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TELEPHONE SYSTEM

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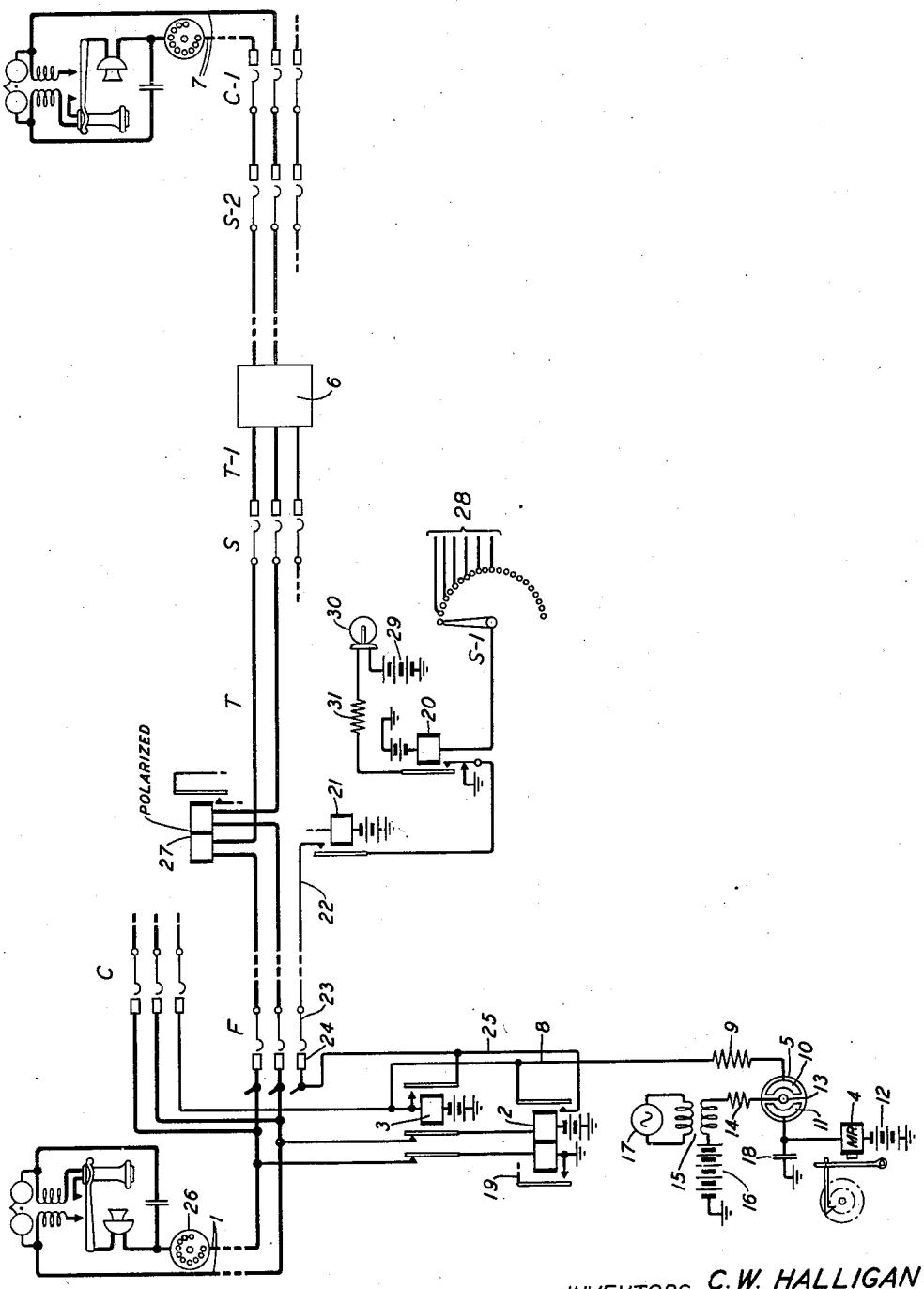

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TELEPHONE SYSTEM

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This invention relates to telephone systems and particularly to those in which message registration is utilized for the purpose of charging the subscribers for the service rendered.

The objects of the invention are to obtain a more reliable performance of the subscriber's message register, particularly where successive operations are required during conversation; to enable repeated operations of the register without the use of excessive currents and voltages and without interfering with the operative condition of associated apparatus; and otherwise to improve systems of this character.

It is often desirable in automatic telephone systems to operate the subscriber's message register at repeated intervals throughout the conversational period as a measure of the charge to be made for the call. And, for reasons of economy, it is also desirable to apply the meter-operating impulses to the sleeve or control conductor of the line to effect the successive operations of the register. Since, however, the usual cut-off relay is connected to the sleeve conductor and is operated during this time, difficulty is experienced in obtaining the successful operation and release of the register in response to each metering impulse without disturbing the operative condition of the cut-off relay. Several arrangements have been suggested in the past for meeting this difficulty. These prior arrangements, however, have disadvantages; usually they require the application of excessive voltages to the sleeve conductor, which interfere with the successful operation of the associated equipment and produce excessive currents in the relay windings.

According to the present invention, the objections above mentioned are overcome by a register-operating circuit arrangement in which the control electrode of a three-element discharge device is connected to the sleeve conductor of the line, and the message register is connected in a circuit including the anode and cathode of the discharge device, and a source of direct current sufficient to maintain the anode discharge once the device is ionized; and in which a source of alternating current is applied to the anode circuit for the purpose of quenching the anode discharge as soon as the control gap of the device is deionized. With this arrangement it is possible to operate the register repeatedly by applying the usual booster battery potential to the sleeve conductor to ionize the discharge device and bring about the flow of operating current in the separate anode circuit, the alternating current source serving to quench the anode current discharge immediately that the booster battery impulse is removed from the sleeve conductor. Since the voltage required to ionize the device is comparatively low, it is possible to limit the potential applied to the sleeve conductor to safe values, although the voltage required to operate the register and maintain the anode discharge is comparatively high. This is true in the present arrangement because the anode circuit containing the message register is entirely separate from the sleeve circuit. These repeated applications of booster battery potential to the sleeve conductor do not disturb the cut-off relay and do not increase the current flowing through said relay sufficiently to produce overheating.

These and other features of the invention will be discussed more fully in detail in the following specification and will also be set forth in the appended claims.

The drawing accompanying the specification illustrates the invention embodied in an automatic telephone system, and for the sake of clearness all parts of the system not essential to an understanding of the invention have been omitted.

Referring to the drawing in particular, it is assumed that the subscribers' lines, such as line 1, appear in the contact banks of a plurality of line-finder switches and also in the banks of a plurality of connector switches. The finder switches F seize the lines when they are calling, and the connector switches C are directed to the terminals of lines that are being called. When a line finder F seizes a calling line, it extends that line through to an associated first selector switch S. The switch S and other succeeding switches are operated selectively in accordance with impulses transmitted by the calling subscriber to extend the connection toward the desired called line.

The subscriber's line 1, and the same is true of other subscribers' lines, is equipped with the usual individual line relay 2 and a cut-off relay 3. Also the line 1, being a message rate line, is provided with an individual message register 4, which may be operated at periodic intervals during the time the subscriber of line 1 is conversing, the duration of the successive periods and the number of times the register is operated in each period depending upon the zone into which the call has been extended. Associated with the register 4 is a discharge tube 5 of the three-electrode gas-filled type, together with the necessary circuit elements for controlling the repeated

operation of the register in accordance with the principle of this invention.

The circuit T, interconnecting the line finder F and the first selector S, is sometimes known as a message-register trunk and includes the necessary apparatus for determining the rate of operation of the message register and for applying a source of booster battery potential to the sleeve conductor of the line to bring about the operation of the register in accordance with the desired rate.

The selector switch S, either directly or through other switches, has access to local circuits and also to trunks T—1 outgoing to distant zones and to different central offices therein. It is common practice to equip these trunks with a control mechanism 6 which identifies the zone into which the call is being extended and establishes zone information in the message register trunk T to determine the rate of charge while conversation is taking place. The mechanism for recording the zone information in the trunk T is not illustrated, since it is old and well known in the art. There is shown, however, a time-controlled selector switch S—1, which makes a revolution at periodic intervals during the conversation and connects the booster battery source to the sleeve conductor a number of times depending upon the zone information recorded in the message register trunk T.

The outgoing trunk T—1 extends to a distant office where it has access through selector switch S—2, and possibly other selectors, and a connector switch C—1 to the called line 7.

Although the invention is not limited to any particular type of central office system, it may be assumed that the system illustrated employs the well-known step-by-step switches. Also the message-register trunk T and the associated equipment, whereby a subscriber's register is operated in accordance with the zone into which a call is extended and in accordance with the duration of conversation, may in general be the same as that disclosed and described in the reissue patent to Stokely 19,491 of March 5, 1935. The discharge tube 5 may be of any suitable type, such as the well-known three-element cold-cathode gas-filled tube.

Considering now the details of the subscriber's line circuit, it will be noted that the sleeve conductor 8 of the line 1 is connected through a high resistance 9 to the control element 10 of the tube 5. The cathode 11, which with the control element 10 forms the control or ionizing gap of the tube, is connected through the winding of the message register 4 to the negative pole of a biasing battery 12. The anode 13 of the tube is connected through a resistance 14 and the secondary winding of transformer 15 to the positive pole of the anode battery 16. The anode 13 and the cathode 11 form the main discharge gap of the tube, and the operating or work circuit of the tube includes this gap, the battery 16, the secondary winding of transformer 15, the resistance 14, the message register 4 and the biasing battery 12. The primary winding of the transformer 15 is connected to a source of alternating current 17 of any suitable frequency. The voltage supplied by batteries 16 and 12 is insufficient to cause discharge across the main gap in the absence of ionization of the control gap. This voltage is, however, sufficient to maintain the discharge across the main gap once the tube is ionized, although ionization across the control gap may have ceased. The voltage of the alternating current source is sufficient to quench the discharge across the main gap when its polarity is in opposition to the voltage supplied by batteries 16 and 12. Consequently, the main gap is quenched at each half cycle of the alternating potential. So long as the control gap remains ionized the discharge is resumed across the main gap on each alternate half cycle of the alternating potential, but the main gap fails to resume its discharge as soon as ionization ceases across the control gap. During the discharge intervals across the main gap current flows in the operating circuit through the winding of the register 4 and into the condenser 18. During the oscillations or half cycles while the main gap is quenched the condenser 18 discharges through the winding of the register 4, thus serving to maintain a substantially constant flow of current through the register notwithstanding the successive interruptions in the flow of current across the discharge gap.

The operation of the system will now be described, assuming for that purpose that the subscriber of line 1 wishes to hold a conversation with the subscriber of line 7 located in a distant central office zone. When the calling subscriber removes his receiver the line relay 2 operates in a circuit from battery through the right winding thereof, inner left contact of relay 3, thence over the loop of the line and returning through the outer left contact of relay 3 and the left winding of relay 2 to ground. Relay 2 applies ground potential to the start wire 19 to initiate the hunting operation of the line finder F. As soon as the finder F places its brushes on the terminals of the calling line 1, the finder comes to rest, and a circuit is closed as follows for operating the cut-off relay 3: Ground through the normal contacts of relay 20, contacts of the relay 21, which operates when the line is seized, sleeve conductor 22 of the trunk circuit T, thence through the sleeve brush 23 and sleeve terminal 24 to the sleeve or control conductor 25 of the subscriber's line, through the right contact of relay 2 to the sleeve or control conductor 8, winding of the cut-off relay 3 to battery. Relay 3 operates and closes a locking circuit through its right contact to the grounded conductor 25 and opens the operating circuit of relay 2, permitting the latter relay to release. The connection of ground potential to the conductor 8 places the voltage of the biasing battery 12 across the control gap 10—11 of the tube 5, but this potential is insufficient to cause ionization of the tube.

The calling subscriber proceeds to operate his impulse dial 26 to control the operation of the switch S, and possibly other switches in the local office to select trunk T—1 outgoing to the distant called office and to control the switches S—2 and C—1 therein to establish connection with the called line 7. During the establishment of the connection the message register trunk T receives the information necessary to determine the rate of charge for the call. When the called subscriber answers, current is reversed over the connection, and the polarized relay 27 operates to condition the circuits of the trunk T and to initiate the charging operation, which continues through the conversational period. At suitable intervals during this period the timing switch S—1 is caused to step through a complete rotary movement to apply impulses of booster battery to the sleeve circuit. As the selector S—1 steps over its terminals it encounters

ground potential on one or more of the conductors 28, depending on the zone information registered in the trunk T, and relay 20 operates and releases a corresponding number of times. For a better understanding of the detailed circuit by means of which the registering information is established in the message register trunk T, reference is made to the above-noted reissue patent to Stokely, No. 19,491.

Each time relay 20 operates it substitutes the positive pole of the booster battery 29 for the ground connection at the normal contact of the relay. The circuit for applying the booster battery 29 may be traced from the positive pole of said battery, ballast lamp 30, resistance 31, closed contacts of relay 20 thence to the control conductors 25 and 8. Since the booster battery 29 and the exchange battery connected to the terminal of the cut-off relay 3 are in series-aiding relation, the application of the booster battery to the control conductor 25 causes some increase in the flow of current through the winding of the cut-off relay 3, thus insuring that this relay will be maintained in an operated condition.

Also, the first application of the booster battery 29 to the control conductor 8 raises the positive potential of the control electrode 10 to a value commensurate with the voltage of the battery 29. This positive potential on the control electrode 10, being opposite in polarity to the potential applied to the cathode 11 by the biasing battery 12, results in a potential difference across the control gap which is sufficient to ionize the tube. As soon, following the ionization of the control gap, as the potential from the source 17 is of a polarity to aid the anode battery 16, a discharge occurs across the main gap of the tube, and current flows in the operating circuit traceable from the positive pole of battery 16 through the secondary winding of transformer 15, resistance 14, anode 13, cathode 11, winding of register 4 to the negative pole of battery 12 and thence to ground. Since condenser 18 is in parallel with the register 4, said condenser also receives charging current from the batteries 16 and 12. The register 4 operates in this circuit and scores a charge on the number wheel mechanism.

During the brief interval that the relay 20 is maintained energized and battery potential is applied to conductor 8, the alternating current source 17 will, according to its frequency, undergo a series of alternations. At each alternate oscillation of this source, the potential induced in the anode circuit opposes the batteries 16 and 12 and causes a momentary deionization of the main gap discharge. During these brief deionizations, however, the register 4 remains operated by reason of its own characteristics and because it is supplied with current from the discharging condenser 18. When the brief interval has expired, determined by the stepping motion of the selector S—1, the relay 20 releases and disconnects the booster 29 to terminate the first application of booster potential to the conductor 8. The release of relay 20 replaces the ground potential to insure the continued holding of the cut-off relay 3. The removal of the booster potential from conductor 8 lowers the voltage across the control gap to its original value, and the ionization ceases. Accordingly, on the next opposing alternation of the source 17 the main discharge gap is quenched and remains so, and after a brief interval the message register 4 releases.

Thus the register 4 is operated and released in response to the first metering impulse applied to the sleeve or control conductors of the subscriber's line, and the cut-off relay 3 is maintained securely operated during this registration. And for each succeeding application of booster potential throughout the conversational period the register is operated and released, and the cut-off relay remains operated.

When the conversation is completed, the subscribers replace their receivers on the switchhooks, and the operated equipment is restored to its normal condition in the usual manner.

Since the control gap of the tube ionizes when a sufficient voltage is applied across the control electrodes and requires a relatively small value of current to maintain the discharge, and since the source for operating the register is connected in the operating circuit of the tube, it is possible to obtain successive operations of the register without applying high voltages to the control conductor. In other words the use of a local circuit through the register and the main gap of the tube makes it possible to apply the relatively high voltages required by the resistance of the register and to maintain the main gap discharge and at the same time to isolate the sleeve or control conductor from these high voltages.

Another advantage of the circuit diclosed is the safeguard it provides against false operation of the register on surges in the sleeve conductor. For example, if direct current were used in the anode circuit of the tube, momentary surges of voltage, sufficient in value to ionize the control gap, would cause false operation of the register. But with alternating voltage superimposed on the anode circuit transient surges from the sleeve conductor cannot maintain conduction in the anode circuit for a sufficient number of cycles of the alternating voltage source to charge the condenser to a voltage high enough to operate the message register. The use of the alternating potential source in the anode circuit thus guards the register by adding, in effect, an interval of time during which the register does not receive enough current to operate.

What is claimed is:

1. The combination in a telephone system of a line having two talking conductors and a control conductor, a discharge device having electrodes forming a control gap and a main discharge gap, a circuit for said control gap connected to said control conductor, an operating circuit for said discharge device including said main gap, a source of potential, means operative at successive intervals for applying said source to said control conductor for relatively short periods of time to produce discharges across the control gap, a source in said operating circuit for causing the flow of current across said main gap and through said operating circuit in response to the discharge of said control gap, said last-mentioned source being of sufficient voltage to maintain said current flow after discharge has ceased in said control gap, a message register for said line connected in said operating circuit and responsive to the flow of current therein, and means for quenching the discharge of said main gap to terminate the flow of current in said operating circuit.

2. The combination in a telephone system of a subscriber's line having talking conductors and a control conductor, a discharge device having a control electrode and a main discharge gap, an operating circuit for said device including said main discharge gap, a source of potential, means

including said source of potential and said control conductor for applying an increase of potential at periodic intervals to said control electrode, a source of current responsive to each application of increased potential to said control electrode for causing a flow of current across said main discharge gap and through said operating circuit, said source of current being of sufficient voltage to maintain the discharge of said main gap, a message register responsive to the flow of current in said operating circuit, and means for quenching the discharge of said main gap upon the removal of each application of increased potential to said control electrode to permit the release of said message register.

3. The combination in a telephone system of a subscriber's line having talking conductors and a control conductor, a discharge device having a control electrode and a main discharge gap, an operating circuit for said device including said main discharge gap, a source of current in said operating circuit, a source of potential, means including said source of potential and said control conductor for applying an increase of potential at periodic intervals to said control electrode to cause the flow of current from said first-mentioned source across said main discharge gap, the potential of said source in the operating circuit being sufficient to maintain the discharge across said main gap, a message register connected in said operating circuit and responsive to the flow of current therein, and a source of alternating current connected to said operating circuit serving on alternate oscillations to oppose the first-mentioned source of current in said operating circuit to quench the discharge across said main gap.

4. The combination in a telephone system of a subscriber's line having talking conductors and a control conductor, a discharge device having a control electrode and a main discharge gap, an operating circuit for said device including said main discharge gap, a source of current in said operating circuit, a source of potential, means including said source of potential and said control conductor for applying an increase of potential at periodic intervals to said control electrode to cause the flow of current from said first-mentioned source across said main discharge gap, the potential of said source in the operating circuit being sufficient to maintain the discharge across said main gap after the removal of the increased potential from said control electrode, a message register connected in said operating circuit and responsive to the flow of current therein, and a source of alternating current inductively connected to said operating circuit and serving on alternate oscillations to reduce the potential applied to said main discharge gap below the value sufficient to maintain the discharge thereof.

5. The combination in a telephone system of a line having talking conductors and a control conductor, a discharge device having a control electrode and a main discharge gap, a relay connected to said control conductor, an operating circuit for said device including said main discharge gap and excluding said control conductor, a source of current in said operating circuit, means for applying a potential to said control conductor to operate said relay without causing the discharge of said device, means for repeatedly increasing the potential on said control conductor and the control electrode of said device to cause discharge current to flow across said main gap from the source in said operating circuit, and a message register for the line included in said operating circuit and responsive to the flow of current therein.

6. The combination in a telephone system of a line having talking conductors and a control conductor, a discharge device having a control electrode and a main discharge gap, a cut-off relay connected to said control conductor, an operating circuit for said device including said main discharge gap and excluding said control conductor, a source of current in said operating circuit, a source of potential and means for applying the same to said control conductor to operate said relay, said source being insufficient to cause the discharge of said device, a second source of potential, means for substituting said second source for said first source of potential to hold said relay operated and to raise the potential of said control electrode sufficiently to cause discharge current to flow from said source in the operating circuit across said main discharge gap, and a message register in said operating circuit responsive to the flow of current therein.

7. The combination with a telephone line having an auxiliary conductor for control purposes of a space discharge device having electrodes forming a control gap and a main gap, a circuit for said control gap including said auxiliary conductor, an operating circuit for said device including said main gap, a source of potential, means for applying said source repeatedly to said auxiliary conductor to cause the discharge of said control gap, a source in said operating circuit for causing current to flow therein and across said main gap in response to the discharge of said control gap, a message register for said line responsive to the flow of current in said operating circuit, and a source of alternating current for quenching the discharge of said main gap.

8. The combination in a telephone system of a subscriber's line having talking conductors and an auxiliary conductor for control purposes of a discharge device having electrodes forming a control gap and a main gap, a circuit for said control gap including said auxiliary conductor, an operating circuit for said device including said main gap and excluding said auxiliary conductor, a source of potential, means for applying said source repeatedly to said auxiliary conductor to cause the discharge of said control gap, a source in said operating circuit for causing current to flow therein and across said main gap in response to the discharge of said control gap, and a message register responsive to the flow of current in said operating circuit.

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