Oct. 20, 1936. T. L. DIMOND 2,058,216

SIGNALING SYSTEM

Filed May 11, 1935

FIG. 1

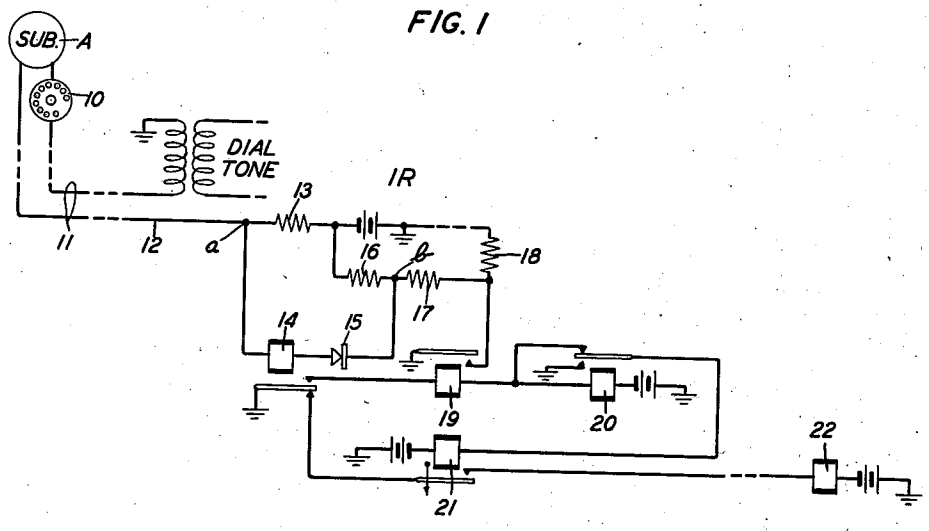
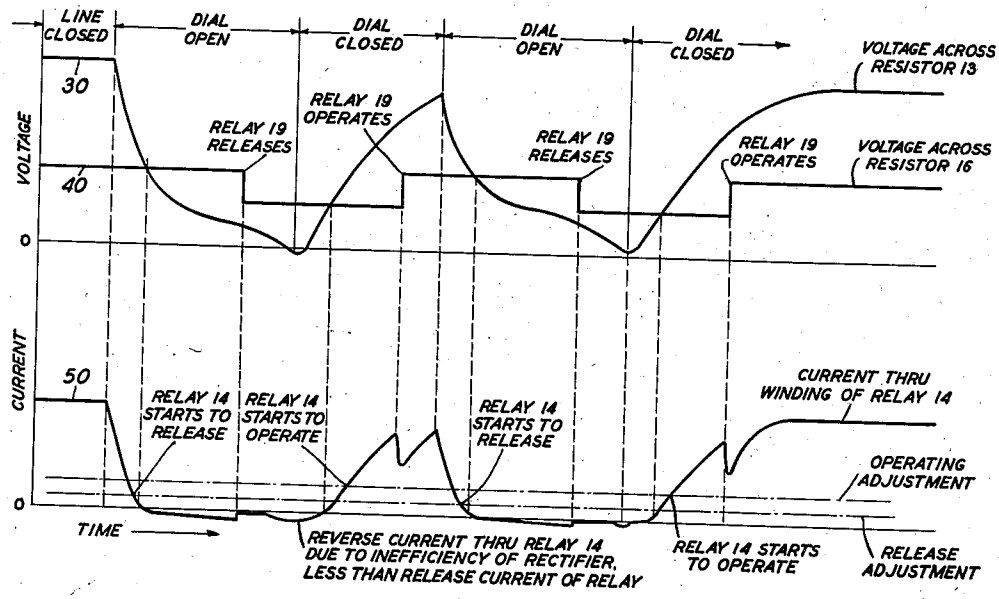


FIG. 2



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SIGNALING SYSTEM

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9 Claims. (Cl. 179—16)

This invention relates to signaling systems and particularly to systems comprising electromagnetic signal receiving means.

The object of the invention is to provide a more sensitive electromagnetic signal receiving means and to insure the accurate response of such a means to incoming signals.

The invention is a signaling circuit arrangement of the Wheatstone bridge type comprising a signal sender, connected in series with the line which constitutes the variable resistance branch of the bridge, and a signal receiving relay for operation when the variable resistance branch of the bridge is opened by the signal sender. To insure the release of the signal receiving relay when the line has a low insulation resistance or high capacity, without increasing the spring tension which holds the armature of the relay in normal position, an asymmetric or unidirectional conductor is connected in series with the winding of the relay. An auxiliary relay which is controlled by the signal receiving relay to repeat the signal impulses to operate a register, is also effective to alter the balance of the bridge so as to aid the operation of the signal receiving relay when it is normal and to aid the release of the signal receiving relay when it is operated.

A better and more complete understanding of the invention may be obtained by considering the specific embodiment of the invention shown in the drawing which forms a part of this specification. The invention is not, however, limited in its application to this specific arrangement and is, in general, applicable to any signaling system in which selective signals are created by the opening and closing of a signaling circuit.

Referring to the drawing:

Fig. 1 shows a portion of an automatic telephone system in which A represents a subscriber's station and IR represents impulse receiving means.

Fig. 2 shows graphs which facilitate the description of the arrangement shown in Fig. 1.

The apparatus at station A includes a dial 10 or an equivalent impulse sender, and is connected by line 11 to a central office or exchange in which automatic switching equipment is provided for establishing a connection between the line 11 and an idle impulse receiving means IR in response to the removal of the receiver at station A to originate a call. The impulse receiving means IR may be used to directly control in succession each of a train of selective switches to complete a desired connection or may be used to operate a register which thereafter controls the various switches through which a desired connection is established. Reference may be had to chapter III of the second edition of "Automatic Telephony" by Smith and Campbell for a description of an automatic telephone system comprising switches of the well-known Strowger type controlled by the dial impulses when dialed. Reference may be had to Patent No. 1,395,977 granted to F. A. Stearn et al., November 1, 1921 for a description of a system comprising switches of the power-driven panel type which are revertively controlled by a register-controller, set in accordance with trains of impulses created by the operation of the dial at any calling subscriber's station to which the register-controller is connected.

The impulse receiving means IR, shown in Fig. 1 of the drawing, comprises an impulse receiving relay 14, a rectifier 15 of the copper-oxide disc type, auxiliary impulse relays 19 and 20, a slow-to-release relay 21, and a register or selector 22. Upon extension of the line 11 to the impulse receiving means IR in response to the removal of the receiver by the subscriber at station A to originate a call, an impulse circuit is completed from battery through resistor 13 and from battery through resistor 16, rectifier 15 and the winding of relay 14 all in series, over conductor 12 and line 11, through the telephone instrument and dial 10 at station A, and through one winding of the dial tone transformer to ground. At substantially the same time ground is connected to the upper end of resistor 18 as indicated in the drawing by the broken line, thereby completing a network which constitutes an unbalanced Wheatstone bridge. Resistor 13 and resistor 16 form adjacent legs of the network, the junction point between these resistors being connected to battery; the line 11 forms the leg opposite resistor 16; the resistors 17 and 18 in series form the leg opposite resistor 13, ground being connected to the junction point between the line 11 and resistor 18; and the winding of relay 14 in series with rectifier 15 forms the bridge from the junction point a between resistor 13 and line 11 and the junction point b between resistors 16 and 17. With the proper choice of resistors and with the network thus completed, the potential of point a is enough higher than the potential of point b to cause the operation of relay 14, the rectifier 15 being poled to offer minimum resistance to the resulting current between these points. The operation of relay 14 closes a circuit through the winding of relay 19 in series with the windings of relays 20 and 21 in parallel. The operation of

relay 19 short-circuits resistor 18; and the operation of relay 20 disconnects the winding of relay 21 from the winding of relay 20 and closes a holding circuit for relay 21. The short-circuiting of resistor 18 raises the potential of point *b* so that the current through the winding of relay 14 and rectifier 15 is reduced to render relay 14 more quickly responsive to the opening of the impulse circuit when the subscriber at station A operates the dial 10. No further action takes place until the subscriber at station A operates the dial to obtain a connection with any other station with which conversation is desired.

Upon the opening of the impulse circuit over line 11 at the dial to transmit the first impulse of a series, the potential of point *a* becomes substantially the same as that of the negative pole of the battery, the current and drop in potential through resistor 13 and the winding of relay 14 in series being very small due to the polarity of rectifier 15. What current there is through the winding of relay 14 is in the opposite direction to that which existed while the impulse circuit was closed, so that relay 14 releases and is not reoperated until the impulse circuit is again closed at the end of the first dial impulse. The release of relay 14 closes at its back contact a circuit for operating the register or selector 22. The release of relay 14 also causes the release of relays 19 and 20. Being slow in releasing relay 21 remains operated during dialing. The release of relay 19 removes the short-circuit around resistor 18 to lower the potential of point *b* and thereby increase the difference in potential between points *a* and *b*; so that, upon the closing of the impulse circuit at the end of the first dial impulse, relay 14 will be more quickly reoperated than it would have been if the short circuit around resistor 18 were continued. With relay 14 reoperated, relays 19 and 20 reoperate, resistor 18 is again short-circuited, and the circuit through the winding of relay 21 closed. The reoperation of relay 14 also opens the register operating circuit. The above described cycle of operations is repeated in response to each succeeding opening and closing of the impulse circuit at the contacts of the dial, thereby effecting the desired operation of the selector or register 22.

In the above-described bridge and rectifier arrangement, there is no current or a very small current through the winding of relay 14 while the line loop is open; the current, if any there be through the winding of relay 14 prior to the closing of the line loop, being in the opposite direction to the current through this winding after the line loop is closed. Upon closure of the line loop, the current, through the winding of relay 14, reverses and increases rapidly to a value considerably above that required for operating relay 14; the necessary unbalance of the bridge being obtained by a proper choice of resistors for use as the fixed resistance branches of the bridge. Upon opening of the line loop, the current through the winding of relay 14 decreases rapidly below the point at which relay 14 begins to release, until there is no current, or a very small current in the opposite direction, through the relay winding. This arrangement is, therefore, one in which the impulse relay is fast in operating upon closure of the line loop and fast in releasing upon the opening of the line loop. In the case of an impulse relay connected directly in series with the line in conventional manner, the current upon closure of the line loop cannot be much in excess of the minimum required for operating the relay and such an impulse relay is slow in operating as compared with relay 14; and the current upon opening of the line loop, due to the conductivity of the line insulation, tends to make the conventional impulse relay slow in releasing as compared with the release of relay 14. Furthermore the variation in the time required for operating the impulse relay 14, due to any commercially allowable variation in its operating capability, is small as compared with the variation in time required for operating an impulse relay which is connected directly in series with the line due to the fact that the actual current through the winding of relay 14 exceeds the minimum operating current by a much larger amount than that by which the actual current can exceed the minimum operating current in the case of an impulse relay which is connected directly in series with the line loop.

The graphs in Fig. 2 indicate the changes in voltage and current that take place in the network in response to the closing and opening of the impulse loop. The curves 30, 40 and 50 are spaced horizontally so that points on each directly above or below each other represent simultaneously existing conditions. The curve 30 represents the varying voltage across resistor 13, and curve 40 represents the varying voltage across resistor 16, during the transmission of a series of dial impulses. The curve 50 represents the varying current through the winding of the impulse relay 14 during the same time interval. The legends shown adjacent the various significant points, render the graphs self-explanatory.

What is claimed is:

1. In a signaling system, a line, a signal sender for opening and closing said line, a Wheatstone bridge network, said line constituting the variable resistance branch of the bridge, a signal receiving relay for response to an unbalanced condition created by the opening of said line by said sender, a signal register, an auxiliary relay for repeating the signals received by said signal receiving relay to operate said register, and means comprising said auxiliary relay for altering the balance of the bridge so as to aid the operation of the signal receiving relay and to aid the release of the signal receiving relay.

2. In a signaling system, a line, a signal sender for opening and closing said line, a Wheatstone bridge comprising said line and a relay, said relay being adapted to operate in response to the closing of said line and to release in response to the opening of said line, and means for altering said bridge to aid the release of said relay.

3. In a signaling system, a line, a signal sender for opening and closing said line, and a Wheatstone bridge comprising said line, a relay and a unidirectional conductor, said conductor being connected in series with said relay to render it responsive to current in only one direction, said relay being adapted to operate in response to the closing of said line and to release in response to the opening of said line, and means for altering said bridge to aid the release of said relay.

4. In a signaling system, a line, a signal sender, a first relay, a second relay, a unidirectional conductor, a battery, a potentiometer comprising resistors connected across the terminals of said battery, another resistor interconnecting said line and one of the terminals of said battery, the winding of said first relay and unidirectional conductor in series being connected from the junction point between two of the resistors of said potentiometer to the junction point

between said line and said other resistor, a circuit comprising said unidirectional conductor, the winding of said first relay, the line and the signal sender, a second circuit including normally open contacts of said first relay and the winding of said second relay, and means including normally open contacts of said second relay for reducing the difference in potential between said junction points.

5. In a signaling system, a line, a signal sender for opening and closing said line, a Wheatstone bridge comprising said line and a relay, said relay being adapted to operate in response to the closing of said line and to release in response to the opening of said line, and means for altering the balance of said bridge to aid the operation of said relay.

6. The combination in a signaling system, of a line, a plurality of resistors, a relay, and a battery all connected to form a Wheatstone bridge, said relay being bridged across the junction point between two of the resistors and the junction point between said line and another of the resistors, a signal sender for opening and closing the line, and a unidirectional conductor connected in series with the winding of said relay.

7. The combination in a signaling system, of a line, a plurality of resistors, a relay, and a battery all connected to form a Wheatstone bridge, said relay being bridged across the junction point between two of the resistors and the junction point between said line and another of the resistors, a signal sender for opening and closing the line, a unidirectional conductor connected in series with the winding of said relay, and a signal register controlled by said relay.

8. The combination in a signaling system, of a line, a plurality of resistors, a relay, and a battery all connected to form a Wheatstone bridge, said relay being bridged across the junction point between two of said resistors and the junction point between said line and another of the resistors, and an impulse sender comprising contacts for opening and closing the line, the difference in potential between said junction points being increased sufficiently upon the closing of said line to cause the operation of said relay and decreased sufficiently upon the opening of said line to cause the release of said relay.

9. The combination in a signaling system, of a line, a plurality of resistors, a relay, and a battery all connected to form a Wheatstone bridge, said relay being bridged across the junction point between two of said resistors and the junction point between said line and another of the resistors, an impulse sender comprising contacts for opening and closing the line, and a unidirectional conductor connected in series with the winding of said relay, there being a sufficient difference in potential between said junction points when said line is closed to cause the operation of said relay and substantially no difference in potential between said junction points when said line is open.

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