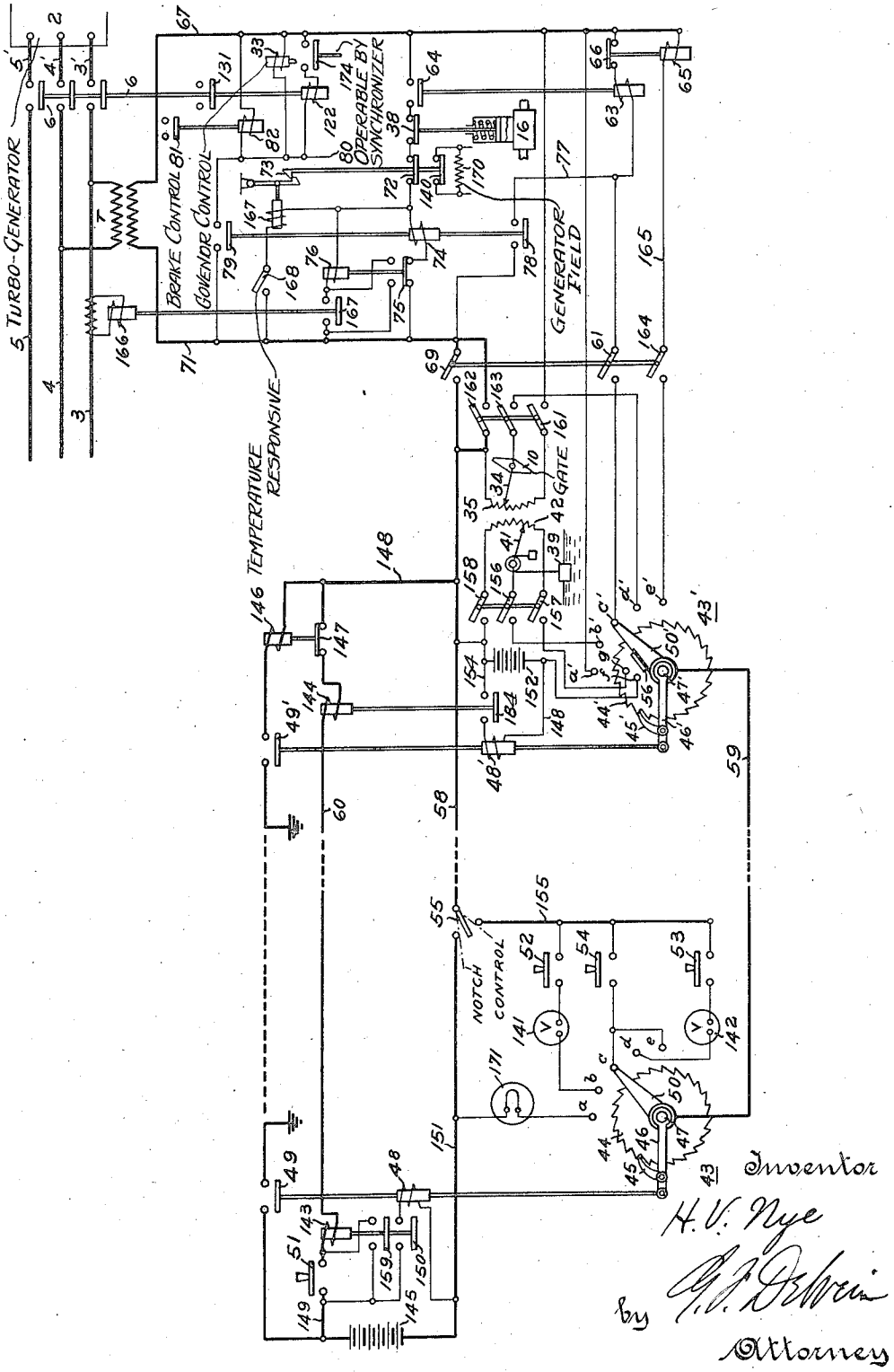
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SIGNALING SYSTEM

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SIGNALING SYSTEM

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8 Claims. (Cl. 177—353)

This invention relates in general to signaling systems, and more in particular to supervisory control systems in which switches may be opened and closed from a distance, and in which operating conditions, such as height of water and gate opening, may be measured and indicated at a distance.

An object of this system is to provide an improved signaling system in which switches and signal transmitting devices may be remotely controlled and supervised.

Another object of this invention is to provide a system in which the notching around of a plurality of rotary selector devices is dependent upon the proper action of all of said devices.

Another object of this invention is to provide a mechanism for testing the synchronism of rotary selector switches which are adapted to be simultaneously notched around under the remote control of an operator.

A further object of this invention is to provide a remote control system in which certain of the switches can be remotely closed after opening, but others must be manually closed after opening.

These and other objects and advantages are attained by this invention, various novel features of which will be apparent from the description and drawing herein, and will be more particularly pointed out in the claims.

The single figure of the drawing shows in simplified diagrammatic form only so much of the copending parent application of H. V. Nye, Serial No. 180,710, Patent No. 1,859,839, May 24, 1932, of which this case is a division, as will suffice to show the connection of the present invention therewith. The system of reference numerals used in the above parent case has been followed in this case in order to expedite comparison therewith.

Referring to the drawing, reference numeral 2 represents a prime mover-generator unit or any other translating device which is connectible to a distribution system comprising in this instance the three phase line 3, 4, 5. As will be obvious from a reading of the specification and claims many of the features of the invention may be applied to systems other than alternating current systems. The prime mover may have operating fluid lead thereto through a conduit and the admission of operating fluid may be controlled by means of a gate 10. For the sake of simplicity the admission controlling means has been shown as a butterfly valve although it is, of course, obvious that such control may take place in the usual manner as by means of guide vanes of the turbine or a needle nozzle, in case the prime mover is of the hydraulic type, or by other means suitable to the particular type of prime mover whether of hydraulic or other type. In order to provide for an indication corresponding to the gate opening a member such as an arm 34 is provided to move in unison with any portion of the gate operating mechanism, the arm 34 being here shown as attached to the gate shaft itself. This arm may be provided with a contact forming the movable element of a potentiometer and adapted to move over and contact with a potentiometer resistance 35. Connection of the generator 2 to the lines 3, 4, 5 may take place through the lines 3', 4', 5' connected to the translating device 2 by means of a circuit breaker 6.

The control system comprises, in general, a remote control station and a remotely controlled station connected together by means of three conductors and a ground circuit. The apparatus at the distant station from which the generating unit may be controlled includes a selector indicated in general by a numeral 43. The selector includes a ratchet wheel 44 fastened to a shaft 47 and provided with teeth adapted to be engaged by a pawl 45 carried by an arm 46. The arm 46 is movable independently of shaft 47 though it is preferably pivoted concentrically with said shaft. The outer end of arm 46 may be reciprocated by means of a solenoid 48. When the solenoid 48 is energized a switch 49 closes its contacts for a purpose to be described. Operating in unison with the ratchet wheel 44 is an arm 50 which is adapted to make contact with any one of a plurality of relatively stationary contacts *a, b, c, d, e*. At the generating station is provided a selector 43' having parts 44', 45', 46', 47', 48', 49', 50', *a', b', c', d'*, and *e'*, corresponding to the parts of the selector 43 indicated by the corresponding unprimed reference characters. The selector 43' is provided with an additional movable contact 56 suitably mounted on and insulated from the arm 50'. The contact 56 is adapted to bridge relatively stationary contacts *f, g*, when the arm 50' makes contact with the contact *b'*.

At the remote control station a number of control switches 51, 52, 53 and 54 are provided and the connections of the system will be best understood by a consideration of the operations performed when particular ones of the control switches are closed. If it be assumed that the parts of the system are as shown in the drawing, except as hereinafter noted, a double throw

switch 55 at the control station being closed on its lower contact, and that the switch 54 be closed, we may trace a circuit from the lefthand contact of switch 54 to contact *c*, arm 50 to a conductor 59 extending from the control station to the generating station and connected to arm 50', to contact *c'* through a contact 61 of a three pole switch which is assumed closed, through a relay coil 63 through contact 66 of a normally closed relay 65 to a bus 67. The term normally closed relay as used herein denotes a relay having contacts which are closed when the relay is in its normal deenergized position. From the right-hand contact of switch 54 a circuit may be traced through conductor 155, switch 55, a conductor 58 which extends from the control station to the generating station, through switch contact 69, to a bus 71. It is apparent that it is not material whether the three pole switch comprising members 161, 163, 162 is closed or not. The buses 67, 71 are supplied from two of the conductors of the system 3, 4, 5 by means of a transformer T. The circuit thus traced causes the energization of relay 63 and the closure of its contact 64 thereby completing a circuit from bus 67, through contact 64, fluid pressure responsive switch 38, contact 72 of a latched-in switch 73, an operating coil 74 of a master relay, through a movable contact 75 of a relay 76, to the bus 71. The relay 76 is normally deenergized and the circuit just traced is through its normally closed or back contacts. The energization of coil 74 causes the closure of the master relay thereby closing its contacts 78 and 79. The closure of contact 78 provides a maintaining circuit for relay 63, from bus 67, through contact 66, coil 63, conductor 77, contact 78, to bus 71. The closure of contact 79 of the master relay connects an auxiliary bus 80 to the bus 71 and the energization of bus 80 energizes solenoid 33 thereby starting the prime mover of turbo-generator unit 2. Energization of bus 80 also energizes a brake control relay 82 to permit the release of the brake on the prime mover. Energization of bus 80 also prepares a circuit for coil 122 which is completed from bus 71 through contact 79, bus 80, coil 122, contact 174, to bus 67 when contact 174 closes. Contact 174 is closed by means of synchronizing devices (not shown). Obviously relays 82, solenoid 33 and switch 6 may be used for other purposes apparent to those skilled in the art.

If the operator at the remote control station desires to test or measure the water level at the generating station he first throws switch 55 into its upper position and closes switch 51. This energizes relays 143 and 144 the circuit for which may be traced from battery 145, conductor 149, switch 51, coil 143, conductor 60 which extends to the generating station, coil 144, a relay contact 147, conductor 148, through a conductor 58 extending between the generating and control stations, through switch 55 to the other side of battery 145. The energization of relay 143 closes a holding circuit for itself through a contact 159 as is clear. The closure of a contact 150 of relay 143 causes the energization of the solenoid 48 from battery 145, conductor 149, contact 150, coil 48, conductor 151 to the other side of the battery. The energization of solenoid 48 causes the arm 46 to swing in a clockwise direction thereby causing the pawl 45 to move the contact arm 50 in the same direction one notch. The energization of relay 144 causes the energization of solenoid 48' from a battery 152, conductor 184, coil 48', a contact 153 of relay 144, conductor 154 to the other side of battery 152. The energization of solenoid 48' causes the pawl 45' to rotate contact arm 50' in a clockwise direction the same amount that contact arm 50 is rotated by solenoid 48. The energization of solenoids 48 and 48' causes the closure of contacts 49, 49' respectively controlled by these solenoids thereby closing a circuit from conductor 149 to contact 49 to ground, to contact 49' to a relay coil 146, conductors 148, 58 through switch 55, to the other side of battery 145, thereby causing relay 146 to open its contact 147 and deenergizing relays 143 and 144 to thereby cause the cores of solenoids 48, 48' to drop back to the deenergized position. The circuit through contacts 49, 49' previously traced is consequently opened and relay 146 is deenergized thereby reclosing contact 147. If the switch 51 is still closed or is closed again the same cycle of operations will be repeated until the contact arm 50 is rotated in a clockwise direction sufficiently to reach the desired contact, in this instance contact *b*. At the same time the contact arm 50' will reach the contact *b'*.

When the operator sees that the correct contact is made by the arm 50 he stops the notching action by opening the switch 51 and throws the switch 55 into its lower position. He then closes the switch 52 and reads the water level on a volt meter 141 which may be calibrated in terms of head of water. The volt meter 141 is fed from the potentiometer 42 in the following manner. The potentiometer 42 itself is fed from conductor 148 through contacts *f*, *g* which are bridged by a contact 56 carried by arm 50' when the arm 50' is in position *b'*, through a switch member 157 through potentiometer 42, switch member 158 to the other side of the battery 152. The circuit for the volt meter may be traced as follows: From switch 55, conductor 155, switch 52, volt meter 141, contact *b*, arm 50, conductor 59, through arm 50' contact *b'*, through a switch contact 156 to the movable contact arm 41 of the potentiometer. From the other side of switch 55 the circuit passes through conductor 58 and switch contact 158 to the upper terminal, as viewed in the drawing, of the potentiometer 42. The volt meter 141 is consequently fed by the drop of potential between the upper terminal of potentiometer 42 and the point of contact between 42 and contact arm 41. This voltage drop is obviously proportional to the head of water.

If the operator desires to determine the degree of gate opening he proceeds as hereinbefore described to step the contact arms 50, 50' around until contact is made with contacts *d*, *d'*. The switch 55 is then again thrown to its lower position and a switch 53 is closed, the operator reading the amount of gate opening on a volt meter 142 suitably calibrated. The potentiometer 35 which is controlled by means of the gate 10 is fed with current as follows: From bus 67 through a switch contact 161, through potentiometer 35 and switch contact 162 to bus 71. The volt meter 142 is fed from contact arm 34, a switch contact 163 to contact *d'*, arm 50', conductor 59, contact arm 50, contact *d*, volt meter 142, switch 53, conductor 155, switch 55, conductor 58, to the lefthand terminal of potentiometer 35 as viewed in the drawing. The voltage fed to the volt meter 142 is consequently proportional to the opening of gate 10.

The float potentiometer 42 is as described preferably fed from a storage battery rather than from the alternating current buses 67, 71 as is potentiometer 35, because greater accuracy of

the reading of water level is desired. Otherwise the potentiometer 42 might as well be fed from the alternating current buses.

Assuming that the generating station has been started and is running and it is desired to stop the same at will the operator may run the contact arms 50, 50' in a manner hereinbefore described until contact is made with contacts *e* and *e'*. The switch 55 is then again thrown down and the switch 54 is closed. A circuit is thereby established from the lefthand side of switch 54 as viewed in the drawing to contact *e*, contact arm 50, conductor 59, contact arm 50', contact *e'*, a switch contact 164, a conductor 165 through a coil 65, controlling a relay contact 66, to bus 67. From the righthand side of switch 54 a circuit is completed through switch 55, conductor 58, conductor 68 (if switch 162 is open), a switch contact 69 to bus 71. The energization of relay 65 causes the deenergization of relay 63 and consequently the deenergization of the master relay 74. All relays fed from auxiliary bus 80 are consequently deenergized resulting also in the deenergization of coil 33 so that the prime mover of unit 2 is shut down.

Without reference to the details of the circuits and auxiliary devices, as hereinbefore described in detail, the sequence of operation of the principal devices set in action, when it is desired to put the generator on the line, is as follows. The selectors 43, 43' being in the proper position, as shown on the drawing, the switch 54 is closed thereby energizing relay 63 which in turn energizes master relay coil 74 the closure of which maintains the circuit of relay 63. The energization of master relay 74 frees the turbine governor for action by energizing coil 33, and causes release of the brakes through energization of relay 82. The gate 10 is consequently opened under control of the governor and when the unit has come up to a predetermined speed an automatic synchronizer takes control and ultimately causes contact 174 to close upon phase equality between generator and line. Closure of contact 174 energizes coil 122 and causes line switch 6 to close to connect the generator to the line.

Under abnormal conditions the sequence of stopping operations is somewhat different. For example, if there should be an overload a relay 166 closes its contacts 167 thereby completing a circuit from bus 71, contact 167, the coil 76 controlling relay contact 75, contact 72 of the latched-in switch 73 through pressure controlled switch 38, contact 64 to bus 67. The opening of contact 75 at the same time closes a holding circuit for coil 76 and opens the circuit of master relay 74. The opening of master relay 74 deenergizes the relays connected to bus 80 and the unit is shut down as hereinbefore described. The holding circuit for relay 76 may be traced from bus 71 through the front or upper contacts of the relay having coil 76, through coil 76, contact 72, pressure switch 38, relay contact 64 to bus 67. It is to be noted that the opening of contacts 78 of relay 74 breaks the holding circuit for relay 63 thereby causing relay 63 to open. The contacts 64 of relay 63 in opening in turn break the holding circuit for relay 76 which is therefore restored to its lower position thus putting the circuits in condition for restarting of the plant.

In case abnormal conditions such as hot bearings or internal difficulties arise in the generating unit a switch 168 is automatically closed by such abnormal conditions thereby completing a circuit from bus 71 through contact 168, through a trip coil 169 for the latched-in switch 73, through a contact 72 of the latched-in switch, through pressure switch 38, to contact 64 to bus 67. The latched-in switch 73 is consequently released and the opening of contact 72 thereof deenergizes the master relay 74 resulting in the shutting down of the unit as previously described. The opening of contact 140 of the latched-in switch at once results in the introduction of resistance 170 in the field winding circuit of the exciter thereby killing the generator field so as to prevent damage in case the closure of switch 168 has been due to internal electrical difficulty in the generator. The unit cannot be re-started if it has been shut down due to the closure of switch 168 until an attendant visits the station and manually re-closes the latched-in switch 73.

The sequence of operation of the principal elements of the control system in shutting down the hydro-electric plant from the control station without reference to the circuits and the auxiliary devices is as follows: The operator moves switch 55 to its upper position and closes switch 51 until contact arms 50 and 50' are notched around to position *e* and *e'* respectively. The operator then moves switch 55 to its lower position and then closes switch 54. The closure of switch 54 energizes relay 65 which in opening deenergizes relay 63. Relay 63 in opening deenergizes master relay 74 which in turn deenergizes the auxiliary bus 80 thereby deenergizing relay 82, coil 122 of switch 6 and also solenoid 33. The deenergizing of solenoid 33 causes the governor servo-motor (not shown) to move the gate 10 towards its closed position.

The sequence of operation of the principal elements of the system upon occurrence of an abnormal condition, such as overload, is briefly summarized as follows: Upon occurrence of excessive overload the relay 166 closes its contact thereby energizing relay 76 which in moving deenergizes master relay 74. Relay 74 in turn deenergizes the auxiliary bus 80 and breaks the holding circuit for relay 63 which in opening deenergizes relay 76 and restores this relay (76) to its initial position. The remainder of the sequence is precisely the same as above described.

Shut-down due to the closure of switch 168 which is responsive to abnormal conditions such as hot bearings and the like is briefly restated as follows: Closure of switch 168 energizes trip coil 169 and causes contacts 140 and 72 of latched-in switch 73 to open. Contact 170 in opening inserts resistance 170 in series with the field winding of the generator exciter to reduce the generator voltage substantially to zero. Contact 72 in opening deenergizes master relay 74 which in turn deenergizes the auxiliary bus and the remainder of the sequence is substantially the same as above described.

If the operator desires to test whether the selector arms 50, 50' are operating synchronously he runs the arm 50 to the contact *a* in the manner hereinbefore described. If the arm 50' has been at the same time notched around to contact *a'* a circuit will be established as follows: From bus 67 through conductor 172, button *a'*, arm 50', conductor 59, arm 50, contact *a* through a device here shown as a lamp 171, through conductor 151 to the upper contact of switch 55, through conductors 58, 68 to bus 71. The device 171 is therefore supplied with current from the buses 67, 71 and will thus indicate the synchronous operation (or lack of it) of the arms 50 and 50'. The device 171 may of course be a volt meter

which may be utilized to test the voltage of the line 3, 4, 5.

It should be understood that it is not desired to limit the invention to the exact details of construction shown and described, for obvious modifications may occur to persons skilled in the art.

It is claimed and desired to secure by Letters Patent:

1. In a system for controlling electrical apparatus from a distance, relatively movable contact means at the controlled and control stations respectively, means whereby a control circuit for said apparatus may be completed through both of said contact means when they are in a predetermined relative position, means at each station for producing a step by step motion of said contact means, a main relay at each of said stations for controlling the energization of said step by step producing means respectively, and a relay controlled jointly by said step by step producing means for momentarily deenergizing said main relays at substantially the end of each step motion.

2. In a system for controlling electrical apparatus from a distance, relatively movable contact means at the controlled and control stations respectively, means whereby a control circuit for said apparatus may be completed through both of said contact means when they are in a predetermined relative position, means at each station for producing a step by step motion of said contact means, a main relay at each of said stations for controlling the energization of said step by step producing means respectively, means for energizing said main relays including a source of energy located at said control station, conductors extending between said stations for connecting said main relays in series, and a primary relay in one of said conductors responsive to the step motion of at least one of said step by step producing means for momentarily and periodically deenergizing the energizing circuit for said main relays.

3. In a system for controlling electrical apparatus at a remote station from a control station, a step-by-step selector switch at the remote station and control station respectively, electromagnetic means at each station operable when energized to advance said selector switches one step at a time, at least three conductors extending between said stations, means utilizing a pair of said conductors for energizing each of said electromagnetic means so as to simultaneously advance each of said selector switches one step, means actuated by at least one of said electromagnetic means for momentarily deenergizing said selector switch advancing means at substantially the end of each advancing step of said selector switches so that said selector switches are synchronously moved step-by-step, means utilizing a third of said conductors and one of said pair of conductors for energizing said electrical apparatus when said selector switches are in predetermined positions, and switch means operable to render said selector switch advancing means inoperative when said electrical apparatus energizing means is operative.

4. In a system for controlling electrical apparatus from a distance, relatively movable contact means at the controlled and control stations respectively, means at each station for producing a step by step motion of said contact means, three conductors and a common conductor extending between said stations, means utilizing one of said conductors and said common conductor for energizing said step-by-step producing means, means utilizing a second of said conductors and said common conductor for deenergizing said step-by-step producing means, a prime mover at said controlled station, a gate for controlling the admission of operating fluid to said prime mover, means, including a relay, for initiating the opening of said gate, and means at the control station for controlling said relay through the third of said conductors and said common conductor when said contacts are in a predetermined relative position.

5. In a system for controlling electrical apparatus from a distance, relatively movable contact means at the controlled and control stations respectively, means at each station for producing a step by step motion of said contact means, three conductors and a common conductor extending between said stations, means utilizing one of said conductors and said common conductor for energizing said step-by-step producing means, means utilizing a second of said conductors and said common conductor for deenergizing said step-by-step producing means, a prime mover at said controlled station, a gate for controlling the admission of operating fluid to said prime mover, means for initiating the opening of said gate, and means at the control station for controlling said initiating means through the third of said conductors and said common conductor when said contacts are in a predetermined relative position and for indicating the magnitude of an operating condition of said prime mover when said contacts are in another position.

6. In a system for controlling electrical apparatus from a distance, relatively movable contact means at the controlled and control stations respectively, means at each station for producing a step by step motion of said contact means, three conductors and a common conductor extending between said stations, means utilizing one of said conductors and said common conductor for energizing said step-by-step producing means, means utilizing a second of said conductors and said common conductor for deenergizing said step-by-step producing means, a prime mover at said controlled station, means responsive to a condition of the fluid supply for said prime mover for producing a voltage varying with said condition, means whereby said voltage is applied to the third of said conductors and said common conductor and is transmitted through them and said contact means to said control station, and means for producing at said control station an indication proportional to said voltage.

7. In a system for electrically controlling apparatus at a station from a distant control station, the combination of rotatable selector devices at each station, electromagnetic means for notching around each of said devices, a common conductor and a plurality of notching conductors extending between said stations, a manually operable notching switch at said control station, means operable upon closure of said notching switch for energizing said electromagnetic means through said common conductor and one of said notching conductors, a relay having normally closed contacts in said notching conductor, means responsive to the notching movement of both of said selector devices for energizing said relay through said common conductor and another of said notching conductors, whereby said selector device at said station is operable to selectively select the apparatus at said station to be

controlled, a supervisory control conductor extending between said stations, manually controlled means at said distant station for controlling said selected apparatus through said common conductor and said control conductor, and a manually operable switch at said distant station for selectively rendering effective either said notching switch or said manually controlled means.

8. In a system for controlling electrical apparatus at a distance, the combination of relatively movable contact means at the controlled and control stations respectively, a manually operable stepping control switch at said control station, means operable only during closure of said manually operable switch for producing a simultaneous step-by-step movement of said contact means at each station, a first relay at said controlled station, a manually operable push button switch at said control station, means for closing a circuit through the winding of said first relay, said push button switch and through said contact means when in one position, means including the contacts of a normally closed relay providing a maintaining circuit for said first relay, means for energizing said normally closed relay through said contact means when in another position whereby said contact means must be returned to said one position to reclose said relay.

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