Dec. 3, 1929. J. W. GOODERHAM 1,738,293

ELECTRICAL CONTROLLING DEVICE

Filed Jan. 17, 1928 2 Sheets-Sheet 1

FIG. 1

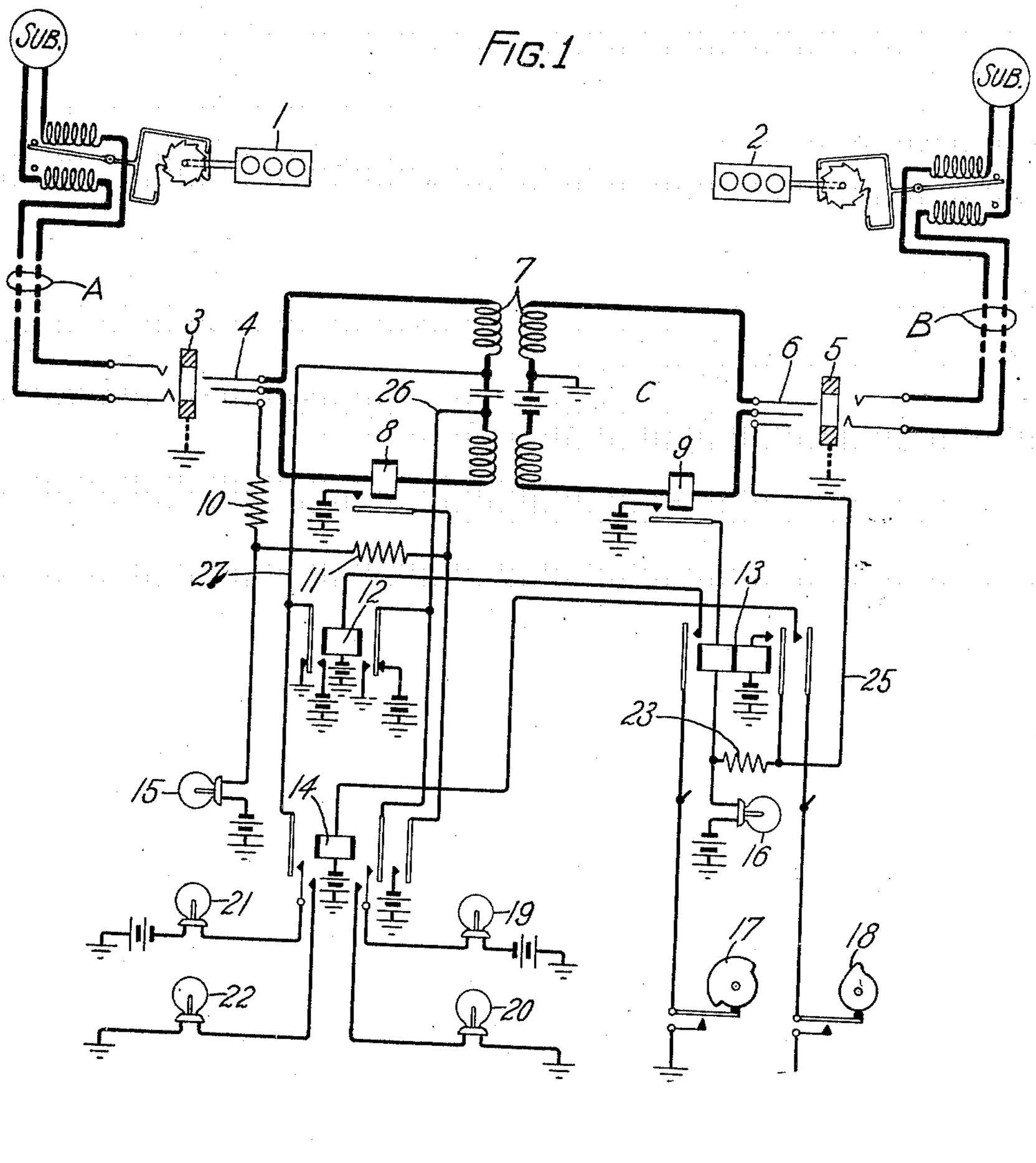

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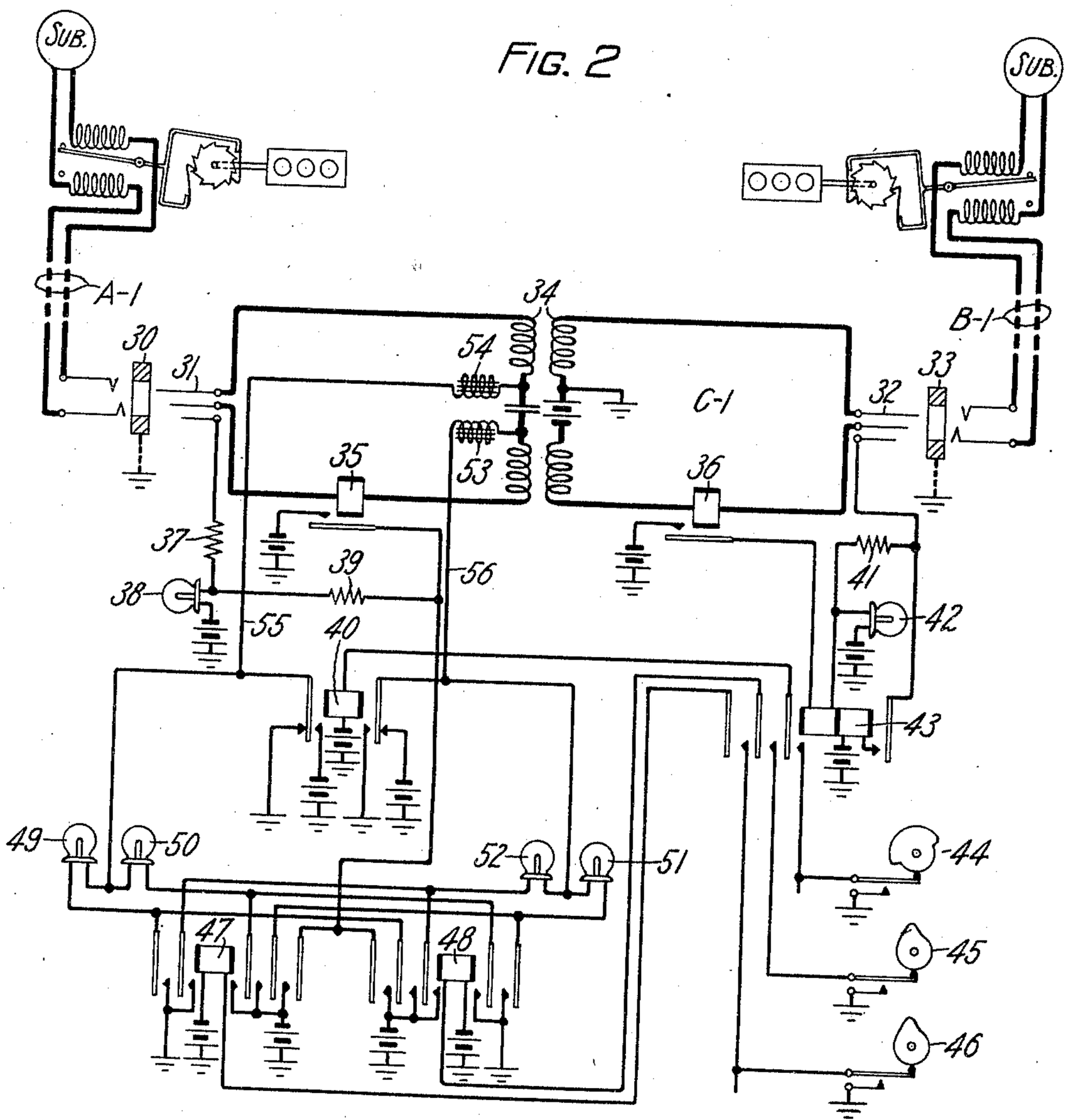
FIG. 2



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UNITED STATES PATENT OFFICE

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ELECTRICAL CONTROLLING DEVICE

Application filed January 17, 1928. Serial No. 247,309.

This invention relates to current controlling devices and particularly to devices for reversing current in telephone lines to operate substation meters.

Its objects are to effect a saving in current consumption, to secure a more economical use of equipment employed at the central office for preventing disturbances in the subscriber's line and to improve the character of the service rendered the subscriber.

Devices have been proposed heretofore for periodically reversing the current in the calling subscriber's line during conversation to operate a meter located at the substation. It has also been proposed to use variable resistance elements, such as tungsten lamps, for effecting a gradual change in the current on reversal to prevent disturbances in the line. In these systems the resistance elements are in circuit continuously, whereas they are effective only for a comparatively small portion of the time.

According to the present invention an advantage over these prior devices is secured by providing a mechanism which automatically connects a set of tungsten lamps to the reversing circuit just before and disconnects the lamps therefrom just after reversal takes place. The resistance of the lamps, being least when the filaments are cold and gradually increasing as the filaments heat, serves to prevent sudden changes of current in the subscriber's line.

A feature of the invention is a reversing mechanism in which certain of the lamps have higher normal resistances than others and are connected to the line in such manner that this difference of resistance causes the current in the subscriber's line to change gradually from a high value in one direction to zero and then to build up in the opposite direction.

In the drawing Fig. 1 illustrates diagrammatically a telephone system embodying the invention. Fig. 2 shows a modification of the invention.

Referring to Fig. 1, the subscribers' lines appear at an operator's position. Two of these lines, the line A, represented as a calling line, and the line B, represented as the called line, are shown terminating in jacks 3 and 5 respectively at the operator's position. The lines A and B are equipped respectively with service meters 1 and 2 located at the substations. These meters are arranged to operate at successive intervals during the conversation in response to repeated reversals of current in the line.

The central office circuits are so arranged that during the time the connection is established the direction of current from the source, which supplies the calling line for talking purposes, is periodically reversed. These reversals are effected by means of a relay 12 which energizes and releases alternately at 15-second intervals, for instance. Since conversation is taking place during the time the reversals are caused, it is necessary to make some provision against sudden changes of current in the subscriber's line and the consequent annoying sounds in the telephone receiver. To this end a group of tungsten filament lamps 19, 20, 21 and 22 forming a Wheatstone bridge, are arranged to be connected to the line just before reversal takes place and to be disconnected therefrom slightly after the reversal. The property of a tungsten lamp, whereby its resistance is substantially less when the filament is cold than when heated, is employed to effect a uniform change in the current strength at the time the circuit is broken by the reversing relay 12.

The reversing equipment is associated with the operator's cord circuit C in such a manner that current from the source is supplied through the left windings of the repeating coil 7 to the calling subscriber's line. Since no reversal occurs in the called subscriber's line his meter is not operated.

A detailed description of the operation will now be given of the system shown in Fig. 1. Assume that the subscriber of line A wishes to converse with the subscriber of line B. The calling party initiates the call in the usual manner and the operator responds by inserting the plug 4 of the cord circuit C in the jack 3. When the plug is inserted in the jack a circuit is completed from battery through the lamp 15, resistance 10, sleeve of the plug and jack to ground. At the same time another circuit is closed from battery

through the right back contact of relay 12, lower left winding of repeating coil 7, supervisory relay 8, ring of the plug and jack and thence over the subscriber's line and returning over the tip side of the connection through the upper left winding of the coil 7 to ground at the left back contact of relay 12. The relay 8 operates in this circuit and completes a circuit from battery through its contact, resistances 11 and 10, and thence to the grounded sleeve conductor. This latter circuit shunts the lamp 15 causing the same to remain extinguished.

The operator communicates with the calling subscriber in the well-known manner and obtains the number of the called line. She thereupon completes the connection by inserting the plug 6 in the jack 5 of the called line B. The insertion of plug 6 completes a circuit from battery through the lamp 16, resistance 23, conductor 25, through the sleeve of the plug 6 and jack 5 to ground. Lamp 16 lights in this circuit. Ringing current is supplied to the called subscriber's line in the usual manner.

When the called party answers, a circuit is completed from battery to the lower right winding of coil 7, winding of supervisory relay 9, thence over the ring side of the called line and returning over the tip side through the upper right winding of coil 7 to ground. The supervisory relay 9 operates in this circuit and closes a circuit from battery through its contact, left winding of relay 13, resistance 23, conductor 25 to ground. The closure of this latter circuit shunts the lamp 16 and extinguishes it, and also causes the operation of relay 13. The relay 13 locks in a circuit from battery through its right winding and contact to the grounded conductor 25.

The relay 13 renders the interrupters 17 and 18 effective. The interrupter 17 causes the operation and release of relay 12 to bring about reversals of current in the calling line. The interrupter 18 operates and releases the relay 14 to connect the lamps to and disconnect them from the subscriber's line during the period reversal is taking place. The interrupters 17 and 18 are so related that the relay 14 operates a short interval before relay 12 operates and releases a short interval after it operates. Relay 14 also operates a short interval before relay 12 releases and releases shortly after the release of relay 12. In this manner the lamps 19 to 22 inclusive are connected in circuit only for the brief interval that the current is being reversed in the subscriber's line.

As soon, following the operation of relay 13, as the interrupter 18 closes its contact, relay 14 operates. Relay 14 at its right contacts connects lamps 19 and 20 to conductor 26 and at its left contacts connects lamps 21 and 22 to conductor 27. Since the lamp 19 has battery connected to both of its terminals its filament remains cold and at its lowest resistance. A circuit for lamp 20 is closed, however, from battery to the right back contact of relay 12, conductor 26, right contacts of relay 14, through the filament of the lamp to ground. This lamp immediately heats its filament, increasing its resistance to the maximum value. The same is true of lamps 21 and 22, namely, the lamp 22 remains shunted while the lamp 21 lights and heats its filament. An instant later the interrupter 17 closes its contact and relay 12 operates. As relay 12 breaks its back contacts, full battery and ground potential is removed from conductors 26 and 27 respectively. The subscriber's line instead of being opened abruptly, however, is connected through cold lamps 19 and 22 to battery and ground, the direction of current flow remaining the same. Since current commences to flow through the lamps 19 and 22 they begin to heat their filaments, uniformly increasing their resistance. The lamp 20 which prior to the operation of relay 12 was lighted brightly, is now included in circuit with the lamp 19. The resistance of this circuit lowers the current flowing through the lamp 20 so that after an interval the lamps 19 and 20 reach a point where their resistances are substantially equal. The same is true in respect to the lamps 21 and 22. Thus, while the armatures of relay 12 are moving from their back to their front contacts the current flowing in the subscriber's line is uniformly reduced substantially to zero. It will be noted that since the lamps 19 and 20 reach a point of substantially equal resistance and lamps 21 and 22 act in the same manner, the potential drop across the conductors 26 and 27 is reduced to zero. When the circuit has reached this condition the relay 12 makes its front contacts and current builds up in the subscriber's line in the opposite direction, thus completing the reversal. The subscriber's meter being of the polarized type responds to this reversal and records one count on the metering train. Shortly after relay 12 makes its front contacts, the interrupter 18 opens its contacts and relay 14 releases, disconnecting the lamps and permitting them to cool their filaments.

Fifteen seconds later the interrupter 17 opens its segment permitting the relay 12 to release. Just prior to the release of relay 12 the interrupter 18 completes the circuit for relay 14 to connect the lamps to the conductors 26 and 27. This time the lamps 20 and 21 are shunted and the lamps 19 and 22 are illuminated. When the relay breaks its front contacts the lamps 20 and 21 rapidly heat their filaments causing a uniform change of current in the subscriber's line in the manner described above. After relay 12 makes its back contacts the interrupter 18 opens its contacts and the lamps are again disconnected from the circuit. This procedure con-

tinues as long as the connection is established.

The relay 14, when operated, maintains a shunt around the lamp 15 to prevent it from flashing should relay 8 momentarily release during the reversing operation.

At the end of conversation the subscribers replace their receivers on the switchhooks. The calling subscriber causes the release of relay 8 removing the shunt and permitting the lamp 15 to illuminate. The called subscriber releases relay 9 which opens the shunt circuit for lamp 16 and this lamp becomes lighted. The operator in response to these signals takes down the connection and relay 13 releases.

A description will now be given of the system shown in Fig. 2 of the drawing. In this figure the subscribers' lines A^1 and B^1 appear in jacks 30 and 33 respectively at the operator's position and are equipped with meters similar to lines A and B previously described.

In this figure, however, the current reversing circuit is somewhat different. The lamps 49 to 52 inclusive are included in circuit with the subscriber's line by means of relays 47 and 48. Relay 47 is controlled by interrupter 46 and relay 48 by interrupter 45. The reversing relay 40 is controlled by the interrupter 44. The interrupters are so arranged that the relay 47 operates just prior to the operation of relay 40 and releases just after relay 40 has operated. The interrupters are further arranged such that the relay 48 is operated just prior to the release of relay 40 and released immediately after the release of relay 40.

The lamps 49 to 52 form a Wheatstone bridge and are selected with different resistances. In other words, the lamps 49 and 51 when cold have a higher resistance than the lamps 50 and 52 when cold. When the lamps 50 and 52 are heated, however, their resistance rises to a value higher than the cold resistance of lamps 49 and 51. Furthermore, the resistance of lamps 49 and 51 when heated is greater than the resistance of lamps 50 and 52 when heated. As will be explained hereinafter, this arrangement of resistances enables a shifting of the bridge balance and a gradual reduction in the current flowing in the subscriber's line from its maximum value in one direction to zero and the gradual increase of current in the opposite direction during the reversal operation.

When the subscriber of line A^1 initiates a call the operator inserts the plug 31 of the cord C^1 in the jack 30. A circuit is thereby closed for the supervisory lamp 38. Moreover a circuit is completed from battery through the right back contact of relay 40, coil 53, lower left winding of repeating coil 34, relay 35, through the ring of the plug and jack, over the subscriber's loop, and returning on the tip side to the upper left winding of coil 34, coil 54 to ground at the left contact of relay 40. Relay 35 operates and closes a circuit through resistances 39 and 37 to shunt the lamp 38.

Obtaining the number wanted by the calling subscriber, the operator inserts the plug 32 in jack 33 which results in the closure of the circuit for lamp 42. After ringing current is applied the called subscriber answers and relay 36 operates. Relay 36 closes a circuit through the left winding of relay 43 and shunts the lamp 42. Relay 43 locks through the sleeve of the plug and jack.

As soon, following the operation of relay 43, as the interrupter 46 closes, a circuit is completed from ground through the contacts of the interrupter, contact of relay 43, winding of relay 47 to battery. Relay 47 operates and connects the lamps in circuit. The lamp 49 is included in a circuit which leads from ground through the left back contact of relay 40, filament of said lamp to ground through the left contact of relay 47. Since both terminals of the lamp are grounded the filament remains cold and, therefore, at its lowest resistance. Similarly the lamp 51 is connected from battery to battery and its filament remains cold. Lamp 50 is included in a circuit from ground, through the left back contact of relay 40, filament of said lamp, to battery through the right contact of relay 47. Similarly lamp 52 is included in a circuit from battery, through the right back contact of relay 40, filament of lamp 52, to ground at the left contact of relay 47. Lamps 50 and 52, therefore, light their filaments and increase their resistance to its maximum value which, as above explained, is greater than the cold resistance of lamps 49 and 51.

An instant later the interrupter 44 closes its contact and operates the relay 40. The instant relay 40 breaks its back contacts the direct battery and ground connections are removed from the subscriber's line. A circuit may now be traced from battery through the middle right contact of relay 47, lamp 51, conductor 56, and thus over the subscriber's line and returning to conductor 55 through the lamp 49 and ground at the left outer contact of relay 47. Current is supplied to the subscriber's line in this circuit and continues to flow in the same direction. The lamps 49 and 51, however, commence to heat their filaments, correspondingly increasing their resistance and gradually reducing the value of the current flowing in the subscriber's line. Furthermore, the direct circuits of lamps 50 and 52 are opened and these lamps are now included in series with the lamps 49 and 51 respectively. Accordingly lamps 50 and 52 receive less current and accordingly reduce their resistances. Thus the resistance of lamps 49 and 51 gradually increases and the resistance of lamps 50 and 52 gradually decreases. This being the case the resistance

of lamp 49 becomes equal to the resistance of lamp 50 and the resistance of lamp 51 becomes equal to that of 52 at a time before the lamps 49 and 51 are fully heated. When the lamps have reached a point of equal resistances the potential across conductors 55 and 56 has reached zero and no current flows over the subscriber's line. Since, however, the lamps 49 and 51 continue to increase their resistance a difference of potential is created between conductors 55 and 56, the difference being such that current now flows over the subscriber's line in the opposite direction. This current will continue to increase gradually until the lamps 49 and 51 reach their highest resistance and lamps 50 and 52 reach their lowest resistance. Shortly after this the relay 40 makes its front contact and full battery potential in the reverse direction is applied across conductors 55 and 56. Shortly after relay 40 closes its front contacts the interrupter 46 opens and relay 47 releases.

At the end of 15 seconds for instance, the interrupter 44 opens its contact and releases relay 40. Just before relay 40 releases, interrupter 45 closes and operates the relay 48. Relay 48 includes the lamp 49 in a circuit from battery to battery, and the lamp 51 in a circuit from ground to ground so that these lamps remain cold as before. Lamps 50 and 52 are included in energizing circuits, however, and light their filaments. When relay 40 breaks its front contacts, lamps 49 and 51 are included in circuit with the line and cause the gradual reduction of the current therein to zero and it is gradually increased in the opposite direction as above explained. An instant later relay 40 closes its back contacts and full potential is applied to the subscriber's line in the original direction. Shortly thereafter the relay 48 releases and disconnects the lamps.

In this manner the current in the subscriber's line is reversed periodically for operating the substation meter and the intensity of the current is so controlled as not to cause any disagreeable clicks in the subscriber's receivers.

At the end of conversation the connection is released in the well-known manner.

While the invention has been illustrated in connection with a manual system it is to be understood that it may be applied to systems employing automatic switches. It is also to be understood that numerous changes and alterations may be made and that the scope of the invention is limited only by the appended claims.

The substation meters have been illustrated diagrammatically, but they may be of any suitable construction. For example, reference is made to the meter shown in the patent to Thomson, No. 1,121,953, granted December 22, 1914.

What is claimed is:

1. In combination, a telephone line, a meter therefor, a source for supplying current to said line, means for connecting said source in circuit with the line, means for altering the connection of the supply source to said line to cause the operation of said meter, a variable resistance element for preventing sudden changes of current in said line, and means for putting said element into use prior to the alteration of said connection and for taking it out of use subsequent to said alteration.

2. In combination, a telephone line and a meter therefor, a source for supplying current to said line and for operating said meter, means for connecting said source in circuit with the line, means for repeatedly interrupting the connection of the supply source to said line, a variable resistance element for preventing abrupt changes of current in said line, and means for closing a connection for said element to render it effective prior to each interruption of said connection and for disconnecting said element subsequent to each interruption.

3. In a telephone system, a subscriber's line and a meter therefor, a battery for supplying current to said line, means for reversing the flow of current in said line to operate the meter, a variable resistance element for preventing sudden changes of current in said line, and means for placing said element in circuit with the line prior to and for removing it from circuit subsequent to said reversal.

4. In a telephone system, a subscriber's line and a meter therefor, a source of current for supplying said line, means for connecting said source in circuit with the line, means for periodically reversing the direction of current flow in the line to repeatedly operate said meter, a variable resistance element for preventing sudden changes of current due to said reversals, and means for automatically connecting said element in circuit before each reversal and disconnecting it therefrom after each reversal.

5. In combination, a telephone line and a meter therefor, a source for supplying current to said line and for operating said meter, means for connecting said source in circuit with the line, means for interrupting the connection of the source to said line, a current carrying element the resistance of which varies in response to the flow of current therein, said element serving to prevent sudden changes in current in the line, and means for connecting said element in circuit before and disconnecting it from circuit after the interruption of said connection.

6. In combination, a subscriber's line and a meter therefor, a source for supplying current to said line, means for reversing the direction of current flow in the line to cause the operation of said meter, a current carrying element the resistance of which increases as

it is heated by the flow of current therein, and means for connecting said element in circuit before reversal and disconnecting it therefrom after reversal to prevent sudden changes of current in the line.

7. In a telephone system, a subscriber's line, a meter for said line, a source for supplying current to the line, means for reversing the direction of current in the line to operate said meter, a closed chamber having a tungsten filament therein, the resistance of which increases as its temperature rises due to current flow therethrough, and means for including said filament in circuit prior to reversal and removing it therefrom subsequent to reversal.

8. In combination, a telephone line and a meter therefor, a source for supplying talking current to said line, means for repeatedly reversing the direction of current flow in the line to operate said meter, a plurality of lamps normally disconnected from the line, and means for connecting said lamps in circuit with the line during each successive reversal to prevent abrupt changes of current in the line.

9. In a telephone system, a subscriber's line, a current operated device therefor, a source for supplying current to said line, means for changing the flow of current from said source to operate said device, a variable resistance device cooperating with said means for causing the current to gradually decrease in one direction and to gradually increase in the opposite direction, and means for connecting said last device in circuit prior to said change of current and for disconnecting it from circuit subsequent thereto.

10. In a telephone system, a subscriber's line, a current operated device therefor, a source for supplying current to the line, means for changing the flow of current from said source to operate said device, a current carrying device the resistance of which varies in response to the flow of current therein, said last mentioned device cooperating with said means for causing the current to gradually decrease in one direction and to gradually increase in the opposite direction, and means for connecting said last mentioned device in circuit prior to each change of current and for disconnecting it from circuit subsequent to each change.

11. In combination, a subscriber's line, a meter for said line, a source of current for supplying the line, means for changing the direction of the current to operate said meter, lamps having variable resistances and cooperating with said current changing means in such a manner as to cause a gradual decrease of the current in one direction and a gradual increase in the opposite direction in the subscriber's line, and means for connecting said lamps in circuit prior to the current change and for disconnecting them subsequent to such change.

12. In combination, a line, a current controlled device for said line, a current source for supplying the line, two current carrying elements the resistances of which vary in response to the flow of current therein, said elements having different normal resistances, means for connecting said elements to the line in such manner that the resistance of one increases while that of the other decreases to effect a gradual change of current flow in said line, and means responsive to said current change for operating said device.

13. In combination, a line, a meter for said line, a source of current supplying the line, two current carrying elements the resistances of which change in response to the flow of current therein, said elements having different normal resistances, means for connecting said elements to the line in such manner that the difference between their resistances varies to effect a gradual change of current flow in said line, and means responsive to the change of current in the line for operating said meter.

14. In a telephone system, a subscriber's line and a meter therefor, a source of current for applying the line, a plurality of current carrying elements the resistances of which change in response to the flow of current therein, means for connecting said elements to the line in such manner that the resistances vary to cause the current to change uniformly from its value in one direction to a given value in the opposite direction, and means responsive to such change of current for operating said meter.

15. In combination, a line, a source of current for supplying the line, two lamps the resistances of which vary in response to the flow of current therein, said lamps having different normal resistances, and means for periodically connecting said lamps to the line in such manner that the resistance of one increases while the resistance of the other decreases to effect a gradual change of current flow in the line.

16. In combination, a line, a current controlled device for said line, means for supplying current to the line, a Wheatstone bridge having elements the resistances of which vary in response to current flow therein, the normal resistances of said elements being such that the bridge is unbalanced, means for connecting said bridge to the line in such manner that it gradually assumes a condition of balance to cause a uniform change of current in said line, and means responsive to the flow of current in said line for operating said device.

17. In combination, a circuit and a current controlled device therefor, a source of current for supplying the circuit, a Wheatstone bridge having lamps for its resistance elements, the resistances of said lamps varying in response to the flow of current therein.

the values of said resistances being such that the bridge is normally unbalanced, means for connecting the bridge to said circuit in such manner that it gradually assumes first a condition of balance and then a condition of unbalance to change the flow of current in said circuit, and means responsive to the change of current flow for operating said device.

In witness whereof, I hereunto subscribe my name this 13th day of January, 1928.

JOHN W. GOODERHAM.