

Feb. 24, 1931.

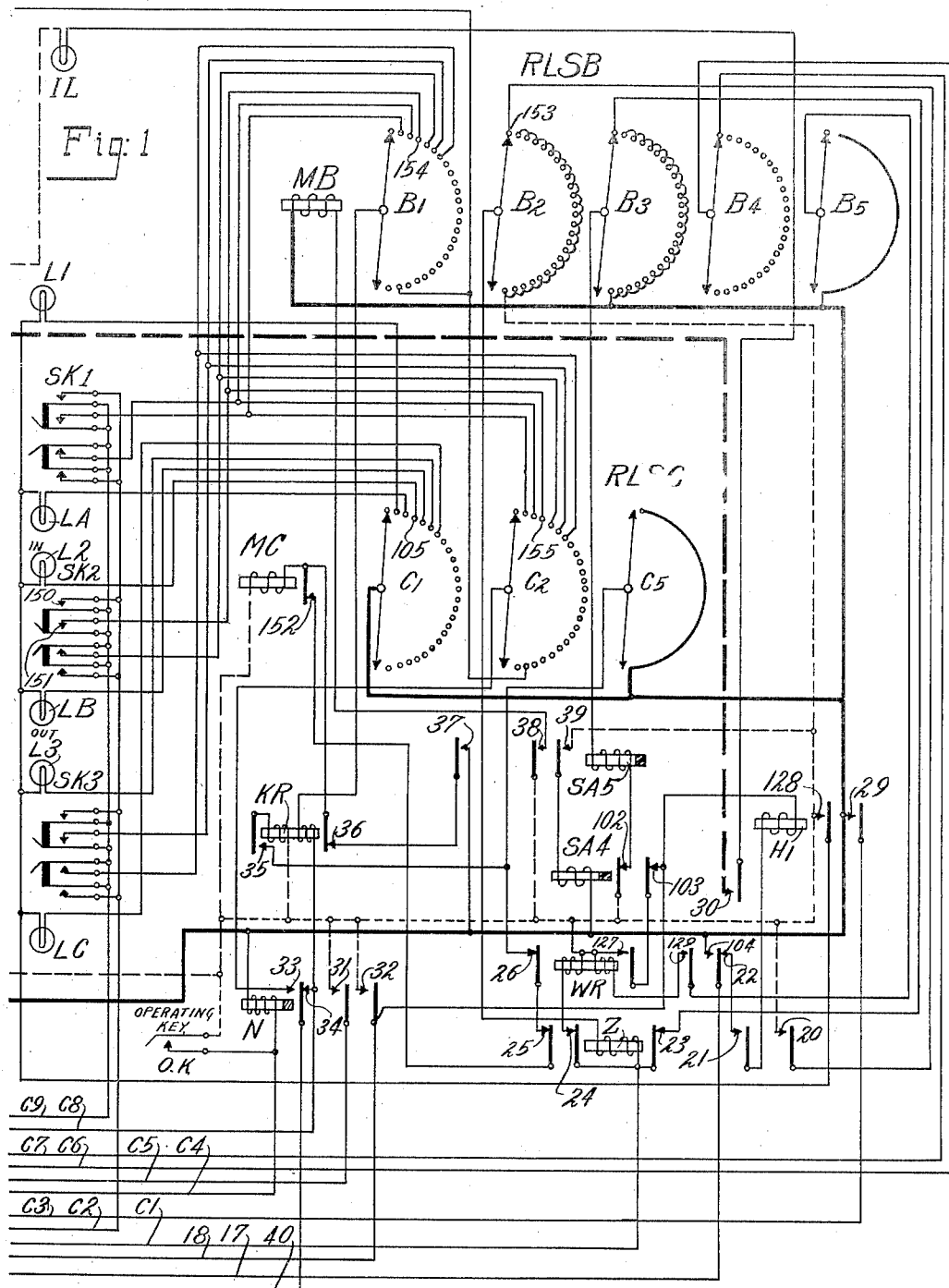
C. REMINGTON

1,793,828

REMOTE CONTROL SYSTEM

Filed June 11, 1927

4 Sheets-Sheet 1



Inventor
Charles Remington

Wm. Walter Cawen Atty.

Feb. 24, 1931.

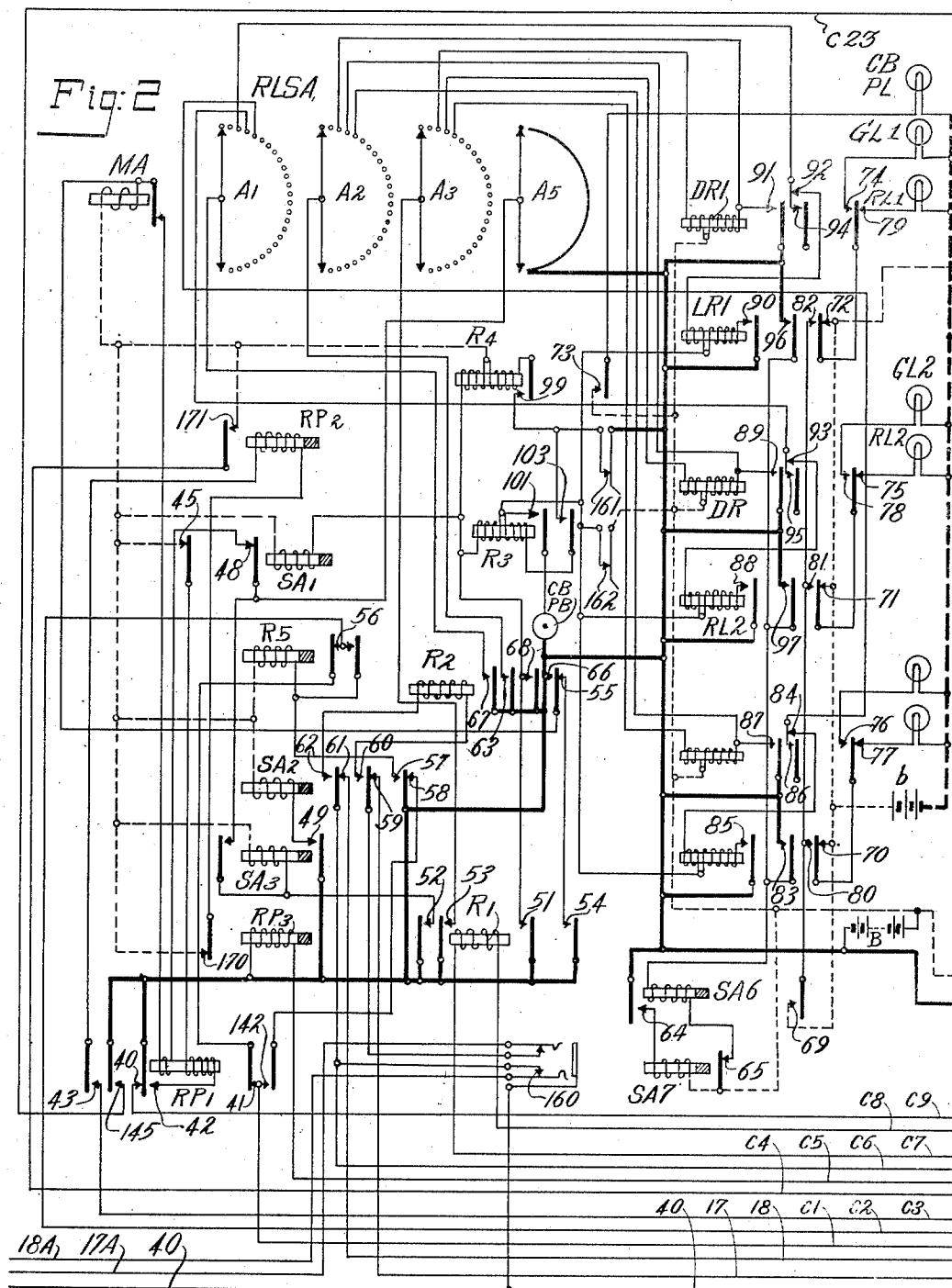
C. REMINGTON

1,793,828

REMOTE CONTROL SYSTEM

Filed June 11, 1927

4 Sheets-Sheet 2



Inventor
Charles Remington

Wm. Walter Owen, Atty.

Feb. 24, 1931.

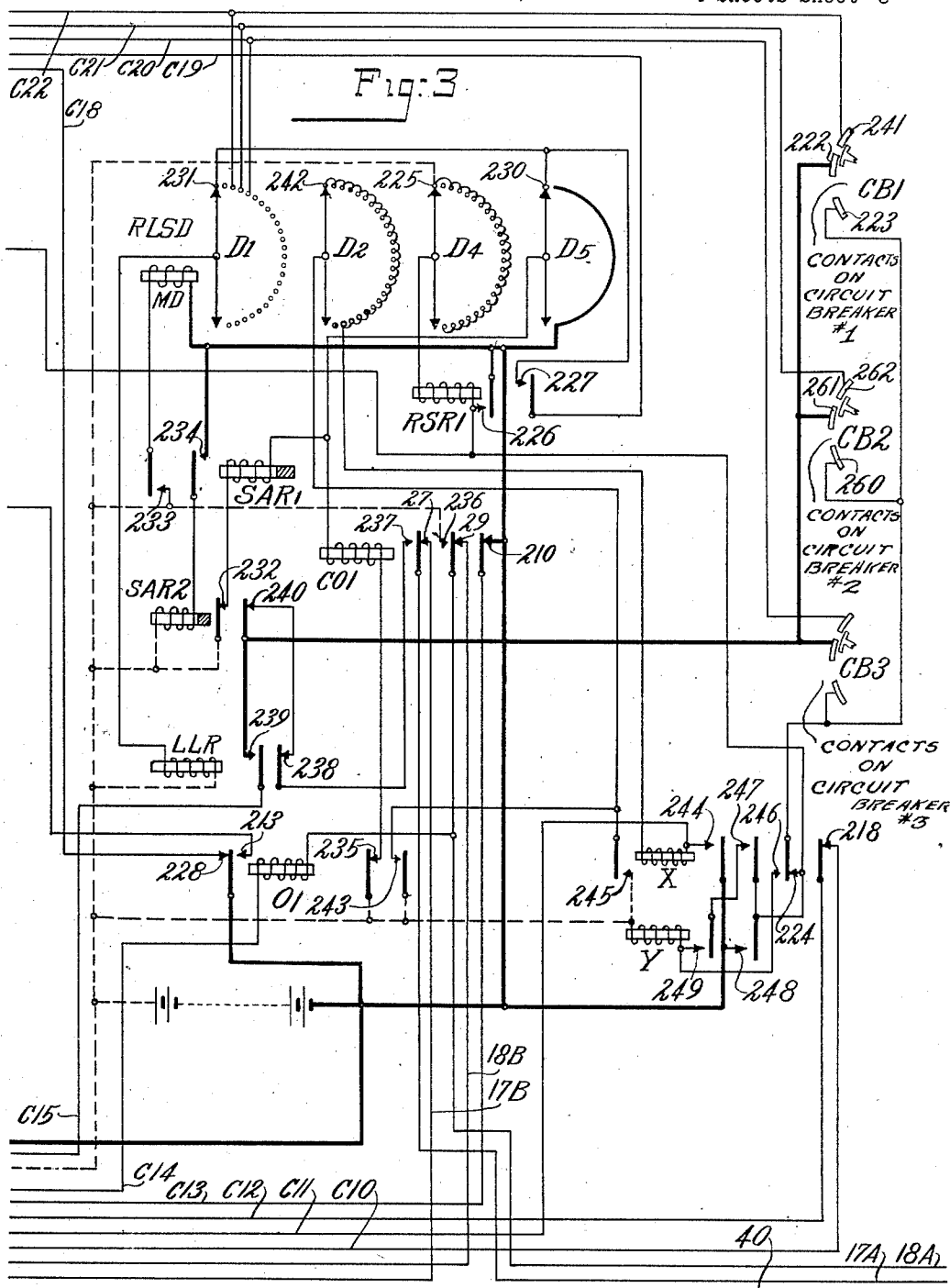
C. REMINGTON

1,793,828

REMOTE CONTROL SYSTEM

Filed June 11, 1927

4 Sheets-Sheet 3



Inventor
Charles Remington
By *Wm. H. C. C. Atty.*

Feb. 24, 1931.

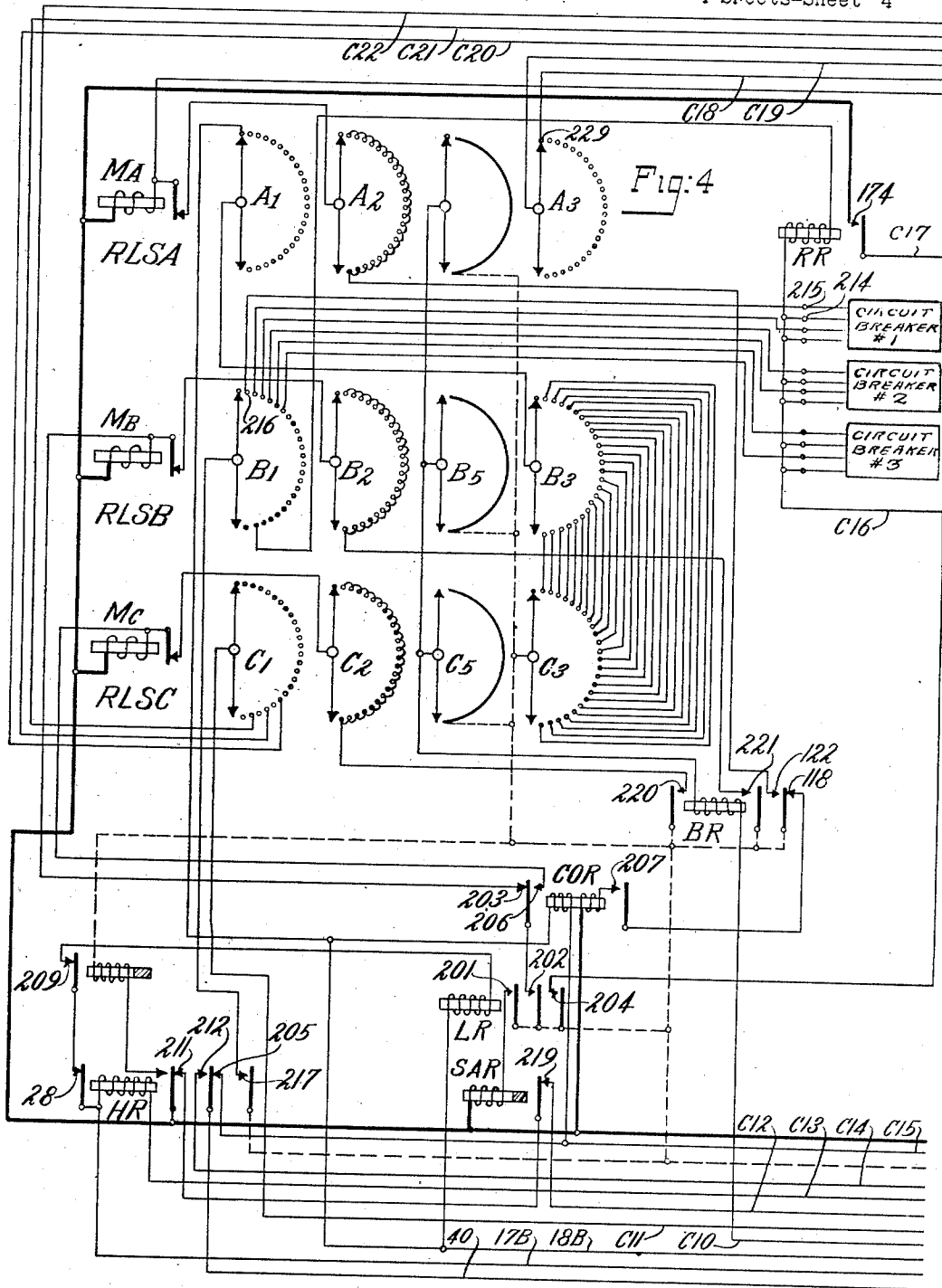
C. REMINGTON

1,793,828

REMOTE CONTROL SYSTEM

Filed June 11, 1927

4 Sheets-Sheet 4



Inventor
Charles Remington
Wm. Walter Owen Atty.

UNITED STATES PATENT OFFICE

CHARLES REMINGTON, OF LIVERPOOL, ENGLAND, ASSIGNOR TO ASSOCIATED TELEPHONE AND TELEGRAPH COMPANY, OF KANSAS CITY, MISSOURI, A CORPORATION OF DELAWARE

REMOTE CONTROL SYSTEM

Application filed June 11, 1927, Serial No. 198,173, and in Great Britain July 16, 1926.

The present invention relates in general to remote control and supervision systems, and more specifically to such systems in which the operation and supervision of power switching devices is performed from a distant station, and the principal object of the invention, briefly stated, is the provision of a new and improved remote control and supervision system, the improvements making the operation of the system more positive and more reliable, and making its original cost and maintenance expense substantially lower.

In general, the present invention relates to improvements in my copending applications Serial Numbers 86,383, filed Feb. 6, 1926, and 109,325, filed May 15, 1926, although the particular novel features disclosed herein are not necessarily limited in the application to disclosures of those applications but can be applied to other systems.

The systems of the foregoing applications employ a pulsing scheme in which the sending switch at the dispatcher's station sends out a fixed number of impulses each time it is operated, one of these pulses being of different polarity from the rest to designate the signal then being transmitted. At the substation, three switches are operated by these impulses, the first and second switches being operated until the reversed impulse is received and the first and third switches, after that pulse is received. The reversed pulse controls the switch over from the second to the third switches through a polarized relay. If the second and third switches have been properly set the dispatcher may operate the selected device by throwing an operating key.

As a further object of the present invention, I have provided a second switch at the dispatcher's office, which switch is operated in synchronism with the sending switch until the distinctive pulse is sent. This second switch is then stopped, to prepare circuits which cooperate with the second and third substation switches to more positively check the impulsing operation, apprising the dispatcher if the switches are correctly set.

As a further object of my invention, I simplify the equipment by eliminating the polar-

ized relays which control the change over from the second to the third substation switch, and substituting therefor relays which are controlled by a pulse of the same polarity as the other pulses of the series.

In connection with the supervisory signals sent by the sender in the substation to indicate the positions of the circuit breakers I provide, as a further object, circuit arrangements for causing the substation sender to repeat the supervisory signals in case the check back indicates that the supervisory switch in the dispatcher's station has not been properly set in response to the impulses transmitted by the substation sender.

Further objects of my invention, not specifically mentioned here, will be apparent from the detailed description and drawings which follow.

One example of carrying the invention into effect will be described with reference to the accompanying drawing which illustrates one form of the invention. It is of course understood that considerable variations may be made from this example without departing from the spirit of the invention.

Fig. 1 illustrates the selecting equipment at the main station, Fig. 2 the supervisory equipment. Fig. 4 the selecting equipment at the substation and Fig. 3 the supervisory equipment.

The drawings should be placed in the following order: Fig. 4 at the extreme left and Figs. 3, 2 and 1 successively to the right of this figure.

Referring to Fig. 1 the selecting equipment comprises two quick acting relays Z and H1, two locking relays KR and WR and three sluggish relays N, SA4 and SA5. In addition a selecting key (SK1, SK2, SK3) having two way operation is provided for each circuit breaker to be controlled moving one way to put the circuit breaker in and the opposite way to pull the circuit breaker out. An operating key OK common to all the keys is also provided for the purpose of effecting the actual operation. In addition two rotary line switches are provided namely rotary line switch RLSB and rotary line switch RLSC. Rotary line switch RLSB functions

as a counting switch and moves through a complete cycle for the transmission of impulses, while rotary line switch RLSC functions as a control switch and only moves as far as a contact by the selecting key operated and serves to select the indicating lamps L1, L2, L3, LA, LB, LC, two of which, such as L1, LA or L2, LB or L3, LC are associated with each key. These lamps are lit when a proper check is received to indicate that the apparatus at the substation has been correctly selected, and that accordingly the correct circuit breaker has been selected. The function of the relays is briefly as follows: the two slow acting relays SA4 and SA5 are for the purpose of interacting with each other to control the transmission of impulses, while one slow acting relay N is adapted to be energized when the operating key OK is depressed to effect certain operations which will be described in detail when describing the complete operation. Of the two locking relays the first KR is provided to energize when a marked contact is reached by the wiper of rotary line switch RLSC to prevent its operating magnet operating further at this time. A second locking relay WR is energized immediately any key is depressed, and effects certain functions initially at the commencement of the transmission of the selecting impulses. Of the quick acting relays one (Z) is energized on the first step of the rotary line switch RLSB and is locked energized until all the keys are restored to normal, while the other relay H1 is energized when the apparatus at the substation is set so as to select a particular circuit breaker to be operated and remains energized as long as the selecting condition remains to enable the operation to be performed whenever the operating key is depressed. For the purpose of this description, accounts will be given of the operations at the control room and the substation separately, it being considered sufficient to indicate the various controls which are effected in the control room to bring about the desired result at the substation, the operations thereat being then described. It will therefore be assumed that the first operation is to put circuit breaker No. 2 in. For this purpose the selecting key SK2 is moved so as to close its upper contacts 150, 151. The closure of contact 150 completes a circuit for the left hand winding of relay WR as follows: positive pole of battery B (represented by thin dotted lines throughout the drawings), left-hand winding of relay WR, contact 24, conductor C1, contact 41, contact 56, conductor C2, contact 150, switch SK2, conductor C9, contact 40, the negative pole of battery B (represented by thick full lines). Relay WR therefore energizes; at the same time a branch circuit is completed over the back contact 23 of the rotary line switch RLSB, wiper B3, relay SA5, back contact 102 of relay SA4 to positive pole of battery B. Relay SA5 thereby energizes. Relay WR in energizing connects negative pole of battery B to the lead 17 which extends over the contact 59 of relay SA2 associated with the supervisory equipment to the lead 17A extending to the substation, and positive pole of battery B over contact 103 of relay SA4 to the lead 18 which extends over another back contact 61 of relay SA2 to the lead 18A extending to the substation. This is the preparatory condition for effecting the apparatus at the substation. In addition a locking circuit is prepared for the right-hand winding of relay WR as follows: positive pole of battery B, contact 129, wiper B5, to negative pole of battery B, but is not completed until wiper B5 has been stepped off normal. When wiper B5 is stepped to an off normal position the locking persists until the wipers again reach the normal position. Further a point is opened at contact 26 in the circuit of operating magnet MC of rotary line switch RLSC in the circuit including its self-interrupting contacts 152. Relay SA5 on energizing connects positive pole of battery B to the operating magnet MB of the rotary line switch RLSB at contact 38, thereby energizing this magnet. It also completes a circuit for relay SA4 at contact 39 and for operating magnet MC at contact 37. Magnet MC and magnet MB are therefore both energized, the wipers of these switches however do not step, as the arrangement is such that this type of switch only steps on the de-energization of the magnet. Relay SA4 on energizing opens the circuit of relay SA5 at contact 102, disconnects positive pole of battery B from the line 18A at contact 103, thereby sending a positive impulse to the substation and connects negative pole of battery *b* (shown in thick dotted lines throughout Figs. 1 and 2) at contact 30 to the impulsing lamp IL which has its other terminal connected to the positive pole of battery *b*, the impulse lamp therefore lights. SA5 on de-energizing opens the circuits of magnet MB, MC at contacts 38, 37 respectively, and SA4 causing magnets MB and MC to de-energize so that the wipers of the rotary line switches RLSB and RLSC advance one step and also causes relay SA4 to de-energize. Relay Z now energizes in the following circuit: positive pole of battery B, wiper B2 of rotary line switch RLSB in off normal position, relay Z, conductor C1, contact 41, contact 56, over conductor C2, contact 150, conductor C9, contact 40 to negative pole of battery B; and opens the original energizing circuit at contact 24 for the left-hand winding of relay WR, and the original energizing circuit for relay SA5 at contact 23, over wiper B3, relay WR remaining energized over the locking winding previously

described, while relay SA5 connected to wiper B3 is connected to negative pole of battery B independently. Relay Z also opens a point at contact 25 in the circuit of the interrupter contacts 152 of magnet MC, it also connects positive pole of battery B to the normal contact 153 engaged by wiper B2 at contact 20, and relay H1 at contact 21 to back contact 22 of relay WR so that when this relay de-energizes the relay H1 is connected between the lines 17A and 18A. The wipers of the rotary line switches RLSB and RLSC continue to advance under the control of SA4 and SA5 until the contacts marked by the selecting key SK2 are reached. These contacts are the fourth contacts engaged by the wipers C2 and B1 respectively. The wiper C2 is not at this time in an active condition as relay N is not energized, but the wiper B1 completes a circuit: negative pole of battery B, contact 40, conductor C9, contact 151, contact 154, wiper B1, winding of relay KR, contact 34 to the lead 40. Current is thereby transmitted over a circuit including the leads 40 and 18A at this instant, which serves the double purpose of operating relay KR and of operating a switch-over relay at the sub-station. It should be mentioned that other impulses similar to the first described impulse to the substation, are sent each time relay SA4 opens and closes its contacts, so that one impulse is sent to the substation for each step made by the rotary line switches RLSB and RLSC. When relay KR operates it closes a locking circuit for itself as follows: negative pole of battery B, wiper C5, contact 35, left-hand winding of relay KR, positive pole of battery B. Relay KR therefore remains energized as long as the rotary line switch RLSC is in an off normal position; relay KR opens the impulsing circuit for magnet MC at contact 36. Magnet MC therefore ceases to operate to further impulses and remains with its wiper C1, C2 resting on the fourth contacts. The rotary line switch RLSB however continues to rotate until a number of impulses corresponding to the movement of a rotary line switch RLSB through a complete cycle is completed. When this occurs, provided the apparatus at the substation has operated correctly, battery will be connected at the substation to the leads 17A and 18A. In the meanwhile at the control room the locking circuit for relay WR will have been opened due to wiper B5 reaching the normal contact, relay WR accordingly de-energizes. Relay Z is however still energized because positive battery is supplied to the normal contact of wiper B2 over its own contact 20, relay Z being of course connected to negative pole of battery B as long as a selecting key is depressed. It will be noted that this relay cannot therefore restore until all the selecting keys have been put back to normal. Relay WR in de-energizing disconnects negative pole of battery B from the lead 17A at contact 22 and at the same time connects relay H1 across the lines 17A and 18A, over contacts 21, 22. Relay H1 responds to battery supplied back from the substation at this time as will be described hereinafter, and connects positive pole of battery B at contact 128 to one side of the lamps marked "In" and "Out", associated with the selecting keys, connects negative pole of battery B over contact 29, conductor C3 to contact 43 of relay RP1 for a purpose to be described later. The lamp marked "In" associated with the selecting key SK2 has its other terminal connected over the fourth contact 105, wiper C1 to negative pole of battery B, and accordingly this lamp energizes and as it corresponds to the selecting key SK2 and to the direction in which the selection key has been operated, namely to operate the upper or "in" springs, it serves as a direct check to the attendant. The attendant can now operate the selected apparatus at the substation and for this purpose he presses his operating key OK. When this occurs, a circuit is completed for relay N as follows: positive pole of battery B, operating key OK, relay N, negative pole of battery B. Relay N energizes, opens the initial energizing contact of relay KR at contact 34 and completes a circuit as follows: negative pole of battery B, contact 40, conductor C9, contact 151 of the selecting key SK2, fourth contact 155, wiper C2 at contact 33 to the lead 40, thereby effecting the operation of the selected apparatus at the substation, as it also connects positive pole of battery B at contact 32 to the lead 18A, thus completing the return circuit for effecting the operation. It completes a circuit for relay RP3 as follows: positive pole of battery B, contact 31, conductor C5, relay RP3 to negative pole of battery B for a purpose to be described later. Relay N being slow acting ensures that the operating circuit is closed for a sufficient interval of time, even if the operating key is only pressed momentarily. Preferably this operating key is of the self restoring type and cannot therefore remain in the operated position after once the attendant has ceased to press it.

Having seen that everything has operated correctly whether the selection only or the selection and operation, the attendant restores his selecting key to normal, whereupon relay Z de-energizes; relay Z in de-energizing opens its own locking circuit at contact 23, so that it cannot energize immediately another key is depressed, and closes its back contacts 24 and 25. The closure of both these contacts is without effect. It will have been noticed that relays SA5 and SA4 cease to operate when the wiper B3 reaches the normal contact because of relay Z being energized as long as the selecting key SK2

was depressed. A circuit is closed for magnet MC, negative pole of battery B, wiper C5, contacts 26, 25, interrupter contacts 152, magnet MC, to positive pole of battery B. Magnet MC therefore operates under the control of its own interrupter contacts to advance the wipers to normal. The circuit of relay H1 is opened at contact 21 by relay Z, and therefore this relay de-energizes and everything is now restored to normal.

Before considering the reception of selecting signals at the substation, for which reference should be had to Fig. 4, it will be well to review briefly the circuits completed to the leads 17A, 18A and 40 at the control room. These are: firstly, battery is connected across the leads 17A and 18A. Secondly, positive impulses are transmitted over lead 18A while negative battery is maintained over lead 17A. Thirdly, when a marked contact is reached, negative battery is connected to lead 40. Fourthly, when a complete cycle of impulses (say 25) have been sent over the leads 17A and 18A, battery is connected across the leads 17A and 18A at the substation and relay H1 is connected across the leads 17A and 18A at the control room in place of battery. Fifthly, to operate the selected apparatus, negative pole of battery is connected to lead 40 momentarily. Sixthly, the circuit for relay H1 across the leads 17A and 18A is opened to restore the selecting equipment at the substation.

It will be noted that the line relay LR (Figure 4) is connected between the conductors 17A and 18A as follows:—conductor 18A, contact 29, conductor 18B, relay LR, contact 209, contact 28, conductor 17B, contact 27, conductor 17A, consequently when battery is connected across the leads 17A and 18A at the control room, the line relay energizes and at contact 201 completes a circuit for relay SAR, at contact 202 for magnet MB of the rotary line switch RLSB over contact 203 and at contact 204 for magnet MA of the rotary line switch or counting switch RLSA. When the pulses are received the magnets MA and MB step the wipers of their respective switches one step at a time, when the contact marked by the selecting key at the control room is reached as previously described, a circuit is completed from negative pole of battery B over conductor 40, over contact 205, the right-hand winding of relay COR, to lead 18B, contact 29, and conductor 18A which is connected to positive pole of battery B. Relay COR accordingly energizes and substitutes the magnet MC of the rotary line switch or checking switch RLSC in place of magnet MB by opening contact 203 and closing contact 206. The rotary line switch RLSB therefore functions as a selecting switch and rests with its wipers on the fourth contact, while magnet MA continues to step on but this time with the magnet MC.

Relay COR completes a locking circuit for itself at contact 207 over the back contact 118 of relay BR. The line relay proceeds to receive pulses, so that in all it receives 25, the number of steps taken by the rotary line switch RLSB at the control room, and RLSA and RLSB and RLSC jointly at the substation. When this cycle has finished, the rotary line switch RLSA will have restored to normal. The rotary line switch RLSB will have its wipers resting on the fourth contact, and the rotary line switch RLSC will have its wipers resting on the twenty-first contact. In this position as battery is disconnected from across the leads 17A and 18A at the control room, the line relay LR de-energizes; shortly after the relay SAR de-energizes. The circuits of the magnets MA, MB and MC are opened. Battery will then be fed to the control room as follows:—positive pole of battery B, wiper C3, wiper B3 and the contacts on which these wipers are resting, wiper A1 and its normal contact to conductor 18B, contact 29 to conductor 18A, and negative pole of battery, contact 210, conductor C13, relay HR, conductor 17B, contact 27, conductor 17A. Relay HR at the substation energizes in series with relay H1 at the control room, disconnects the line relay from across the conductors 17A and 18A at contact 28, opens a point in the circuit of relay BR at contact 211, disconnects conductor 40 from the cut-off relay COR at contact 205 and connects it up at contact 212 over conductor C14 to relay O1, the other winding of which is connected to conductor 18A. Consequently at this time it is possible for the operator at the control room, by pressing the operating key, and thereby connecting battery between the conductors 40 and 18A to operate relay O1, thereby effecting the putting in of circuit breaker No. 1 as follows:—negative pole of battery B, contact 213, conductor C16, terminal 214, interposing relay for operating circuit breaker No. 1 (not shown), terminal 215, fourth contact 216 of wiper B1, wiper B1, contact 217 to positive pole of battery B. Relay O1 also serves the purpose of preventing the sending of supervisory signals from the substation, while the operation is in progress, as will be apparent by the further description. Additional means which will be described later are provided for preventing the transmission of supervisory signals while the selecting operation is in progress.

Having effected the desired operation and having restored the selecting key to normal the circuit in which relay HR is energized is opened as well of course as the circuit for relay O1 and the interposing relay. Relay O1 in de-energizing simply permits the transmission of supervisory signals whereas the relay HR in de-energizing completes a circuit for relay BR as follows:—positive pole of

battery B, wipers B5 or C5 (in parallel as long as both switches are off-normal) relay BR, conductor C10, contact 218, conductor C12, contacts 219, 211 to negative pole of battery B. Relay BR energizes and completes a circuit at contacts 220 and 221 for interrupter contacts and magnet MC and for interrupter contacts and magnet MB. Magnets MB and MC therefore operate to open their interruption contacts and step the wipers B1, B2, B3 and B5 and wipers C1, C2, C3 and C5 respectively to normal. It will be noted that relay BR also closes a contact 122, which is without effect as the wiper A2 is then in normal position. If however for any reason the wiper A2 had stuck in an intermediate position, this circuit would have served to restore it to normal by energizing the magnet Ma through its interrupter contacts. Relay BR by opening contact 118 opens a locking circuit for relay COR which deenergizes, the line relay and relay SAR having already deenergized immediately subsequently to the transmission of the selecting impulses and consequently everything is now restored to normal.

A description will now be given of the transmission of supervisory signals when a circuit breaker changes its position, whether automatically or under the control of an attendant. A description will be first given with reference of Fig. 3 which shows the substation equipment. When the circuit breaker No. 2 is put in due to the operation previously described, a rotary brush controlled thereby momentarily connects two segments together, thereby completing a circuit for relay RSR1 as follows:—negative pole of battery B, segments 261, 260, contact 224, relay RSR1, wiper D4, normal contact 225 to positive pole of battery B. Relay RSR1 energizes and completes a locking circuit for itself over contact 226 independently of the transitorily closed contact between the segments. It also completes a circuit, provided the rotary line switch RLSA is in normal position for slow relay SAR1 and relay LLR at contact 227. These circuits may be traced as follows:—negative pole of battery B, contact 228, conductor C18, normal contact 229, wiper A3, conductor C19, contact 227, normal contacts 230, 231 where the circuit divides, one part passing over wiper D1, relay LLR to positive pole of battery and the other part passing over wiper D5, relay SAR1, contact 232 to positive pole of battery B. These circuits are so arranged that only provided the rotary line switch RLSA is at normal, and that relay O1 is not energized, that is provided no selecting signals are being transmitted and provided that no circuit breaker is being operated, can the relays SAR1 and LLR energize. Relay SAR1 on energizing completes a circuit for magnet MD at contact 233. Magnet MD accordingly energizes.

A circuit is also completed at contact 234 for relay SAR2 which energizes. It should be mentioned that a circuit in parallel to the circuit through relay SAR1 extends to relay CO1 and thence over contact 235 to positive pole of battery. Relay CO1 on energizing opens contact 210 to prevent relay HR from energizing and to prevent battery being transmitted back over the conductors 17A and 18A, disconnects the conductor 18A from the conductor 18B and the line relay LR at contact 29, and connects positive battery to said conductor at contact 236, disconnecting conductor 17A from the selecting equipment, and connects it at contact 237 to contact 238 opened by relay LLR which energizes at the same time as relay CO1. Relay LLR in addition connects negative pole of battery B over conductor C15 to the lead 40 at contact 239 over contact 205. It will therefore be seen that on the initial step, a circuit is completed over the conductors 18A and 40 due to the fact that negative pole of battery B is connected to the conductor 40 and positive battery to the conductor 18A. This prepares the supervisory equipment at the control room. Relay SAR2 is energized shortly after this by relay SAR1, over contact 234, and opens the circuit of relay SAR1 at contact 232 and a point in the circuit already opened by LLR at contact 240. Relay SAR1 accordingly deenergizes and opens the circuit of magnet MD which advances the wipers D1, D2, D4 and D5 one step, at wiper D4 the circuit of relay RSR1 is opened so that this relay accordingly deenergizes and opens the original energizing circuits for relay SAR1, CO1, and LLR. LLR remains deenergized as its circuit is also opened at wiper D1, but wiper D5 connects negative pole of battery B direct to relays SAR1 and CO1. Relay SAR1 therefore is in a position to energize whenever relay SAR2 is deenergized while the relay CO1 remains locked energized. Relay SAR1 on deenergizing opens the circuit of relay SAR2, so that this relay shortly after deenergizes. Relay LLR also being deenergized battery is connected across the conductors 17A and 18A, positive to conductor 18A and negative to conductor 17A, to effect the next operation at the control room. It will be noticed that relays SAR1 and SAR2 intermittently energize and consequently pulses are continued so that the wipers step successively back to the normal position and pulses are sent correspondingly over conductors 17A and 18A. During its stepping each time the wiper D1 reaches a contact connected to negative pole of battery B, a circuit is completed for relay LLR from the segments of the circuit breakers which are in so that LLR energizes and connects negative pole of battery to lead 40, and at contact 238 opens the circuit across the conductors 17A and 18A which circuit is open at 240. Relay LLR deenergizes im-

mediately wiper D1 leaves the contact corresponding to the circuit breaker which is in, that is when relay SAR2 is deenergizing, and is therefore without effect as regards impuls-
 5 ing over the conductors 17A and 18A. Negative pole of battery is connected to the contacts stepped over by the wiper D1 for each time that a circuit breaker is in, for instance when circuit breaker No. 1 is in, negative pole
 10 of battery is connected via rotary brush between the two upper segments 222, 241 as shown and thence to the third contact engaged by wiper D1. If circuit breaker No. 2 was in, negative pole of battery would have
 15 been connected over segments 261, 262 to the fourth contact and similarly with the other circuit breakers, so that LLR sends an impulse over the lead 40 for each circuit breaker that was in, that is it completes a circuit between
 20 the conductors 18A and 40 momentarily. When the switch reaches normal position, CO1 and SAR1 restore to normal, and everything is then restored to its original condition with battery disconnected from all three con-
 25 ductors 17A, 18A and 40.

It may be mentioned at this point that if the selecting equipment is operated to put a circuit breaker in, when the wiper C1 at the
 30 substation is set on a contact corresponding to that circuit breaker, and the operating key depressed so that relay O1 would be energized, a circuit is completed as follows, as soon as the circuit breaker is actually in:—
 35 negative pole of battery B, segments 261, 262 engaged by rotary brush, conductor C21, twenty-third contact engaged by wiper C1 of rotary line switch RLSC, wiper C1, conductor
 40 C11, relay X, wiper D2 of rotary line switch RLSD, its normal contact, contact 243 of relay O1 to positive pole of battery B. Relay X on energizing effects the following circuit changes: It completes at contact 244 a
 45 locking circuit for itself independent of the circuit over wiper C1, and at contact 245 a locking circuit for itself dependent on wiper D2 and its normal contact but independently of the contact of relay O1, at contact 224 it
 50 opens the circuit of relay RSR1, and at contact 246 prepares a circuit for relay Y so that this relay will energize if the circuit breaker should immediately come out, and a momentary circuit be completed between the
 55 lower segments 261, 260 engaged by the rotary brush. Relay X closes at contact 247 a point in a circuit which however has no effect at this time, opens at contact 218 a point in the circuit of relay BR to prevent this relay energizing, and thereby prevents the
 60 rotary line switches RLSC and RLSD from restoring to normal. Relay Y on energizing at contact 248 connects negative pole of battery to the upper winding of relay RSR1 thereby energizing this relay, and completes a locking circuit for itself at contact 249.
 65 Relay RSR1 then proceeds to effect the opera-

tion of the transmission of supervisory signals, the operation proceeds as before, except that as negative pole of battery is connected over the circuit, contact 244, conductor C11, wiper C1 and its twenty-third contact, to the fourth contact in the bank of
 70 wiper D1 corresponding to the particular circuit breaker discussed, and relay LLR to positive pole of battery B, the signal sent will be that the circuit breaker is in although
 75 actually it may be out. This signifies that the circuit breaker has actually moved to the "in" position. When wiper D2 reaches its twenty-fifth contact, the locking circuit of relay X is opened and this relay releases as also
 80 does relay Y. Relay BR energizes and the selecting equipment returns to normal. Relay RSR1 having de-energized as before on the first step of D4 has energized again owing
 85 to relay Y being held energized, while the locking circuit for relay RSR1 is open, and so the supervisory signals are repeated and this time the circuit breaker in question is signalled as being "out".

It will be noted that the operations at the
 90 substation are as follows:—Firstly battery is initially connected across the conductors 18A and 40, secondly battery impulses are sent over the conductors 17A and 18A, and thirdly
 95 each time a rotary line switch is in a position corresponding to a circuit breaker that is in, battery is again connected across the conductors 40 and 18A and no impulse is sent over conductors 17A and 18A at that time.

With this preliminary recapitulation of the
 100 signals sent from the substation a description will now be given with reference to Fig. 2 of the reception of supervisory signals at the controlling station. It will be noted that relay R1, when wiper B4 of the rotary line
 105 switch RLSC is in normal position and the operating key is not depressed, is connected across the leads 18A and 40 in the circuit, lead 40, contact 34, conductor C8, relay R1, conductor C7, normal contact B4, wiper B4,
 110 conductor C6, contact 160, lead 18A, so that when the substation initially connects battery across the leads 18A and 40, relay R1 is energized, completes a circuit for relay SA3 at contact 52, and connects negative pole of
 115 battery at contact 53 to wiper A3 of the rotary line switch RLSC. It also completes a circuit as follows:—positive pole of battery B, magnet MA, contact 55, contact 54, to negative pole of battery B. Magnet MA of the
 120 rotary line switch RLSC thereupon energizes but does not however advance the wipers until it is released. Relay R1 connects negative pole of battery B at contact 51 to the lefthand windings of relays R3 and R4
 125 and to relay SA1. SA3 on energizing completes a circuit for relay SA2 at contact 49, which relay disconnects the leads 17A and 18A at contacts 61, 59 respectively from their extensions 17 and 18 to the selecting equip-
 130

ment so as to render the selecting equipment inoperative, and connects them to relay R2 at contacts 62 and 60. Relay SA2 also completes an energizing circuit for relay R5 at contact

57. Relay SA1 on energizing disconnects positive pole of battery B from the right-hand winding of relay RP1 at contact 45, and opens a point at contact 48 in the circuit of the left-hand winding of relay RP1. R4 also energizes and completes a circuit of contact 73 for the circuit breaker pilot lamp CBPL which lights to indicate that a supervisory signal is being received from the substation. Relay R4 completes a locking circuit for itself at contact 99 through the contacts 161 of the circuit breaker alarm key. Relay R3 energizes by current flowing through its left-hand winding and the contact 162 of the master key and locks energized over the contact 161 of the circuit breaker alarm key. At the same time it connects positive pole of battery B at contact 101 to the circuit breaker pilot bell CBPB, whereupon the bell rings and calls the attention of the attendant to the change of position of a circuit breaker at the substation. All these operations take place due to battery being connected across the leads 18A and 40 of the substation. The next control exerted from the substation is the transmission of impulses over the leads 17A and 18A causing the relay R2 to pulse, the relay R1 de-energizing immediately the magnet of the rotary line switch at the substation de-energizes. Relay R2 maintains at contact 68 the circuits of relays R3, R4 and SA1, connects negative pole of battery to wiper A2 at contact 63, establishes a new circuit for the magnet MA at contact 66 and connects negative pole of battery to wiper A1 at contact 67. As described 25 pulses are received by relay R2 which thereby causes magnet MA to step 25 times and so restore to normal, but at various times the circuit is completed over the leads 18A and 40 causing the relay R1 to energize as each wiper D1 at the substation (Fig. 3) makes connection with a contact connected to a circuit breaker which is in.

For the circuit breaker described the rotary line switch RLSD at the substation will advance three steps when a circuit will be completed over the leads 18A and 40 for the relay R1. The wipers A1, A2 and A3 will then be resting on the fourth contacts; relay R1 will be energized at this time and a circuit will be completed as follows:—negative pole of battery B, contact 53, wiper A3, fourth contact, left-hand winding of relay DR to positive pole of battery B. The relay DR having differential windings and being normally energized through its right-hand winding and contact 89 deenergizes at this time so that in doing so it disconnects the green lamp and connects a circuit for the red lamp. By pressing the circuit breaker alarm key the

locking circuit for relays R3 and R4 is opened which thereupon de-energize and everything restores to normal.

It should be mentioned that the relay SA2 was locked energized after the first step over wiper A5 and bank contact engaged thereby. The operation of the circuit breaker alarm key causes the circuit breaker pilot lamp to be extinguished and the ringing of the circuit breaker pilot bell to cease.

If a circuit breaker were already in, say circuit breaker No. 1, the red lamp would be lit and the effect of the wipers A1, A2 and A3 would be exactly the same as in the case just described of circuit breaker No. 2. If a circuit breaker is out, take also, for instance, circuit breaker No. 1, then the green lamp would be lit owing to the differential relay DR1 being energized and in this case as no circuit would be completed over wiper A3, relay R1 not being energized, while wipers A1 and A2 although connected up by R2 would have no effect, relay DR1 simply remaining energized and the circuit of LR1 is open so that relay LR1 cannot energize and the green lamp remains lit. If on the other hand a circuit breaker that was in has come out or been pulled out, then the circuit through left-hand winding of relay LR1 would be closed over wiper A1 for a sufficient period through the make before break contacts of relay DR1 to energize this relay, while relay DR1 would be energized through its right-hand winding over wiper A2 and would change the red lamp for a green lamp. Relay LR1 on energizing opens the lamp circuit at contact 72 and connects it at 82 to a flashing circuit which is initiated due to the closure of contact 96. Relay LR1 completes a locking circuit for itself over contact 90 and contact 162 of master key. Relay LR1 at contact 96 completes a circuit for relay SA6 over contact 65. Relay SA6 completes a circuit for relay SA7 at contact 64; relay SA6 and SA7 intermittently energize so that the circuit completed by relay SA6 is an intermittent one causing lamp GL1 to flash. The attendant by pressing the master key can open the locking circuit of relay LR1 with the result that the green lamp glows steadily and further the intermittent action of relay SA6 and SA7 is caused to cease due to the opening of contact 64.

It may happen that the rotary line switch RLSD at the control station does not keep pace with the rotary line switch RLSD at the substation. It is important in such a case that a warning should be given and consequently when impulses cease and relay SA1 de-energizes, a circuit will be completed for the left-hand winding of relay RP1, as follows:—negative pole of battery B, wiper A5 in off normal position, contact 48, left-hand winding of relay RP1, interrupter contacts of magnet MA, magnet MA to positive pole of battery B. Wiper A5 will of course be in

off normal position if it has not stepped properly with the rotary line switch RLSB at the substation when a train of impulses is completed. RP1 energizes and locks energized at contact 42. It opens contact 40, thereby preventing any selecting operation from being effective. In addition it connects negative pole of battery B to the twenty-fourth contact engaged by wipers B1 and C2 of rotary line switch RLSB and RLSC respectively over contact 145 and conductor C23, and also connects negative pole of battery B to the lower terminal of the winding of relay Z over contacts 58, 142, conductor C1 in a similar manner to the operation of a selecting key, thereby causing the transmission of a selecting signal corresponding to the marking of the twenty-fourth contact which serves at the substation to select a relay RR to cause the transmission of a supervisory signal when the apparatus has been correctly set. When relay H1 operates after the selecting signal has been sent, a circuit for relay RP2 is completed as follows:—positive pole of battery B, contact 170, relay RP2, contact 43, conductor C3, contact 29, negative pole of battery B. Relay RP2 closes a circuit for relay N as follows:—positive pole of battery B, contact 171, conductor C4, relay N to negative pole of battery B. Relay N therefore energizes which is equivalent to the operation of an operating key, and so completes a circuit for relay RR which energizes relay RSR1 at contact 174, and so causes the transmission of signals to be repeated. Relay N completes a circuit for relay RP3 as follows:—negative pole of battery B, relay RP3, conductor C5, contact 31 to positive pole of battery B. Relay RP3 opens the circuit of relay RP2 at contact 170; relay RP2 thereupon de-energizes. Magnet MA restores the rotary line switch RLSA to normal preparatory to the transmission of the next series of impulses. This is effected by having the left-hand winding of relay RP1 of sufficiently low resistance to enable magnet MA to energize in series with this winding. This would mean of course an intermittent operation of relay RP1 but as it would imply some serious fault if the rotary line switch was more than one step out, the chattering would quickly call attention to the fault.

If the switch RLSA is not in its normal position after the second transmission of the signal, the above cycle of operation will be repeated, in fact the repetition of the transmission of the signal will continue until the switch RLSA steps with switch RLSB, or until the attendant halts the operation.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:

1. In a remote control system, a stepping switch, a plurality of switching devices ac-

cessible thereto, an impulse transmitter, a checking switch operated thereby, a manual key, means operated responsive to the operation of said key for marking a certain contact in said checking switch and for starting said transmitter to impulse said stepping switch and checking switch, means for stopping said switches when said marked contact is reached to select a switching device and for holding said checking switch thereon as long as said key remains operated, means for checking the position of said stepping switch, said means including contacts on said checking switch and contacts on said key, and means for operating said selected device.

2. In a remote control system, a plurality of multi-position switching devices, a device selector associated therewith, indicating means corresponding thereto, a supervisory sender associated with said devices, a supervisory selector associated with said indicating means, means operated by one of said devices changing its position for operating said supervisory sender to transmit a code indicating the positions occupied by all said devices, means responsive to said code for operating said supervisory selector to set said indicating means in accordance with the positions of all said devices, a checking means operated to determine if said supervisory selector has functioned properly, a particular device, means controlled by said checking means if said supervisory selector has not functioned properly for setting said device selector to select said particular device, means for checking the operation of said device selector and for operating said selected device, and means controlled by said selected device for reoperating said supervisory sender to again transmit said code.

3. In a remote control system, a plurality of multi-position switching devices, a selecting switch and a supervisory sender associated with said devices, supervisory signals corresponding to said devices, a supervisory switch and a selecting sender associated with said signals, normal positions for said senders and switches, a supervisory start relay, means responsive to a change in position of one of said devices for energizing said relay, means controlled by said relay for starting said supervisory sender out of its normal position, means controlled by said sender for stepping said supervisory switch, means controlled jointly by said sender and supervisory switch in one cycle of operation for arranging said signals to indicate the positions occupied by all of said devices, and means operated if said supervisory sender and switch do not reach their normal position simultaneously for operating said selecting sender and switch in a particular manner to restart said supervisory sender and switch.

4. In a remote control system, a control station, a substation, an impulse transmitter

in the control station for transmitting a constant number of impulses, a pair of switches in the control station, a receiver in the substation comprising a plurality of switches, devices in the substation accessible to the receiver, means for operating the transmitter to generate a constant number of impulses and to divide the constant number in two parts dependent upon the device to be selected, means for operating the first of the switches in the substation receiver responsive to the first part of the constant number of impulses generated by the transmitter to select one of said devices, means for operating the second of said switches in the substation receiver and said switches in the control station in synchronism therewith, means for operating a third of said switches in the substation receiver responsive to remaining part of the constant number of impulses generated by the transmitter and for operating the second switch in the substation receiver and one of said switches in the control station in synchronism therewith, a checking circuit, and means for completing said checking circuit only in case all of said switches have operated synchronously as set forth.

5. In a remote control system, a control station and a substation, devices at the substation, an impulse sender in the control station including means for transmitting a fixed number of impulses in each operation and for dividing the constant number into two parts dependent upon the device to be selected, a selecting switch in the substation, means for operating said selecting switch in response to the first part of said constant number of impulses to select a device, a checking switch in the substation, means for operating said checking switch in response to the remaining part of said constant number of impulses, other checking switches in the control and substations, means for operating certain of said other checking switches in synchronism with said selecting switch and for operating certain of them in synchronism with said first checking switch, and means in the control station operated if all the switches operate in synchronism to indicate the selected device.

6. In a remote control system, a control station and a substation, devices at the substation, an impulse sender in the control station including means for transmitting a fixed number of impulses in each operation and for dividing the constant number into two parts dependent upon the device to be selected, a selecting switch in the substation, means for operating said selecting switch in response to the first part of said constant number of impulses to select a device, a checking switch in the substation, means for operating said checking switch in response to the remaining part of said constant number of impulses, other checking switches in the control and substations, means for operating certain

of said other checking switches in synchronism with said selecting switch and for operating certain of them in synchronism with said first checking switch, means in the control station operated if all the switches operate in synchronism to indicate the selected device, and means operated from the control station to control the selected device only in case all the switches have operated synchronously.

7. In a remote control system, a control station and a substation; devices at the substation; a sender in the control station including means for transmitting a fixed number of impulses and for dividing the fixed number into two parts dependent upon the device to be selected; a control switch at the control station, means for operating said control switch in response to the first part of said fixed number of impulses to stop on a predetermined contact; a checking switch at the substation, means for operating said checking switch in response to the remaining part of said fixed number of impulses; a selecting switch in the substation; a counting switch in the substation, a counting switch in the control station, means for operating both said counting switches and said selecting switch in the substation in synchronism with said control switch to cause said selecting switch to select one of said devices and for operating both said counting switches in synchronism with said checking switch; means in the control station operated if all the switches operate in synchronism as set forth to indicate the selected device, and means at the control station for controlling the operation of the selected device only in case all the switches have operated synchronously.

8. In a remote control system, a control station and a substation, trunk conductors between said stations, a plurality of switching devices at the substation, means including an impulse transmitter for transmitting impulses over a pair of said trunk conductors and for generating other impulses, a selecting switch at said substation, means responsive to the impulses transmitted over said pair of conductors for operating said selecting switch, a control switch in said control station, means for operating said control switch in synchronism with said selecting switch, a counting switch in said control station, contacts in said counting switch corresponding to said switching devices, means for operating said counting switch responsive to said other impulses generated by said transmitter to successively engage said contacts, means for marking a particular one of said contacts in accordance with the particular switching device to be selected, means for transmitting a particular signal over a third one of said trunk conductors in response to said counting switch engaging said marked

contact, means responsive thereto for stopping said selecting switch to select the switching device corresponding to the marked contact and for stopping said control switch in a corresponding position, means for checking the accuracy of said selection, and means for operating said selected switching device only if said checking arrangement indicates that said selecting switch and said control switch have been set in corresponding positions in accordance with said signal.

9. In a remote control system, a control station and a substation, a trunk between said stations, a stepping switch at the substation, a plurality of switching devices accessible thereto, an impulse transmitter at said control station, means for operating said transmitter to send a group of impulses over a pair of conductors of said trunk, means responsive to said impulses for operating said stepping switch, a control switch in said control station, means for operating said control switch in synchronism with said stepping switch, a counting switch in said control station, contacts corresponding to said switching devices accessible to said counting switch, means for marking a particular one of said contacts in accordance with the device to be selected, means controlled by said transmitter for operating said counting switch, means responsive to the counting switch engaging said marked contact for sending an impulse over one conductor of said pair of conductors and a third conductor of said trunk in series, means responsive thereto for stopping said stepping switch to select the corresponding device and for stopping said control switch in a corresponding position, and means for controlling the operation of said selected device over a circuit including said third conductor and a wiper of said control switch.

10. In a remote control system, a control station and a substation, a trunk between said stations, a stepping switch at the substation, a plurality of switching devices accessible thereto, an impulse transmitter at said control station, means for operating said transmitter to send a group of impulses over a pair of conductors of said trunk, means responsive to said impulses for operating said stepping switch, a control switch in said control station, means for operating said control switch in synchronism with said stepping switch, a counting switch in said control station, contacts corresponding to said switching devices accessible to said counting switch, means for marking a particular one of said contacts in accordance with the device to be selected, means controlled by said transmitter for operating said counting switch, means responsive to the counting switch engaging said marked contact for sending an impulse over one conductor of said pair of conductors and a third conduc-

tor of said trunk in series, means responsive thereto for stopping said stepping switch to select the corresponding device and for stopping said control switch in a corresponding position, means for checking the accuracy of said selection, and means for operating said selected device over a circuit including said third conductor and a wiper of said control switch only if said stepping switch and said control switch are accurately set in corresponding positions.

11. In a remote control system, a control station and a substation, a trunk between said stations, a stepping switch at the substation, a plurality of switching devices accessible thereto, an impulse transmitter at said control station, means for operating said transmitter to send a group of impulses over a pair of conductors of said trunk, means responsive to said impulses for operating said stepping switch, a control switch in said control station, means for operating said control switch in synchronism with said stepping switch, a counting switch in said control station, means controlled by said transmitter for operating said counting switch to send an impulse over one conductor of said pair of conductors and a third conductor of said trunk in series at a predetermined time, means responsive thereto for stopping said stepping switch to select a device and for stopping said control switch in a corresponding position, means operated over said first pair of conductors for automatically checking the accuracy of said selection, and means for controlling the operation of said selected device over a circuit including said third conductor and a wiper of said control switch.

In witness whereof, I hereunto subscribe my name this 9th day of May, A. D. 1927.

CHARLES REMINGTON.