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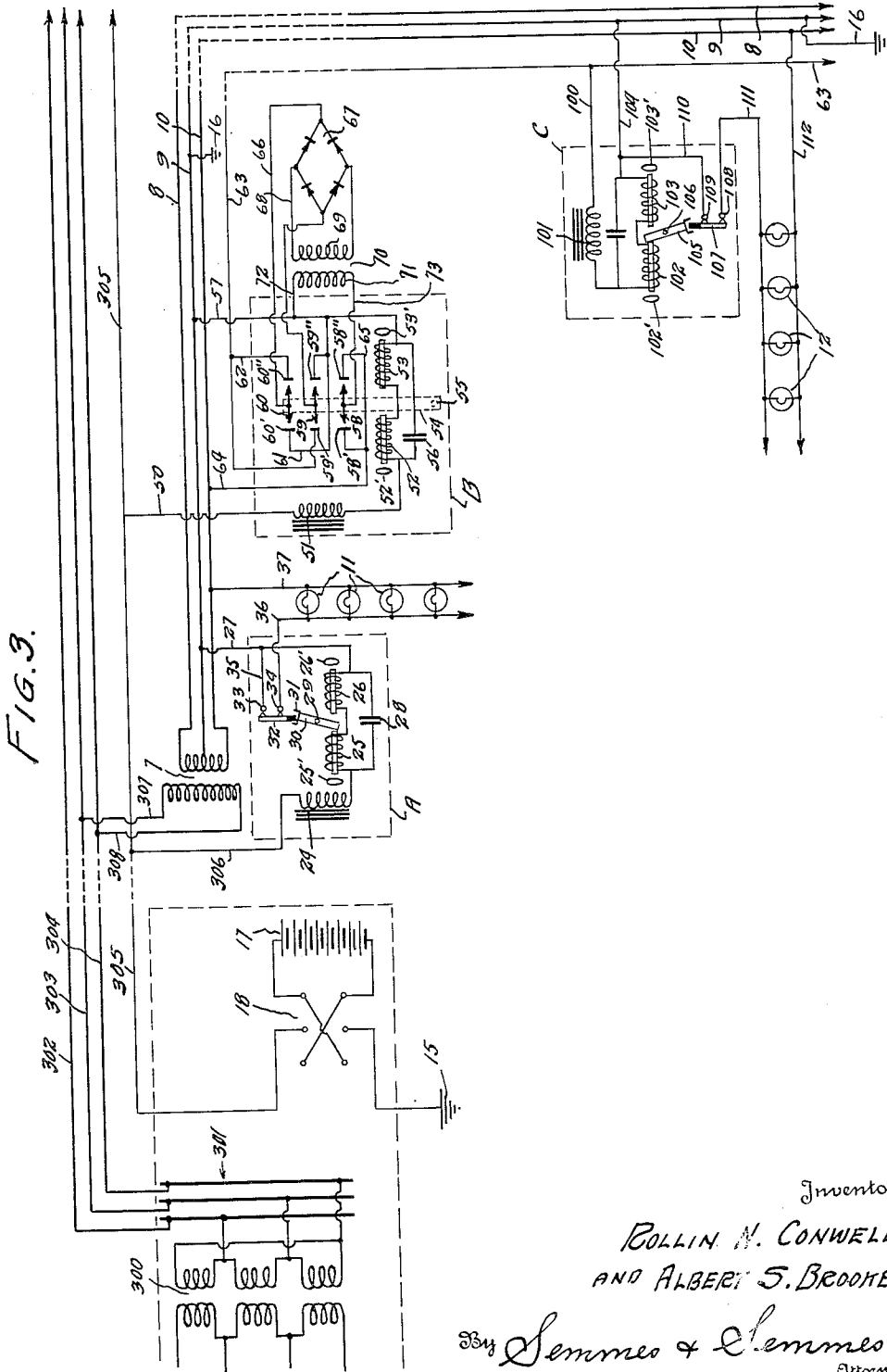
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2,213,384

SYSTEM OF REMOTE CONTROL

Original Filed Oct. 15, 1936

3 Sheets-Sheet 2



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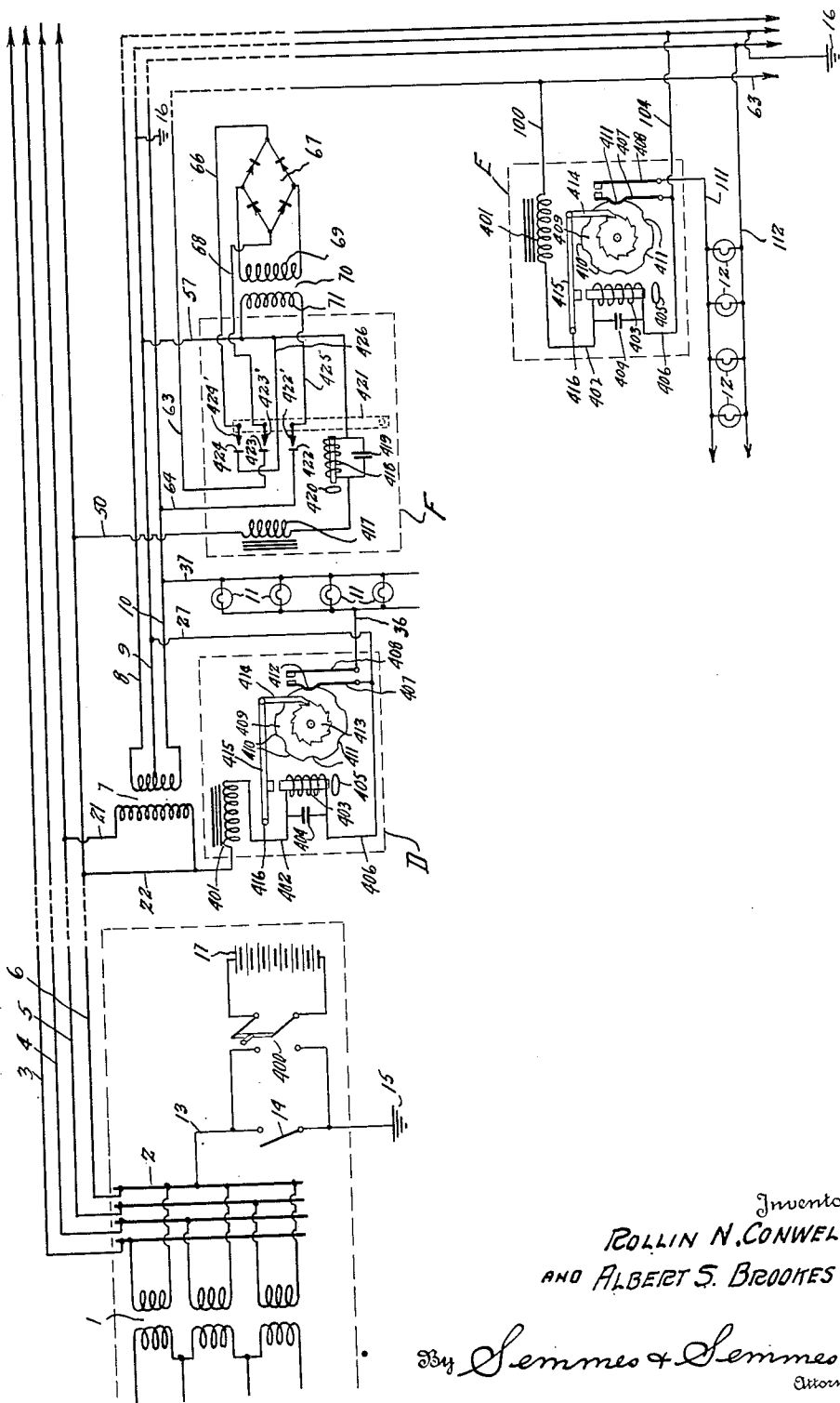
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FIG. 4.



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SYSTEM OF REMOTE CONTROL

Rollin N. Conwell, Bloomfield, and Albert S.
Brookes, East Orange, N. J.Application October 15, 1936, Serial No. 105,780
Renewed January 20, 1940

7 Claims. (Cl. 171-97)

This invention relates to systems of remote control.

It is particularly of advantage for use with distribution systems. In suburban areas of cities house lighting service must be continuous. Where a multiple system of street lighting is used, it frequently happens that there is insufficient load to warrant the running of feeders exclusively for street lighting, and under such circumstances the lights are connected to the house lighting or service feeders. There is a problem presented, then, of turning on or off the street lights. Clock operated switches are not reliable for this type of work.

Moreover, multiple street lighting can be justified for either congested or sparsely settled areas on the basis of lower investment cost, higher operating efficiency and hence lower operating costs, and greater efficiency.

The system which we have described herein is particularly useful for remote control of loads such as storage hot water heaters and other heating loads, as well as multiple street lights. Such types of loads are generally connected to the secondary feeder mains leading from the usual distribution transformer.

The present invention is an improvement on that disclosed in our copending application Serial No. 54,958, filed December 17, 1935.

An object of the invention is to provide a system of control which furnishes at low cost a positive method of operating a larger number of electrical controllers from a remote point without the use of large size control wires.

A further object of the invention is to provide a system for effecting remote control which is economical to construct and maintain.

With these and other objects in view, which may be incident to our improvements, the invention consists in the parts and combinations to be hereinafter set forth and claimed, with the understanding that the several necessary elements comprising our invention may be varied in construction, proportions and arrangement, without departing from the spirit and scope of the appended claims.

In order to make our invention more clearly understood, we have shown in the accompanying drawings means for carrying the same into practical effect without limiting the improvements in their useful applications to the particular constructions, which, for the purpose of explanation, have been made the subject of illustration.

In the drawings:

Figure 1 is a diagrammatic view of our invention as applied to the three-phase four-wire distribution system.

Figure 2 is a modification of the invention shown in Figure 1, in which a pilot wire is used to extend the operation of the system beyond the end of the three-phase four-wire distribution main.

Figure 3 is a diagrammatic view of our invention as applied to a three-phase three-wire distribution system.

Figure 4 is a diagrammatic view of our invention as applied to a three-phase four-wire distribution system. In this form we employ a sequence relay.

Referring to the drawings, we have shown a three-phase power transformer which we have indicated generally by the numeral 1, which is adapted to feed through a power bus 2, a three-phase four-wire distribution main comprising wires 3, 4, 5 and a neutral wire 6. Through a distribution transformer which we have indicated generally by the numeral 7, current is fed into secondary feeder mains 8, 9 and 10. From the secondary feeder mains current is tapped to lights 11 and 12, or other loads, such as storage hot water heaters. Connected to the neutral wire 6 of the distribution main is a wire 13 which is connected through the neutral grounding switch 14 to ground 15. Wire 9 of the secondary feeder main is likewise grounded through a connection 16.

Direct current to operate our remote control is adapted to flow in a circuit comprising the grounds 15 and 16, the neutral wire 6 and wire 9 of the secondary feeder main, as will hereinafter be more fully explained. We have shown a source of direct current 17 for operating our remote control. Current from this source is controlled through reversing switch 18 so that current of any desired polarity for turning on and off the multiple street lights, storage hot water heaters and so forth can be employed. In operation, the neutral grounding switch 14 is open. The reversing switch is connected through leads 19 and 20 to ground 15 and to wire 13, respectively. The primary of distribution transformer 7 is connected by a lead 21 to wire 5 of the three-phase four-wire distribution main and by a wire 22 to the neutral wire 6 of such distribution main. The wire 22 has connected to it a lead 23 in which is located a choke coil 24. The lead 23 passes to an actuating coil 25 of a polarized relay which is connected through the oppositely disposed actuating coil 26 of the polarized relay to the lead 27

which is connected to wire 9 of the secondary feeder main.

Actuating coils 25 and 26 are provided with short circuited turns at 25' and 26'. A condenser 28 may be connected across the actuating coils 25 and 26. Pivoted at 29 is a permanent magnet 30 carrying a yoke 31 which is adapted to actuate the contact member 32 which is adapted to make or break the circuit through contacts 33 and 34. Upon direct current being sent through the polarized relay actuating coils 25 and 26 one of them repels and the other attracts the permanent magnet 30, which will cause the magnet 30 to assume the desired position to complete the circuit through contacts 33 and 34, or to break the circuit. The switch will remain in any thrown position until acted upon by current of reverse polarity. The details of this polarized relay are given in our copending application Serial No. 54,958. Connected to contact 33 is a lead 35 which connects with the lead 27. Connected to contact 34 is a lead 36. Lead 37 connects with wire 10 of the secondary feeder main. Upon closing of the circuit through contacts 33 and 34, current will flow through leads 36 and 37 from the secondary feeder main to light lights 11 or perform other useful functions such as supplying electricity to storage hot water heaters.

By operating the reversing switch 18 to send direct current in either direction over the neutral wire 6 of the four-wire distribution main, the polarized relay can be made to make or break the circuit at contacts 34 and 33 to turn on or turn off the lights 11.

The function and advantages of the choke coil 24, the short circuited turns 25' and 26', and the condenser 26 across the operating coils 25 and 26 have been more fully set forth in our application above referred to and constitutes no part of the present invention.

In case there are a number of stations which would be strung out along the distribution main, it might be necessary to have wire 6 of very heavy construction to carry sufficient current to operate the stations. In order to economize in construction, we have devised this method for obtaining current to operate a series of polarized controllers or relays which comprises a system of cascading for the remote control of electrical apparatus. The direct current for operating a remote polarized relay, we obtain through the instrumentality of a rectifying circuit system.

Connected to the neutral wire 6 is a wire 50 in which is located a choke coil 51, and operating coils 52 and 53 of a polarized relay having a permanent magnet armature 54, which is pivoted as indicated at 55. The operating coils 52 and 53 are provided with short circuited turns 52' and 53', respectively. There may be used a condenser 56 connected across the operating coils 52 and 53. The operating coil 53 is connected by means of a lead 57 to wire 9 of the secondary feeder main. This arrangement, as can be seen, is quite similar to the one just described in connection with the other polarized relay. This polarized relay, however, is a triple contact polarized relay having contact members 58, 59 and 60, which are adapted to move and make contact with adjacent contacts mounted in the switch structure.

Contact 58 is adapted to move to make contact with contact 58' or 58''; contact 59 with contacts 59' or 59''; and contact 60 with contact 60' or 60''. The contact 60' is connected to a lead 61 which is connected to lead 57. Contact 60'' is connected to a lead 62 that is connected to a pilot

wire 63. Contact 59' is connected to the pilot wire 63 and the contact 59'' is connected to the lead 61. Contact 58' is connected to a lead 64 which is connected to wire 10 of the secondary feeder mains. Contact 58'' is connected to a lead 65 which is connected to the lead 64.

The movable contact 60 is connected by means of a lead 66 to an output terminal of a full wave rectifier 67. The input terminals of the rectifier 67 are connected to a secondary 69 of a transformer 70 whose primary 71 is connected through a lead 72 to the lead 57 and through a lead 73 to the movable contact 58.

For purposes of simplicity we have designated the polarized relay comprising operating coils 25 and 26 as A, and the polarized relay and triple contacts having operating coils 52 and 53 by the letter B.

The details of the polarized relay A and another similar relay C are fully set forth in our copending application Serial No. 54,958. The arrangement is such that the contact opening and closing element will remain in the position in which it is thrown until the coils are energized by a direct current of opposite polarity to that which moves the contact into the position which it is occupying. The polarized relay B is so constructed that the contacts which are controlled by it remain closed only during the passage of current through the actuating coils. The details of such construction are well known to those skilled in the art, and for purposes of simplicity a detailed description is here omitted.

Upon direct current being impressed on neutral wire 6 through the reversing switch 18, current will flow through lead 50, through the operating coils 52 and 53 of the polarized relay, through lead 57 and wire 9 to the ground at 16, and back through ground 15. This will operate the polarized relay to move the permanent magnet armature 54 to either make the series of contacts 60, 60', 59, 59', 58, 58'; or to close the contacts 60, 60''; 59, 59''; and 58, 58''. Depending upon which series of contacts is closed, direct current will be sent out from the full wave rectifier 67 of either one polarity or the other along the pilot wire 63 to a polarized relay or group of relays C similar to the polarized relay A.

The current flows through the pilot wire 63 into lead 100 through a choke coil 101, through an operating coil 102, and an operating coil 103 of the polarized relay, out through lead 104 to wire 9 of the secondary feeder main, and thence to ground through 16. The operating coil 102 is provided with the short circuited turns 102' and the operating coil 103 with the short circuited turns 103'. This polarized relay is provided with a permanent magnet 105 pivoted at 106 which is adapted to move a contact element 107 to make and break the circuit between contacts 108 and 109. Contact 108 is connected by a lead 110 with lead 104 and contact 108 is connected by lead 111 with the multiple lights 12 or storage hot water heaters. The multiple lights 12 are connected through a lead 112 with the wire 10 of the secondary feeder main. The lights may be turned on or off depending upon the polarity of the current fed from the rectifier 67 to polarized relay C.

Let us trace the circuit from rectifier 67, when contacts 60, 60'; 59, 59'; 58, 58' are made. Contacts 60 and 60' will permit current to flow from an output terminal of rectifier 67 through lead 66, contact 60, contact 60', lead 61, and lead 57 to wire 9. Current will flow from the other output terminal of the rectifier through lead 68, con-

tact 59, contact 59' to pilot wire 63. The rectifier 67 is energized by alternating current supplied through input terminals which are in circuit with the secondary 69 of the transformer 70. Transformer 70 has its primary energized by alternating current flowing through wires 10, 64, contact 58', contact 58, lead 73, primary winding of transformer 71, and lead 57 to wire 9.

When contacts 60, 60'', 59, 59'', 58, 58'' are made, primary 71 of transformer 70 is energized through wires 10, 64, contact 58', contact 58, lead 73, primary winding 71, lead 72, lead 57 to wire 9 of the secondary feeder main. One output terminal of the rectifier 67 feeds direct current through line 66, contact 60, contact 60'', lead 62 to pilot wire 63. The current through the other output terminal flows through lead 68, contact 59, contact 59'', lead 57, to wire 9 of the secondary feeder main.

Thus it will be apparent that, depending which way the armature 54 of the rectifier is moved, current of either polarity may be sent along pilot wire 63 to operate polarized relay C.

Because of this cascading arrangement, heavy wire to carry large direct current is not necessary, thus effecting a substantial saving in cost of installation and maintenance.

In Figure 2 is shown an arrangement which is quite similar to Figure 1, except that where it is not desired to continue the three-phase four-wire distribution main beyond a certain point, a pilot wire may be connected as indicated at 200 to the neutral 6. Connected to the pilot wire is the polarized controller A and the polarized controller B, the last through a lead 201. The operation is similar to that just described for Figure 1. Upon operation of the reversing switch 18, the polarized controller A operates to make or break the switch for its load.

In Figure 3 we have shown a form of the invention adapted for use with a three-phase three-wire distribution main. There is provided a three-phase power transformer 300 provided with a bus 301 which carries wires 302, 303 and 304 of a three-phase three-wire distribution main. The source of direct current 17 is connected through the reversing switch 18 with a pilot wire 305. The lead to the choke coil 24 of the polarized relay A is made through a line 306 which connects with pilot wire 305. Lead 50 of the polarized relay B connects also with the pilot wire 305.

Distribution transformer 7 has its primary connected by leads 307 and 308 to wires 303 and 304 respectively of the distribution main.

Upon operation of the reversing switch 18, current of either polarity may be caused to flow through the pilot wire 305. This, through the connections shown, will operate polarized relay A to turn on or off lights 11 and to operate polarized relay B to cause full wave rectifier 67 to operate polarized relay C to turn on or off lights 12.

Throughout the drawings and specification, where we have used the term "polarized relay" we have meant a relay which will close its contacts when direct current is caused to flow through it in one direction and open its contacts when current is caused to flow through it in the reverse direction. The selecting mechanism may be through the use of permanent magnets or through the use of rectifying elements in series or parallel with the relay coils. We may not employ a polarized relay or a polarized controller, but may instead employ a sequence relay or a sequence controller. Such form of device is

shown in the drawings, Figure 4. By "sequence relay" is meant a relay which closes the contacts on the first impulse or series of impulses and opens the contacts on some following impulse or series of impulses. The various aforesaid impulses may be similar or they may be different in polarity, magnitude or duration, or any combination of these characteristics. Several types of controllers may be employed, such as, those which select on polarity, those which select on magnitude, and those which select according to the duration of the impulse.

In Figure 4 is shown our system employing a sequence relay or controller instead of a polarized relay or controller. The circuits, with the exception of the necessary connections for the change, are somewhat similar to those shown in Figure 1. There are shown in Figure 4 the same three-phase four-wire distribution main, the same secondary feeder mains, and the same pilot wire 63. The secondary feeder mains are connected to the three-phase four-wire distribution main by a similar distribution transformer.

Instead of the reversing switch 18, we have shown a switch 400 which is adapted to be opened and closed to send direct current impulses over the neutral wire 6 of the four-wire distribution main. Such a direct current impulse will pass through wire 22 through a choke coil 401, through a lead 402, to sequence relay actuating coil 403. This coil may have a condenser 404 connected across its ends. The coil 403 is provided with a short circuited turn 405. From coil 403, direct current flows through a lead 406, a lead 27, to wire 9 and to ground at 16, returning to 15. Also connected to lead 406 is a spring contact member 407 which is adapted to make contact with a contact member 408. In the position shown in Figure 4, the spring in the contact 407 has separated contact 407 from contact 408. Upon rotation of a cam disc 409 having arcuate cam surfaces 410 and indented cam surfaces 411, the contact 407 will be moved to make a contact when the arcuate cam surfaces 410 are moved underneath a bent portion 412 of the contact 407. This closes the circuit through contacts 407 and 408 and alternating current will flow through leads 37 and 36 to light the multiple street lights 11.

The means for moving the disc 409 comprises a ratchet wheel 413 which is engaged by a pawl 414 pivoted on an armature 415, which armature is pivoted at 416. The coil 403 will attract the armature at each impulse and move the cam carrying disc 409 a certain distance at each impulse. The details of this sequence relay are given in our copending application Serial No. 54,958.

It is obvious that each impulse will move the cam carrying disc 409 a certain amount, and that alternately the street lights 11 will be turned on and off in the sequential operation controlled through the switch 400. I have designated the sequence relay, for purposes of simplicity, by the letter D. For purpose of operating a sequence relay E, which is similar in construction to the sequence relay D just described, we employ direct current impulses from the full wave rectifier 67 which is controlled by a relay F which will be later described.

The details of construction of sequence relay 70 E will not be given, since the construction and circuit arrangement are the same as that described in connection with sequence relay D. Upon a direct current impulse being sent over pilot wire 63, sequence relay E will be operated

to either light the street lights 12 or turn them off. Like parts of sequence relay E have been given the same numerals with which such parts were designated in describing similar sequence relay D.

We will now describe the relay F. Relay F is connected through leads 50 to neutral wire 6 of the four-wire distribution main and through lead 57 to wire 9 of the secondary feeder main. Through ground connections 15 and 16 the circuit is completed to send direct current from the source 17 through relay F. In lead 50 is a choke coil 417. The lead 50 connects with one end of an operating coil 418 across whose ends may be connected a condenser 419. A short circuiting turn 420 is provided for the operating coil 418.

Upon energization of operating coil 418 by direct current through closing the switch 400, an armature 421 will be attracted to close contacts 422 and 422'; 423 and 423'; 424 and 424'.

Closing of contacts 422 and 422' energizes primary 71 of transformer 70, through current flowing through lead 64 from wire 10, contacts 422, 422', lead 425, primary 71 and the lead 57 to wire 9 of the secondary feeder main.

At the same time, closing of contacts 423 and 423' sends a direct current impulse through pilot wire 63 to sequence relay E, by closing a circuit including the pilot wire 63 and contacts 423 and 423', the lead 68 from the output of full wave rectifier 67, the lead 66, contacts 424 and 424', the lead 426, wire 57 to wire 9 of the secondary feeder main, wire 104, sequence relay E and wire 100 to the pilot wire 63.

Thus a direct current impulse is sent to the sequence relay E to turn on or off the multiple street lights 12.

The construction of relay F is such that when the actuating coil 418 is no longer energized, the contacts 422 and 422', 423 and 423' and 424 and 424' will be separated.

While we have shown and described the preferred embodiment of our invention, we wish it to be understood that we do not confine ourselves to the precise details of construction herein set forth, by way of illustration, as it is apparent that many changes and variations may be made therein, by those skilled in the art, without departing from the spirit of the invention, or exceeding the scope of the appended claims.

We claim:

1. A system of remote control for a four-wire three-phase distribution system having a neutral wire comprising a load, an alternating current power supply, a source of direct current, a switch connecting the load to the power supply, a three-wire secondary feeder circuit associated with said distribution system, cascaded polarized control members, the first in the series being connected to the neutral wire, means to impress direct current on the neutral wire to operate the first control member, and means to operate another group of the control members by the current taken from the three-wire secondary feeder circuit.

2. A system of remote control for a four-wire three-phase distribution system having a neutral wire comprising a load, an alternating current power supply, a source of direct current, a switch connecting the load to the power supply, cascaded polarized relays, the first of said relays in the series being connected to the neutral wire and adapted to open and close the switch connecting the load to the power supply, means to impress direct current on the neutral wire to operate the first relay, means to rectify the current

from the three-wire secondary feeder circuit, and means operated by the rectified current to actuate another group of said polarized relays.

3. A system of remote control for a three-wire distribution system having a pilot wire comprising a load, an alternating current power supply, a source of direct current, a switch connecting the load to the power supply, a three-wire secondary feeder circuit associated with said distribution system, cascaded polarized relays, the first relay in said series being connected to the pilot wire, means to impress direct current on the pilot wire to actuate said relay to open and close the switch, and means to operate another group of the controllers by the current taken from the three-wire secondary feeder circuit.

4. A system of remote control for a three-wire distribution system having a pilot wire comprising a load, an alternating current power supply, a source of direct current, a switch connecting the load to the power supply, a three-wire secondary feeder circuit, cascaded polarized relays, the first relay in the series being connected to the pilot wire, means to impress direct current on the pilot wire to operate said first polarized relay to open and close the power supply switch, means to rectify the current from the three-wire secondary feeder circuit, and means operated by the rectified current to actuate another of said controllers.

5. A system of remote control for a three-wire distribution system having a pilot wire comprising a load, an alternating current power supply, a source of direct current, a switch connecting the load to the power supply, a three-wire secondary feeder circuit, cascaded polarized relay control units, the first relay in said series being connected to the pilot wire to open and close said power supply switch, a choke coil in said relay to limit the flow of alternating current to the polarized relay, short circuited turns on the relay actuating coils to render negligible the effect of the alternating current, means to impress direct current on the pilot wire to operate said first relay, means to rectify the current from the three-wire secondary feeder circuit, and means operated by the rectified current to actuate another group of the controllers.

6. A system of remote control for a four-wire three-phase distribution system having a neutral wire comprising a load, an alternating current power supply, a source of direct current, a switch connecting the load to the power supply, a three-wire secondary feeder circuit, cascaded polarized relay controls, the first of said relays in the series being connected to the neutral wire to open and close the power supply switch, a choke coil for the relay to limit the flow of alternating current to the relay, short circuited turns on the relay actuating coils to render negligible the effect of the alternating current, means to impress direct current on the neutral wire to operate said first relay, and means to operate a second group of controllers by the current taken from the three-wire secondary feeder circuit.

7. A system of remote control for a four-wire three-phase distribution system having a neutral wire comprising a load, an alternating current power supply, a source of direct current, a switch connecting the load to the power supply, a three-wire secondary feeder circuit, cascaded polarized relay controls, the first relay in the series being connected to the neutral wire to open and close the power supply switch, a choke coil for

the relay to limit the flow of alternating current to the relay, short circuited turns on the relay actuating coils to render negligible the effect of the alternating current, means to impress direct current on the neutral wire to operate said first mentioned relay control, means to rectify

the current from the three-wire secondary feeder circuit, and means operated by the rectified current to actuate another group of polarized controls.

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