March 20, 1945. A. S. MARTINS 2,371,972

SIGNALING SYSTEM

Filed Feb. 22, 1944

FIG. 1

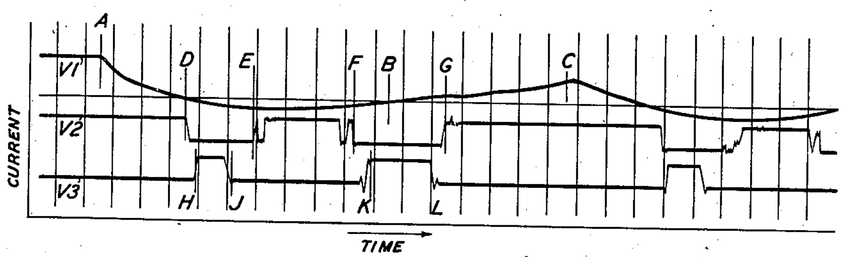


FIG. 2

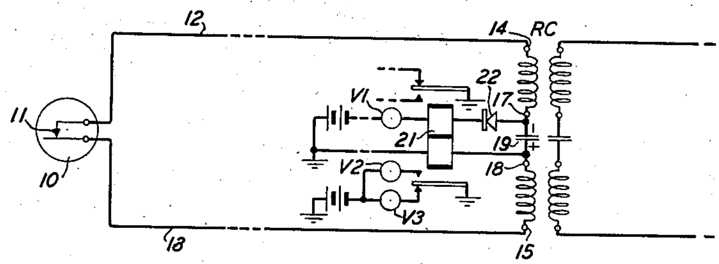
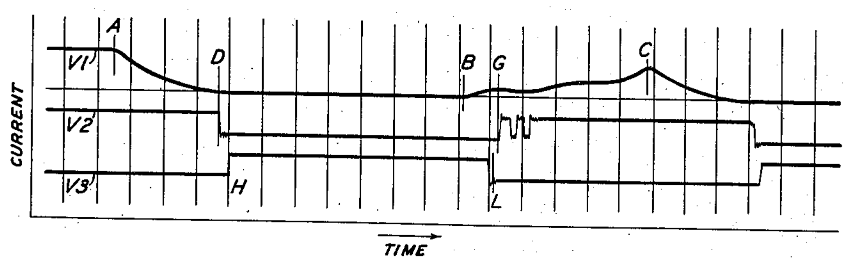


FIG. 3



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SIGNALING SYSTEM

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10 Claims. (Cl. 179—16)

This invention relates to improvements in signaling systems and particularly to means for preventing impulse surges from falsely actuating signal responsive relays.

The objects of the invention are to obtain a greater degree of reliability and certainty in the operation of signal responsive relays; to render these relays immune to surges; to safeguard the relays from false operations; and to secure other improvements and advantages in signaling systems.

In automatic telephone systems numerical switches of the conventional type, such as selectors and connectors, include impulse relays which vibratorily respond to impulses transmitted by the dial mechanism. Impulse relays are also included in impulse repeater circuits, as well as in incoming and outgoing trunk circuits of automatic telephone systems. It often occurs, particularly in connection with interoffice trunks wherein the primary windings of the well-known repeating coil bridge are interposed serially between the incoming line conductors and an impulse responsive relay and the bridge condenser, that the impulse responsive relays are falsely actuated by transient surges set up during the dialing operation. It has been found in practice that when the dial pulsing contacts open during an impulse cycle the current through the impulse relay windings decays to zero to release this relay and then builds up in the opposite direction sufficiently to reoperate the relay falsely. The false reoperation of the impulse relay naturally results in false operation of the switch, which in turn selects a wrong trunk or wrong number, thereby causing annoyance to the calling subscriber.

Various schemes have been proposed for preventing false operation of the impulse responsive relay among which is included that of connecting dry rectifiers across the primary windings of the repeating coil. This prior arrangement, while it appears to deal effectively with surges arising at the repeating coil, does not block out the reversed current surges produced by the condenser connected between the mid-taps of the repeating coil.

According to the present invention false operation of the impulse responsive relay is prevented by inserting an asymmetric resistance, such as a copper oxide rectifier, serially in circuit between the impulse responsive relay and the condenser, which is connected between the mid-taps of the primary windings of the repeating coil for passing voice frequency currents, the impedance characteristics of the asymmetric resistance being such as to allow current in the normal direction but to substantially block out current in the opposite direction. With this arrangement the reverse current produced by the transient surges is limited to a safe value and as a consequence the impulse relay responds with more reliability to the transmitted impulses.

This and other features of the invention will be described in detail in the following specification, taken in connection with the accompanying drawing in which:

Fig. 1 illustrates graphically the current conditions in a typical impulse signaling circuit during a dialing operation when an asymmetric resistance is not employed;

Fig. 2 illustrates schematically an impulse signaling circuit in which an asymmetric resistance is provided serially between an impulse responsive relay and a repeating coil winding and condenser; and

Fig. 3 illustrates graphically the current conditions when an asymmetric resistance is employed, as in Fig. 2.

Referring now to Fig. 2 of the drawing, there is illustrated in schematic form a telephone circuit of the automatic type comprising the usual subscriber's dial **10** having impulse contacts **11** connected to line conductors **12**, **13**, which in turn are connected through conventional switches that are not shown since they are not essential to the invention, to primary winding terminals **14**, **15** respectively, of repeating coil RC. It is to be understood that there may be any number of switches inserted between the dial **10** and repeating coil RC, and that the subscriber's dial **10** may instead be part of an operator's telephone set without affecting the invention. The secondary windings of repeating coil RC may be connected to a switch in the same office or through trunks to a switch in a distant office. These connections, however, are well known and have been omitted to simplify the drawing.

To mid-taps **17**, **18** of the primary winding of repeating coil RC a condenser **19** is connected for talking transmission purposes and in parallel with condenser **19** is connected an impulse responsive relay **21** having an upper and lower winding. An upper contact of this relay may be arranged to step a selector switch in the same office or to repeat pulses to a distant office. Between the upper winding of relay **21** and mid-tap **17** is inserted an asymmetric resistance, **22**, preferably of the copper oxide rectifier type, which is poled to pass current in the direction of the arrow and to block current in the opposite direction. While only one asymmetric resistance is disclosed, it is of course understood that a similar resistance, properly poled, may be inserted between the lower winding of relay 21 and terminal 18 in order to improve the transmission balance of the circuit. Or again, the balance may be effected by short-circuiting the resistance 22 after the transmission of pulses has been completed.

The operation of an impulse signaling circuit of the type schematically disclosed in Fig. 2 is well known and accordingly will be briefly recited herein. The circuit is seized in the normal manner by the subscriber lifting his handset (not shown) from the mounting support (not shown) after which impulse responsive relay 21 is actuated in a circuit that can be traced from positive pole of grounded battery through lower winding of relay 21, lower primary winding of repeating coil RC, over line conductor 13, through closed dial impulse contact 11, and back over line conductor 12 through upper primary winding of repeating coil RC, asymmetric resistance 22, and thence to negative pole of battery through the upper winding of relay 21. Upon actuation of relay 21 the front contacts are closed and the succeeding circuits (not shown) are prepared for reception of the transmitted impulses in the conventional manner. Upon actuation of dial 10, whereby the impulse contact 11 is opened and closed intermittently, relay 21 responds vibratorily thereto and operates the switches (not shown) in the well-known manner.

To ascertain the transient effect upon impulse relay 21 during dial pulsing vibrating elements V1, V2, V3 of a conventional oscillograph, such as that disclosed in A. M. Curtis Patent 1,907,745 of May 9, 1933, were temporarily inserted in the upper winding, lower front contact, and lower back contact circuits, respectively, of relay 21. Oscillograms of the current variations in these circuits were then obtained for both conditions, that is, without use of the asymmetric resistance 22 and then with this asymmetric resistance, as shown graphically in Figs. 1 and 3.

Referring now to Fig. 1, which is a graph of an oscillographic record taken of the pulsing operation of impulse relay 21 when an asymmetric resistance was not employed in the circuit, curve V1 represents the current through the upper winding of relay 21, curve V2 represents the current through the lower relay make contact and curve V3 represents the current through the lower relay break contact. It is readily seen that curves V2 and V3 depict the operating and releasing periods of relay 22 in response to the closing and opening operations of dial impulse contact 11. With the pulsing contact 11 closed, relay 22 is energized and its lower make contact is closed, consequently, as indicated by the curves, current flows through vibrating elements V1, V2 only, the left end of curve V3 for the lower break contact being represented as of zero current. In curve V1 the point A represents the instant the pulsing contact 11 was opened, point B represents the instant the pulsing contact 11 was reclosed, and point C represents the reopening of the contact 11 for starting another pulse cycle, the interval A—C therefore, representing one complete impulsing cycle. In curve V2, point D indicates the release of relay 21, which corresponds to the instant at which the relay current is passing through its zero value; points E to F indicate the interval through which the reversed current is of sufficient magnitude to falsely reoperate relay 21; and point G indicates the reoperation of relay 21 following the closure of impulse contact 11, as at point B of curve V1. In curve V3 points H—J and K—L respectively indicate separated portions of the release period of relay 21, that is, the periods during which the lower back contact is closed, while the interval between points J and K indicates the period during which the unwanted reversed current is effective to open the lower back contact.

An inspection of the curves V1, V2, V3 of Fig. 1 will therefore reveal that upon opening contact 11 the current in the winding of relay 21 falls off to a zero value, at which time the lower make contact is opened and the lower break contact is closed, and then continues to build up in the reverse direction sufficiently to falsely reopen the lower break contact and shortly thereafter to reclose the lower make contact. This false reoperation of relay 21 continues until the value of the reversed current is insufficient to energize the relay further after which the lower make contact opens and the lower break contact closes. The false reoperation of relay 21 appears to be caused particularly by condenser 19, the circuit proximity of relay 21 to condenser 19 also being a contributing factor. It is well known that, when a contact, such as pulsing contact 11, is opened in a circuit containing inductive elements, the current persists thereafter for a short interval of time, the current in this instance charging condenser 19. The accumulated charge on condenser 19 raises its potential above that of the battery so that upon discharge thereof the current reverses and surges through a local circuit including relay 21, which falsely reoperates due to the magnitude of the surge. This circuit can be traced from the lower terminal of condenser 19 through lower winding of relay 21, positive and negative poles of battery, and thence to the upper terminal of condenser 19 through upper winding of relay 21.

Applicant has found that, by inserting an asymmetric resistance 22 in the above-traced condenser 19-relay 21 circuit with the resistance 22 properly poled, the reversed current surges were effectively blocked. The effectiveness of applicant's invention is readily apparent in Fig. 3, which is a graph of an oscillographic record taken of the pulsing operation of impulsing relay 21 connected in circuit with an asymmetric resistance 22, as shown in Fig. 2. The same character references are employed in Fig. 3 as in Fig. 1 to identify the same curves and the various points thereon wherever they are repeated. From curve V1, it will be seen that there is very little, if any, reversed current to falsely actuate relay 21. This is further borne out by curves V2 and V3, whereon the interval between points D and G indicates a continuous open period for the lower make contact and the interval between points H and L indicates a continuous closed period for the lower break contact of relay 21.

While this invention has been shown and described in accordance with the preferred embodiment merely for the purpose of illustration, it is, of course, understood that various modifications may be made and that the features thereof may be applied to many other and widely varied fields without departing from the scope of the invention as defined in the appended claims.

What is claimed is:

1. In a signaling system, a line, an impulse transmitting device at one end of said line, a repeating coil at the other end of said line, a relay responsive to impulse transmitted by said device,

a signaling circuit comprising said line and device and windings of said repeating coil and relay, a condenser at mid-taps of the primary windings of said repeating coil, and means serially interposed between a winding of said relay and said condenser for preventing false operation of said relay.

2. In a signaling system, a line, an impulse sender at one end of said line, a repeating coil at the other end of said line, an impulse relay responsive to impulses transmitted by said sender, a signaling circuit comprising said line and sender and windings of said repeating coil and relay, a condenser at mid-taps of the primary windings of said repeating coil, and an asymmetric resistance serially interposed between a winding of said relay and said condenser, said relay being so polarized by said asymmetric resistance as to be responsive only to closures of said impulse sender.

3. In a signaling system, a line, an impulse transmitting device connected to one end of said line, a repeating coil connected to the other end of said line, an impulse relay responsive to said device, a signaling circuit including said line and device and windings of said repeating coil and relay, a condenser bridged across said relay windings, and a rectifier connected serially with said condenser and a winding of said relay for preventing false operation of said impulse responsive relay.

4. In a signaling system, a line, a dialing device connected to one end of said line, a repeating coil connected to the other end of said line, an impulse relay vibratorily responsive to impulses transmitted by said device, a signaling circuit including said line and device and windings of said repeating coil and relay, a condenser bridged across said relay windings for passing voice frequency currents, and a copper oxide rectifier connected serially with said condenser and a winding of said relay for preventing false operation of said impulse responsive relay.

5. In a signaling system, a line, an impulse transmitter connected to one end of said line, a repeating coil conductively connected to the other end of said line, an impulse relay vibratorily responsive to impulses transmitted by said device, a signaling circuit comprising said line and device and windings of said repeating coil and relay, the primary windings of said repeating coil and the windings of said relay being serially interconnected, a condenser bridged across said relay windings, and a copper oxide rectifier connected serially with said condenser and each winding of said relay for preventing false operation of said impulse responsive relay.

6. In a signaling system, a line, a dial at one end of the line for transmitting current impulses, a repeating coil at the other end of said line, an impulse relay responsive to said current impulses, said repeating coil having a primary winding split into two sections in which the outer ends thereof are connected with said line and the inner ends thereof are connected with windings of said relay, a condenser connected to said inner ends of said repeating coil windings, and an asymmetric resistance interposed serially between one of said inner ends and a winding of said relay for preventing false operation of said relay.

7. In a signaling system, a line comprising two sections; a repeating coil for inductively linking said line sections; said repeating coil including a primary and secondary winding; a condenser at the mid-taps of said primary winding; an impulse sender in one of said sections for alternately opening and closing said line; a relay responsive to said impulse sender; a source of direct current; a circuit comprising said source, relay, primary winding, and said impulse sender; and an asymmetric resistance connected serially between said relay and the mid-taps of said primary winding for preventing false operation of said relay.

8. In a signaling system, a line, an impulse sender, a repeating coil including a primary winding conductively connected to said line, a condenser disposed at the mid-taps of said winding, said repeating coil and condenser being adapted for talking transmission purposes, an impulse responsive relay also connected to the mid-taps of said primary winding, a source of direct current for energizing said relay with normal current therethrough in a definite direction while said line is closed; said relay being deenergized when said line is opened by said impulse sender, and an asymmetric resistance included serially between said relay and the mid-taps of said primary winding for preventing transient current produced at the opening of said line from falsely reoperating said relay, said transient current being of a direction opposite to that of the normal current.

9. In combination, a line, a repeating coil having a primary winding and a secondary winding, an impulse relay having two windings, one pole of battery connected to one of said relay windings and the other pole of battery connected to the other relay winding, the windings of said relay being connected to the mid-taps of said primary winding, a condenser also connected to the mid-taps of said primary winding, an impulse transmitter for closing and opening an impulsing circuit through said primary winding to cause said relay to energize and deenergize therewith, said impulse transmitter also causing said condenser to charge and discharge through the relay windings, and an asymmetric resistance serially connected with one of said relay windings and a mid-tap of said primary winding, whereby the condenser discharge through said relay windings is rendered ineffective.

10. In combination, an impulse circuit comprising, a line, an impulse sender, a primary winding of a repeating coil having separated mid-taps, an impulse relay having two windings, a battery, all elements of said circuit being connected in series, a condenser connected to the mid-taps of said primary winding, said condenser also being bridged across said relay windings, and an asymmetric resistance in series with one of said relay windings and said condenser.

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