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AUTOMATIC LINE VOLTAGE COMPENSATOR AND IMPULSE REPEATER FOR SIGNALING SYSTEMS

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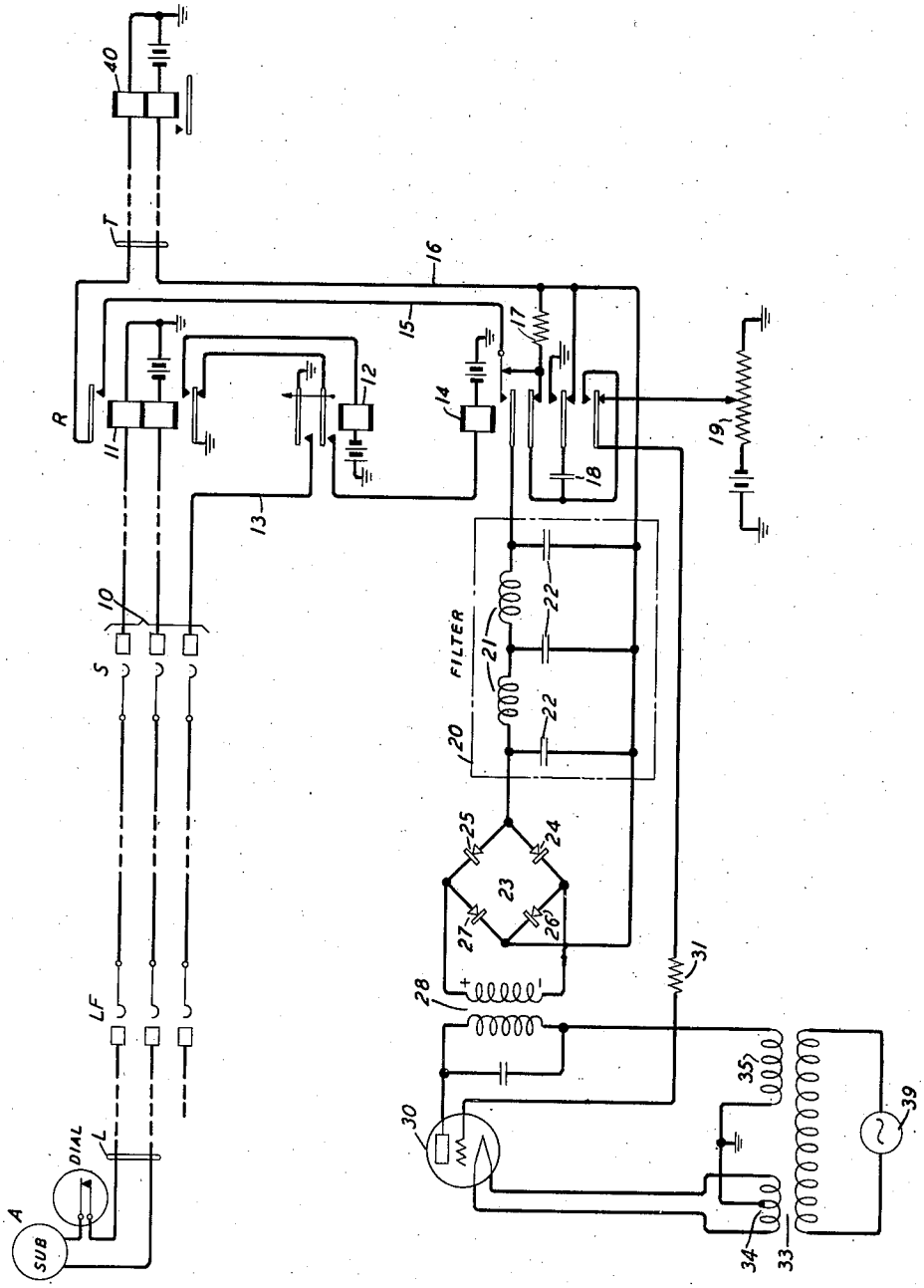

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AUTOMATIC LINE VOLTAGE COMPENSATOR AND IMPULSE REPEATER FOR SIGNALING SYSTEMS

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This invention relates to signaling systems and particularly to systems in which selective signaling is effected by the transmission of current impulses.

Objects of the invention are an increase in the resistance of lines over which selective current impulses may be efficiently and satisfactorily transmitted, automatic voltage compensation for outgoing loops of different resistances and the improvement of impulse repeaters in electrical signaling systems.

In selective signaling systems for instance dial telephone systems in which impulse repeaters are provided for repeating current impulses from an incoming impulse circuit over a line comprising two conductors connected in a loop circuit in series with the windings of an impulse receiving relay, it is known to convert the outgoing loop circuit to two separate ground return circuits during the transmission of impulses, each of the two circuits including a different one of the conductors of the line, thereby to increase the energization of the impulse receiving relay and insure its reoperation between impulses. In such an arrangement an impulse repeating contact is included in each of the two grounded repeating circuits and variation in the contact spring adjustments, variation in earth potential in the ground return circuits and variation in the characteristics of the impulse relay affect reproduction of the signal impulses in the outgoing circuits and the response of the impulse receiving relay. Furthermore the increase in the energization of the impulse receiving relay is always the same as that which would result from a doubling of the voltage applied to the windings of the relay; and this fixed increase may be more than is necessary or may not be sufficient depending upon the resistance of the line with which it is associated.

This invention is an impulse repeating circuit arrangement in which an increased voltage is applied to the outgoing loop circuit during the transmission of impulses, the increase being automatically regulated in accordance with the resistance of the outgoing loop circuit, whereby the current energizing the impulse receiving relay is substantially the same for all lines with which the repeater may be associated.

One feature of the invention is an impulse repeating circuit arrangement in which the voltage normally applied to the outgoing loop circuit is increased during the transmission of impulses, the increase being automatically regulated de-

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pending on the resistance of the loop and independent of the normal voltage.

Another feature of the invention is an impulse repeating circuit arrangement comprising a single impulse repeating contact and in which the voltage applied to the line over which impulses are to be transmitted is automatically varied in accordance with the resistance of the outgoing loop circuit.

The invention and its features including those above-mentioned will be better understood from the following description of an impulse repeater in a dial telephone system as shown schematically in the drawing which forms a part of this specification. The invention is not limited in its application to the particular system or arrangement shown in the drawing but is generally applicable to electrical signaling systems.

The drawing shows in part a dial telephone system comprising a repeater R.

The dial telephone system is represented by a subscriber's station A and line L, a line finder LF and an associated selector S, the repeater R, a trunk T connected to the repeater, and an impulse receiving relay 40 connected to the distant end of the trunk T.

The subscriber's station A is of the type used in common battery telephone systems and includes a dial for use in controlling the operation of selective switches through which desired connections are established. The line finder LF and selector S are each represented by a set of brushes and a single set of terminals and may comprise a switch of any known type, for instance, a switch of the two-motion step-by-step type. The set of terminals 10 representing the bank of selector S are individually associated with the repeater R which comprises an impulse receiving relay 11, a slow-to-release relay 12, and a switching relay 14. The repeater R is associated with the trunk T extending to a distant office which may be of the dial type comprising switches for further extending the connection or may be of the manual type in which call indicator equipment is provided for displaying the called subscriber's number in accordance with the selective signals received over the trunk T from the originating office. The windings of impulse receiving relay 40 at the distant end of trunk T are connected in series with a battery across the conductors of the trunk T; and if the resistance of the trunk exceeds a certain value, the voltage of this battery is not high enough to insure the reoperation of relay 40 between impulses. Therefore the repeater R further in-

cludes means for increasing the voltage applied in series with the conductors of trunk T during the transmission of impulses thereover.

The booster voltage means included in the repeater R comprises an alternating current source 39, transformer 33, vacuum tube 30, output transformer 28, full wave rectifier 23 and a filter 20. The primary winding of transformer 33 is connected to an alternating current power source 39, for instance the usual 60-cycle power supply; the winding 34 is connected to heat the filament of tube 30; and the winding 35 provides a suitable potential for the plate circuit of tube 30. The grid of tube 30 is normally connected through resistor 31, and a back contact of relay 14 to a point on potentiometer 19 which is at a sufficiently negative potential with respect to ground to block tube 30. The rectifier 23 comprises rectifying elements 24, 25, 26 and 27 which may be of the copper oxide disc type.

A call having been initiated at station A by removal of the receiver thereat, a line finder LF is actuated to extend a connection from the subscriber's line L to the selector S; and, in response to the dialing of the first digit of the called subscriber's number, the selector S is operated to select an idle set of terminals in the level corresponding to the digit dialed. The selected set of terminals is represented by the terminal set 10 connected to the repeater R. The line relay 11 of repeater R is thereupon operatively energized in series with the line L. The operation of relay 11 closes a circuit for operating relay 12; and relay 12 connects ground to conductor 13 to maintain the connection through the line finder LF and selector S until the connection is released at the calling station, in the usual and well-known manner. The operation of relay 11 further closes a circuit for energizing relay 40, this circuit being traced from battery through the lower winding of relay 40, lower conductor of trunk T, conductor 16, resistor 17, continuity back contact of relay 14, conductor 15, upper front contact of relay 11, upper conductor of trunk T and through the upper winding of relay 40 to ground. Relay 40 is thus operatively energized to prepare the selector switch or register with which the relay is associated. It should be noted that condenser 18 is connected in parallel with resistor 17 across the conductors of trunk T, the voltage thus applied to condenser 18 being equal to the drop in potential in resistor 17.

When the subscriber at station A dials the next digit of the called subscriber's number, relay 11 is alternately released and reoperated as many times as there are units in the digit dialed. The first release of relay 11 closes a circuit including the inner front contact of relay 12 for operating relay 14 and opens the circuit over trunk T to cause the release of relay 40. Relay 14 is slow in releasing and remains operated while all of the impulses in the train are being received by relay 11 and repeated to relay 40. Relay 12 is also slow in releasing and remains operated during the response of relay 11 to dial impulses. The operation of relay 14 opens the bridge comprising resistor 17 across conductors 15 and 16; and, when relay 11 reoperates at the end of each dial impulse, the circuit for reoperating relay 40 includes the right winding of transformer 28, rectifier 23 and filter 20. The operation of relay 14 also closes a connection from ground through its middle lower front contact, condenser 18, outer lower front contact of relay 14 and resistor 31 to the grid of tube 30 so that the charge on condenser 18 constitutes a negative bias which is substituted for that normally applied through the outer lower back contact of relay 14. Since the voltage across condenser 18 depends upon the resistance of element 17 and the current in the loop circuit over trunk T above described, the bias thus applied to the grid and the energization of transformer 28 by current in the plate circuit of tube 30 likewise depend on the current in the loop circuit over trunk T. If the resistance of trunk T is low, the voltage across condenser 18 will be high enough to continue to block the tube 30; but if the resistance of trunk T is higher, the voltage across condenser 18 is relatively lower so that tube 30 becomes conductive and the primary winding of transformer 28 is then energized by a pulsating current in the plate filament circuit. The voltage thus generated in the right winding of transformer 28 is added, through rectifier 23, to the voltage of the battery connected to the windings of relay 40 so as to increase the current through these windings and thereby insure the operation of relay 40 each time relay 11 reoperates during the transmission of dial impulses. The filter 20 tends to filter out alternating current components and to smooth out the current in the trunk loop circuit. The blocking of tube 30 while relay 14 is nonoperated prevents the charging of the condensers 22 of filter 20; so that, when relay 14 operates, these condensers cannot interfere with the repeating of impulses to relay 40.

The above-described booster voltage arrangement is of primary importance in case the switching system is such that repeater R may be operatively associated with any one of a plurality of trunks, the loop resistance of which differs one from another. In such a case, an intermediate dial-controlled selector or a non-numerical outgoing trunk selector may be individually associated with the repeater R and have access to trunks of different lengths to the same or different destinations. If the repeater R is permanently associated with a particular trunk and the resistance of the outgoing impulse loop circuit does not vary, the tube 30, condenser 18 and potentiometer 19 may be omitted and a suitable alternating current voltage be applied directly to the primary winding of transformer 28. The secondary winding of transformer 28 may have a number of voltage taps so that the desired voltage may be applied to rectifier 23.

What is claimed is:

1. In combination, a two-conductor line, an impulse receiving relay and a battery at one end of said line, one pole of said battery connected to ground and through one winding of said relay to one of the conductors of said line, the other pole of said battery connected through another winding of said relay to the other conductor of said line, an impulse repeating relay at the other end of said line, means including a contact of said impulse repeating relay for closing a loop circuit including said conductors, windings and battery to effect the operation of said impulse receiving relay, a non-grounded source of booster potential, and means controlled by said impulse repeating relay for connecting said source of booster potential in a loop circuit including said conductors, windings and battery during the transmission of impulses over said line corresponding to impulses received by said impulses repeating relay.

2. In an impulse repeater, an impulse receiving relay responsive to incoming impulses, outgoing conductors, a resistor, means comprising a contact of said impulse receiving relay connecting said resistor across said conductors, a non-grounded voltage source, and means controlled by said impulse receiving relay to connect said voltage source across said conductors in place of said resistor while said relay is responding to a train of impulses.

3. In an impulse repeater, an impulse receiving relay responsive to incoming impulses, outgoing conductors, a resistor, means comprising a contact of said impulse receiving relay connecting said resistor across said conductors, a non-grounded voltage source, and means rendered effective by the response of said impulse receiving relay to the first impulse of a train of impulses to connect said voltage source across said conductors in place of said resistor until said relay has responded to all of the impulses in the train.

4. In an impulse repeater, an impulse receiving relay responsive to incoming impulses, outgoing conductors, a resistor, means comprising a contact of said impulse receiving relay connecting said resistor across said conductors, a non-grounded voltage source, said source comprising a rectifier and means for applying a desired alternating voltage across said rectifier, and means controlled by said impulse receiving relay to connect said voltage source across said conductors in place of said resistor while said relay is responding to a train of impulses.

5. In an impulse repeater, an impulse receiving relay responsive to incoming impulses, outgoing conductors, a resistor, means comprising a contact of said impulse receiving relay connecting said resistor across said conductors, a non-grounded voltage source, said source comprising a vacuum tube, an output transformer, an alternating current source, a transformer having a primary winding connected to said alternating current source, a winding for heating the filament of said tube and a winding connected in series with the primary winding of said output transformer and the anode and cathode of said tube, and a rectifier, the secondary winding of said output transformer being connected across the input terminals of said rectifier, and means controlled by said impulse receiving relay to connect the output terminals of said rectifier to said conductors in place of said resistor while said relay is responding to a train of impulses.

6. In combination, an electrical transmission line, means closing a signal circuit including a voltage source and said line, and means comprising means included in said circuit for automatically varying the voltage connected in series with said line an amount proportional to the length of the line, thereby to effect the transmission of signals by current of required amplitude.

7. In combination, an electrical transmission line, means closing a signal circuit over said line, said circuit including a voltage source connected in series with said line, and means comprising means included in said circuit for automatically increasing the voltage connected in series with said line during the transmission of signals over the line an amount proportional to the length of the line, thereby to effect the transmission of signals by current of required amplitude.

8. In combination, an electrical transmission line, means closing a signal circuit over said line, said circuit including a resistor and a first voltage source connected in series with said line, an additional source of voltage, means for connecting said additional source of voltage in place of said resistor during the transmission of signals over said line, and means including said resistor for varying the voltage of said additional source according to the length of said line.

9. In a signaling system, an impulse repeating relay responsive to signal impulses, a resistor, a line, an impulse receiving relay, a voltage source, means comprising a contact of said repeating relay closing a signaling circuit including said resistor, line, impulse receiving relay and voltage source, a condenser connected in parallel with said resistor, an additional voltage source comprising a vacuum tube, an output transformer, an alternating voltage source, a transformer having a primary winding connected to said alternating current source, a winding connected to heat the filament of said tube and a winding connected in series with the primary winding of said output transformer and the plate and filament of said tube, and a rectifier connected across the secondary winding of said output transformer, and means controlled by said impulse repeating relay to connect said rectifier in said signaling circuit in place of said resistor and to connect said condenser to the grid of said tube so as to vary the conductivity of said tube and the voltage across the output terminals of said rectifier according to the resistance of said line.

10. In a signaling system, an impulse repeating relay responsive to signal impulses, a resistor, a line, an impulse receiving relay, a voltage source, means comprising a contact of said repeating relay closing a signaling circuit including said resistor, line, impulse receiving relay and voltage source, a condenser connected in parallel with said resistor, an additional voltage source comprising a vacuum tube, an output transformer, an alternating voltage source, a transformer having a primary winding connected to said alternating voltage source, a winding connected to heat the filament of said tube and a winding connected in series with the primary winding of said output transformer and the plate and filament of said tube, and a rectifier connected across the secondary winding of said output transformer, means controlled by said impulse repeating relay to connect said rectifier in said signaling circuit in place of said resistor and to connect said condenser to the grid of said tube so as to vary the conductivity of said tube and the voltage across the output terminals of said rectifier according to the resistance of said line, and means comprising inductive windings and condensers connected to said rectifier to filter out alternating current components and to attenuate pulsations in the current in said signaling circuit.

11. In a signaling system, an impulse repeating relay responsive to signal impulses, a resistor, a line, an impulse receiving relay, a voltage source, means comprising a contact of said repeating relay closing a signaling circuit including said resistor, line, impulse receiving relay and voltage source, a condenser connected in parallel with said resistor, an additional voltage source comprising a vacuum tube, an output transformer, an alternating voltage source including a transformer having a winding connected to heat the filament of said tube and a winding connected in series with the primary winding of said output transformer and the plate and filament of said tube, and a rectifier connected across the secondary winding of said output transformer, means controlled by said impulse repeating relay

to connect said rectifier in said signaling circuit in place of said resistor and to connect said condenser to the grid of said tube so as to vary the conductivity of said tube and the voltage across the output terminals of said rectifier according to the resistance of said line, means comprising inductive windings and condensers connected to said rectifier to filter out alternating current components and to attenuate pulsations in the current in said signaling circuit, and means connecting a source of biasing potential to the grid of said tube to render the tube non-conductive during the time said resistor is connected in said signaling circuit.

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