Nov. 8, 1938. G. A. BURNS 2,135,794

REMOTE CONTROL SYSTEM

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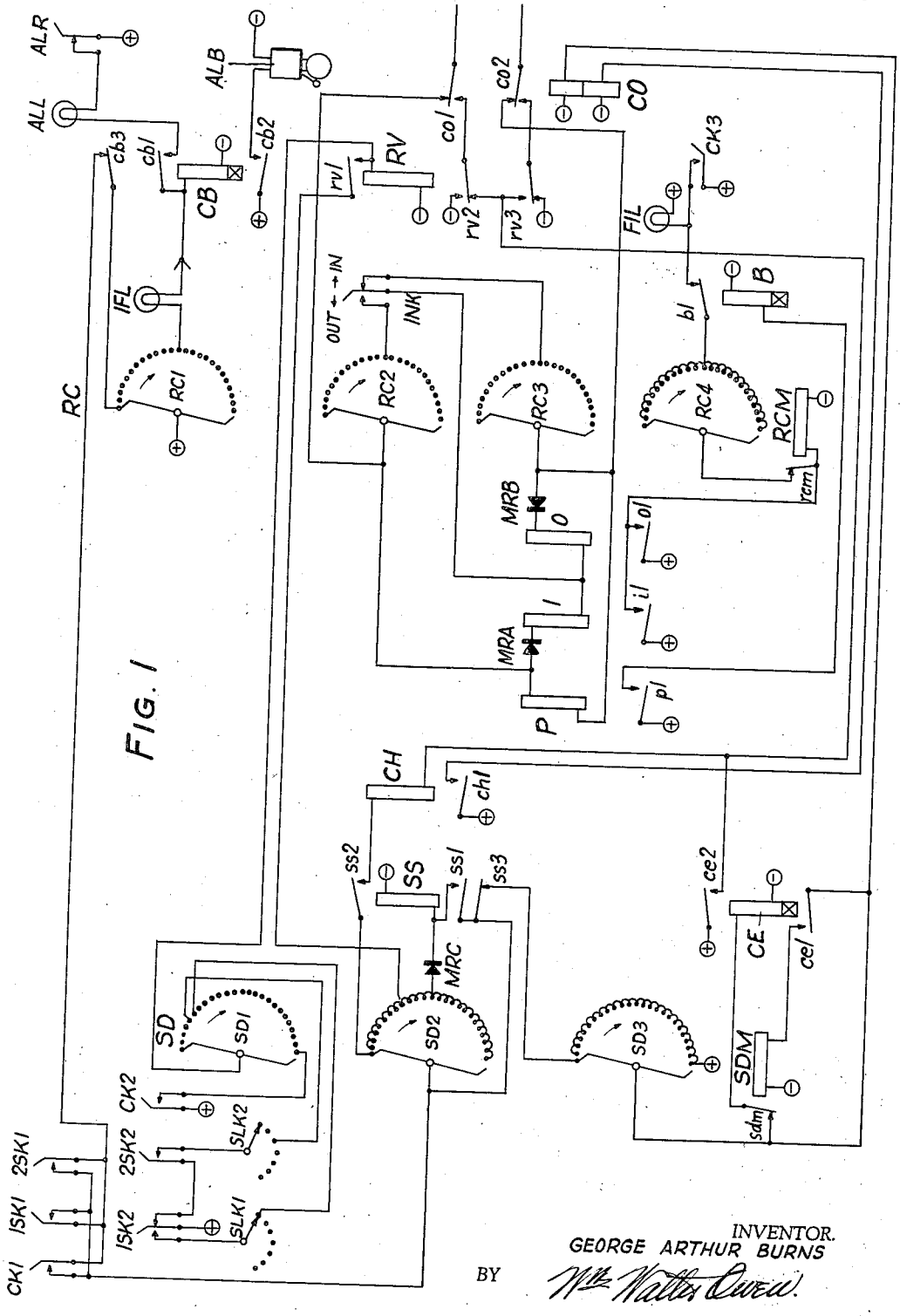


FIG. 1

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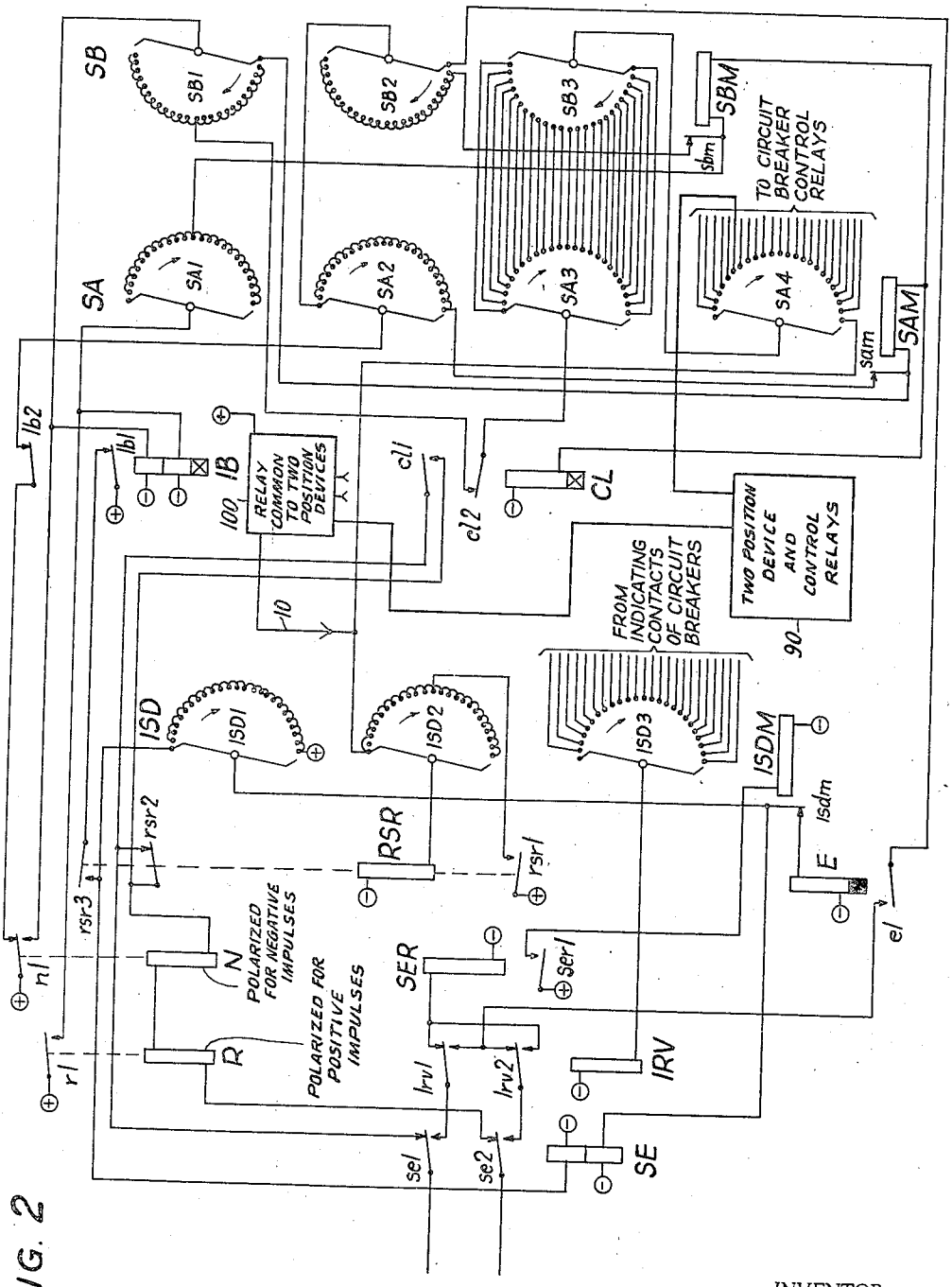


FIG. 2

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2,135,794

REMOTE CONTROL SYSTEM

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6 Claims. (Cl. 177—353)

The present invention relates to improvements in remote control and/or indicating systems particularly of the type in which circuit breakers or the like at a substation may be supervised and/or operated from a main station. The object of the invention is to provide a simplified system of this type which enables a considerable reduction in the amount of apparatus required without materially reducing the facilities offered.

It has already been suggested to indicate the state of the various circuit breakers or the like by means of keys which are manually operated to the appropriate position in response to an alarm signal indicating lack of correspondence with the position of the associated piece of apparatus. In this arrangement however continuously rotating switches were used and different switch positions were employed for the operating and checking circuits.

According to one feature of the invention further simplification is effected by arranging that the position of circuit breakers or the like at a substation is indicated at the main station by keys associated with a rotary switch which is set in operation whenever a piece of apparatus changes its position, said keys operating suitable contacts and indicating by their appearance the position of the associated apparatus.

According to another feature of the invention the position of circuit breakers or the like at a substation is indicated at the main station by keys each controlling contacts associated with a single position in two banks of a rotary switch and indicating by its appearance the position of the associated apparatus.

The invention will be better understood from the following description of one method of carrying it into effect reference being had to the accompanying drawings comprising Figs. 1 and 2 which should be arranged side by side to form a complete circuit.

Fig. 1 shows the apparatus at the main station while Fig. 2 shows the apparatus at the substation, the two being connected together by means of a two-conductor line.

All the apparatus is normally in the position shown. When it is desired to select and operate a circuit breaker or a tap change switch at the substation, the rotary selecting key SLK1, Fig. 1, is moved by hand to the appropriate position and the start key 1SK is then operated to start up the main station apparatus. A duplicate selecting key and start key are also shown designated SLK2 and 2SK respectively, and these are located at the opposite end of the control panel to enable the operator to work the apparatus from this position when desired. Contact 1SK2 however is provided with break springs to prevent any effective operation if the two keys should be inadvertently operated simultaneously.

Upon the operation of the start key, positive from wiper RC1 of the switch RC is extended over springs 1SK1 of key 1SK, springs *ss*3, and wiper SD3 of the switch SD to operate relays CO and CE in parallel. Relay CO at armatures *co*1 and *co*2, extends the line circuit to the armatures of the reversing relay RV and impulse relay CE preparatory to the transmission of the selecting impulses to the substation. Relay CE at armature *ce*1 energizes the driving magnet SDM of the sending switch SD and at armature *ce*2 connects positive to the upper line conductor. Upon energizing the magnet SDM opens the interrupter springs *sdm* to release relay CE which in turn opens the circuit for the magnet and on the release of the magnet armature the wipers SD1 to SD3 are rotated to the second position. In this position relay SS is operated over wiper SD2 from positive, over the circuit previously traced over wiper RC1 and at armature *ss*1 locks up and at armature *ss*2 prepares a cicuit for relay CH, while over wiper SD3 an alternative circuit is provided from positive on the bank commoning for the relays CO and CE. An alternate action therefore takes place between relay CE and the driving magnet SDM to effect the automatic rotation of the wipers of the switch SD, and for each step of the switch a positive pulse is connected by way of armature *ce*2 to the upper line conductor extending to the substation.

As soon as the wipers reach the position corresponding to the setting of the switch SLK1, for instance position 6 as shown, wiper SD1 encounters positive through springs 1SK2 of key 1SK which operates relay RV and this relay thereupon at armature *rv*1 locks up to the positive through the bank of wiper SD2 and at armatures *rv*2 and *rv*3 reverses the connections to the line. Stepping of the switch SD continues without interruption but from this point positive pulses are connected to the lower line conductor extending to the substation through springs *ce*2 each time relay CE energizes. When the full complement of impulses have been sent the wipers of the switch SD again come into their first position where relay RV is released, but as relay SS remains held, positive potential is now extended to relay CH through springs *ss*2 which operates over the line circuit and at its armature *ch*1 maintains relay CO operated. The metal rectifier

MRC is connected up in such sense as to prevent relay RV holding to the locking circuit of relay SS.

At the substation the selecting impulses are received on the magnetically polarized relays N and R connected in series, relay N responding to what will be termed normal pulses, i. e. when positive is connected to the upper line conductor and relay R responding when the polarity of the pulses is reversed.

On the first operation of relay N, the first time relay CE operated, relay 1B is operated from positive through springs *n1*, and over the wiper SB1 of the switch SB in its first position the driving magnet SAM of the switch SA is energized in series with the low resistance winding of relay CL. Relay 1B at armature *1b2* opens the homing circuit of the switches SA and SB and relay CL at armature *cl2* shunts armature *rsr2* to prevent the undesired opening of the line circuit.

Normal pulses incoming over the line are repeated by armature *n1* over the above circuit to the driving magnet of the switch SA which therefore advances its wipers SA1 to SA4 to a position corresponding to the marking in the bank SD1 of the sender switch at the main station. It will be understood that the bracketed conductors leading from the bank SA4 extend to interposing relays (not shown) which control the "Trip" and "Close" movements of the circuit breakers. Each of the circuit breakers or two-position devices and the control relays respectively associated therewith may be of any desired commercial construction and for that reason only one unit has been diagrammatically illustrated at 90, which unit corresponds to the sixth off-normal position of the rotary switch SA.

Subsequently reversed pulses after relay RV operates are received on relay R which at armature *r1* holds relay 1B and repeats the pulses over wiper SA1 (which has moved to position 6) to the driving magnet SBM of the switch SB. Accordingly the magnet SBM of switch SB responds to the remainder of the impulses in the series and sets its wipers SB1 to SB3 to a position complementary to those of the switch SA.

As a check on the reception of the full complement of impulses, neither more nor less, the banks of wipers SA3 and SB3 are connected together reversed, so that a circuit is only completed through them when the sum of the pulses received by the two switches corresponds to the predetermined total. More specifically, the rotary switches SA and SB have their bank contacts so connected and arranged that any selected one of the two-position devices, such, for example, as the device 90, is caused to operate only when the number of impulses making up the two impulse trains transmitted respectively to the two rotary switches noted is equal to a predetermined number. Thus, in each case and irrespective of the two-position device to be operated, a predetermined number of impulses is transmitted from the main station over the line circuit and are divided between the two switches SA and SB through the operation of the relay RV and the resulting transfer of the control from the polarized relay N to the polarized relay R. This predetermined number of impulses is, with the arrangement illustrated, twenty-five and assuming, for example, that it is desired to select the two-position device 90, six of the twenty-five impulses are transmitted to the switch SA. If thereafter only eighteen impulses are transmitted to the switch SB, the two switch wipers SA3 and SB3 are not connected together so that the circuit for causing the operation of the two-position device 90 is held open. As a consequence, this device cannot be operated.

When relay RV at the main station releases at the end of the train of selecting pulses, relay N at the substation is re-operated in series with relay CH at the main station and at armature *n1* holds relay 1B and completes a series circuit over wiper SB1, armature *cl2*, wipers SA3, SB3 and SA4, and over the selected conductor extending to the interposing relay controlling the operation of the circuit breaker it is desired to produce. Tripping and closing the breaker require different selections from the main station and it will therefore be clear that in general two positions are required in the bank of wiper SA4 for each breaker controlled.

Whenever a circuit breaker or tap change switch at the substation changes its position either due to control from the main station or, in the case of a breaker, automatically due to the operation of the protective gear, a common device (not shown) is operated to effect the momentary application of positive to the start lead 10 connecting with the bank 1SD2 of the switch 1SD. This device may take any one of a variety of well-known forms. For example, it may comprise a slow-acting relay, as indicated diagrammatically at 100, having its contacts arranged to extend positive battery to the conductor 10 when it is operated and having its operating circuit arranged to be momentarily energized when the operating element of any one of the two-position devices, such, for example, as the device 90, is moved from either of its two positions to the other. Consequently when the position of the breaker in question is changed, the momentary application of positive to lead 10 brings about the operation of relay RSR which locks by way of its armature *rsr1* over the bank commoning, and at armature *rsr2* opens the line circuit thereby releasing relay CH at the main station and relay N at the substation. At the main station relay CH brings down relay CO which at its armatures *co1* and *co2* connects up the I and O receiving relays which are polarized by means of the metal rectifiers MRA and MRB.

At the substation relay N releases relay 1B which at armature *1b1*, Fig. 2, operates relays E and SE over the circuit including springs *rsr3*, wiper 1SD1, upper winding of relay SE and through springs *isdm* to relay E. Relay SE at its armatures *se1* and *se2* prepares the line for the transmission of indicating pulses from the substation. Moreover at armature *1b2* a self-interrupted homing circuit is completed for the switch SA controlled by the interrupter springs *sam* and when the wipers arrive on the home contact the homing circuit is extended to switch SB controlled by the interrupter springs *sbm*. When both switches are home, positive over armature *n1* and its back contact is extended over the wipers SA2 and SB2 in series and armature *e1* to the lower line conductor with the result that relay SER connected to the upper line conductor is operated in series with relay O at the main station. Relay SER at armature *ser1* energizes the driving magnet 1SDM of the switch 1SD which thereupon opens its interrupter springs *1sdm* and releases relay E. Relay E after its slow period opens the line circuit at armature *e1* and in turn brings down relay SER which opens the magnet circuit and on the release of the magnet armature the wipers 1SD1 to 1SD3 are moved

to the second position. In this position relay RSR is released by the opening of its energizing circuit, but as wiper 1SD1 is now in engagement with the bank commoning the circuit is maintained for relays E and SE. An alternate action therefore takes place between the relays E, SER and the magnet 1SDM the effect of which is to rotate the wipers of the switch 1SD over their bank contacts, and during this operation relay 1RV, connected to wiper 1SD3, tests over the bracketed conductors shown, the "in" or "out" condition of the circuit breakers or tap change switches connected thereto.

If the breaker or tap switch connected with it is "out" at this instant, wiper 1SD3 will encounter a disconnection on the associated bracketed conductor so that relay 1RV is not operated and accordingly a positive pulse is extended over the lower line conductor. If however, the breaker or tap switch is "in", wiper 1SD3 will encounter positive on the associated conductor which operates relay 1RV whereupon at armatures *1rv1* and *1rv2* the connections to the line are reversed so that a positive pulse is now applied to the upper line conductor when relay E energizes.

At the main station the indicating pulses are received on the rectifier-polarized relays I and O and repeated to the driving magnet RCM of the switch RC either by springs *il* or *ol* which accordingly steps its wipers over their banks in synchronism with those of the switch 1SD at the substation. A high resistance relay P bridged across the polarized relays I and O is operated by all indicating pulses regardless of their polarity, and serves to energize the slow release relay B which remains operated during the impulsing period and holds open the circuit of the faulty impulse lamp FIL connected to the bank of wiper RC4. During the stepping of the switch RC individual indicating lamps such as 1FL connected to the various contacts in the bank of wipers RC1 are lighted progressively to identify the circuit breakers connected with at the substation. A low resistance relay CB in the feed circuit to the lamps operates and locks to the alarm reset key ALR, at the same time lighting a common alarm lamp ALL and ringing a common alarm bell ALB.

Considering the impulsing circuit of the switch RC in detail, it will be seen that when positive is applied to the lower line conductor indicating the "out" position of a breaker, a circuit is completed at the main station through the metal rectifier MRB in the conducting direction, winding of relay O, indicating key INK in "out" position, wiper and bank RC2 to the upper line conductor, a return circuit being supplied by way of relay SER at the substation to negative. It will be appreciated that a key such as INK is provided for each circuit breaker or tap switch at the substation and it will be seen that the operation of relay O is only possible if the key is in accord with the indicating pulse, that is, for normal pulses in its upper or "out" position. The conditions are similar if the breaker is "in" except that owing to the operation of relay 1RV a reversed pulse is sent and relay I is operated by way of wiper RC3.

When however, a pulse is produced corresponding to a breaker which has changed its position, the relay I or O as the case may be will be short-circuited by the key and at the same time the rectifier in the circuit will be non-conducting. Under these circumstances relay SER at the substation fails to re-operate and the operation of the switch 1SD is temporarily suspended. It will be understood that the resistance of relay P alone without relay I or O in parallel with it is sufficiently high to prevent the operation of relay SER in series therewith.

The operator at the main station observes that the progressive lighting of the individual indicating lamps has ceased and the lamp which is lighted at this instant indicates the particular key INK which requires to be moved to the opposite position to correspond with the circuit breaker at the substation, the lamps and keys being, if desired, in close proximity. When the operator moves the key to the correct position, relay I or O as the case may be is again connected in circuit with relay SER at the substation which thereupon re-operates and enables the transmission of indicating pulses to recommence.

When all indicating pulses have been transmitted, the wipers of the switch 1SD at the substation will again come into their first position where the circuit is opened for relays E and SE which release and open the transmitting circuit to the line. At the main station the wipers of the switch RC will also have arrived at the first position and owing to the cessation of impulsing relays P and B are released. The common alarm lamp ALL and bell ALB are cut off by the momentary operation of the alarm reset key ALR which unlocks relay CB while the restoration of the start key releases relay SS. If the start key is not at once restored the operation is not prejudiced; it must be restored however before a further selection can be made from the main station.

It will be understood that in the event of a circuit-breaker changing its position automatically, transmission takes place from the substation in the manner just described. The only difference is that since relays SS, CH and CO at the main station are not operated, the initial opening of the line circuit by armature *rsr2* is without effect. It will be seen also that if such automatic change occurs while a train of indicating pulses is being sent, relay RSR will be re-operated and when the first indicating train has been disposed of a second will immediately be started.

If owing to a line fault the switch RC at the main station falls out of step with the switch 1SD at the substation, wiper RC4 will still be in engagement with the bank commoning after pulsing has ceased and accordingly when relay B releases, the faulty impulse lamp FIL is lighted in series with the driving magnet RCM which remains inoperative in this circuit and moreover the impulse transmission cannot be restarted by operating the indicating key associated with the lighted indicating lamp.

To check whether the fault is of an intermittent nature such as extraneous induction in the line, the operator throws the check key CK which results in the substation apparatus signalling back a complete train of indicating pulses. Conveniently the last position in the bank of the switch SD is allocated for the check feature so that when the check key is operated this position is marked by the connection of positive potential over springs CK2 to the last contact in the bank of wiper SD1. At the same time over springs CK3 a self-interrupted driving circuit is completed for the magnet RCM of the switch RC which accordingly rotates its wipers to the

home position. When this position is reached, positive on the wiper RC1 is extended through springs *cb*2 over springs CK1 which simulate the operation of the start key springs 1SK1, and in the manner already described the apparatus now performs a selecting function to cause the switch SA at the substation to select its last position. When this has been done the operating circuit at the substation ordinarily used for controlling the circuit breakers is effective to extend positive to the common start conductor 10 connecting with the bank of wiper 1SD2, thereby simulating the change in position of a circuit breaker. Accordingly the substation apparatus sends back to the main station a complete set of indicating pulses in the manner already described.

If the trouble has now disappeared, these will be correctly received and may be arranged to cause the lighting of a check lamp connected to the last contact engaged by wiper RC1. On the restoration of the check key and the momentary operation of the alarm release key, the apparatus is restored to normal assuming that the indicating keys correctly represent the position of the substation equipment. A special key similar to the indicating keys may be connected to the check position of the switch RC, or the appropriate springs may be directly operated by the key CK.

If however, the faulty impulse lamp FIL again lights, the fault is likely to be of a permanent nature and the line circuit must therefore receive attention.

I claim:—

1. In a remote control system, a main station, a substation, a line circuit extending between said stations, a plurality of two-position devices in said substation, an automatic switch in said substation and operative to select any one of said devices, means responsive to the operation of said switch for transmitting impulses of different polarity over said line circuit, depending upon the position of the device selected by said switch, a pair of relays associated with said line circuit, means whereby one of said relays responds to impulses of one polarity transmitted over said line circuit and the other thereof responds to impulses of a different polarity transmitted over said line circuit, a plurality of keys at said main station, each of said keys corresponding to one of said devices and being operable to either of two positions respectively corresponding to the two positions of the corresponding device, an automatic switch in said main station operated in synchronism with said first-named automatic switch and operative to connect the corresponding key in circuit with said relays when a particular one of said devices is selected, each of said keys including means for rendering said relays inactive when the position of the key fails to correspond to the position of the corresponding one of said devices, means for stopping the operation of said switches when said relays are rendered inactive, a plurality of signal devices individually corresponding to said two-position devices, and means including said signal devices for indicating a disagreement between the position of any selected one of said two position devices and the position of its corresponding key.

2. In a remote control system, a main station, a substation, a line circuit extending between said stations, a plurality of two-position devices in said substation, an automatic switch in said substation and operative to select any one of said devices, means responsive to the operation of said switch for transmitting impulses of different polarity over said line circuit, depending upon the position of the device selected by said switch, a pair of relays associated with said line circuit, means whereby one of said relays responds to impulses of one polarity transmitted over said line circuit and the other thereof responds to impulses of a different polarity transmitted over said line circuit, a plurality of keys at said main station, each of said keys corresponding to one of said devices and being operable to either of two positions respectively corresponding to the two positions of the corresponding device, an automatic switch in said main station operated in synchronism with said first-named automatic switch and operative to connect the corresponding key in circuit with said relays when a particular one of said devices is selected, each of said keys including contacts for shunting the one of said relays which is responsive to impulses of the polarity corresponding to the position of the device which corresponds to the key when the position of the key disagrees with the position of said corresponding one of said devices, means including each of said relays, when shunted by any one of said keys, for stopping the operation of both of said switches, a plurality of signal devices individually corresponding to said two-position devices, and means including said signal devices for indicating a disagreement between the position of any selected one of said two-position devices and the position of its corresponding key.

3. In a remote control system, a main station, a substation, a line circuit extending between said stations, a plurality of two-position devices in said substation, an automatic switch in said substation and operative to select any one of said devices, means responsive to the operation of said switch for transmitting impulses of different polarity over said line circuit, depending upon the position of the device selected by said switch, a pair of relays associated with said line circuit, said relays being so connected and arranged that one thereof responds to impulses of one polarity transmitted over said line circuit and the other thereof responds to impulses of a different polarity transmitted over said line circuit, a plurality of keys at said main station, each of said keys corresponding to one of said devices and being operable to either of two positions respectively corresponding to the two positions of the corresponding device, an automatic switch in said main station operated in synchronism with said first-named automatic switch and operative to connect the corresponding key in circuit with said relays when a particular one of said devices is selected, each of said keys including means for rendering said relays inactive when the position of the key fails to correspond to the position of the corresponding one of said devices, means for stopping the operation of said switches when said relays are rendered inactive, a plurality of signal devices individually corresponding to said two-position devices, means including said signal devices for indicating a disagreement between the position of any selected one of said two position devices and the position of its corresponding key, and means operative when a condition of disagreement between the position of a selected two-position device and the position of the corresponding key has been corrected for initiating the operation of said switches.

4. In a remote control system, a main station, a substation, a plurality of two-position devices

in said substation, a line circuit extending between said stations, a pair of oppositely poled relays connected in said line circuit, an automatic switch for successively selecting said devices, means responsive to the selection of a device for sending a pulse of one polarity over said line circuit to operate one of said relays when a selected device is in one position and for sending a pulse of another polarity over said line circuit to operate the other of said relays when a selected device is in its other position, a plurality of keys individually corresponding to said devices and each operable to either of two positions respectively corresponding to the two positions of the corresponding device, means for associating each key with said line circuit as the corresponding device is selected, means connecting said keys with the relays whereby when its position corresponds to the position of the corresponding device the one of said relays is operated which responds to impulses of the polarity corresponding to the position of the said corresponding device and neither of said relays is energized when the position of the key does not correspond to that of the corresponding device, and means operative when the position of any selected device does not correspond to the position of the corresponding key for stopping the operation of said switch.

5. In a remote control system, a main station, a substation, a plurality of two-position devices in said substation, a line circuit extending between said stations, a pair of oppositely poled relays connected in said line circuit, an automatic switch for successively selecting said devices, means responsive to the selection of a device for sending a pulse of one polarity over said line circuit to operate one of said relays when a selected device is in one position and for sending a pulse of another polarity over said line circuit to operate the other of said relays when a selected device is in its other position, a plurality of keys individually corresponding to said devices and each operable to either of two positions respectively corresponding to the two positions of the corresponding device, means for associating each key with said line circuit as the corresponding device is selected, means connecting each of said keys with the relays whereby when its position corresponds to the position of the corresponding device the one of said relays is operated which responds to impulses of the polarity corresponding to the position of the said corresponding device and neither of said relays is energized when the position of the key does not correspond to that of the corresponding device, means operative when the position of any selected device does not correspond to the position of the corresponding key for stopping the operation of said switch, a plurality of signal devices individually corresponding to said two-position devices, and means including said signal devices for indicating a disagreement between the position of any selected one of said two-position devices and the position of its corresponding key.

6. In a remote control system, a main station, a substation, a plurality of two-position devices in said substation, a line circuit extending between said stations, a pair of oppositely poled relays connected in said line circuit, an automatic switch for successively selecting said devices, means responsive to the selection of a device for sending a pulse of one polarity over said line circuit to operate one of said relays when a selected device is in one position and for sending a pulse of another polarity over said line circuit to operate the other of said relays when a selected device is in its other position, a plurality of keys individually corresponding to said devices and each operable to either of two positions respectively corresponding to the two positions of the corresponding device, means for associating each key with said line circuit as the corresponding device is selected, means connecting the keys with the relays whereby when its position corresponds to the position of the corresponding device the one of said relays is operated which responds to impulses of the polarity corresponding to the position of the said corresponding device and neither of said relays is energized when the position of the key does not correspond to that of the corresponding device, means operative when the position of any selected device does not correspond to the position of the corresponding key for stopping the operation of said switch, and means operative when a condition of disagreement between the position of a selected two-position device and the position of the corresponding key has been corrected for initiating the operation of said switches.

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