

June 10, 1930.

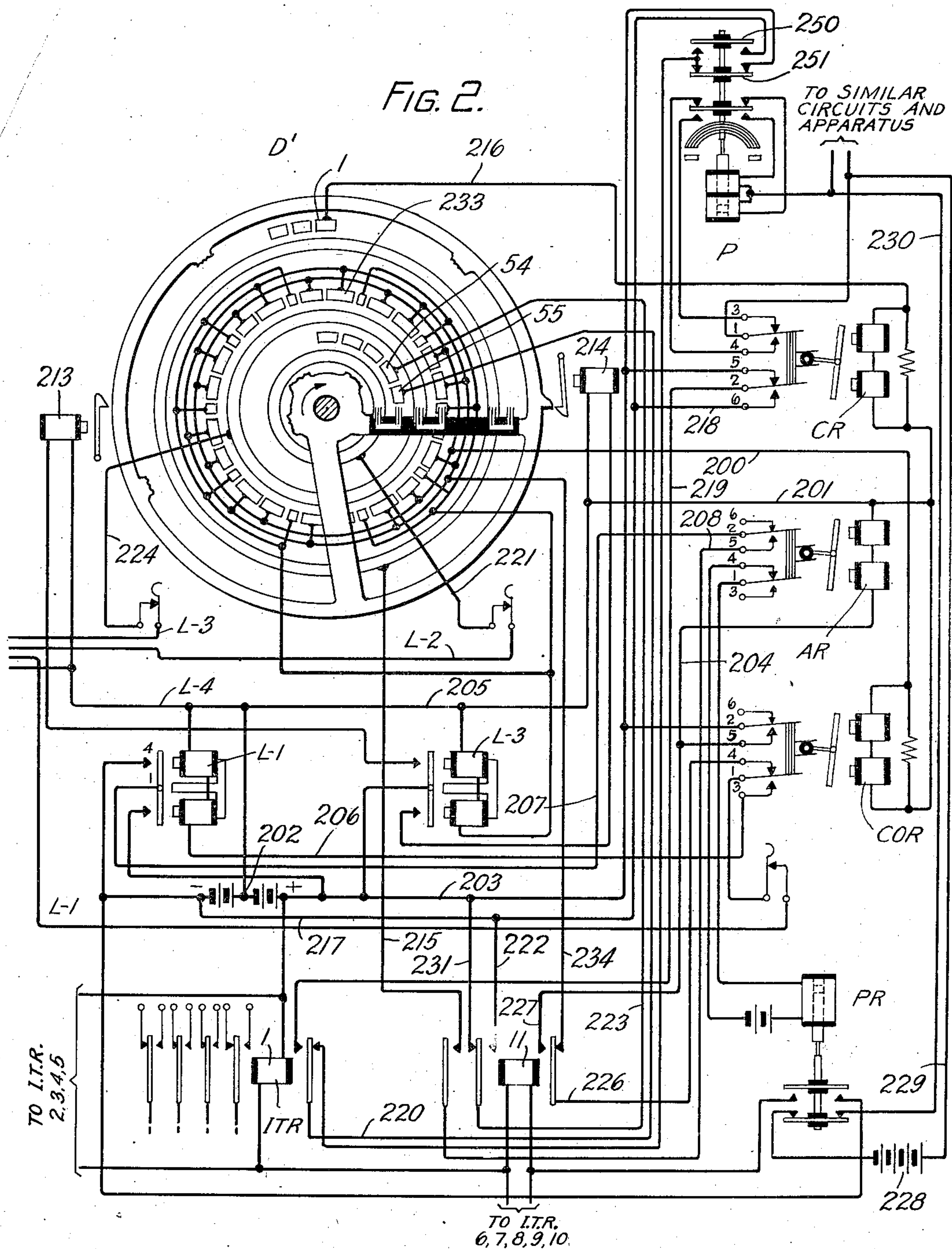
J. C. FIELD

1,762,971

REMOTE CONTROL POWER SYSTEM

Filed Feb. 2, 1929

2 Sheets-Sheet 2



INVENTOR
J. C. FIELD

BY *Irving Mac Donald*

ATTORNEY

UNITED STATES PATENT OFFICE

JOSEPH C. FIELD, OF MAPLEWOOD, NEW JERSEY, ASSIGNOR TO BELL TELEPHONE LABORATORIES, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK

REMOTE-CONTROL POWER SYSTEM

Application filed February 2, 1929. Serial No. 337,039.

This invention relates to remote control systems in general, and particularly to systems wherein a dispatcher located at a central control station can operate circuit breakers and the like located at distant sub-

stations. Its object is to provide the dispatcher with signals to insure that he has conditioned the substation equipment to operate only the desired circuit breaker and no other before he throws the key which actually closes or opens the breaker; in other words, to provide means for enabling the dispatcher to check the operation of the devices controlling the actual shifting.

The invention contemplates providing a series of polarized relays at the substation corresponding to the breakers with means whereby the dispatcher first operates the relay corresponding to the breaker he desires to shift. The relay by its response transmits a checking signal back to the dispatcher to indicate the position the relay assumed. The dispatcher notes this signal, and if correct, operates means at the substation to actually close the circuit of the shifting magnet of the breaker corresponding to this relay, this circuit including contacts of said relay.

More specifically, each circuit breaker is provided with auxiliary contacts which are shifted by the shifting of the circuit breaker under control of the dispatcher, the change of position of these contacts causing one of the pair of signal lamps individual thereto before the dispatcher to light and the other to be extinguished to indicate such change of position. Instead of having the circuit which the dispatcher closes to shift a circuit breaker lead directly to the shifting magnet of such breaker, in accordance with the present invention, it leads to and controls a relay at the substation individual to such circuit breaker which when it operates causes a signal to be transmitted back to said pair of lamps, the character of the signal being determined by the position the relay contacts assume; in other words, one or the other lamp of the pair individual to this breaker is lighted depending upon the polarity of the impulse transmitted by the relay. The dispatcher,

noting the signal, then actually operates the circuit breaker. To do this he throws a key which supplies power to the circuit breaker magnet controlled by this relay.

Referring to the drawings, Figs. 1 and 2 show a central or control station and a remote station with the interconnecting line wires. Fig. 1 should be placed to the left of Fig. 2.

Referring to Fig. 1 the control and indicating panel in the dispatcher's office contains a control key CK and three indicating lamps 100, 101 and 102, one red, one green and one white, for each power switch P, Fig. 2, to be supervised. The red and green lamps indicate the position of the power switches, except while checking, they indicate the position of the control relays CR, Fig. 2, one of which is provided for each power switch or circuit breaker. The white lamp 100 is lighted only when the power switch P or control relay CR is in the opposite position as to the position indicated by the control key CK. The dispatcher's station is also provided with an operating key OK, a set-up key SK, synchronizing lamps 103, 104, 105, alarm bell 106, bell key 107, phasing bell 109 and phasing lamp 108. A relay and distributor panel is located in both the dispatcher's station and the substation, each panel containing one distributor for a number of power switches and one indicating or control relay CR for each power switch to be supervised. The control relays CR at the substation are operated from the dispatcher's keys CK, OK through both distributors. Each power switch is provided with auxiliary contacts which correspond to the dispatcher's keys. As soon as any power switch completes an operation its auxiliary contacts operate one of the indicating relays IR on the apparatus panel at the dispatcher's station, changing the indication corresponding to the position of that particular power switch. In this system four line wires are used between the dispatcher's station and the substation, the first line wire L—1 being used for the phasing and controlling circuits, the second line wire L—2 for the indicating circuits, the third line wire L—3 for syn-

chronizing the rotation of the brush carriers on both distributors and the fourth line wire L—4 providing a common return circuit for all lines.

5 Whenever the dispatcher desires to operate any power switch at the distant station he turns the control key CK of that power switch to the desired position and then operates the set-up key SK. As soon as the
10 indication transfer relays ITR at the substation have operated, the dispatcher receives a visual indication by the lighting of a red and a white indication transfer lamp 110, 111 associated with the operating key OK. This
15 indicates that the control relay CR at the remote station is set but the power switch has not yet been operated. Before operating the operate key OK, it should be noted that there are no white lamps 102 lighted on other
20 control keys CK and that the white lamp on the control key previously operated has been extinguished, and that the indication received corresponds to the control key position. This indicates that the control relay
25 desired and no other at the substation has been operated and prepared to either open or close the power switch.

Upon the actuation of the operation key OK the power switch will be operated and
30 the indications will be transferred from the contacts of the control relays CR to the auxiliary contacts of the power switches. This will be indicated by the lighting of the green lamp 112 in place of the red and white indication transfer lamps 110 and 111 associated
35 with the operate key OK.

Whenever a power switch automatically changes its position the alarm bell 106, and a
40 white lamp 100 is lighted at the control key CK corresponding to that power switch. At all times the dispatcher has a visual indication of the position of all the supervised units and is notified immediately of any change.

45 For the synchronous operation of brush carriers of the distributors there are provided control segments, collector rings, two line relays L—3 and line wire L—3. The battery for the synchronizing circuit is connect-
50 ed from the windings of the line relay L—3 to the synchronizing segments, across the brush to the collector ring and thence to the L—3 line, to the collector ring of the distant station distributor, across the brush to
55 the synchronizing segments, through the windings of the line relay L—3 and thence to the line L—4. When the brush arm on each distributor passes over a synchronizing segment, the two L—3 line relays being in
60 series will operate simultaneously and will thus release the brush arm of each distributor at the same instant by energizing the respective release magnets 113, 213 and 114, 214. The brush of each distributor after passing
65 over the synchronizing segment cuts off the

source of current applied to said release magnets to permit them to return to the deenergized position so that the release magnet latches will engage with the next stop on the brush arm. Since the stops on the brush
70 carrier are in alignment with the synchronizing segments the brush carrier will be stopped every tenth of a revolution by the release magnet latches, this stopping time being determined by the different phase rela-
75 tion of the brush carriers of the two distributors. If, however, the distributors are not running in synchronism and if one brush arm should lag behind, the other arm will be brought into step each time the stop on the
80 brush carrier engages with the release magnet latch. In other words, the brush carrier which is running the faster will be stopped at the release magnet latch and held until the slower brush carrier reaches the corre-
85 sponding position. This means for maintaining the synchronous operation of the brush carriers of the distributors is described in detail in patent to J. C. Field No. 1,496,875, issued June 10, 1924, and therefore need
90 not be further described.

It is believed that the invention will be most readily understood from a detailed description of the operations necessary
95 to close a power switch. Assuming that the dispatcher desired to close power switch P, Fig. 2, which is shown in the open position he will turn the control key CK to the closed position, this position being
100 the alternate one from that indicated in the drawing, whereupon the white lamp 100 lights, the green lamp remaining lighted. The dispatcher then turns the set-up key SK for a quarter turn and releases it. The 5—4
105 contact of the set-up key SK breaks negative battery feed to the operate key OK from source 120, thus preventing the power switch from being operated until the set-up key has completed its operation. The 1—2 contact
110 of the set-up key SK closes and operates relay S—2 over the following circuit: battery 115, conductors 116, 117, relay S—2, conductor 118, contact 2—1 to the other side of the battery. A set of make contacts 119 on relay
115 S—2 closes and connects the positive side of battery 120 to the control keys CK. The other set of contacts 121 connects positive battery over conductor 122 through the cut-off segments of the middle ring of the distributor D in the dispatcher's station across
120 the brush to the middle collector ring, line L—3 to the middle collector ring on distributor D' at the substation, through the brush and corresponding segments, conductor 200, and thence through the winding of the cut-off relay COR, conductor 201, to the common
125 return L—4 connected to the midpoint of battery 120. This positive impulse operates the cut-off relay COR to the 1—3 and 2—5 contact position. The 2—5 contact of the
130

cut-off relay COR sends a positive impulse through the winding of the auxiliary power relay AR over the following circuit: positive side of battery 202, conductor 203, contact 2—5 of relay COR, conductor 204, auxiliary power relay AR, conductors 201, 205 to the common return L—4 connected to the midpoint of the battery 202. This positive impulse operates the auxiliary power relay AR to close its 1—3 and 2—5 contacts. The 1—4 contact of this relay in opening breaks the circuit of the power relay PR which releases. The lower set of contacts on this relay disconnects battery 228 from the operating or shifting magnets of all the power switches one of which P, only is shown. The upper set of contacts closes a circuit to operate all the indication transfer relays ITR and relay 11. The 1—3 contact of the set-up key SK which closes about $\frac{1}{2}$ second after the 1—2 contact closes, operates the relay S—3 over the following circuit: positive side of battery 115, conductors 116, 117, relay S—3, conductor 123, contacts 3—1 of the set-up key SK to the negative side of battery 115. Relay S—3 in operating allows a negative impulse to be sent from the contact of the control relay CK to segment 51 on the dispatcher's distributor to operate the relay L—1 at the substation which in turn will operate the control relay CR corresponding to the desired power switch. The circuit for operating relay L—1 is as follows: negative side of battery 120, conductors 124, 125, contact of control key CK, conductor 126, segment 51 which corresponds to control key CK, through the brush of the distributor to the inner ring of the distributor, conductor 127, make contact of relay S—3, conductor 128 to line L—1, over line L—1, to the distant substation, the 1—3 contact of cut-off relay COR, conductor 206, line relay L—1 to the common return L—4. Line relay L—1 in closing its 1—4 contact sends out a negative impulse to operate control relay CR corresponding to the power switch P it is desired to close. The circuit for relay CR is as follows: negative side of battery 202, contacts 4—1 of relay L—1, conductor 207, the 2—5 contact of auxiliary power relay AR, conductor 208, outer left armature and make contact of relay 11, conductor 215, outer ring of the substation distributor D', across the brush to segment No. 1, conductor 216, control relay CR, conductors 201, 205 to the common return wire L—4. This negative impulse operates control relay CR corresponding to power switch No. 1 to the 1—4 and 2—6 position. The 2—6 contact of the control relay CR which corresponds to power switch No. 1 sends out a negative impulse through the substation distributor segment No. 55 over the L—2 line through the winding of the relay L—2 to the L—4 line to operate the L—2 relay to operate indicating relay No. 1, corresponding to the control relay CR oper-

ated, which indicating relay will change the lamp signals to indicate the response of the control relay CR. The negative impulse which operates relay L—2 passes over the following circuit: negative side of battery 202, conductor 217, 218, the 2—6 contact of control relay CR, conductor 219, right armature and make contact of indication transfer relay No. 1, conductor 220, segment 55 of the distributor D' at the substation across the distributor brush to the inner distributor ring, conductor 221 to line L—2, thence to the dispatcher's station through line relay L—2 thereat to the common return line L—4. The line relay L—2 in operating on this negative impulse closes contact 1—4 which closes a circuit for indicating relay No. 1. This circuit is as follows: negative side of battery 120, conductors 130, 131, 1—4 contact of relay L—2, conductor 132 to the outer collector ring of the dispatcher's distributor across the brush to segment No. 5, conductor 133, indicating relay No. 1, conductor 134 to the common return L—4. This impulse operates indicating relay No. 1 to the 1—4 and 2—6 contact position. The 1—4 contact of the indicating relay lights the red lamp 101 and extinguishes the green and white lamps 102 and 100 respectively on the control key CK operated. The 2—6 contact opens a circuit momentarily which causes the alarm bell 106 to ring, which will be later described in detail.

In the meantime at the remote station relay 11 has sent out a negative impulse from segment 54 of the substation distributor over the L—2 line to operate line relay L—2 to the 1—4 contact position. This circuit is as follows: negative side of battery 202, conductors 217, 222, inner left armature and make contact of relay 11, conductor 223, segment 54 of the substation distributor, across the brush to the inner collector ring, conductor 221 to the L—2 line and thence to the dispatcher's station through line relay L—2 to the common return L—4. This impulse operates line relay L—2 to the 1—4 contact position. This contact operates the indicating relay No. 50 over the following circuit: negative side of battery 120, contact 1—4, conductor 132, outer collector ring, across the brush to segment 4, conductor 135, indicating relay No. 50, conductors 136, 137 to common return L—4. Indicating relay No. 50 moves to the 1—4, 2—6 position which lights a red lamp 111 and white lamp 110 and extinguishes the green lamp 112 on the operate key OK. It also rings the alarm bell 106. The set-up key SK in restoring and opening its 1—2—3 contacts allows relays S—2 and S—3 to release. The right armature of relay S—2 in falling back sends out a negative impulse over the L—3 line to operate the cut-off relay COR to the 1—4, 2—6 position. The circuit for operating relay COR is as follows: negative side of battery 120, (Fig. 1) conductor 130, 130

right armature and back contact of relay S—2, conductor 122, distributor cut-off segments, across the distributor brush to the L—3 line, thence to the distant substation, conductor 224, middle collector ring of the substation distributor D', across the brush to the cut-off segments, conductor 200, cut-off relay COR, conductors 201, 205 to common return L—4.

The set-up has now been made but the dispatcher cannot operate the power switch P until the set-up key SK has closed its 4—5 contact. This contact does not close until the set-up key has returned to its original position. The time interval between the breaking of the 1—2—3 contacts to the closing of the 4—5 contact in the set-up key should be about 2 seconds.

The dispatcher now presses the operate key OK which sends out a negative impulse to operate the auxiliary power relay AR to the 1—4 and 2—6 contact position. This circuit is as follows: negative side of battery 120, conductor 124, contact 4—5 of the set-up key SK, contacts of the operate key OK, normal contact of relay S—3, conductor 128, line L—1 to the distant substation, the 1—4 contact of cut-off relay COR, conductor 226, right armature and make contact of relay 11, conductor 227, 204, auxiliary power relay AR, conductors 201, 205 to the common return L—4. The 1—4 contact on the auxiliary power relay AR closes to operate the power relay PR over an obvious circuit. Power relay PR in operating permits the closure of the circuit of the magnet of power switch P, which was prepared by the operation of the control relay CR. This circuit is as follows: battery 228, conductor 229, the 1—4 contact of the control relay CR, auxiliary contacts on the power magnet P, lower winding of the power magnet, conductor 230, contacts of the power relay PR to the other side of battery 228. The circuit breaker or power switch is now closed and since the indication transfer relay is released upon the energization of the power relay these relays release their armatures and the control of the indication is transferred from the control relays to the auxiliary breaker contacts. Relay No. 11 in restoring sends a positive impulse through segment 54 over the L—2 line to operate line relay L—2 to the 1—5 position to change the lamp indications on the operate key OK to show the response of the substation equipment. This circuit is as follows: positive side of battery 202, conductors 203, 231, inner left armature and back contact of relay 11, conductor 223, segment 54 of the substation distributor D' across the brush to the inner collector ring, conductor 221, line L—2 to the distant dispatcher's office, line relay L—2 to the common return L—4. This positive pulse operates relay L—2 to its 1—5 position which contact sends a positive im-

pulse to the outer collector ring across the brush to segment No. 4 through the winding of the indicating relay No. 50. This circuit is as follows: positive side of battery 120, conductors 138, 139, the 1—5 contact of relay L—2, conductor 132, outer collector ring, across the brush to segment No. 4, conductor 135, indicating relay No. 50, conductors 136, 137 to the common return L—4. This positive impulse operates relay No. 50 to the 1—3, 2—5 contact position which lights the green lamp 112 and extinguishes the red and white indication transfer lamps 111 and 110.

A change in the position of power switch P changes the polarity of battery to the segment 55 in the same manner as that described for the operation of the control key at the dispatcher's station. For instance, if a power switch is opened the auxiliary contact 251 places positive current on the associated distributor segment 55, while on the other hand if the power switch is closed, the auxiliary contact places negative current on the associated segment. The path is as follows for positive potential: positive side of battery 202, conductor 203, auxiliary contact 251 of power switch P, conductor 203, normal contact of ITR relay No. 1 conductor 220, to segment 55. As the brush arms of the distributors at each end of the line rotate and pass over the segments, the potential of the inner segments which correspond to the power switches at the distant station is transmitted over the L—2 line. This operates the L—2 line relay at the dispatcher's station. The line relay repeats these impulses to the receiving collector ring and the outer segments of the distributor at the dispatcher's station, thence to the indicating relays. The impulses distributed to these relays operate each individual relay following a change in polarity caused by the operation of a power unit in the outlying station. Consequently all of the indicating relays at the dispatcher's station will correspond in position to the position of the power units which they indicate. The operation of the individual indicating relays changes the indicating lamps from red to green or vice versa.

Also in connection with any change in the position of power units at the substation followed by the change in indicating lamps, the alarm 106 will be operated and the auxiliary white lamp on the associated control key CK will be lighted and remain so until the incoming signal has been acknowledged by the dispatcher by changing the position of his control key CK.

The alarm bell 106 is operated by the momentary opening of the S—1 relay circuit through contacts on each of the indicating relays when any one of the indicating relays changes position from one side to the other. It will be noted that relay S—1 is normally

energized from battery 115 over conductors 140, 141, left armature and make contact of relay S—1, relay S—1, conductor 142, either the 2—5 or the 2—6 contact of the indicating relay No. 50 and either the 2—5 or the 2—6 contact of the indicating relay No. 1 to the other side of battery 115. This momentary opening of the circuit allows the S—1 relay to fall off, closing the circuit of bell 106. At the instant the alarm bell is energized the S—4 relay will operate in series therewith from battery 115 over an obvious circuit, and the armature of relay S—4 restores the S—1 relay to its normal energized condition. The bell key 107 is provided so that the alarm bell 106 may be either single stroke or continuous ringing at the discretion of the dispatcher. The phasing bell 109 and lamp 108 are operated whenever the distributors are out of synchronism. This is brought about by using certain ones of the middle row of segments adjacent to the middle collector rings on the distributors. At the distant station segments 233 in this row are connected over conductors 234 through a back contact of the relay 11, contact 1—4 of relay COR to the L—1 line. At the dispatcher's station the L—1 line is connected through a back contact on relay S—3 to the upper set of normally closed contacts on the operate key OK to the winding of the S—5 relay to the midpoint of battery 120. The brush on the distributor at the dispatcher's station leading to the L—3 line has positive or negative battery thereon from segments on D except when passing over the dead segments 144. If the two distributors are running exactly in synchronism relay S—5 connected to line L—1 will not receive any current. If the distributor at the dispatcher's station is running faster or slower than the distributor at the distant station the S—5 relay will receive pulses of current and will operate the phasing bell 109 and lamp 108 intermittently. This will indicate that the distributors are out of synchronism and not properly operating and that therefore no control key should be operated before correcting their condition. This arrangement for giving a signal when the distributors are out of synchronism by an amount less than that required to operate the automatic synchronizing means is described in detail and claimed in Patent No. 1,719,506 dated July 2, 1929, to J. C. Field and therefore need not be further described since it forms no part of this invention.

If the dispatcher so desires he can perform a number of control operations at the same time by simply turning the desired control keys before turning the set-up key. Any control operation made may be canceled by turning that key to its original position before turning the set-up key. The white lamp 103 is provided for the purpose of indicating to the dispatcher the condition of the line wire

L—2 and that the incoming signals from the auxiliary breaker contacts are being received. Red and green lamps 105 and 104 are for the purpose of indicating to the dispatcher that the synchronizing circuit of the distributors over the L—3 line is operating properly. The red lamp 105 will flash each time that the right release magnet 114 of the distributor is energized, while the green lamp 104 will flash each time that the left release magnet is energized.

What is claimed is:

1. In a remote control system, the combination with a dispatcher's station and a substation, power switches thereat, a pair of lamps at the dispatcher's station for each power switch, a polarized relay at the dispatcher's station for each pair of lamps, auxiliary signaling contacts on each power switch, battery connections thereto adapted to be reversed by the shifting of the power switch to cause said relay to change the indications of said lamps, of a series of polarized relays at the substation for said power switches having similar battery connections adapted to be substituted for the auxiliary signaling contacts of the corresponding switches, electromagnetic means at the substation controlled from the dispatcher's station for effecting the substitution, a signal at the dispatcher's station operated thereby, means at the dispatcher's station for operating a given polarized relay at the substation, said relay in shifting the battery connections operating the corresponding polarized relay at the central office to change the indications of the pair of lamps controlled thereby, means controlled by the dispatcher for restoring said electromagnetic means, a signal at the dispatcher's station operated thereby, a circuit for applying power to the shifting magnet of the selected switch, said circuit including contacts of the polarized relay at the substation whose position has been changed, and means controlled by the dispatcher for closing said circuit.

2. In a remote control system, the combination with a dispatcher's station and a substation, power switches thereat, a pair of lamps at the dispatcher's station for each power switch, a polarized relay at the dispatcher's station for each pair of lamps, auxiliary signaling contacts on each power switch, battery connections thereto adapted to be reversed by the shifting of the power switch to cause said relay to change the indications of said lamps, of a source of current normally connected to the shifting magnets of said power switches, a cut-off relay for disconnecting said source therefrom, a series of polarized relays for said power switches having similar battery connections adapted to be substituted for the auxiliary signaling contacts of the corresponding switches, transfer relays for effecting such substitution, means including a common set-up key at the dispatcher's station to operate

said cut-off relay to energize said transfer relays and disconnect said current source from said shifting magnets, a control key at the dispatcher's station for each power switch adapted when operated to actuate the corresponding polarized relay at the substation, the reversal of said battery connections upon the response of said polarized relay changing the indications of said pair of lamps, a common switch operating key at the dispatcher's station, a pair of lamps for each key, said transfer relays in operating changing the indications of said lamps, means actuated by the operation of said latter key to reconnect said source to the shifting magnets and release said transfer relays, whereupon a circuit is closed to operate the shifting magnet of the selected power switch, said circuit including contacts of the shifted polarized relay, said transfer relays in releasing again changing the indication of the lamps associated with the operate key.

3. In a remote control system, a dispatcher's station and a substation, circuit breakers thereat, a control and indicating panel at the dispatcher's station having a control key and three lamps for each circuit breaker, polarized control relays at the substation for said circuit breakers, means for lighting one of said lamps when the corresponding relay or circuit breaker is in the opposite position to the position indicated by the control key, one or the other of the remaining lamps being lighted depending on the open or closed position of the corresponding breaker, a common set-up key, a common operate key and lamps associated therewith, means operated by the actuation of the set-up key to remove the power source from the breakers, means actuated thereby to change the indications of said lamps associated with the operate key, means actuated by the joint operation of a control key and set-up key to operate the corresponding polarized relay, means actuated thereby to send back an impulse to extinguish the two lighted lamps of said control key and light the remaining lamp to indicate to the dispatcher the response of said polarized relay, means including a switch operating key to reconnect the power source to the breakers, whereupon a circuit is closed to operate the shifting magnet of the selected breaker, said circuit including contacts of the shifted polarized relay, and means at the substation actuated by the operation of said latter key to transmit an impulse to change the indications of the lamps on said operating key to indicate to the dispatcher that the apparatus has functioned to close the breaker circuit.

In witness whereof, I hereunto subscribe my name this 31st day of January, 1929.

JOSEPH C. FIELD.