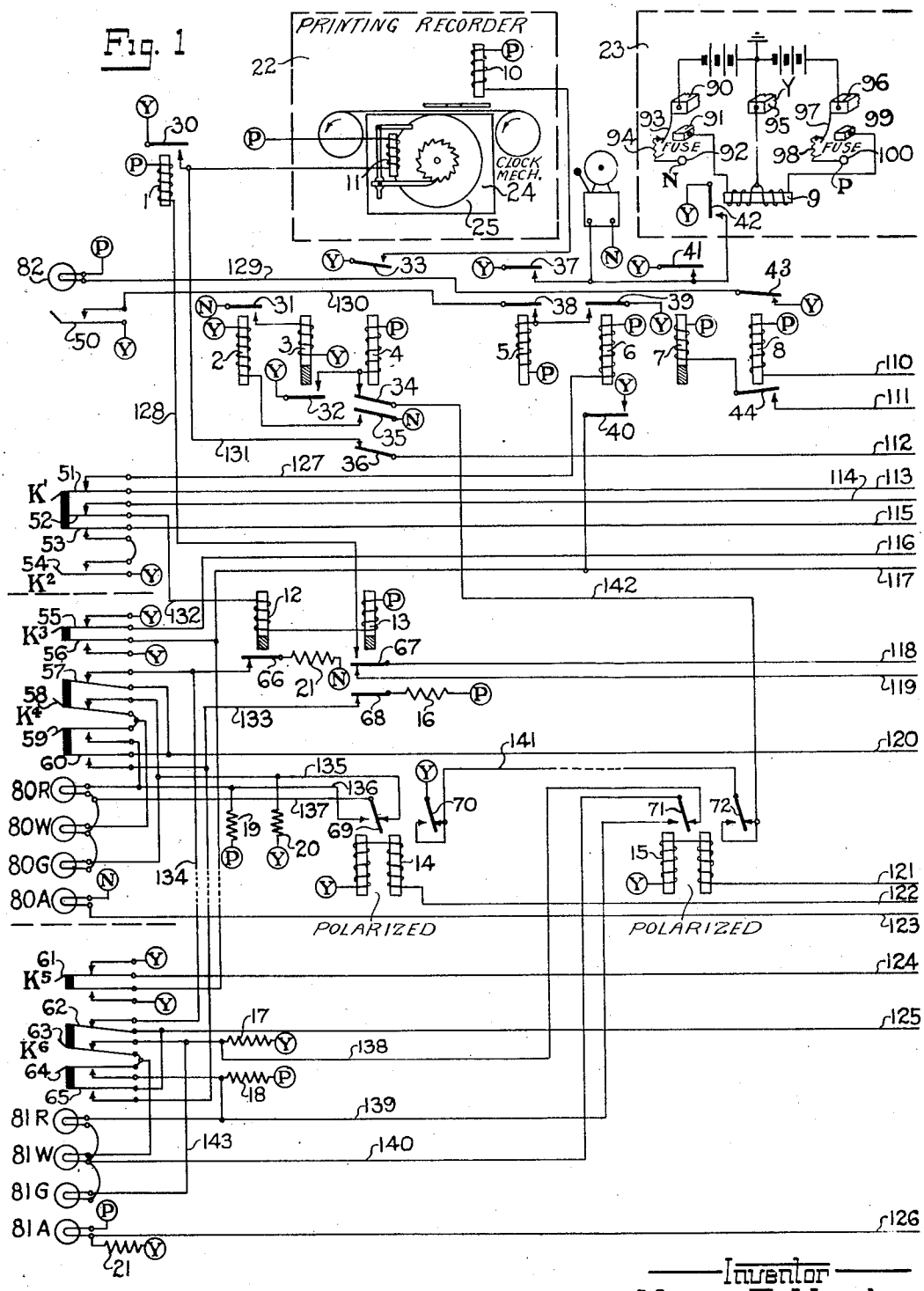
May 5, 1931. H. E. HERSHEY 1,803,614

REMOTE CONTROL SYSTEM

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Fig. 1



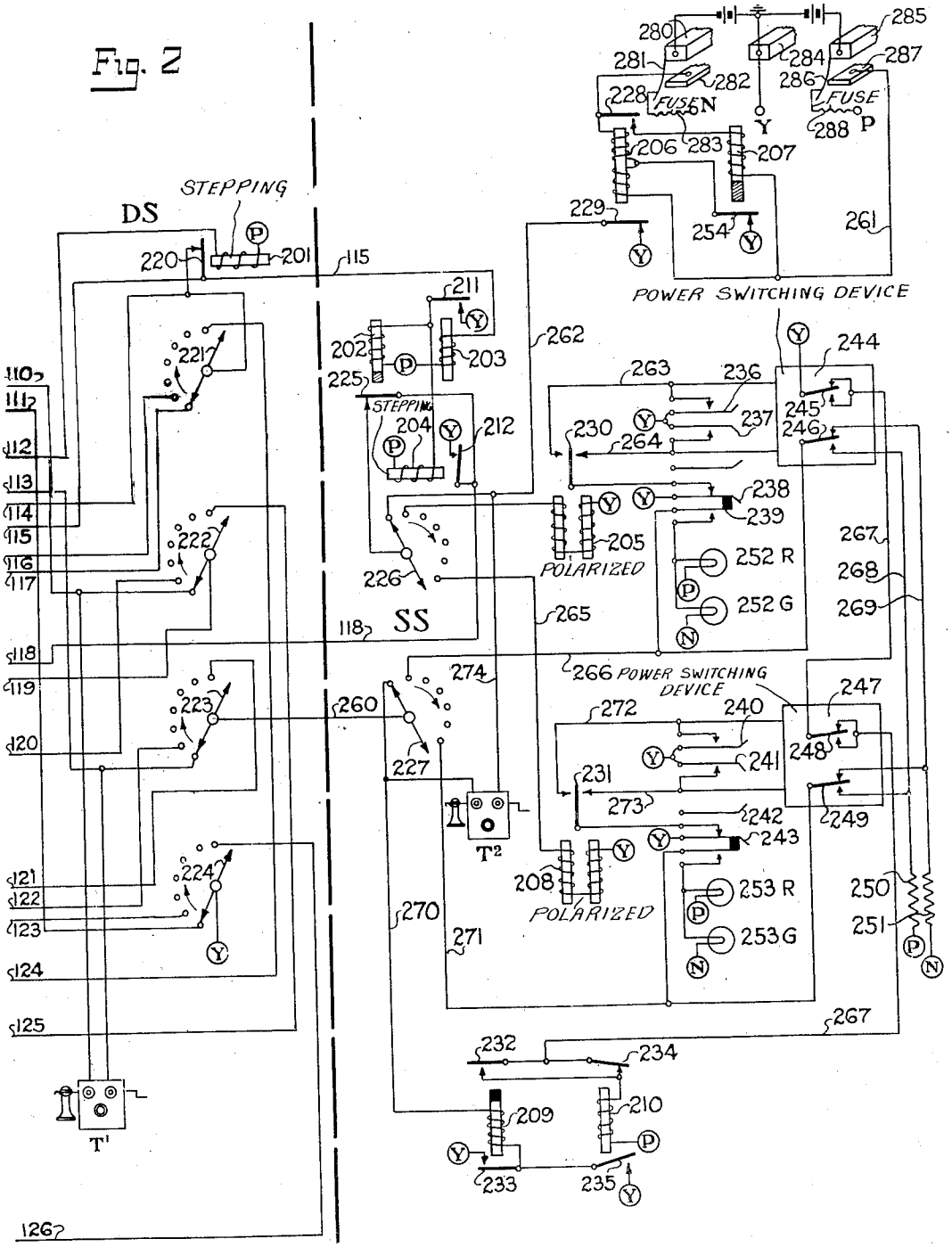
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May 5, 1931. H. E. HERSHEY 1,803,614

REMOTE CONTROL SYSTEM

Filed Oct. 11, 1926 2 Sheets-Sheet 2

Fig. 2



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UNITED STATES PATENT OFFICE

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REMOTE CONTROL SYSTEM

Application filed October 11, 1926. Serial No. 140,777.

This invention relates in general to remote control systems, more particularly to such systems in which one of a plurality of switching devices in a remote control station can be selectively operated by a dispatcher in a central station, and the supervision of that operation being instantly given. The principal object of the invention, briefly stated, is the production of a new and improved remote control system, in which a greater speed and accuracy of operation is obtained, and in which a printed record is made of the various operations performed together with the date and time of their successful performance.

One of the objects of the invention is to provide improved stepping arrangements for operating the selective switches in both the control station and the substation in synchronism and for giving instantaneous supervision by the operation of signals at the control station when the operation of the power devices at the substation has been controlled from the control station.

Features of the invention relate to the automatic operation of the switches to signal the dispatcher at the control station when the power devices automatically change their position, and to generally improve the selection, operation, and supervision of devices at a remote station.

In accordance with a further object of my invention, I provide a printing recorder consisting of a clock recorder arranged to stamp the date and hour, and in addition, I provide a circuit designating wheel which is rotated step-by-step in synchronism with the selecting switches of the system, so that when the printing recorder is operated, a printed copy is made of the circuit or device which was operated and the date and time of such operation.

Further objects and features not specifically mentioned will be apparent from the detailed description and claims which follow.

The drawings comprising Figs. 1 and 2, when arranged with Fig. 2 to the right of Fig. 1 with correspondingly numbered lines in alignment, show sufficient details to enable a clear understanding of my invention. The apparatus shown in Fig. 1 and that shown to the left of the dotted line, Fig. 2, comprises the equipment at the dispatcher's station. The equipment to the right of the dotted line in Fig. 2 comprises the equipment at the substation, that equipment being connected to the dispatcher's station over the trunk comprising conductors 115, 118 and 260.

Referring now to Fig. 1 in more detail, it will be seen that I have provided a group of keys comprising keys K1—K6, inclusive, through which the positioning and operating of the dispatcher's switch DS is controlled. Each of the circuits at the substation are controlled by a pair of keys, such as K5 and K6 which are associated with the twenty-fourth bank contact. Associated with each group of keys is a lamp bank comprising four lamps through which the apparatus at the distant substation controlled by that particular key group is supervised. This lamp group comprises a red lamp to designate the closed position of the associated apparatus, a white lamp to designate that that apparatus has changed its position, a green lamp to designate the open position of that apparatus, and an amber or white lamp to give indications when the wipers of the dispatcher's switch DS are resting upon the particular circuit. In connection with each circuit of the system, I have provided a polarized relay, such as relay 14, that relay being operated to directly control the signal lamps. The preferred type of relay for this use is a polarized relay in which the relay is polarized by a permanent magnet and operated by one or more electro-magnets to move the armature in one or the other of its two positions. The relay is so constructed that its armature will remain in the position to which it was last set after the operating current through the electro-magnets has been shut off by means of the permanent magnet. In Fig. 1, I also show the printing recorder 22 which comprises a clock mechanism 24 and a circuit recording wheel 25. The circuit recording wheel 25 is operated in synchronism with the dispatcher's switch DS, preparing it to print the circuit number or name of any device which is operated, upon the recorder tape. The clock mechanism prints the date and the hour of

the circuit operations. In Fig. 1, I also show the power supply and supervisory equipment 23, which consists of the three main battery bus-bars 90, 95, and 96, the alarm bus-bars 91 and 99, and the battery supply bus-bars 92 and 100 which are connected to the main bus-bars through fuses 93 and 97, respectively. The power supply for the system of my invention comprises positive and negative batteries each of about fifty volts potential, connected together, the junction being grounded to form a neutral. In Fig. 1 the main bus-bar 90 is the negative bus-bar and the main bus-bar 96 is the positive bus-bar. The negative supply bus-bar 92, which is fused to main bus-bar 90 is hereinafter designated as N, and in order to simplify the drawings as much as possible, all connections to this bus-bar are terminated in a small circle marked with an N. Similarly the positive bus-bar 100 is designated as P and all connections thereto terminated in a circle marked with a P. The neutral or Y bus-bar is grounded and connections thereto are terminated in a circle marked with a Y. The supervisory relay 9 is associated with the power supply unit to operate certain supervisory equipment to apprise the operator of a blown fuse, in a manner which will be hereinafter explained. In Fig. 1, I also show the relay groups and switches which are instrumental in controlling the dispatcher's switch DS.

Referring now to Fig. 2, I show there the dispatcher's switch DS, comprising the magnet 201 and the wipers 221 to 224, inclusive. This switch is preferably a rotary lineswitch of the Strowger system, such as is shown and explained in the second edition of the book Automatic Telephony, by Smith and Campbell in the paragraph beginning at the top of page 52. This switch mechanism, which is familiar to one skilled in the art, consists of a plurality of double ending wipers which have access to rows of contacts appearing in a semi-circular bank, there usually being twenty-five contacts in each row of the bank. The wiper assembly of this switch, which may include from one to six wipers, is advanced step-by-step by a motor magnet and armature, the mechanism being so arranged that the wipers are advanced when the magnet is deenergized and the armature retracted rather than when the magnet attracts the armature. In Fig. 2, I also show a station switch SS which is similar in construction to the switch DS. Since the switches DS and SS each have twenty-five contact sets, a maximum of twenty-four separate switching circuits can be controlled thereby. The twenty-fifth contact set is used as a home position, through which non-switching circuits are completed, for purposes which will be hereinafter explained. Accessible through the wipers of the switch SS are a plurality of polarized relays, such as relay 205 for example, those relays being mechanically similar to the relays at the dispatcher's station, differing therefrom in that they are so arranged that they do not remain in the position to which they were last set when the current through the electromagnet dies away. In Fig. 2, I show a plurality of power switching devices represented by squares such as 244 and 247. These power switching devices may be any one of a number of well known devices such as circuit breakers, governor controls, gauge controls, or load metering devices. The exact type or description of this power switching apparatus does not form an essential part of this invention and I have therefore chosen merely to represent such apparatus by symbol. Associated with each of the apparatuses to be controlled are a group of springs having a main spring which rests against one contact when the switching device is in its closed position and against another contact when the switching device is in its open position. These springs are so adjusted that the main spring breaks away from the one contact before it may close its circuit with the other contact. In Fig. 2, I also show a plurality of manual keys, through the operation of which an attendant at the substation, can isolate the substation from the dispatcher's station, and control it manually. I also show magneto telephones T1 and T2 which are connected through the normal positions of the switches DS and SS to the trunk conductors between the two stations, so that the dispatcher and the attendant at the substation carry on telephone conversation if they so desire.

In Fig. 2, I also show the substation main bus-bars 280, and 285 to which the negative supply bus-bar N and the positive supply bus-bar P are fused by alarm fuses 283 and 288, respectively. Alarm bus-bars 282 and 287 are connected to opposite ends of supervisory relay 206. The neutral bus-bar 284 is grounded. Throughout the figure connections to the substation negative bus-bar are designated by N, connections to the positive bus-bar P and connections to the neutral bus-bar as Y, in order to avoid an unnecessary complication of the figure.

The operation of the system of my invention is in general quite similar to that of other remote control systems of which I am aware, but differs therefrom in several important features as will be apparent from the detailed description which follows. When the system is normal, that is neither employed to control a switch at the substation or to give the dispatcher automatic supervision of the switches at the substation, the wipers of switch DS and SS stand in what I term a home position, that being the position in which they are shown on the drawings. With the wipers in this position, the telephones T1 and T2 are connected to permit communications between the two stations. Each switch-

ing device at the substation, such as 244 and 247, is in one of its two positions, either open or closed, and the keys associated with those switching devices at the dispatcher's station, are thrown to a corresponding position. That is key K4 which is associated with the switching device 244 is shown thrown to the device closed position on the drawings, and the device 244 is assumed to be closed. Similarly the key K6 is in the device closed position and the device 247 with which it is associated is assumed to be in its closed position. At the dispatcher's office the lamp 80R which is associated with device 244 will be lighted to designate that that device is closed and similarly lamp 81R will be lighted to designate that the device 247 is closed. The polarized relays 14 and 15 will be set as shown on the drawings. Under these conditions, relay 4, relay 8, and relay 210, will be maintained energized for the purpose which will be hereinafter explained.

The system of my invention is arranged to handle two main kinds of signals, that is directive signals in which case the dispatcher selects a particular device at the substation and operates it, the system returning supervision to apprise him of the correct operation of that selector device. The system is also arranged for supervision of the automatic operation of a device at the substation. Assume for example that the breaker 244 automatically opens itself responsive to an unusual load condition. That breaker upon going out, opens the circuit of relay 210 permitting that relay to fall back and close its circuit for the pick-up relays of the dispatcher's station to cause the dispatcher's switch DS and the secondary switch SS to rotate over their banks. As the two switches are advanced step-by-step, testing wiper of the switch SS tests for the polarity of the contact associated with each of the devices in the substation. If the device has not changed its position, the polarity is picked up by the testing wiper and will be the same as that which was picked up by it when it swept over its bank previously, and no change will take place. When a device which has changed its position is reached, the test wiper picks up an opposite polarity, which operates polarized relay at the dispatcher's office associated with that particular device. The operation of the polarized relay opens the chain circuit of relay 4, permitting that relay to fall back and close the circuit for the magnet 10 of the printing recorder. The deenergization of relay 4 opens a point in the stepping circuit of the switch DS, preventing that switch from stepping off the contacts on which it is resting until the printing recorder has had time to operate.

After a brief interval, the relay 4 is again energized, and held energized over the chain extending through the polarized relay of the supervisory equipment, the stepping circuit is again closed and the switches DS and SS continue to advance their wipers towards the home position. If any other switching devices have changed position meanwhile, the switches will be stopped on the contacts, associated therewith and the printing recorder again operated to make a record of that operation.

If the dispatcher desires to select a particular device at the substation, he first operates the selecting key associated with that device, responsive to which operation the switches DS and SS step in synchronism until their wipers are lined on the contacts associated with the operated key. After the switching device has been selected, there are two possible operations that the dispatcher can perform upon it. These operations are controlled by a double throw operating key, which is arranged to close the switching device when thrown in one direction and to open it when thrown in the other direction. As soon as the switching device has been operated, supervisory circuits changed by it cause a change in the position of the polarized relay associated with the supervisory equipment of that device, to apprise the dispatcher of the successful completion of the switching function and to operate the printing recorder to record the circuit number and the time of operation. The dispatcher then releases his device selecting key, whereupon the switches DS and SS step their wipers into the home position.

From the foregoing, it will be evident that the successful operation of the system depends upon the two switches DS and SS being in step at all times. When the two devices reach their home position, a circuit is completed to the wipers of the switches to light a home position supervisory lamp, which informs the operator that the selecting switches are properly aligned upon their respective home position contacts. If when the dispatcher starts to select a particular device at the said station, he notices that this home position supervisory lamp is not lighted, he knows that the selecting switches are not properly aligned and therefore he cannot perform the desired operation. To remedy this condition, the dispatcher will operate an aligning key, which energizes the motor magnet of one of the stepping devices without energizing the motor magnet of the other, by which arrangement he can align the two switches upon their home positions.

Fuse alarms are provided to apprise the dispatcher of a blown fuse either in his own station or in the substation. Connected to the fuse alarm bus-bars are supervisory relays, which control circuits for a bell or buzzer which sounds to inform the dispatcher of the blown fuse. The circuits are so arranged that when the fuse at the dispatcher's

station is blown, the signal sounds constantly, and when the fuse at the substation blows the signal sounds intermittently.

In order to permit an attendant at the substation to isolate a device from the control of the dispatcher and to operate that device, two keys are provided individual to each device in the substation. In an out position lamps are also provided so that the attendant at the substation may know the condition of each device in the switching station. Although the operation of these key sets isolates the particular device from the control of the dispatcher, it does not isolate the device from the supervision of the dispatcher, the supervisory circuits being so arranged that the corresponding supervisory lamps at the dispatcher's station are operated whenever the attendant at the substation operates a device.

Having thus described my invention in general I will now proceed with a detailed description of its operation.

Selecting switches in their home position

When the control and supervisory equipment of this system is in its normal position, the selecting switches DS and SS stand upon a particular contact set designated as the home position. With the wipers so aligned certain supervisory circuits are maintained closed, the one extending from the grounded neutral Y, through springs 229 of relay 206 of Fig. 2, conductor 262, the home position contact and wiper 226, springs 225, trunk conductor 118, spring 67 and its break contact, conductor 119, wiper 222 and the home position contact it engages, conductor 110, to the winding of relay 8 to the P bus-bar. Relay 8 is maintained energized over this circuit, and at springs 43 closes a circuit from the grounded Y through conductor 129 and the home position, supervisory lamp 82 to the P bus-bar. The lamp 82 is lighted over this circuit to inform the dispatcher that the control switches are properly aligned upon their home positions. At the substation, relay 210 is maintained energized over a normally closed chain circuit, extending from the Y bus-bar through springs 245 of the switching device 244, conductor 267, which extends through similar springs on all of the switching devices in the substation, through conductor 267, through the springs 234, the winding of relay 210, to the P bus-bar. It will be noted that the springs in this chain such as spring 245 for example, maintain a point in the circuit closed regardless of the position in which they are set, that is the switching device maintains the chain closed except when it is in the act of changing its position. A second similar chain is maintained at the dispatcher's station, extending from the Y bus-bar through spring 70 of the polarized relay 14 through conductor 141, and thence through similar springs on all of the other polarized relays in the office to conductor 142, through the springs 34, through relay 4, to the P bus-bar. The relay 4 is maintained energized over this circuit for a purpose which will be hereinafter explained.

Dispatcher selects circuit one

Assuming now that the dispatcher desires to perform a switching operation through switching device 244 of the substation, he will select that device by throwing the key K3, which will associate his apparatus with the device 244 through bank #1. Operation of key K3 closes springs 56 and opens springs 55. The opening of springs 55 removes ground from the bank contact of circuit 1 in the bank over which wiper 221 rotates, to render that contact selectable by the dispatcher's switch DS. The closing of springs 56 closes a circuit to the common start conductor 117 traceable from the Y bus-bar through spring 56, through conductor 117, through the home position bank contact and wiper 221 thence over two parallel paths, first through conductor 114, springs 52, conductor 132, through the winding of relays 12 and 13 in series to the P bus-bar, and second through springs 220, the conductor 115, through the winding of relay 203 to the P bus-bar. Relays 12 and 13 and 203 energize over this circuit, relay 12 to remove the N bus-bar potential from the operating conductor 134 of the dispatcher's key set, relay 13 to remove the P bus-bar potential from the operating conductor 133 of the dispatcher's key-set, and relay 203 to close the circuit at spring 211 from the Y bus-bar through relay 202 to the P bus-bar and a second circuit through the winding of motor magnet 204 of the selector switch SS to the P bus-bar. Relay 202 and magnet 204 energize over these circuits, the former to open at spring 225 a point in the home position, control circuit, for a purpose which will be hereinafter explained. Magnet 204 upon energizing prepares to advance the wipers 226 and 227 of the switch SS one step, that advance being made when the armature retracts. Magnet 204 at springs 212 closes a circuit from the Y bus-bar through conductor 118, through spring 67 and its make contact, through the winding of relay 1 to the P bus-bar, energizing the relay 1. Relay 1 upon pulling up closes a circuit from the Y bus-bar though springs 30, thence over parallel paths, the one through the motor magnet 11 of the printing recorder to the P bus-bar, and the second over conductor 131, springs 36, conductor 112, through the winding of motor magnet 201 of the dispatcher's switch DS to the P bus-bar, energizing those magnets preparatory to advancing their respective switches one step. When magnet 201 energizes at springs 220, it opens the circuit just traced to relay 203, permitting that relay to fall back and open the circuit of magnet 204

at springs 211. Magnet 204 falls back advancing the wipers 226 and 227 one step, and at springs 212 opening the circuit just traced for the relay 1. Relay 1 accordingly falls back, opens at spring 30 the circuits for the magnet 11 and the magnet 201. These magnets fall back, the former to advance to the printing recorder one step and the latter to advance the wipers 221—224, of the switch DS, one step. Since the key K3 is operated, spring 55 has removed ground from the contact engaged by wiper 221 when that wiper has taken one step, and the circuit for the relay 203 will therefore remain open, and the switches DS and SS will stop upon the contacts which are one step from the home position and associated with circuit 1. When wiper 224 associates itself with the contact of circuit 1, a circuit is closed from the Y bus-bar through wiper 224, conductor 123, through the lamp 80A, to the N bus-bar, lighting that lamp to apprise the dispatcher of the fact that the switches are aligned upon the contacts of circuit 1. Relays 201 and 203 and magnet 204 have come to rest deenergized and after a brief interval relays 12, 13, and 202 deenergize. The control conductor 120 is now connected through wiper 222, conductor 119, spring 67 and its break contact, conductor 118, springs 225, through the winding of polarized relay 205 to the Y bus-bar. It was previously assumed that the switching device 244 was in its closed circuit position, and the key K4 was accordingly thrown upward corresponding thereto. With the key K4 thrown up, the N bus-bar potential is connected through resistance 21, springs 66, springs 57 to the conductor 120, to cause current to flow over the above traced circuit through relay 205 to operate the spring 230 to the left, closing a circuit from the Y bus-bar through springs 238, springs 230, conductor 263, to the winding of one of the operating magnets in device 244. The closure of this circuit is without particular effect at this time, as the energized magnet is the magnet which closes the device 244 which is assumed to be closed. The dispatcher upon desiring to open the device operates the key K4 in the opposite direction, opening springs 57 and 58 and closing springs 59 and 60. When springs 57 and 58 are opened relay 205 deenergizes and armature 230 falls back to its normal position. When spring 60 of key K4 is closed, a circuit is closed from the P bus-bar through resistance 16, springs 68, conductor 133, springs 60, to conductor 120 and thence over the previously traced circuit through magnet 205, energizing that magnet in the direction to close the circuit from springs 230 to conductor 264, current flowing over that circuit through the magnet of device 244 which opens that device. The operation of key K4 to close springs 59 and 60 closes a circuit for the lamp 80W traceable from the P bus-bar through resistance 19, conductor 136, springs 59, through the lamp 80W, conductor 137, through springs 69 now in engagement with its right-hand contact, conductor 135, through resistance 20 to the Y bus-bar. The lamp 80W lights over this circuit. Accordingly the lamp 80R and the lamp 80W are both lighted, the former to indicate the switching devices in its closed position and the latter to indicate that a change is about to take place. As soon as the switching device 244 changes its position, at spring 245 it opens the chain circuit of relay 210 momentarily, that relay upon falling back closes a point in the circuit of relay 209, accomplishing no useful purpose at this time, since the switch SS is out of its home position. Device 244 operates spring 246, to disconnect conductor 266 from the N bus-bar and to connect it to the P bus-bar through the resistance 250 and conductor 268, closing a circuit from that conductor through spring 246, conductor 266, wiper 227 now engaging that conductor, conductor 260, wiper 223, conductor 122, through the winding of relay 14 to the Y bus-bar, energizing the relay 14 which operates its spring 69 away from its right-hand contact and closes a circuit through its left-hand contact. If the device 244 is of the nature of a circuit breaker or of some other quick acting device, relay 14 will be operated before the light 80W has had time to light up to full brilliancy. The operation of spring 69 short circuits the lamp 80R by applying P bus-bar voltage to both its terminals over circuits from P bus-bar through resistance 19, upper terminal lamp 80R, through the lamp 80R, conductor 137, spring 69 and its left-hand contact, conductor 136 back to the P bus-bar. The application of P bus-bar voltage to conductor 137 short circuits the lamp 80W since the key K4 is operated to close springs 59, and closes a circuit for the lamp 80G traceable from that bus-bar voltage on conductor 137 through the lower terminal lamp 80G, conductor 135 through resistance 20 to the Y bus-bar. Accordingly, the lamp 80G is lighted to indicate to the dispatcher that the switching device 244 has completed its operation and is in its open circuit position. This completes the dispatcher's operation of the device 244 and accordingly he restores the key K3, which applies Y bus-potential through springs 55, conductor 116 to the bank contact engaged by wiper 221, closing the previously traced circuit for relay 203, causing that relay to energize preparatory to advancing the switch SS and the switch DS one step. If all of the selecting keys, such as key K5 and etc., are in a normal position, wiper 221 will encounter grounded contacts until it reaches the home position. Accordingly, switches DS and SS will operate in a buzzer-like fashion until they have positioned their wipers in their respective home positions.

Automatic supervision

Assume now that during the interval that the dispatcher had the selecting switches DS and SS out of their normal position, the switching device 247 changed its position. The chain circuit of relay 210 would be opened, but since the wiper 227 is not in its home position, the function to be performed by that relay would be prevented. When the dispatcher released his key K3 to permit the switches DS and SS to return to their home positions, these switches would step until they encountered the contacts associated with the device 247. Wiper 227 of the switch SS as it is being stepped along tests the position of each device. If a device is in the position corresponding to the setting of the control keys associated therewith, the potential picked up by the wiper 227 will operate the supervisory relay 15 for example, the same direction as it is already set, without any particular effect. Assuming that device 247 has changed position, when wiper 227 encounters the contact to which conductor 271 is connected, it will pick up P bus-bar potential instead of N bus-bar potential closing a circuit for relay 15, to energize that relay in such direction as to cause it to shift springs 71 and 72 from the position which they are shown in the drawing, to the opposite position. As spring 72 is shifted it momentarily opens the chain circuit of relay 4, permitting that relay to fall back and at spring 36 open the impulsing circuit. The opening of the impulsing circuit arrests the motion of switches DS and SS, holding them upon the contacts associated with the device 247. The deenergization of relay 4 closes at springs 35 a circuit from the N bus-bar, through springs 35, winding of relay 2 to the Y bus-bar, energizing that relay. Relay 2 upon energizing closes the obvious circuit for relay 3, energizing that relay to close the obvious circuit for the relay 4. Relay 4 upon falling back also closes at springs 33 a circuit from grounded Y bus-bar, through the winding of magnet 10 to the P bus-bar, energizing the magnet 10 which presses the ribbon of the printing recorder down against the type, to record the time and circuit number of the device being supervised. It will be understood that during the stepping of switches DS and SS, the circuit recording wheel 25 of the recorder 22 is stepped in synchronism by the action of the magnet 11, so that the record printed on the tape will give the number of the circuit of the supervised device, in addition to the date and time of operation. The operation of springs 71 short circuits the closed position lamp 81R, circuit traceable from the P bus-bar through resistance 18 to the upper terminal of lamp 80R through the lamp, to conductor 140, through spring 71 now engaging with its left-hand contact, conductor 139 back to the resistance 18. The operation of springs 71 also closes a circuit for the white lamp 81W, that circuit being traceable from grounded Y bus-bar through resistance 17, spring 63 and its make contact, the upper terminal of the lamp 81W, through the lamp to conductor 140, spring 71 and its left hand contact, conductor 139 through resistance 18 to the P bus-bar. Lamp 81W lights up over the circuit to indicate to the dispatcher that a change has taken place on that circuit. The green lamp 81G is also lighted from a circuit traceable from resistance 17, conductor 143, through the upper terminal of lamp 81G, through the lamp to conductor 140 to spring 71 and its left-hand contact, conductor 139 through the resistance 18, to the P bus-bar. The dispatcher upon noting that the white and green lamps of the circuit are lighted, will note that the switching device controlled thereby has moved to its out position. Since the key K6 was set to the closed or upper position, he will move that key to the position corresponding to the lamp signals, that is to the out position. When the dispatcher operates key K6 to open springs 62 and 63 and to close springs 64 and 65, he short circuits the white lamp over circuits traceable from P bus-bar through resistance 18, through spring 64 and its make contact to the upper terminal of lamp 81W, through the lamp to conductor 140, through spring 71 and its left hand end contact, conductor 139, through resistance 18 to the P bus-bar. Accordingly lamp 81W is extinguished and the supervisory equipment is in position indicative of the position of the device at the substation. When relay 4 is again energized as explained above, the impulsing circuit is closed at springs 36, and the circuit of the printing magnet is opened at spring 33. Switches DS and SS and the circuit recorder of the printing recorder, are accordingly stepped onward until the wipers reach their respective home positions.

Automatic supervision with selecting switches in home position

Assume now that the switches DS and SS have reached their home position before the switching device 247 changed its position. When spring 248 of the device 247 opened the chain circuit of relay 210, that relay fell back and closed a circuit from the Y bus-bar, through springs 235, through the winding of relay 209, conductor 270, wiper 227 now engaging the contacts to which said conductor is connected, conductor 260, wiper 223 and its home position contacts, conductor 113, springs 51, conductor 127, through the winding of relay 6 to the P bus-bar. Relays 209 and 6 energize over this circuit. Relay 209 upon energizing locks itself through springs 233, through the P bus-bar to relay 6 over the circuit just traced, and at springs

232 closes a point in the chain circuit to deenergized relay 210, that relay energizing as soon as spring 248 has reached its fully operated position. Relay 6 upon energizing closes at springs 40 a circuit from the Y bus-bar, the conductor 117, home position and contact and wiper 221 of the switch DS, through springs 220 and conductor 115 to the relay 203, energizing that relay to start the stepping operation of switches DS and SS. Switches DS and SS will buzz around in a step-by-step manner until the contacts associated with device 247 are encountered, at which time the difference of polarity will be picked up by wiper 227 and the polarized relay 15 will operate in the above described manner to open the chain circuit of relay 4, permitting that relay to fall back and open the impulsing circuit at springs 36 and close the printing recording circuit as mentioned before. The operation of relay 15 also changes the signal lamps 81 to indicate the new position of device 247, lighting the white lamp 81W to call the dispatcher's attention to the change. Switches DS, SS and the circuit number wheel 25 of the printing recorder will accordingly be stopped and the record of the circuit change made. The dispatcher upon noting the white lamp will operate the key in the manner hereinbefore explained and supervision will be complete after which the switches DS and SS will step on into their normal position.

Fuse blows at substation

The battery supplied for the switching equipment in the substation is connected to the bus-bars 280, 284, and 285, from which it is led off through fuses to the battery supply leads of the various units. These fuses are of the alarm fuse type, in which the spring 281 is connected to the main battery bus-bar, and held in position by the fuse member 283 which in turn is connected to the post through which the battery is led to the various units. Adjacent to the springs 281 is the alarm bus-bar which normally carries no potential. Connected to the bus-bar 282 is the upper winding of the relay 206, and connected to the lower winding of the relay 206 is the signal bus-bar 287. If for example the fuse 283 blows out, spring 281 moves over and establishes a connection between the main battery bus-bar 280 and the alarm bus-bar 282, thereby closing a circuit from the Y bus-bar through spring 254, through the upper winding of relay 206, through the alarm bus-bar 282, through springs 281, to the battery bus-bar 280. Relay 206 energizes over this circuit and at spring 228 closes a circuit traceable from the Y bus-bar through spring 254, through the lower winding of relay 206, through the winding of relay 207, through springs 228 and thence to battery through alarm bus-bar 282. Relay 207 energizes over this circuit for a purpose which will be explained presently. The energization of relay 206 opens springs 229 thereby opening the circuit over which relay 8 of the dispatcher's office was normally held energized, permitting that relay to deenergize and at springs 44 close a circuit traceable from Y through wiper 224 now standing in its home position, conductor 111, springs 44, through the winding of relay 7 to the P bus-bar. Relay 7 energizes over this circuit and at springs 41 closes the obvious circuit for the audible alarm, causing this alarm to ring to apprise the dispatcher of the blown fuse. Returning now to the substation relay 207 upon pulling up opens the circuit just traced, through the upper winding of relay 206, causing that relay to deenergize. Relay 206 upon its deenergizing again closes a circuit for relay 8, causing that relay to energize and open the circuit of relay 7. Relay 7 falls back after an interval and opens the circuit of the audible alarm. Relay 206 upon deenergizing opens the circuit of relay 207, permitting that relay to fall back after a definite interval. When relay 207 falls back, the circuit is again completed for relay 206 and that relay energizes to restart the above described cycle of operation. Accordingly, the audible signal at the dispatcher's office will be intermittently operated by the blowing of a fuse at the substation, to apprise the dispatcher of the condition.

Fuse blows a dispatcher's station

The battery supplied for the dispatcher's station is carried through a similar fuse arrangement, to provide supervision of blown fuses. In case the fuse 94 blows, the spring 93 connects the alarm bus-bar to the main bus-bar 90 closing the circuit from the initial bus-bar 95 to the left-hand winding of relay 9, alarm bus-bar 91, spring 93, to the main bus-bar 90. Relay 9 energizes over this circuit and at spring 42 closes the obvious circuit for the audible alarm causing that signal to operate to apprise the dispatcher of the blown fuse. It will be seen that a blown fuse at a dispatcher's station will cause the audible signal to be continuously operated.

Audible alarm for automatic supervision

It may happen that the dispatcher's duties require him to be away from the control cabinet, and therefore makes it necessary that audible alarm be given whenever a circuit breaker or the like changes its position at the substation. I have provided the key comprising springs 50 for this purpose. When the dispatcher desires to set the audible signal, he operates this key to close springs 50. When relay 6 is operated responsive to the operation of relays 209 and 210, as explained above, it closes the obvious circuit for relay 5 at springs 39. Since relay 6 closes the step-

ping circuit of magnet 201 of switch DS, and since the circuit of relay 6 is opened when wiper 228 disengages its home position contact, relay 6 soon falls back, opening the circuit of relay 5. Relay 5 upon energizing closes through springs 37 the obvious circuit for the audible alarm. Normally the alarm is not sounded, since relay 5 is only momentarily operated. However when key springs 50 are closed, relay 5 locks itself through those springs, springs 38 and conductor 130 to the Y bus-bar, and consequently remains energized after relay 6 restores, and the audible alarm is sounded continuously.

Manual control of substation

It may happen that during an emergency a substation can best be controlled locally. Accordingly, I have made provisions whereby an attendant at the substation can isolate any device from the control of the dispatcher, and control it. I have also provided lamp signals to apprise the attendant of the position of the device he chooses to control. For example, if the attendant desires to control device 244, he operates the key associated therewith to open springs 238 and to close springs 239. The operation of springs 238 removes the Y bus-bar potential from the main spring 230 of control relay 205, so that even though the dispatcher operates that relay, he cannot operate the device 244. The operation of springs 239 closes a point in the circuit of supervisory lamps 252. If the device 244 is in its closed position as assumed before, lamp 252R will be lighted over a circuit from the N bus-bar, through resistance 251, conductor 269, spring 246, conductor 266, through spring 239, through lamp 252R to the P bus-bar. Lamp 252G is short circuited since it has N bus-bar potential on both of its terminals. To open the device 244 the attendant operates springs 237, closing a circuit from the Y bus-bar through the magnet which opens the device. To close the device, the attendant operates springs 236, closing a circuit from the Y bus-bar through the magnet which closes the device. The operation of device 244 from its closed to its open position moves springs 245 and 246 from their respective upper contacts to their lower contacts. The operation of spring 246 disconnects the conductor 266 from the N bus-bar and connects it to the P bus-bar to alter the above traced circuits so that the lamp 252R is short circuited and the lamp 252G is lighted to inform the attendant that the device 244 has properly operated. It should be noted that the operation of springs 238 and 239 removes the device 244 from the control of the dispatcher, but does not remove the device from the supervision of the dispatcher. When the device 244 was moved by the attendant at the substation, chain of relay 210 was opened by springs 245, and that relay instigated the automatic supervision in the manner hereinbefore explained, changing the signal light at the dispatcher's station to conform with the new position of the switching device.

Realigning DS and SS

From the foregoing it is apparent that in order that the system may operate correctly, the switches DS and SS must be properly aligned at all times. When the switches are in their home position, if they are properly aligned, relay 8 is energized, and the signal lamp 82 is lighted in a manner hereinbefore pointed out. If for any reason the switches get out of step, the attendant at the despatcher's station will be apprised of the fact by the failure of the lamp 82. It will then be necessary for him to realign the switches before the system can properly operate. To do this, he manually sets the switch DS in its home position, either by directly operating the armature of the switch, or by manually operating the relay 1. The latter method is preferable, inasmuch as it not only sets the switch DS upon its home position, but also keep the recording desk 25 in step with the switch DS. After the despatcher has operated the relay 1 a sufficient number of times to bring the devices into their normal position, he operates the key K1, to perform the following functions. At springs 51, a point in the circuit of relay 6 is opened, to prevent that relay operating at this time. At springs 52, a point is opened in the circuit of relays 12 and 13, thereby preventing those relays from operating, to prevent the ground returned over conductor 118 from operating the relay 1 and stepping the switch DS. At springs 53, key K1 prepares a point in an auxiliary stepping circuit, which circuit is used for aligning purposes only. The despatcher then operates the key K2, closing a circuit from the Y bus-bar, through springs 54, springs 53, conductor 115, through the winding of relay 203 to the P bus-bar at the sub-station. Relay 203 energizes over this circuit, closing the obvious circuit for the relay 202 and the magnet 204. Magnet 204 energizes, and at springs 212 closes a return circuit from the Y bus-bar over conductor 118, that circuit being without effect at this time since relay 13 is deenergized. Magnet 204 prepares to advance the wipers of the switch SS one step. The despatcher releases the key K2, permitting the relay 203 and the magnet 204 to deenergize, thereby advancing the wipers of the station selector SS one step. The despatcher will hold key K1 operated, and operate key K2, as many times as are required to bring the switch SS into its home position. When the switch reaches the home position and relay 202 is deenergized, relay 8 is energized over a circuit traceable from the Y bus-bar at the sub-

station, springs 229, conductor 262, the home position, and wiper 226 of the switch SS, springs 225, conductor 118, conductor 119, wiper 222 and its home position, conductor 110, through the winding of relay 8 to the P bus-bar. The energization of relay 8 closes a circuit through springs 43 to the signal lamp 82 to apprise the despatcher that the switches are now realigned. The despatcher then releases key K1, restoring the apparatus to its normal position in readiness for the next operation to be performed.

Telephone service

With the switch DS and switch SS both in their home position, magneto telephone service between the dispatcher's station and the substation is possible over a circuit from the terminal of telephone T1 to conductor 110, through the home position and wiper 222, conductor 119, through spring 67 and its break contact, conductor 118, through spring 225, through wiper 226 and its home position, conductor 274, through telephone T2, conductor 270, through wiper 227 now in its home position, conductor 260, wiper 223 and its home position, to the telephone T1.

While I have chosen to show my invention in connection with a particular type of apparatus, it will be understood that I have done so merely by way of example, and as there are modifications and adaptations which can be made by one skilled in the art without departing from the scope of the invention.

Having thus described my invention, what I consider new and desire to have protected by Letters Patent is pointed out in the appended claims.

What is claimed is:

1. In a remote control system, a selector switch, a magnet for said selecting switch, said magnet having means to advance said switch during its deenergization, a second selective switch containing a magnet having means to advance said switch during its deenergization, a relay and manually controlled circuits therefor over which said relay is energized to close a circuit to the magnet of said first switch, a control relay associated with the second switch, means operated by said first magnet for closing a circuit to said control relay, means responsive to the operation of said control relay for closing the circuit to the magnet of said second switch, and means controlled by the said magnet of said second switch for opening the circuit of said first manually controlled relay, to thereby deenergize said relays and magnets to advance their respective switches.

2. In a control system, a step-by-step switch having a switch bank and a wiper therefor, a plurality of keys, a contact in said switch bank for each key, a home position contact in said switch bank, a set of springs in each key having one of such springs connected to said home position contact, another set of springs in each key having one of such springs connected, respectively, to individual ones of said contacts, and means responsive to the operation of any one of said keys for initiating the operation of said switch by way of its home position contact and the first set of springs, for continuing the operation of said switch responsive to the switch wiper engaging the individual contacts connected to the unoperated keys and for stopping the switch responsive to the switch wiper encountering the individual contact connected to the operated key.

3. In a control system, a switch having a switch bank and a wiper therefor, a plurality of switching devices, a plurality of keys, each one of which corresponds to one of said devices, a contact for each key in said switch bank, a home position contact in said switch bank, a set of springs in each key having one of such springs connected to said home position contact, another set of springs in each key having one of such springs connected, respectively, to individual ones of said contacts, means responsive to the operation of any one of said keys for initiating the operation of said switch by way of its home position contact and the first set of springs, for continuing the operation of said switch responsive to the switch wiper engaging the individual contacts connected to the unoperated keys and for stopping the switch responsive to the switch wiper encountering the individual contact connected to the operated key, and means for operating the switching device corresponding to the operated key.

4. In a control system, a first and second switch each having a switch bank and a wiper therefor, a plurality of switching devices each controlled by way of a contact in the switch bank of the second switch, a plurality of keys each one of which corresponds to one of said devices, a spring in each of said keys connected to a corresponding contact in the switch bank of said first switch, a home position contact in the bank of said first switch, said home position contact connected to a spring in each key, means responsive to the operation of each key for initiating the operation of said switches by way of said last spring and home position contact, means for continuing the operation of said switches responsive to the wiper of the first switch engaging the contacts connected to the unoperated keys, means for stopping the switches responsive to the wiper of the first switch encountering the contact connected to the operated key, and means for operating the switching device corresponding to the operated key.

5. In a remote control system, two selecting switches each having a stepping magnet, means for energizing the magnet associated with the first of said switches, means con-

trolled by said magnet for energizing the magnet associated with the second of said switches, means controlled by the energization of said second magnet for deenergizing both said magnets, means for operating said switches one step responsive to the deenergization of said magnets, means for reenergizing said first magnet independent of said first means, said second magnet thereby reenergized responsive to the reenergization of said first magnet for deenergizing both said magnets to operate the switches another step, and means for stopping said switches when a desired number of steps have been taken.

6. In a remote control system, two selecting switches each having a stepping magnet, a stepping relay in the first switch, means including a circuit for energizing said relay, a second circuit completed by the energization of said relay for energizing the magnet associated with the first switch, a second relay associated with said second switch, a third circuit completed by the energization of said first magnet for energizing said second relay, a fourth circuit completed by the energization of second relay for energizing the second magnet, contacts on said second magnet operated responsive to its energization for opening said first circuit to deenergize said first relay whereby said first relay deenergizes and opens the circuit of the first magnet, the deenergization of the first magnet opens the circuit to the second relay, and the deenergization of the second relay opens the circuit to the second magnet, means for operating said switches one step responsive to the deenergization of said magnets, a fifth circuit completed over said contacts by said second switch in its new position for reenergizing said first relay whereby said first magnet, said second relay, and said second manget are reenergized and deenergized over their respective circuits to operate said switches another step, and means for continuing the stepping operation of said switches as long as a circuit is completed for said first stepping relay in successive positions of said second switch.

7. In a control system, a plurality of devices adapted for automatic operation in response to power changes, a switch having access to said devices, a signal set for each device, a relay, a chain circuit extending through all said devices for controlling said relay, locking contacts on said relay for maintaining said relay normally energized over said circuit, other contacts on said relay, means responsive to the operation of any one of said devices from one position to another for momentarily interrupting said circuit to deenergize said relay to close said other contacts, means responsive to the closure of said other contacts for initiating the operation of said switch, means responsive to said initiation for operating said switch to successively test for the changed or unchanged positions of said devices, means controlled through said switch for operating the signal sets corresponding to the devices which have changed positions, a second relay energized over a circuit including said other contacts, contacts on said second relay for reenergizing said first relay when the chain circuit is closed after its momentary interruption whereby said first relay is maintained energized over its locking contacts and the chain circuit, means in the chain circuit responsive to another one of said devices automatically operating during the testing operation for again deenergizing said first relay whereby after the switch has completed its first cycle of operation the switch is reoperated in a second cycle of operation to again test all the positions of said devices and to operate the signal set corresponding to the said other device, and means whereby said second relay is not energized responsive to the second closure of said other contacts by the second deenergization of said first relay until said switch has completed its first cycle of operation.

In witness whereof, I hereunto subscribe my name this 7th day of October, A. D. 1926.

HARRY E. HERSHEY.