on a single line or half duplex basis.

The repeater station R comprises the transmitting relay 1 having contacts for applying alternately positive and negative potential to the line circuit in response to corresponding impulses transmitted in any desired manner to its windings. The repeater R also includes the receiving relay 2 having contacts for retransmission of signals into any desired circuit in response to signals through its windings incoming over the line circuit 4, 5 from the distant station S.

The station S is a teletypewriter station having a relay or magnet winding for operation of the translating or recording device in response to line impulses, and having transmitting or distributor contacts controlled by a keyboard for transmission of impulses by alternately opening and closing the line circuit.

The line circuit will be assumed to consist of a pair of cable conductors, such as one pair of a twisted quad, and to be of considerable length. There may thus be a large distributed mutual capacity between the conductors 4 and 5, which is schematically represented in the drawing by condensers 15 and 16, and also large distributed grounded capacities between each conductor and the cable sheath, which are represented in the drawing by condensers 11, 12 and 13, 14.

From the contacts of sending relay 1 the transmission circuit is connected through the upper winding of receiving relay 2 and resistance 3 to the line circuit and through the lower winding of relay 2 to the balancing network represented by resistance 8, it being a requirement of the circuit that receiving relay 2 shall not leave its right-hand or marking contact when the armature of sending relay 1 alternately closes its right and left-hand contacts, changing the current flow in the line and balancing circuits.

With the circuit in normal or marking condition as shown in the drawing, the line current through the line winding of relay 2 holds the armature against the marking contact. The current through the balancing winding is in a direction to move the armature to spacing, but the number of ampere turns of this winding is only half of that of the line winding. Thus, when the line circuit is opened at station S, in the sending of a spacing impulse, the line current is reduced to zero and the current in the balancing or biasing winding will operate relay 2 to spacing; when the line circuit is again closed the line winding will operate relay 2 to marking. When transmitting relay 1 is operated to spacing to send a spacing impulse to station S, the line circuit will have both its ends connected to spacing potential and the current in the line winding of relay 2 will be reduced to zero; simultaneously therewith the current in the local circuit including the biasing winding of relay 2 will be reversed and will now hold the armature against the marking contact. Relay 2 thus remains inactive during transmission through its windings of impulses from the transmitting relay into the line and artificial line circuits.

It is evident that the grounded line capacity 13,14 of line conductor 5 remains practically fully charged to the spacing potential applied thereto at the repeater station; on the other hand, the grounded line capacity 11,12 of conductor 4 will be charged in opposite directions during transmission by relay 1. These charging surges are likely to affect relay 2 and cause it to kick off at times when it should remain inactive.

Thus, again assuming the circuit in marking condition and that relay 1 operates to spacing, capacities 11,12 will discharge and again charge up to the spacing potential at both ends of the line circuit, the current direction will be quickly reversed in the line winding of relay 2 and the magnitude of this current may momentarily be greater than the reversed current in the balancing winding and the relay will be temporarily operated to its spacing contact. When thereafter relay 1 operates back to marking the charging current into capacities 11,12 quickly reverse, and in this case holds relay 2 firmly in marking position before the current is reversed in the balancing winding, thus having a desirable effect in this instance.

To at least partly obviate the undesirable effect of the charging currents when a spacing potential is applied through the line winding of relay 2 to the line, it has been proposed to reduce the transient current in the direction of the repeater stations by inserting an impedance in the line circuit at the repeater end. This impedance must be of fairly large value to sufficiently oppose the transient current flow through relay 2, and consequently has a serious distorting effect upon the signal impulses; another disadvantage is that the impedance cannot be given a fixed value and be expected to give satisfactory operation for all the different lengths of lines in use in the present day plant. This last objection, of course, also applies to the insertion of a transient impedance in the balancing network designed to match that of the line circuit.

In accordance with the invention a capacitance-resistance network 9,10 is inserted to provide a path for a part of the transient current from the line conductor 4 through the balancing winding of relay 2 to the contacts of relay 1 in parallel with the line winding of relay 2. To aid the effect of this by-path a small resistance 3 may, if desired, be inserted in series with the line winding of relay 2. By this arrangement the action of the line surges may be made simultaneous and in opposite directions in the two windings of relay 2 and also in proper proportions relative to the proportions of the number of turns in the two windings, with the result that relay 2 will remain inactive during transmission by relay 1, and will respond to signals from station S. With equal numbers of turns in the two windings of relay 2, the network 9,10 with 4 microfarad capacity and 400 ohm resistance and the line resistance 3 of 200 ohms, this system has been found to give satisfactory high speed operation on a 40-mile No. 19 B. and S. gauge, two-wire cable line.

With this arrangement the balancing network or artificial line 8 may consist of a fixed resistance. The variable resistance 7 for control of the line current is preferably connected in the return conductor at the repeater end of the line where it will have no distorting effect upon the signals incoming from station S.

The network 9,10 introduces less distortion and causes less transmission loss than networks serially included in the line circuit.

For a complete system extending from the subscriber's station S to another similar sub-

scriber's station the entire system shown in the drawing, except relays 1 and 2, may be duplicated. Contacts S and M of relay 2 would constitute sending contacts for the other line circuit, corresponding to the contacts of relay 1; one winding of relay 1 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 2 and resistance 8.

What is claimed is:

1. A polar signaling relay having two windings in differential connection, an outgoing line circuit connected through said windings and including signal transmitting means and also including an incoming line wire connected to one of said windings, and a capacity branch circuit for passing transient discharges from said line wire through the other of said windings and said transmitting means to prevent kick-off of the relay armature due to capacity unbalance of said line circuit.

2. A polar telegraph relay having two windings, signal transmitting means connected to one side of both of said windings, an impedance network including capacitance connected from the other side of one of said windings to the other side of the other winding to prevent kick-off of said relay, an incoming line conductor having high capacity to ground connected to an intermediate point of said network, and a balancing line circuit having no capacity to ground connected to another point of said network.

3. In a telegraph repeater a polar relay having two windings, a high capacity outgoing line circuit including one of said windings and an incoming line conductor, a balancing line circuit including the other winding and a low capacity balancing network, signal transmitting means connected to both of said circuits, a discharge equalizing network connected directly between said line conductor and said balancing network to pass a portion of the discharges from said line conductor through said other winding, and an apportioning impedance connected in said outgoing line circuit.

4. A telegraph signaling system comprising a two-wire line circuit having a line side and a return side, grounded fixed balancing circuit means, a polar relay having two windings in differential connection, a grounded source of marking potential, a grounded source of spacing potential connected in said return side, signal transmitting relay means having contacts for alternately applying said potentials simultaneously through said two windings to said line side and said balancing circuit means, a capacity branch circuit connected from said line side to a point between said balancing circuit means and the associated winding of said polar relay, a fixed resistance connected in series with the other of said windings for apportionment between said two windings of discharges from said line side, and a variable line current control resistance included in said return path.

5. A telegraph system inculding a polarized signaling relay having opposing windings, a line circuit including said windings, balancing circuit means included in said line circuit, and signaling means for alternately charging and discharging said line circuit, characterized in this that means are included for apportioning the said line discharges between said opposing windings to prevent kick off of said relay, said means comprising a capacity branch connected from said line circuit in series with the balancing winding of said relay, and fixed resistance means connected from said line circuit in series with the line winding of said relay, said fixed resistance being small to prevent biasing of the signals in said line circuit said line circuit having sufficient capacity unbalance to cause said relay to kick-off when said apportioning means are excluded from said system.

6. An unsymmetrically balanced telegraph system comprising a polar signaling relay having two windings, a transmission circuit including a high-capacity real line and a low-capacity balancing network artificial line connected through said two windings in series-aiding relation for reception, transmitting means connected for transmission into said transmission circuit through both of said windings in differential relation, and a capacity-resistance branch circuit connected to said two windings for apportioning between them in differential relation unbalanced line transients due to signal transmission to prevent kick-off of said relay, the difference in capacity of said real line and said artificial line being great enough to cause kick-off of said relay due to signal transmission in the absence of said branch circuit, and the impedance of said branch circuit being such that it will pass a desired proportion of the said line transients caused by the signaling currents.

7. A high-capacity line circuit, a substantially non-reactive artificial line, a polar relay having two windings serially connected between said line and artificial line, transmitting means connected to transmit through said two windings into the reactance of said line circuit and into the non-reactive impedance of said artificial line, respectively, and a discharge equalizing network connected to divert a proportion of the unbalanced line charge current due to signal transmission from one winding to the other to prevent kick-off of said relay, the capacity of said line circuit being high enough to cause the flow of line transients in response to signal transmission of sufficient strength to operate said relay in the absence of said discharge equalizing network, and said discharge equalizing network having such an impedance that it will pass the desired proportion of the said line charge current caused by the signal transmission.

8. In a telegraph system including transmitting means connected through two windings of a polar receiving relay to a high-capacity real line circuit and a substantially non-reactive artificial line, respectively, whereby the system is sufficiently unbalanced to cause the relay to kick off during transmission due to unbalanced line charge currents effected by the transmission of signals, the method of operation which comprises transmitting telegraph signals through said windings into said real line and artificial line and dividing the said unbalanced line charge currents to flow through both of said windings in differential relation to prevent said kick-off of said relay.

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