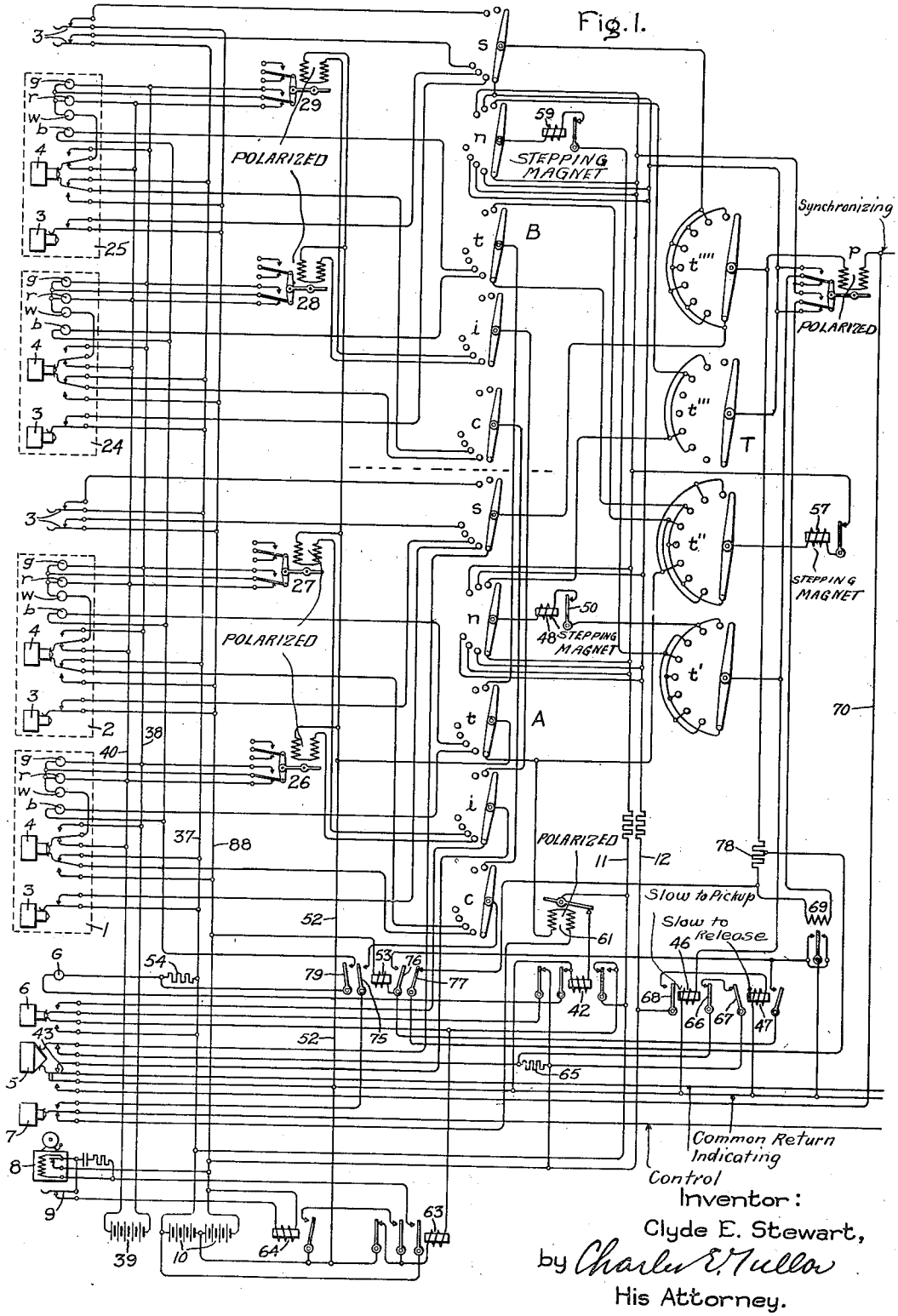
Feb. 6, 1934. C. E. STEWART 1,945,665

SUPERVISORY CONTROL SYSTEM

Filed March 8, 1928 2 Sheets-Sheet 1

Fig. 1.



Inventor:
Clyde E. Stewart,
by Charles E. Mullen
His Attorney.

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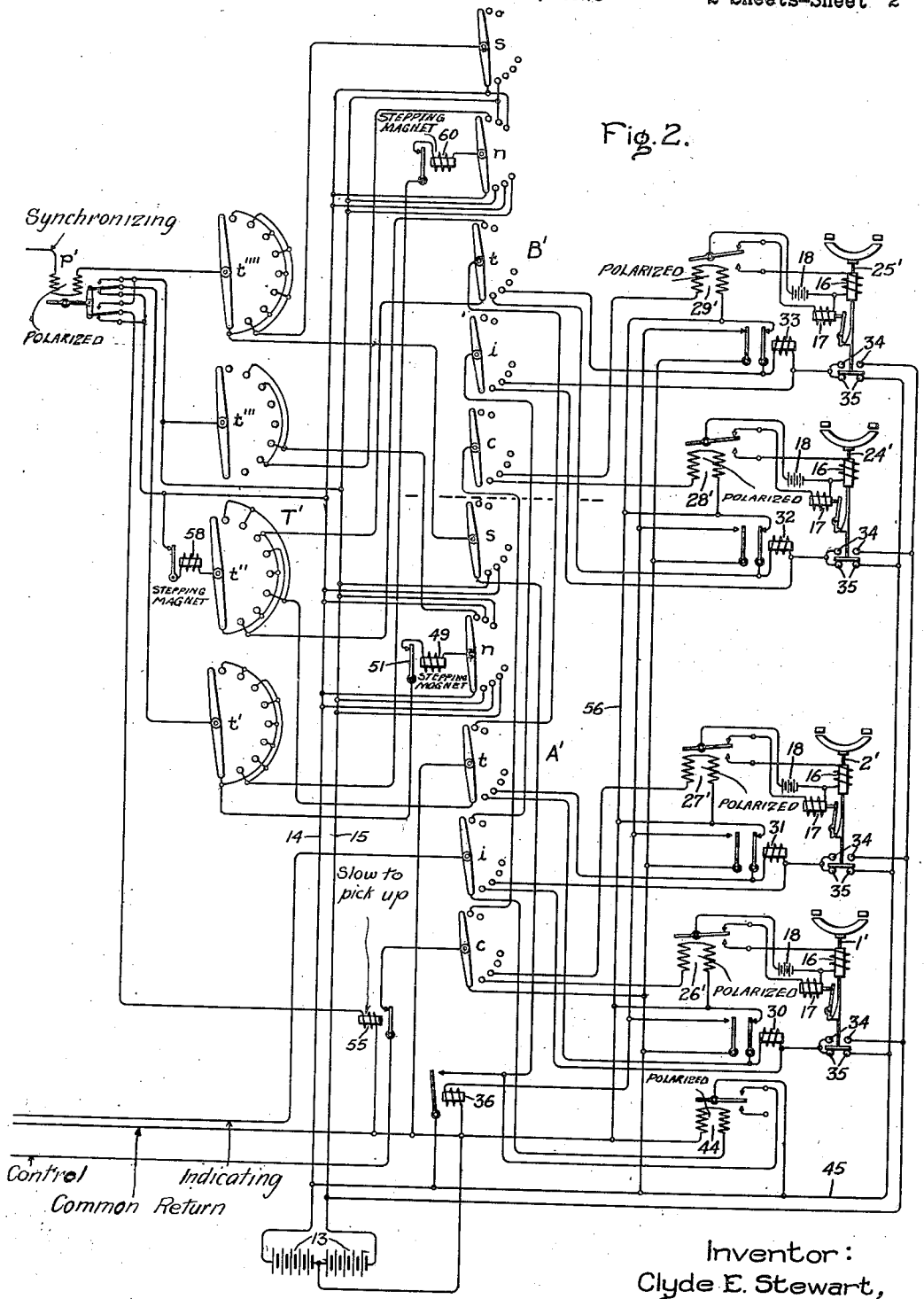
Fig. 2.



Inventor:
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UNITED STATES PATENT OFFICE

1,945,665

SUPERVISORY CONTROL SYSTEM

Clyde E. Stewart, Philadelphia, Pa., assignor to General Electric Company, a corporation of New York

Application March 8, 1928. Serial No. 260,168

22 Claims. (Cl. 177—353)

My present invention relates to selective remote control systems and more particularly to such systems in which a rotary distributor, or selector, switch at a dispatcher's station and another at a remote station are synchronously operated, thereby to connect a conductor which extends between the two stations to a selected one of a plurality of circuit devices in each station.

More particularly my invention relates to certain improvements in systems of the above type and while my improvements are primarily intended to render systems of the above type of greater practical utility in connection with the remote control and supervision of power switches and indicating devices, such as are used in stations of the usual power distribution system, they are not limited thereto and are equally applicable to systems of this type generally applied.

Still more particularly my invention, in one of its aspects, relates to the means whereby synchronous operation of the two selector switches is effected and it has for its purpose to provide an efficient means for synchronously operating the selectors and one which is simple in its circuit construction. In accordance with this aspect of my invention I provide means whereby the polarity of current flowing in a conductor extending between the two stations is reversed upon each concurrent operation of both switches and means responsive to each reversal of polarity for actuating the switches. The concurrent operation of the two switches need not be simultaneous. If an asynchronous operation of one switch occurs the current in the mentioned conductor will not be reversed and the switches will be rendered inoperative and will remain in the position at which the asynchronous operation occurred. If an asynchronous operation of the other switch then occurs, the polarity of the current in said conductor will be reversed and synchronous operation will resume.

The polarity responsive means which I prefer to employ comprises a pair of polarized relays, one relay of the pair being located in each station. This relay is so associated with the switch in its respective station that any operation of the relay will cause a succeeding operation of the switch. Since both distributor switches must operate to reverse the polarity of the current in the conductor both relays will operate together and through them the complete synchronizing of the switches is effected.

In order to restore a condition of synchronism between the two switches after an asynchronous operation of one has occurred a resetting device is provided, this device comprising means for causing each of said switches to operate independently of the other to a predetermined position from which position synchronous operation of the two switches may be had. In the form disclosed this means comprises a switch for grounding the synchronizing conductor thereby causing each switch, upon each operation thereof, to reverse the current through the polarity responsive means associated therewith, which polarity responsive means in turn causes a succeeding operation of the switch. Means are also provided whereby the circuit of the polarity responsive means associated with either switch is interrupted when the switch reaches a predetermined position thereby interrupting the operation of the switch. From this position both switches may be operated synchronously.

A further purpose of my invention is to provide a system of the type mentioned which has the capacity to provide remote control and supervision over a large number of devices and which may readily be expanded to meet an increased demand for remote control and supervision resulting from added power equipment in a particular power installation. In accordance with this aspect of my invention I provide means whereby the conductors extending between the two stations and likewise the devices, in this instance polarized relays, which are employed as synchronizing means at each station are connected, in rotation, to a plurality of selector switches at each station. Thus, for example, if more devices are to be controlled than there are different positions of a selector switch then two or more switches may be employed in each station, these switches in the two stations being connected synchronously, and in rotation, to the synchronizing means at each station and to the conductors which extend between the stations. In this manner a single synchronizing means and a single set of line conductors may be employed substantially independently of the number of devices to be controlled or supervised.

In systems of the prior art a large portion of the apparatus employed may be classed as common apparatus, i. e. apparatus which is operated in common with each remote control or supervisory operation. By my invention, as will be more fully described, it will be seen that a very substantial economy in this common equipment is effected, this equipment in my system comprising essentially the selector switches at the two stations plus a single pair of polarized relays which are utilized to effect the synchronizing function, together with necessary keying devices which are mounted on the control panel. Thus the greater portion of the equipment of my system is apparatus which is associated with individual supervised devices and, hence, operates selectively.

Still another purpose of my invention is to provide means whereby certain of the circuits including line conductors are opened during operation of the selectors and, if desired, for a desired

time interval thereafter, or, are opened, in response to an asynchronous operation thereof, thereby to prevent faulty operation of the apparatus resulting from surges upon the line, from improperly connected circuits through the selectors, or from unintentional operation of a control key.

The novel features which I believe to be characteristic of my invention will be set forth with particularity in the appended claims. My invention itself, however, both as to its organization and method of operation, together with further objects and advantages thereof may best be understood by reference to the following description taken in connection with the accompanying drawings in which Fig. 1 represents the circuit which is employed at the control station and Fig. 2 that which is employed at the remote station.

Referring to the drawings, A and B represent selector switches which are employed at the dispatcher's station and A' and B' represent selector switches which are employed at the remote station. While for simplicity of the circuits I have shown only two of these switches in each station it will of course be understood that a greater number may be employed equally as well. In small installations a single switch in each station may be utilized. Each of these switches is made up of five semicircular banks of contacts *s, n, t, i, c,* each of which has a cooperating wiper associated therewith. These wipers are all connected to a common shaft and are adapted to move in a step by step manner over their respective contact banks in response to energization and deenergization of a suitable driving motor magnet which is associated therewith, through a ratchet and pawl arrangement. Switches of this type are well known in the signaling art and one which may be employed is fully shown in Patent No. 1,472,463 to O. F. Forsberg et al, issued October 30, 1923.

As usually constructed each of the banks of contacts of which the selector switches are comprised include in the neighborhood of twenty-five contacts. In the system to be described the first contact from each bank will be herein designated as the normal contact since it corresponds to the normal position of the associated wiper. Each of the other contacts, with the exception of the last is allotted to a particular remote device which is to be supervised. In cases where the number of remote devices, which is to be supervised, exceeds the capacity of a single selector switch, that is, in the case mentioned, exceeds 23, then additional selector switches may be employed and operated in accordance with my invention. In the latter case in each of the stations a selector switch T, T' is also provided which operates to cause successive operation of the different selector switches A, B in each station, in rotation, each of the switches being operated synchronously with a selector switch in the other station.

Extending between the dispatcher's station and the remote station are four conductors, one of which extends from the wiper of the bank *s* of the switch A through the windings of the polarized *p* and *p'* to the wiper of the bank *s* of the switch A' in the remote station. This conductor will be known as the synchronizing conductor since it is over this conductor that reversed polarity impulses are transmitted for synchronously operating a selector switch in each station. A second conductor extends between the wipers of the banks *t* of the switches A and A' and constitutes a common or return conductor for all impulses which are transmitted. This conductor is maintained at ground potential and therefore it not necessarily metallic. A third conductor extends between the wipers of the banks *i* of the switches A and A' and is known as the indication conductor since it is over this conductor that impulses are sent from the remote station to the dispatcher's station to indicate the operation of a remote device. A fourth conductor extends between the wipers of the banks *c* of the switches A and A' and is known as the control conductor since it is over this conductor that impulses are sent for controlling the operation of the supervised devices at the remote station.

A control panel unit 1, 2, 24, 25 is allotted to each of the remote devices which are to be controlled. Each of these control panel units have mounted thereon four indicating lamps *g, r, w, b* having distinctive colors which are indicative of a condition of the system. Also mounted upon each of these panels is a push button contacting device 3, hereinafter known as a stop key, and a turn key 4.

Mounted upon the panel at the dispatcher's station are certain control and signal devices which are common to all of the supervised devices as distinct from apparatus which is individual to each of the supervised devices. One of these devices comprises a contact making push button which will hereinafter be designated as the emergency reset button 5, since its purpose is to reset the selectors upon their normal positions in case, for any cause, they have operated out of step. A second comprises a push button 7 which is utilized in connection with the turn key 4 for the purpose of operating any of the remote devices after the selector switches have been actuated to a position corresponding to that of the particular device which is to be operated. A third comprises a push button 6 which will hereinafter be known as the start key since its purpose is to start the synchronous operation of the respective selectors. In addition to these an alarm device 8 which may comprise a bell and an alarm key 9 are provided, the purpose of which will later be set forth.

The dispatcher's station is provided with a source of potential 10, the opposite sides of which are connected through conductors 11 and 12 to alternate contacts on the banks *n* of each of the switches A, B, etc. at that station and an intermediate point of which is connected to the common conductor. The positive side of the source of potential is also connected through the contacts of the stop keys 3 of each of the alternate panels 1, 2, etc. to the even contacts on the panels *s* of the switches A, B, etc. and the negative side of the source of potential 10 is connected through the contacts of the stop keys 3 of the alternate panels to the odd contacts of the bank *s* of each of the switches A, B, etc.

At the remote station a source of potential 13 is provided, the opposite sides of which are similarly connected through conductors 14 and 15 to alternate contacts on each of the banks *n* and *s* of the switches A' and B' etc. Similarly an intermediate point on this source of potential is connected to the common conductor. The devices which are to be supervised at the remote station are herein represented as switches 1', 2', 24', 25', each of which switches have actuating coils 16 and trip coils 17 respectively, which are connected through obvious circuits to a source of potential 18. The energization of these

coils is adapted to be controlled by means of the contacts of the polarized relays 26', 27', 28', 29' which are connected to the contacts of the bank c of the switches A', B'. The automatic operation of the selectors, as in response to an automatic operation of a device at the remote station, is effected by relays 30, 31, 32, 33, each of which is individual to a particular supervised device and is controlled by auxiliary contacts 34, 35 associated therewith; plus a common relay 36 which is operated in response to operation of any of the relays 30, 31, 32, 33 to initiate the synchronous operation of the selectors. The supervisory indication at the dispatcher's station is effected by polarized relays 26, 27, 28, 29 which are controlled by the interlocks 34 and 35 on the switches, and which control the lamps on the panels 1, 2, 24, 25.

Having now generally indicated the character of the apparatus, its more detailed structure may best be understood by reference to its operation. Assume the apparatus to be in the position shown in the drawings and that the dispatcher desires to actuate the switch 2' to its closed position. It will be noted on the panel 2 corresponding to this switch that the green light g is lighted, the circuit of this light extending from the negative side of the source of potential 39 through conductor 38, lamp g, armature and lower contact of the polarized relay 27, conductor 40, to the positive side of the source of potential 39. It will also be noted that red light r is extinguished since it is short circuited by the armature of relay 27. This indicates to the operator that the switch 2' is in its open position. The dispatcher will first observe that the lamp G is lighted. The circuit of lamp G extends from the positive side of source 10 through resistance 54, lamp G and the middle armature of relay 42 to the intermediate point on the source 10. The lighted condition of this lamp indicates that both of the selector switches A and A' are upon their normal contacts and that the system is in readiness for operation. He will then operate the turn key 4 to the position opposite to that shown in the drawings. In so doing the white light w will be lighted through a circuit extending from the negative side of the source of potential 39 through conductor 38, upper contact of the key 4, lamp w, armature and lower contact of the polarized relay 27 and conductor 40 to the positive side of the source of potential 39. The lighting of the lamp w indicates to the operator that the key 4 is no longer in the position corresponding to the position of the remote switch. The purpose of this will later be set forth. He will then operate the stop key 3 on panel 2 to open its contacts, thereby disconnecting negative potential from the third contact of the bank s of the switch A. He will then press the start key 6 and thereby close a starting circuit for the switches. This circuit extends from the negative side of the source of potential 10 through conductor 12, left-hand contact and armature of relay 42, upper contacts of the start key 6, normal contact and wiper of the bank i of the switch A, contacts 43 of the emergency reset button 5, indication conductor, wiper and normal contact of the bank i of switch A' at the remote station and relay 44 to the intermediate point on the source 13 at the remote station. Relay 44 comprises the starting relay and operates in response to the start key 6 to supply positive potential to the normal contact of the bank s of switch A'. In so doing it completes a synchronizing circuit for the switches. This circuit extends from the positive side of the source of potential 13 through conductor 45, contacts of the relay 44, normal contact and wiper of the bank s of the switch A', normal contact and wiper of the bank t'''' of the transfer switch T', polarized relays p' and P, wiper and normal contact of the bank t'''' of the transfer switch T, wiper and normal contact of the bank s of switch A, upper contact of the emergency reset button 5, right hand contact of relay 46, left hand contacts of relay 47 and conductor 12 to the negative side of the source of potential 10. Relays p and p' will then be energized and will move their armatures to the position opposite to that shown in the drawings and will thereby close a local circuit for the motor magnets of the switches A and A' at each of the stations. At the dispatcher's station this circuit will extend from the negative side of the source of potential 10 through conductor 12, upper contact and upper armature of the polarized relay p, wiper and normal contact of the bank t' of the transfer switch T, contacts 50 and winding of the motor magnet 48 of the switch A, wiper and normal contact of the bank n of the switch A and conductor 11 to the positive side of the source of potential. A similar circuit may be traced at the remote station from the negative side of the source of potential 13 through conductor 15, upper contact and upper armature of the polarized relay p', wiper and normal contatct of the bank t' of the switch T', contacts and winding of the motor magnet 49 of switch A', wiper and normal contact of the bank n of the switch A' and conductor 14 to the positive side of the source of potential 13. Thus the motor magnets 48 and 49 of the switches A and A' will both be energized and will open their own circuits by means of their contacts 50 and 51 respectively. They thereby deenergize themselves and step their associated wipers on to the second contacts of their respective banks. Both ends of the previously traced circuit of the motor magnets 48 and 49 are now connected to points of like polarity and hence these magnets remain deenergized until the polarized relays are again operated. The second contact of the bank s of the switch A is connected through contacts of key 3 on panel 1 to the positive side of the source of potential 10, and likewise the second contact of the bank s of the switch A' is connected to the negative side of the source of potential 13. Accordingly in this position of the switches current will be supplied through the relays p and p' in the opposite direction from that in which it previously flowed. The polarized relay p and p' will then be actuated back to the position shown in the drawings. Current will then again be supplied through the local circuits of the motor magnets extending from positive potential at the upper armature and its lower contact of the polarized relays p and p' through the circuits previously traced to negative potential at the second contact of the bank n of each of the switches A and A'. The motor magnets will then step their wipers on to the third contact. This operation of the switches would continue but for the fact that in this position the polarized relays p and p' will be deenergized due to the fact that the third contact of the bank s of the switch A' is disconnected from battery at the contacts of the stop key 3. Thus the switches will stop upon their third contact. It will be recalled that the contacts of the key 3 on panel 2 were opened by

the operator in selecting the remote switch which was to be operated. The blue lamp *b* on the panel 2 will now be lighted through a circuit which extends from the intermediate point on the source of potential 10 through ground conductor 52, wiper and third contact of the bank *t* of the switch A, blue lamp *b* on the panel 2, left-hand contact 79 and armature of the relay 53, (which is now closed due to operations later to be described) resistance 54 and conductor 37 to the positive side of the source of potential 10.

The lighting of the blue lamp *b* indicates to the operator that the selectors have reached a position corresponding to the supervised device which it was desired to operate and that the apparatus is now in position to perform the desired remote operation.

To operate the switch 2' the dispatcher will now press the key 7 to close its upper contacts, thereby completing a circuit which extends from the negative side of the source of potential 10 at the control station through conductor 88, lower contact and lower armature of the turn key 4 on panel 2, third contact and wiper of the bank *c* of the switch A contact and armature 75 of the relay 53, which is now closed, upper contacts of the control key 7, control conductor, contacts of the relay 55, wiper and third contact of the bank *c* of the switch A', relay 27', conductor 56 to the intermediate point on the source of potential 13. Thus relay 27' will actuate its armature to the position opposite to that shown in the drawings, thereby closing the circuit of the operating magnet 16 and closing the circuit breaker 2'.

When the switches A and A' stopped on their third contacts an indicating circuit was established which extends from the positive side of the source of potential 13 through conductor 45, interlock 35 on the switch 2', third contact and wiper of the bank *i* of the switch A', indication conductor, contacts 43 of the emergency reset button 5, wiper and third contact of the bank *i* of the switch A, polarized relay 27 and conductor 52 to the intermediate point on the battery 10. Upon operation of the switch 2' to its closed position current in this circuit will be reversed by means of the interlocks 34 and 35 and the relay 27 will be operated to the position opposite to that shown in the drawings.

In this position the lamp *g* on the panel 2 will be short circuited by the armature and upper contact of the relay 27 and thereby extinguished. The red lamp *r* will be lighted through a circuit extending from the positive conductor 40, red lamp, armature and upper contact of the relay 27 to the negative conductor 38. The white lamp *w* will likewise be extinguished by the operation of the relay 27. This informs the operator that this turn key 4 is in a position corresponding to the position of the remote switch.

In this position of the switches A and A' and with the upper contacts of the key 7 closed, it will be seen that the polarity of the current through the control circuit and hence through relay 27' may be reversed by reversing the position of turn key 4. Thus the operator may open and close the switch 2' as many times as desired by operating the turn key 4. At the same time the relay 27 will be automatically controlled by the interlock 34 and 35 on the switch and hence each operation of the switch will be indicated on the panel 2.

When it is desired to restore the switches to their normal position the operator will again press the stop key 3 on the panel 2 to close its contacts, thereby supplying negative potential to the third contact of the bank *s* of the switch A. The relays *p* and *p'* will again be energized and in operating their armatures will cause a successive energization of the motor magnets 48 and 49 through local circuits previously traced and synchronous operation of the switches A and A' will resume. It will thus be seen that upon each operation of the switches the current through the polarized relays *p* and *p'* is reversed and that each reversal of the position of these relays causes a successive energization of the motor magnets 48 and 49 through their respective local circuits. These magnets then deenergize themselves by opening their associated series connected contacts and cause a successive operation of the switches.

When the switch A has reached its last or twenty-fifth contact a circuit will be closed extending from the common conductor 52 through the wiper and twenty-fifth contact of the bank *t* of switch A, wiper and normal contact of the bank *t* of the switch B, normal contact and wiper of the bank *t''* of the switch T', motor magnet 57 and armature to the positive conductor 11. Likewise at the remote station a circuit through corresponding elements will be closed extending from the common conductor through the wiper and twenty-fifth contact of the bank *t* of the switch A', wiper and normal contact of the bank *t* of the switch B', normal contact and wiper of the bank *t''* of the switch T'', motor magnet 58 and armature to the positive conductor 14. Thus the switches T and T' will be actuated by their motor magnets, which deenergize themselves by their own contacts, to their second position. Since the second contact of the banks *t''* of these switches is connected to the last or twenty-fifth contact of the bank *t* of the switches B and B' it will be seen that the motor magnets 57 and 58 can not again be energized until the switches B and B' have been operated throughout their complete range. The circuit of the upper armature of the polarized relay *p* and the motor magnet 48 of the switch A is now interrupted at the normal contact of the bank *t'* and the upper armature of the relay *p* is now connected in circuit, at the second contact of the bank *t'*, with the motor magnet 59 of the switch B. Likewise at the remote station the circuit of the upper armature of the relay *p'* and the motor magnet 49 is interrupted at the normal contact of the bank *t'* of the switch T' and the upper armature of the relay *p'* is connected in circuit at the second contact of the bank *t'* with the motor magnet 60 of the switch B'. Likewise the synchronizing conductor is transferred by means of the wipers of the banks *t''''* of the switches T and T' from the wipers of the banks *s* of the switches A and A' to the wipers of the banks *s* of the switches B and B'. The indication conductor is now extended from the wiper of the bank *i* of the switches A and A' to the wiper of the banks *i* of the switches B and B' and likewise the control conductor is extended from the wipers of the bank *c* of switches A and A' to the wipers to the bank *c* of the switches B and B'. In other words, in response to operation of the switches A and A' to their last contacts the switches T and T' have been actuated through one step and all of the circuits have been transferred from the switches A and A' to the switches B and B'. Thus these latter switches are now prepared for synchronous operation. Since potential is normally supplied from the negative side of the source of potential 10 through con-

ductor 12 to the normal contact of the bank *s* of the switch B and, at the control station, positive potential is normally supplied through the conductor 14 to the normal contact of the bank *s* of the switch B', it will be seen that the polarized relays *p* and *p'* will now be operated and will cooperate with the motor magnets 59 and 60 respectively to drive the switches B and B' through their complete range of operations.

It will be seen that during this operation the switches can be stopped upon any desired contact simply by opening the contacts of any desired stop key 3 and likewise if during this operation a remote switch is operated by an automatic device, as for example, in response to an overload, a circuit through the indication conductor will be completed and the change will be registered by the lamps on the panel corresponding to the operated device.

When the last of the selector switches, in the case illustrated, the switches B and B', have reached their last, or twenty-fifth contacts, circuits will be completed which will cause operation of the transfer switches T and T' thereby to initiate the resetting operation of the selectors to their normal positions. To assure positive operation of the apparatus, in predetermined sequence, during the resetting operation, each selector is reset individually and each resetting of any selector is followed by an operation of the transfer switch which in turn completes the circuit for the resetting operation of a different selector. After all of the selectors have been reset the transfer switches will be actuated to, in the case illustrated, the fifth contact which similarly with each succeeding fourth contact constitutes the normal position of the transfer switch for the next cycle of operations.

The initial circuit for the resetting operations at the dispatcher's station extends from the common conductor 52 through the wiper and last contact of the bank *t* of the switch A, wiper and last contact of the bank *t* of the switch B, second contact and wiper of the bank *t''* of the switch T, motor magnet 57 and armature to the positive conductor 11. At the same time a corresponding circuit at the remote station may be traced from the common conductor through the wiper and last contact of the bank *t* of the switch A', wiper and twenty-fifth contact of the bank *t*, switch B', second contact and wiper of the bank *t''* of the switch T', motor magnet 58 and its contacts to the positive conductor 14. The motor magnets 57 and 58 will then step the switches T and T' on to their third contacts. Since the third contacts of the banks *t''* of the switches T and T' are connected to the normal contacts of the banks *t* of the switches B and B' it will be seen that these motor magnets cannot again operate until the switches B and B' have been restored to their normal position. This will occur as follows: With the switch T on its third contact a circuit will be closed which extends from the negative conductor 12 through the wiper and third contact to the bank *t'''* of the switch T, last contact and wiper of the bank *n* of the switch B, motor magnet 59, third contact and wiper of the bank *t'* of the switch T, upper armature and its lower contact of the polarized relay *p* to the positive conductor 11. A corresponding circuit may be traced at the remote station as follows: from the negative conductor 15 through the wiper and third contact of the bank *t'''* of the switch T', last contact and wiper of the bank *n* of the switch B', motor magnet 60, third contact and wiper of the bank *t'* of the switch T', upper armature and its lower contact of the polarized relay *p'* to the positive conductor 14. Thus the motor magnets 59 and 60 will be energized and will actuate their associated wipers through one step, thereby restoring them to the normal position. When this occurs a circuit for motor magnet 57 at the control station will be completed which extends from the common conductor 52 through the wiper and last contact of the bank *t* of the switch A, through the wiper and normal contact of the bank *t* of the switch B, third contact and wiper of the bank *t''* of the switch T and motor magnet 57 to the positive conductor 11. Similarly at the remote station a circuit for motor magnet 58 will be completed which extends from the common conductor through the wiper and last contact of the bank *t* of the switch A', wiper and normal contact of the bank *t* of the switch B', third contact and wiper of the bank *t''* of the switch T', motor magnet 58 to the positive conductor 14. The motor magnets 57 and 58 will then step the switches T and T' on to their fourth contacts where the circuits of these motor magnets will be interrupted at the normal contacts of the banks *t* of the switches A and A'. A circuit will then be completed for motor magnet 48 which extends from the negative conductor 12 through the wiper and fourth contact of the wiper *t'''* of the switch T, last contact and wiper of the bank *n* of the switch A, motor magnet 48, and its contact 50, fourth contact and wiper of the bank *t'* of the switch T and upper armature and its lower contact of the polarized relay *p*, to the positive conductor 11. Likewise at the remote station a circuit will be completed for motor magnet 49 which extends from the negative conductor 15 through the wiper and fourth contact of the wiper *t'''* of the switch T', last contact and wiper of the bank *n* of the switch A', motor magnet 49, and its contact 51, fourth contact and wiper of the bank *t'* of the switch T', upper armature and lower contact of the polarized relay *p'* to the positive conductor 14. Thus the motor magnets 48 and 49 of switches A and B will both be energized and in operating will actuate their associated wipers through one step, thereby restoring them to the normal position shown in the drawings. When this occurs a circuit will be completed at the control station which extends from the ground conductor 52 through the wiper and normal contact of the bank *t* of the switch A, fourth contact and wiper of the bank *t''* of the switch T and motor magnet 57 to the positive conductor 11. At the remote station a similar circuit will be completed which extends from the common conductor through the wiper and normal contact of the bank *t* of the switch A', fourth contact and wiper of the bank *t''* of the switch T' and motor magnet 58 to the positive conductor 14. The motor magnets 57 and 58 will be energized and will actuate their associated wipers to their fifth contact. It will be seen that the fifth contact of the bank *t''* is connected through the normal contact and wiper of the switch B to the last contact and wiper of the switch A. Thus this motor magnet can not again become energized until the switch A has been operated throughout its complete range. Thus each of the switches have now been actuated throughout a complete cycle of operations and have been restored to the normal position which is that shown in the drawings.

With reference to the switches T and T' it will be seen that each successive four contacts on

each bank of these switches are wired symmetrically. Thus the fifth contact and each succeeding fourth contact constitutes a normal position of these switches. This is due to the fact that the circuit is so arranged that after switch A has moved to its last contact the switch T must be actuated through one step before the switch B can be operated. After the switch B has moved to its last contact the switch T must be actuated through one step before the switch B can be restored to its normal position. The switch B having been reset to its normal position the switch T must again be operated before the switch A can be reset to its normal position. After the switch A has been reset the switch T is then moved on to its fifth contact which constitutes the normal contact for the next cycle of operations.

While I have shown a particular switching means operable responsively to predetermined operation of the different switches A, B, etc., which are employed in the system to transfer the line conductors to the next switch in the rotational sequence, it will be understood that I am not to be limited thereto since other switching means may be employed for the purpose. I have found, that my arrangement as described is positive and reliable in its operation. This is due to the fact that the predetermined sequence of operations above related is rigidly fixed. No selector switch can operate following a predetermined operation of a different selector switch without an intervening operation of the transfer selector.

It will likewise be seen that while in the arrangement shown in the drawings each successive four contacts of the different banks of contacts of switches T and T' are wired symmetrically that this number will be varied in accordance with the number of selector switches A, B etc. which are employed. For example, if three selector switches are employed obviously two more stepping operations of the transfer switches will be required and hence each successive six contacts on the banks of the switch T will be wired symmetrically. Likewise when four selector switches are employed, each successive eight contacts on the banks of the switches T and T' will be wired symmetrically. Since as stated, as ordinarily constructed these switches have twenty-five contacts per bank, or one greater than a multiple of any of these numbers, it is necessary that the last two contacts of the bank t'' should be strapped together in order that the switches will be actuated from their twenty-fifth to their normal position.

The operation of the apparatus in response to operation of a supervised device is as follows: Let us assume that the switch 2' at the remote station has now been actuated from its closed position to its open position automatically, as by an overload device. The relay 31 which is associated with this switch, and which corresponds to the relays 30, 32, 33, each of which are individual to each of the other switches, is normally held closed through a circuit which extends from the common conductor 56 through the right hand contact and armature of the relay 31, winding of relay 31, one of the interlocks, in the present case interlock 34, of the switch 2' to the negative conductor 15. When the switch 2' moves from its closed position to its open position this circuit is momentarily interrupted at the interlocks 34 and 35 with the result that the relay 31 will open its right hand contacts and close its left hand contacts. In so doing a circuit will be completed which extends from the positive conductor 45 through the left hand armature and contact of the relay 31 and relay 36 to the common conductor. Relay 36 will then close its contacts. It will be seen that the contacts of relay 36 are connected in parallel with those of the relay 44 which latter contacts are operated in response to operation of the start button 6. Thus both of these relays operate as starting relays and closing of either of their contacts will apply positive potential from the source 13 to the normal contact of the bank s of the switch A'. Thus polarized relays p and p' in cooperation with the motor magnets of the different switches will drive the selectors through the complete cycle of operations which was described above as in response to operation of the start key. When the selectors A and A' are upon their third contacts a circuit will be completed from the positive side of the source of potential 13 through the interlock 35 on the switch 2', third contact and wiper of the bank i of the switch A', the indication conductor, contacts 43 on the emergency reset button 5, wiper and third contact of the bank i of the switch A, polarized relay 27 to the common conductor 52. Relay 27 will then be energized to close its lower contacts and operate the lamps on the panel 2 in the manner above described, that is, reversing the lighting of the red and green lamps g and r and causing the white light w to be lighted. It will be recalled that the turn key 4 is in the position opposite to that shown in the drawings. The lighting of the white light w informs the operator as to which of the remote switches has been automatically operated and that the turn key 4 is not now in the position corresponding to that of the remote switch. He will then turn the key 4 to the position shown in the drawings and, since the armature of relay 27 is in its lower position, he will thereby extinguish the lamp w.

When the wiper of the bank t of switch A' engages its third contact a further circuit is completed for restoring the relay 31 to its initial energized condition. This circuit extends as follows: from the common conductor through the wiper and third contact of the bank t, winding of relay 31, and interlock 35 to the positive side of the battery 13. The relay then completes a holding circuit for itself which includes its right hand contacts and interlock 35. Thus it is in condition to respond to the next operation of the switch.

A signal bell 8 at the control station is provided to give an audible signal to the operator to call his attention to the operation of a remote device or to an abnormal operation of the selectors from their normal position or to notify him of a proper return of the selectors to that position after operation thereof. The operation of this device is as follows. With the switches A and B in their normal position a circuit is completed which extends from the common conductor through conductor 52, wiper and normal contact of the bank t of the switch A, relay 61, lower contacts of the key 7, control conductor, contacts of the relay 55, wiper and normal contact of the bank c of the switch A' to the positive side of the source of potential 13 and thence back to the common conductor. Thus the armature of the relay 61 is normally held in the position shown in the drawings. When the switches A and A', or either of them, leave their normal contacts this circuit is opened, thereby causing the contacts

of the relay 61 to separate and to interrupt an obvious circuit through relay 42. The contacts of this relay are then moved to a position opposite to that shown in the drawings. By so doing the right hand armature of the relay 42 in passing from its left hand contact to its right hand contact momentarily interrupts a circuit which extends from the positive conductor 11 through the armature and contact of the relay 42, winding of relay 63 and its left hand contact and armature to the intermediate point on the source of potential 10. The deenergization of relay 63 will complete a circuit which extends from the positive side of the source of potential 10 through the right hand armature and contact of the relay 63, winding of the bell 8, and its buzzer contacts to the negative side of the source of potential. The bell will then be sounded. A circuit will also be completed through the right hand contacts of the relay 63, winding of the bell 8, bell key contacts 9, relay 64 to the negative side of the source of potential. The operation of this relay will complete a circuit from the middle point on the source of potential 10 through the armature and contact of the relay 64, middle armature and contact of relay 63, winding of relay 63, right hand armature and contact of relay 42 to the positive side of the source of potential. Thus the relay 63 will be operated to its normal position thereby interrupting the circuit of the bell 8. Thus the operator by leaving the bell contacts 9 either closed or opened may secure a single sound from the bell, as of a gong, or he may secure continuous ringing thereof as is desired in response to the remote operation of a switch, or in response to accidental movement of either selector from its normal contact.

Thus with the system standing at rest on its normal contact if due to an abnormal condition, such as a surge upon the line, either of the switches A or A' is advanced one or more steps, the relay 61 and hence the relay 42 will be deenergized. The lamp G will be extinguished by means of the middle contacts on the relay 42. The alarm bell 8 will be sounded in response to the momentary interruption of the circuit of relay 63 at the right hand contacts of relay 42. This informs the operator of an abnormal condition of the system. The starting circuit which includes upper contacts of the start key 6 and the normal contact of the bank *i* of switch A will be interrupted at the left hand contacts of relay 42. Thus it is impossible to start the system with the switches out of step. In order to start the equipment the operator must first press the emergency reset button 5 and thereby, in a manner later to be described, restore all of the selectors to their normal position.

The bell 8, however, will not be sounded when the switches A and A' leave their normal contact in response to operation of the start key 6 for the reason that the lower contacts of the start key short circuit the right hand armature and contacts of the relay 42. When the operator releases the start key after the switches have left their normal contacts the right hand armature of relay 42 is against its right hand contact and hence relay 63 does not respond. The relay 42 nevertheless has operated and by means of its middle contacts has interrupted an obvious circuit for the lamp G. When the switches return to their normal position after being operated either in response to an automatic device or to the start key 6 the bell 8 will be sounded and the lamp G will be again lighted.

It may be stated here that if the operator desires to operate a plurality of switches in succession he may open the contacts of the stop key 3, corresponding to each of these switches and operate the corresponding turn key 4. He will then press the start button 6 and the selector switches will move to the contact corresponding to the first switch which is to be operated. The operator will then operate that switch by means of the key 7 and close the contacts 3 corresponding thereto. The selectors will then go to the contacts corresponding to the next switch. The operator will then press the button 7 to cause the operation of that switch and close the contacts 3 corresponding thereto, repeating this operation until all of the switches have been operated, after which the selectors will return to their normal position.

If the operator desires to check the position of the lamps upon his panel he will leave all of the contacts 3 closed, merely pressing the start button 6. The selectors will then complete a cycle of operations during which the indicating circuit for each of the supervised devices is completed and the polarized relays 26, 27, 28, 29 corresponding thereto will automatically check the lighting of the lamps.

As has previously been noted, when the selectors return to their normal position the circuit of the polarized relays *p* and *p'* is interrupted at the contacts of the relays 36 and 44. It may occur, however, that due to surges upon the indication or synchronizing conductors, as the selectors reach the normal contacts, the relay 44 or the polarized relays *p* and *p'* may be actuated. If this occurs the selectors will not stop, but will be stepped to their second position where the polarized relays are again energized and successive operation of the switches will take place. To prevent this contingency relay 46 is inserted, having contacts 66 which are in circuit with the polarized relays *p* and *p'* and the normal contact of the bank *s*. This relay is connected between the neutral point on the source of potential 10 and a point of positive or negative potential as determined by the upper armature of the polarized relay *p*. This relay is of the slug type and is slow to energize, such that during a period of rapidly reversing polarity through its winding, as during the rapid stepping operation, the contacts thereof and hence the circuit of the normal contact of the bank *s* is open. Consequently, when the selector reaches its normal contact the relays *p* and *p'* can not be energized until a time interval has elapsed sufficient to permit the energization of the relay 46 and the closing of its right hand contact. The relay 46 will then be energized and will close its contacts 66, at the same time opening its contacts 68 and deenergizing the relay 47 which is connected in an obvious circuit. Relay 47 is also of the slug type but is slow to deenergize. Thus an additional period elapses before its left hand contact and armature 67 come into engagement, thereby short circuiting the resistance 65 and completing the circuit of the polarized relays *p* and *p'*. During this interval of time the reactive charge on the line will leak off through resistance 65 which is connected in parallel with contacts 66 and 67 of relays 46 and 47 respectively.

As is now apparent the right hand contacts of the relay 47 remain closed for a short interval

of time after the selector switches have come to rest and the winding of relay 47 has been deenergized by parting of the contact and armature 68. The closing of these contacts, however, will have no effect since the contacts of relay 69 will be open at this time as will later appear.

If during the operation of the selectors, one of them becomes retarded or advanced by a single step or an odd number of steps with respect to the position of the other, relays p and p' will immediately be deenergized since the wipers of the contacts of the banks s and s' fall upon contacts of like polarity. This is due, of course, to the fact that the even contacts of the banks s of the switch A are connected to points of negative polarity and the odd contacts are connected to points of positive polarity, whereas the reverse is true with respect to the bank s of switch A'. Thus the operation of the switches will be interrupted, when this occurs, and the switches will remain upon non-corresponding contacts due to the asynchronous operation.

Likewise when the operator stops the selectors upon a particular contact by moving one of his stop keys 3, it may occur that the switches have not operated synchronously and are out of step. Thus it is desirable when either of these conditions exist to open the control conductor and thereby prevent the performance of an erroneous remote control operation. For this purpose the relays 69 and 53 have been included in the circuit and their connections and operation will be presently described.

The winding of the relay 69 is connected between a point of alternately positive and negative polarity as determined by the wiper s of the switch A and a point of like simultaneous polarity as determined by the position of the lower armature of the polarized relay p. Let us assume that the switches A and A' have operated synchronously and have been stopped by the operator by means of a stop key 3 upon an even contact. A circuit for the relay 69 will then be completed extending from the negative side of the source of potential 13 at the remote station through conductor 15, even contact of the bank s of switch A' upon which the wiper is standing, normal contact of the bank t'''' and wiper of the switch T', polarized relays p and p', resistance 78, winding of relay 69 to positive potential at the lower armature and upper contact of the polarized relay p. Similarly had the selectors been stopped upon an odd contact this circuit would be complete but the current flowing therein would be of reversed polarity, the circuit extending from the positive conductor 14 at the remote station to the negative conductor 12 at the lower contact and lower armature of the polarized relay p. During the rapid synchronous operation of the switches A and A' it will be seen that the current through the relay 69 is rapidly reversed. This relay is such that its armature is not attracted to either of its contacts under this condition of rapidly reversing polarity. When the switch is stopped in the manner described the relay 69 will close its contacts although the current flowing therein will not be of sufficient magnitude to operate, of itself, the relays p and p'. This is due to the high impedance of the circuit in which this relay is included. Thus when the switches A and A' have operated synchronously and have stopped upon corresponding contacts the contacts of the relay 69 will be closed and a circuit will be completed which extends from the common conductor through the contacts of the relay 69, righ hand contacts of the relay 47, which are closed for an interval, as was previously explained in connection with the operation of that relay as the switches approach their normal contacts, after the switches A and A' have stopped, and winding of the relay 53 to the negative conductor 88. This relay 53 will be energized and will close its contacts 79, 75 and 76 and open its contact 77, thereby completing the control circuit, which was previously traced by means of its contact 75, completing the circuit for the lamp b by means of its contact 79, opening the short circuit around a portion of resistance 78, by means of contact 77, and at the same time closing a holding circuit for itself by means of contact 76. Thus this relay will remain energized until a later operation of the relay 69. The purpose of opening the short circuit about resistance 78 is to render the relay 69 more sensitive to voltage variation.

Now let it be assumed that an asynchronous operation has occurred and that the selector A has stopped upon an even contact and the selector A' upon an odd contact. The relay 69 will then be deenergized due to the fact that the opposite terminals of its energizing circuit, as previously traced, are connected to points of like polarity. The contacts of the relay 69 will then be open and the relay 53 will be deenergized, thereby interrupting the control circuit and the circuit of the blue light b, separating its holding contacts 76 and by means of contact 77 placing a short circuit about a portion of resistance 78.

If during synchronous operation of the selectors A and A', one of them be advanced or retarded with respect to the other, by an even number of steps, it will be seen that the relay 69 will be momentarily deenergized as the asynchronous operation occurs and the positions of the selectors momentarily disagree by a single or odd number of steps after which it will be energized, or, if one of them be advanced or retarded by an odd number of steps the relay 69 will be permanently deenergized. In either case its contacts separate and thereby deenergize the relay 53. This relay cannot again become energized until the end of the next selecting operation, when the contacts of relay 69 and the right hand contacts of relay 47 are again simultaneously closed for an interval of time sufficient to permit the closing of the contacts of relay 53.

It will of course be understood that the operation of relays 69, 46 and 53 is the same with reference to the operation of selectors B and B' as with reference to A and A'.

After the selectors have stopped upon a certain contact due to an asynchronous or abnormal operation of one of them, the operator may again cause the operation of the switches by pressing his emergency reset button 5. By means of the lower contacts of this button and conductor 70 the synchronizing conductor will be connected to the common conductor at a point between the polarized relays p and p'. Thus current will flow from the positive or negative sides of the batteries 10 and 13 as determined by the position of the wipers of the banks s of the selector switches, and thence through the polarized relays p and p' to the common conductor. Thus both of the polarized relays p and p' will operate independently of each other and will cause independent operation of the switches in the different stations. Thus these switches will complete a cycle of operations and return to the normal position. At the control station the circuit including the normal contact of the bank s of the switch A is open at

the upper contacts of the emergency reset button 5. Accordingly the operation of the selector switches at the control station will be interrupted at this point. Since the circuit of the normal contact of the switch s of the switch A' at the remote station is interrupted at the contacts of the relays 36 and 44 the operation of these selectors will be interrupted at this point. During the resetting operation the circuit of the indication conductor is opened at the contacts 43 of the emergency reset button 5, and accordingly the position of the polarized relays 26, 27, 28, 29 will not be affected by this asynchronous and independent operation of the switches.

To prevent operation of a remote switch during periods when the selector switches are being rapidly actuated due, for example, to reactive surges in the control conductor, a relay 55 is inserted at the remote station in a manner similar to relay 46 at the control station. The contacts of this relay are inserted in the control conductor and its winding is connected between the common conductor and a point of positive or negative potential as determined by the position of the lower armature of the polarized relay p'. This relay is a slow pick-up relay. Thus during rapid actuation of the switches and rapid reversal of current through its winding the contacts will remain open but after the switches have been stopped for an appreciable period the contacts of the relay are closed and the control circuit is completed.

While I have described my invention in connection with the operation of switches, it will, of course, be understood that it is not limited thereto, since other signal devices, indicating devices, meters, and the like may likewise be supervised and controlled.

Likewise, while I have described my invention in connection with a system employing two distributor, or selector switches, at each station, its operation when one selector, or a number of selectors greater than two, in each station will be readily apparent from the description given.

While I have shown and described a single embodiment of my invention it will, of course, be understood that I do not wish to be limited thereto since many modifications, both in the circuit arrangement and in the instrumentalities employed may be made without departing from the spirit and scope of my invention as set forth in the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States, is,—

1. In combination, a control station, a remote station, a plurality of step by step selector switches in each of said stations, each of said switches having a circuit controlling member arranged for rotation through a plurality of circuit controlling positions, circuit control devices in said control station and circuit control devices corresponding thereto in said remote station, a conductor extending between said stations, means for synchronously operating, in rotation, the selector switches in each station thereby to connect said conductor selectively in circuit with corresponding circuit control devices in both stations, said means including means associated with a selector switch in both stations to produce synchronous operation thereof, and means responsive to predetermined operation of any switch to connect said synchronous operating means and said conductor with a different switch, and means for restoring each of said switches to a predetermined initial position.

2. In combination, a control station, a remote station, a plurality of rotary selector switches in one of said stations, each of said switches having a circuit controlling member arranged for rotating through a plurality of circuit controlling positions, and a rotary selector switch corresponding to each of said first mentioned selector switches in the other station, a conductor extending between said stations, a plurality of control devices in each station, each of said control devices being selectively connected in circuit with said conductor by corresponding selector switches in each of said stations, means in each station adapted to cooperate with corresponding selector switches to produce synchronous operation thereof, and means operable to connect said last means, in rotation, to different corresponding selector switches in each station to produce synchronous operation of said different switches, and to restore all of said selector switches to a predetermined initial position after actuation thereof.

3. In combination, a control station, a remote station, a plurality of rotary selector switches in each station, circuit control devices in each of said stations, conductors extending between said stations, each of said conductors being connected to a rotary selector switch in each station and adapted thereby to be connected in circuit with selected circuit control devices, means for reversing the polarity of current through one of said conductors in response to each operation of the selector switches to which said conductor is connected, means responsive to the polarity of the current in said conductor for actuating said switches, means for connecting said conductors and said polarity responsive means to a different switch in each station in response to a predetermined operation of the said switches to which said conductors were previously connected, said means being operable in response to predetermined operation of all of the rotary switches in each station to connect said conductors and polarity responsive means to the switches to which they were first connected, thereby to cause all of the rotary selector switches in each station to operate in rotation.

4. In combination, a control station, a remote station, a plurality of rotary selector switches in each station, circuits controlled thereby, a conductor connected to a rotary selector switch in each station, means for reversing the polarity of current through said conductor upon each operation of the selector switches to which said conductor is connected, means responsive to each reversal of polarity of the current in said conductor for actuating said switches, means for connecting said conductor to a different switch in each station in response to a predetermined operation of the said switches to which said conductor was previously connected, said means being operable in response to predetermined operation of all of the rotary switches in each station to connect said conductor to the switches to which it was first connected and to restore each of said switches to a predetermined initial position, thereby causing all of the switches in each station to operate in rotation.

5. In combination, a control station, a remote station, a plurality of selector switches in each station, each of said switches having a circuit controlling member arranged for rotation through a plurality of circuit controlling positions, means for operating synchronously a switch in each station, means for connecting said synchronizing means to different switches in each

station, in rotation, to cause operation thereof through a predetermined arc and responsive to said operation of all of said switches to restore each of said switches to an initial position in predetermined sequence.

6. In combination, a pair of rotary selector switches, a circuit controlled thereby, a conductor connecting said switches, means for reversing the current in said conductor in response to concurrent operation of said switches and for substantially deenergizing said conductor in response to an asynchronous operation of one of said switches, a polarized relay connected in said conductor having two positions corresponding to the direction of current in said conductor, said relay being adapted to remain in either of said positions when said conductor becomes deenergized, and means for controlling said circuit in response to the relative position of said polarized relay and one of said switches.

7. In combination, a pair of switches, each of said switches including a bank of contacts and a wiper adapted to cooperate therewith, alternate contacts of said banks being connected to points of opposite polarity, a conductor connecting said wipers, said wipers being normally in engagement with contacts of opposite polarity, independent means connected in said conductor for operating each switch in response to reversal of current in said conductor and means for grounding said conductor at a point between said independent means.

8. The combination, in a remote control system, a control station, a remote station, a selector switch in each of said stations, having a plurality of positions, a plurality of circuit control devices in each station, a conductor extending between said stations and adapted to be connected by said switches to a selected circuit control device in each station, means for synchronously operating said switches through each of said positions, means for interrupting the operation of said selector switches in a position corresponding to the selected circuit control device and means for indicating when both of said selector switches occupy said last mentioned position, said indicating means being inoperative when one only of said switches occupies said position.

9. In combination, a selector switch having a plurality of contacts, an actuating magnet, means actuated by said magnet successively to engage each of said contacts in rotation, a source of electromotive force, opposite sides of said source being connected to contacts alternately engaged by said means, polarity responsive means connected between said first means and an intermediate point on said source, and means responsive to said polarity responsive means for actuating said magnet thereby to operate said first means to engage a successive contact.

10. In combination, a first station, a second station, a step-by-step selector switch in each station, a conductor joining said switches, means for reversing the current in said conductor upon each operation of said switches, means responsive to each current reversal for causing a successive operation of the switches, a circuit extending through both of said switches in a certain position thereof, means operable over said circuit for closing the circuit of said conductor in one of said stations, and means for maintaining the circuit of said conductor open at a point in the other station for a predetermined interval after said switches reach said certain position and for then closing said circuit at said point whereby said switches remain in said position independently of charges accumulated on said conductor during operation of said switches.

11. In combination, a pair of selector switches, each of said switches having a normal position and a plurality of other positions, a synchronizing circuit extending through said switches including means for synchronously operating said switches through said positions, means for closing said circuit in the normal position, and means operable when the switches return to the normal position to prevent closure of said circuit for a predetermined interval.

12. In combination, a control station, a remote station, a selector switch in each station, each of said selector switches comprising a plurality of banks of contacts, alternate contacts in each of said banks being connected to points of opposite polarity, a wiper cooperating with each of said banks, a conductor including a polarized relay in each station connected to one of said wipers in each station, each of said polarized relays having an armature arranged alternately to engage oppositely disposed contacts, said contacts of each relay being connected to points of opposite polarity, and an actuating magnet for each of said switches, each magnet being connected between the armature on the associated polarized relay and one of said wipers.

13. In combination, a first station, a second station, a plurality of selectors in each station, a line conductor extending between a selector in each station, a plurality of apparatus units in each station each apparatus unit in one station corresponding to an apparatus unit in the other station, an additional transfer selector in each station, said transfer selector having a member rotatable through a plurality of circuit controlling positions and arranged to connect said conductor to corresponding selectors in each station, means for synchronously operating a selector in each station when said conductors are connected thereto thereby successively to connect said line conductors in circuit with different corresponding apparatus units in each station, and means responsive to predetermined operation of each selector to operate said rotatable member to its next position in rotation thereby to connect said conductor to different selectors in each station whereby said first-mentioned selectors in each station may be operated in rotation each selector being operated synchronously with a selector in the other station.

14. In combination, a first station, a second station, a plurality of selectors in each station, a line conductor extending between a pair of said selectors, one selector being in each station, a plurality of apparatus units in each station, each apparatus unit in one station corresponding to an apparatus unit in the other station, means for synchronously operating a selector in each station thereby successively to connect said line conductor in circuit with different corresponding apparatus units in each station, an additional transfer selector in each station, said transfer selector having a member rotatable through a plurality of circuit controlling positions and arranged to connect said synchronizing means and a line conductor to corresponding selectors in each station, and means responsive to predetermined operation of each of said first-mentioned selectors to operate said rotatable member to its next position in rotation thereby to connect said conductor and synchronizing means to different

selectors in each station whereby said first-mentioned selectors in each station may be operated in rotation, each selector being operated synchronously with a selector in the other station.

15. In combination, two selector switches, each switch having two banks of stationary contacts, a cooperating wiper for each bank and means including a motor magnet for operating the two wipers simultaneously in response to the completion of an energizing circuit for the motor magnet, and means for effecting the synchronous operation of the wipers of both switches including a conductor interconnecting one wiper of one of said switches and a wiper of the other switch, means for supplying potentials to a similar group of stationary contacts in each bank engaged by said wipers which are interconnected by said conductor so that adjacent contacts in the same group are supplied with potentials of opposite polarity and corresponding contacts in the two groups are supplied with potentials of opposite polarity, and means responsive to each reversal of current in said conductor due to the movement of the wipers interconnected by said conductor for completing an energizing circuit for each motor magnet through the other wiper and a stationary contact of the associate selector switch.

16. In combination, two selector switches, and means for operating said switches in synchronism including a motor magnet for each switch, means responsive to the operation of each switch by its motor magnet for reversing the potential applied to one of the terminals of its motor magnet, a conductor, means for reversing the current in said conductor, and means responsive to reversals of current in said conductor for reversing the potentials applied to the other terminals of said motor magnets.

17. In combination, two selector switches, each switch having a bank of stationary contacts, a cooperating wiper and a motor magnet, means for operating said switches in synchronism including means responsive to each operation of a switch by its motor magnet for reversing the polarity applied to one of the terminals of the motor magnet, a conductor interconnecting said wipers, means for supplying potentials to a similar group of contacts in each bank so that adjacent contacts in the same group and corresponding contacts in the two groups are supplied with potentials of opposite polarity, and means responsive to a reversal of current in said conductor due to the movement of said wipers for reversing the potentials applied to the other terminals of said motor magnets.

18. In combination, two selector switches, each switch having two banks of stationary contacts and a cooperating wiper for each bank, a conductor connecting one wiper of one of said switches with the corresponding wiper of the other switch, means for supplying potentials to a similar group of contacts in each bank so that adjacent contacts in the same group are supplied with potentials of opposite polarity and so that the corresponding contacts in the two groups whose cooperating wipers are interconnected by said conductor are supplied with potentials of opposite polarity, a motor magnet for each switch having one terminal connected to the other associate wiper which is not connected to said conductor, and means responsive to each reversal of current in said conductor due to the movement of the wipers connected thereto for reversing the potential supplied to the other terminal of each of said motor magnets.

19. In combination, two selector switches, each switch having two banks of stationary contacts and a cooperating wiper for each bank, a conductor connecting one wiper of one of said switches with the corresponding wiper of the other switch, means for supplying potentials to a similar group of contacts in each bank so that adjacent contacts in the same group are supplied with potentials of opposite polarity and so that the corresponding contacts in the two groups whose cooperating wipers are interconnected by said conductor are supplied with potentials of opposite polarity, a motor magnet for each switch having one terminal connected to the other wiper which is not connected to said conductor, and a two position polarized relay associated with each switch and connected in series with said conductor for connecting the other terminal of the associate motor magnet to a source of potential of one polarity when current flows through said conductor in one direction and to a source of potential of the opposite polarity when current flows through said conductor in the opposite direction.

20. In combination, a control station, a remote station, a plurality of selector switches in each station, a transfer switch in each station, each of said switches having a plurality of stationary contacts and a cooperating wiper, means for synchronously operating the wiper of a selector switch in said control station with the wiper of a selector switch in said remote station, means responsive to a predetermined operation of said synchronously operated wipers for effecting the operation of the wipers of both of said transfer switches, and means responsive to said operation of the wipers of said transfer switches for effecting the synchronous operation of the wiper of another selector switch in said control station with the wiper of another selector switch in said remote station.

21. In combination, a control station, a remote station, two selector switches in each station, a transfer switch in each station, each of said switches having a plurality of stationary contacts and a cooperating wiper, a conductor interconnecting the wipers of said transfer switches, means electrically controlled over said conductor while the wipers of said transfer switches are in engagement with certain stationary contacts for synchronously operating the wiper of a selector switch in said control station with the wiper of the selector switch in said remote station, means responsive to a predetermined operation of said synchronously operated wipers for effecting the movement of the wipers of said transfer switches into engagement with other stationary contacts, and means controlled over said conductor when the wipers of said transfer switches are in engagement with said other stationary contacts for effecting the synchronous operation of the wipers of the other selector switches in said stations.

22. In combination, two selector switches, and means for operating said switches in synchronism including a motor magnet for each switch, means responsive to the operation of each switch by its motor magnet for reversing the potential applied to one terminal of its motor magnet and means for simultaneously reversing the potentials applied to other terminals of said motor magnets.

CLYDE E. STEWART.