

Sept. 21, 1926.

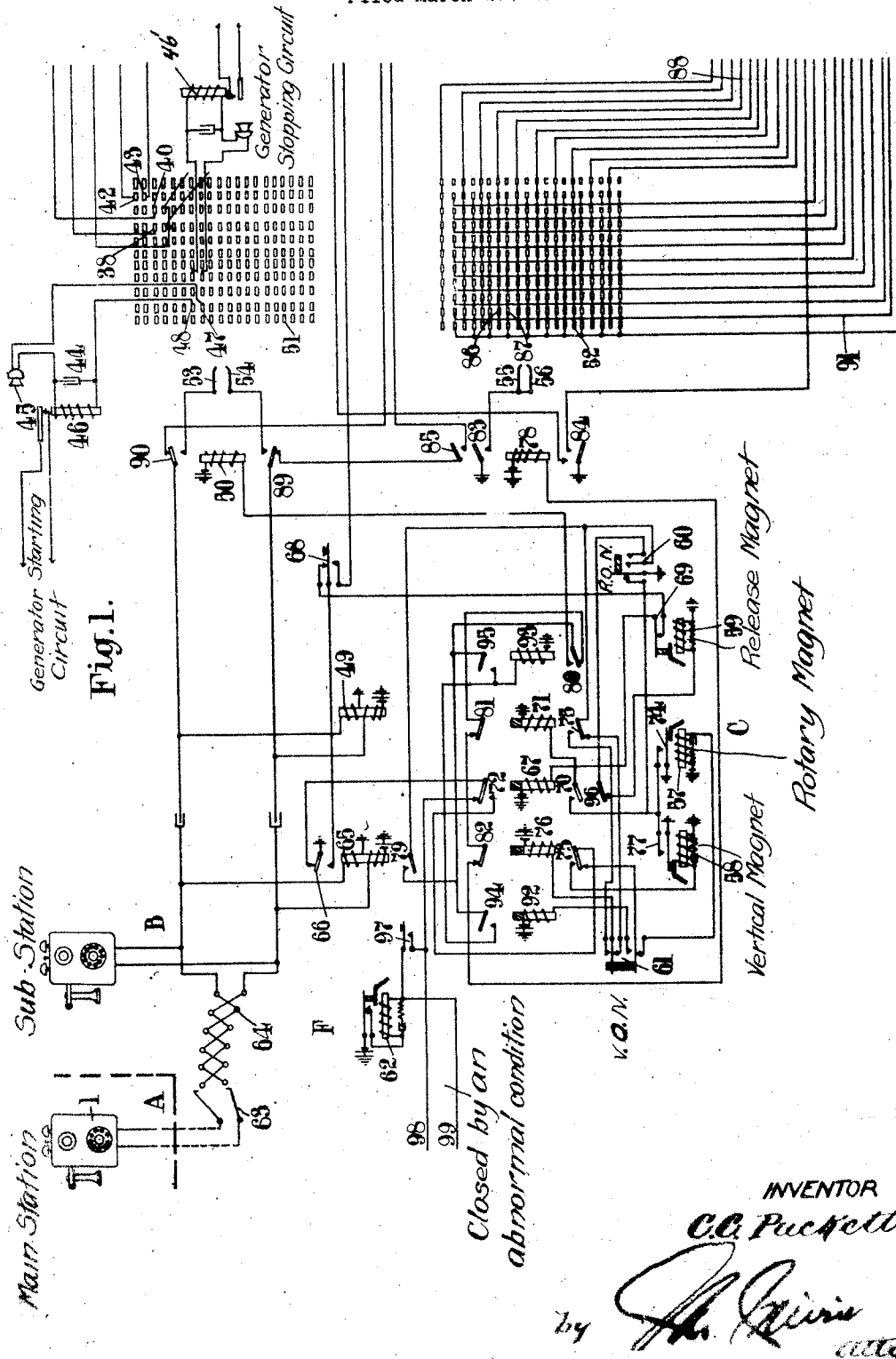
1,600,358

C. C. PUCKETTE

REMOTE CONTROL SYSTEM

Filed March 21, 1924

2 Sheets-Sheet 1



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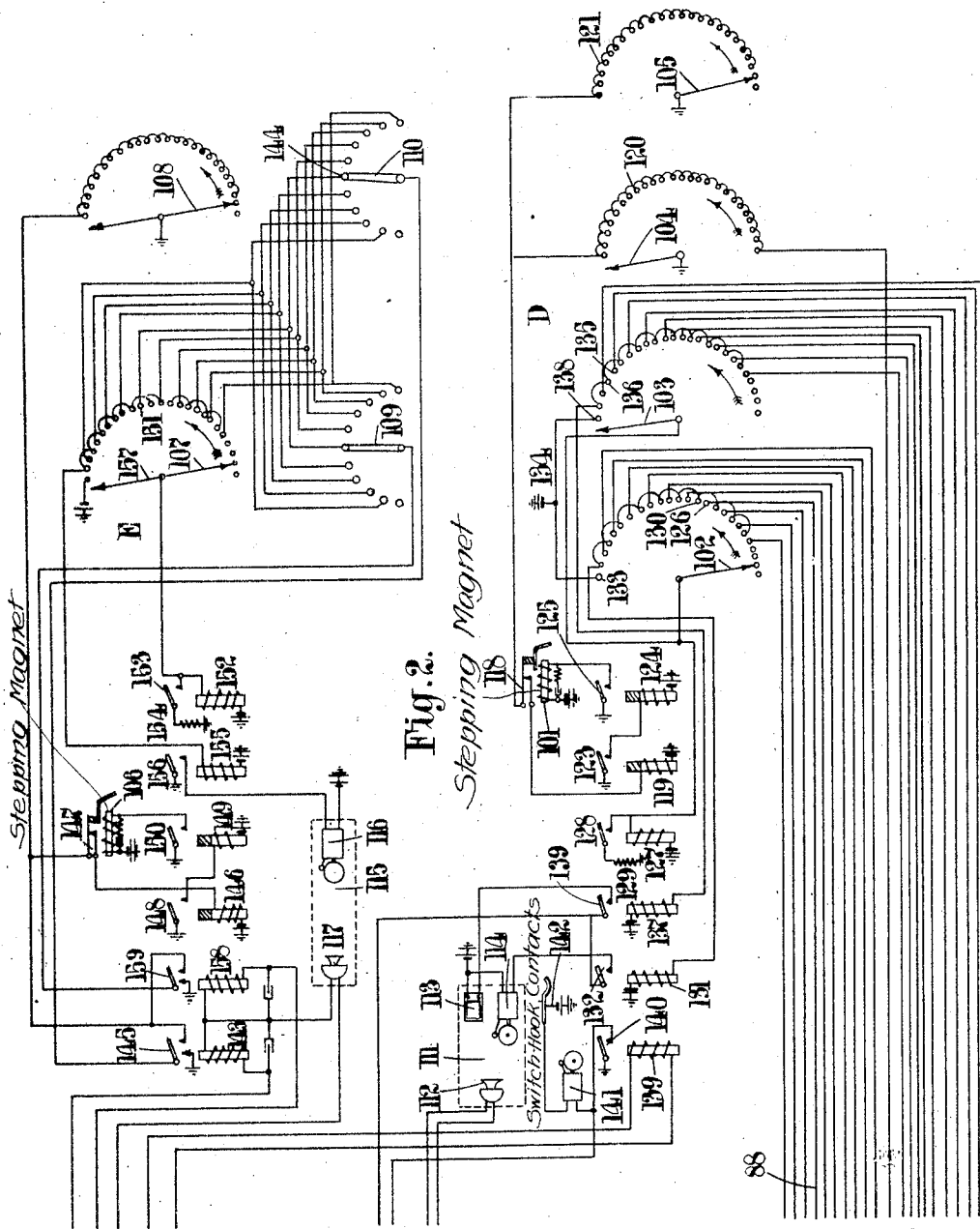
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2 Sheets-Sheet 2



INVENTOR

C. C. Fickett,

by *Thos. Cairn* ally

UNITED STATES PATENT OFFICE.

CHARLES CLARKE PUCKETTE, OF STOKE, ENGLAND, ASSIGNOR TO COVENTRY AUTOMATIC TELEPHONES LIMITED, OF STOKE, COVENTRY, ENGLAND.

REMOTE-CONTROL SYSTEM.

Application filed March 21, 1924, Serial No. 700,953, and in Great Britain December 27, 1923.

This invention relates to systems for controlling and supervising the operation of electrical machinery from a remote point over line wires.

5 The object of the present invention is to provide a remote control system where the selecting devices consist of electro-magnetic step-by-step two co-ordinate switches, which used in conjunction with a limited
10 number of rotary switches and relays contains several novel operating and control features.

The system will be described in connection with a power distributing arrangement in which a power substation is controlled
15 from a main power station over wires between the main and the substation, the despatcher being situated at the main station. A pair of telephone wires are connected between the main station and the
20 substation, and a telephone fitted with an impulse transmitter is located at the main power station over which the despatcher performs and supervises power control operations at the substation. The impulse
25 transmitter may be similar to that described in the specification of United States patent specification No. 1,324,356, so arranged that the line loop is broken a number
30 of times according to the digit pulled or dialled. At the substation a similar telephone set is installed, to enable the whole of the automatic remote control equipment to be operated either from the
35 main power station or the substation; also to enable telephonic communication to be established between the two points. At each substation is installed a one hundred point two co-ordinate selecting switch which
40 may be similar to that shown in United States patent specification No. 1,076,020. This switch is adapted to make a selection (out of one hundred) by movements in two planes. It first makes a number of
45 rotary steps according to the first train of impulses (tens) to select a particular row and then make a number of vertical steps according to the second train of impulses (units) to select a particular set of terminals in that row. The substation equipment
50 also includes several rotary step-by-step switches and a quantity of relays.

By the manipulation of his impulse transmitter the despatcher directs the selecting switch at a substation so that the

wipers engage a particular set of terminals. Thus if the despatcher dials "2" and then "7" on the impulse transmitter, the selecting switch makes two rotary steps followed by seven vertical steps so that the wipers
60 engage the set of terminals twenty seven. This may be a position corresponding to a certain condition of supervision and control, as will be afterwards explained.

A feature of the invention relates to arrangements in which the despatcher after
65 setting the two co-ordinate switch by two trains of impulses (tens and units) receives signals corresponding to the distinctive setting of the switch, thus verifying that it
70 has been correctly positioned before the control operation is performed. The despatcher may or may not proceed with the operation after receiving the signals.

A further feature relates to the method
75 of signalling. The tens and units signals must be easily distinguishable from each other and, for example, a bell may be employed for the tens signals and a buzzer for the units signals. Suppose that the des-
80 patcher wishes to perform a control operation corresponding to a setting of thirty-five on the two co-ordinate switch. He would manipulate his impulse transmitter to send out first a train of three impulses
85 followed by a train of five impulses. He would then verify the selection by placing the telephone receiver to his ear. If the switch is correctly positioned he will hear three rings from the bell followed by five
90 impulses from the buzzer. This will be repeated continuously until the despatcher performs a further operation by which he proceeds or discontinues with the control.

Reference should now be made to the accompanying drawings in which at the main
95 station A Fig. 1 is shown the telephone with impulse sender, the remainder of Fig. 1 and the whole of Fig. 2 being apparatus located at one of the substations B. The telephone
100 circuit is not shown in detail as this is unnecessary and furthermore is not confined to any particular arrangement. It is understood, however, that by the manipulation of the impulse transmitter 1 the line circuit
105 is broken a number of times in accordance with the digit dialled. Telephone B is situated at the substation and is provided to permit the operation and control of the equipment in the same way as with tele-
110

phone A. Furthermore, telephone conversation can be carried on between the two telephones. The two co-ordinate switch C at the substation, which may be of the type already referred to, is shown by its terminal banks 51 and 52, wipers 53, 54, 55 and 56, rotary stepping magnet 57, vertical stepping magnet 58, release magnet 59, off-normal springs 60, which operate when the switch makes its first rotary step, and off-normal springs 61 which operate when the switch makes its first vertical step. A rotary step-by-step switch is indicated at D, Fig. 2, by its magnet 101 and single-ended wipers arranged as shown at 102, 103, 104 and 105 and co-operating terminal banks. A second similar switch is indicated at E by magnet 106 and double-ended wipers 107 and 108 and co-operating terminal banks. The wipers 109 and 110 are attachments of measuring instruments and will be referred to later. At 62, Fig. 1, is shown the magnet of a single motion rotary step-by-step switch F, wipers of which are indicated at 63 and bank terminals at 64. This switch is of the kind commonly used in automatic telephony and is arranged to supply alternating current for ringing purposes in the following manner. The wipers 63 of this switch are connected to the incoming controlling wires, and the corresponding rows of bank terminals 64 are alternately multiplied to the two leads extending to the line relay 65. In this manner when the switch F is stepped, the current from the battery connected to the windings of the line relay 65 is converted into alternating current which rings the bell at the main station. At 111 is shown a signalling set consisting of a microphone 112 placed in a closed box in close proximity to a buzzer 113 and a trembler bell 114. A second signalling set is shown at 115, and consists of a trembler bell 116 placed in a closed box in close proximity to a microphone 117. The section lining on certain relays indicates that they are provided with copper slugs or sleeves to render them slow releasing.

Returning to the two co-ordinate switch, it should be noted that the banks 51 and 52 are for the purpose of simplification in the drawing shown so that selection is made in the following manner.

The first selection (tens) moves the wipers vertically in the drawing and the second selection (units) moves the wipers horizontally to engage terminals in the row. Switch C, of course, may be of the well-known Strowger type used in automatic telephone systems.

Suppose now that the despatcher wishes to start up a machine at the substation the selection of which control is by number seventy two. A master control relay shown

in the drawing at 46 is connected to the bank terminals of the two co-ordinate switch so that it can be operated when number 72 is transmitted.

The master control relay upon operation completes the circuit of the machine in any well known manner. Similar relays will be associated with other bank terminals.

The complete operation is as follows: The despatcher at the main power station removes the receiver from telephone A thereby closing the line loop. Wiper 63 will be resting upon terminals of bank 64 so that by the loop closure a circuit is completed for relay 65. Relay 65 operates and at contacts 66 completes the circuit for relay 67 via normal contacts of key 68 and release magnet springs 69. Relay 67 operates and at contacts 70 completes the circuit of relay 71 from earth at off-normal springs 60 causing relay 71 to operate. The despatcher dials the digit 7 on his impulse transmitter causing the line loop to be broken seven times in rapid succession. Relay 65 responds to the impulses falling away at each break and completing a circuit for rotary stepping magnet 57 as follows: earth at back contacts 66, operated contacts 72, back contacts 73, bottom springs at 61, magnet 57 to earthed battery. The switch makes seven rotary steps and on the first step springs 60 operate to open the original energizing circuit of relay 71 which relay is now held from earth at springs 74, these springs being closed by the armature of magnet 57 when in its attracted position. During impulsing both relays 67 and 71 receive current intermittently, but being slow releasing do not fall away. When the impulses cease relay 71 releases and completes the following circuit: earth at operated springs 60, back contacts 75, normal springs 61, relay 76 to earthed battery. Relay 76 operates and prepares the circuit for the vertical stepping magnet 58. The despatcher dials the second digit 2 and relay 65 again responds to the impulses completing a circuit for magnet 58 each time the relay releases as follows: earth at back contacts 66, operated contacts 72 and 73, magnet 58 to earthed battery. The switch makes two vertical steps and upon the first operation of the armature of magnet 58 springs 77 again complete a circuit for relay 71 over armature 70 and relay 71 operates. On the first vertical step springs 61 operate to open the original energizing circuit of relay 76 which relay is now held in the following circuit: earth at operated springs 60, operated contacts 75, operated springs 61, relay 76 to earthed battery. During impulsing relays 67 and 71 again receive current intermittently but do not fall away. At the cessation of the vertical impulse train relay 71 releases and opens the circuit of relay 73.

Relay 76 falls away and completes the circuit of relay 78 as follows: earth at operated springs 60, operated contacts 79, back contacts 80, 81 and 82, relay 78 to earthed battery.

Relay 78 upon operation at contacts 83 and 84 places earth on wipers 55 and 56 and, as the terminals of the co-operating bank 52 are connected in such a manner as to indicate by their multiple connection the position of wipers 55 and 56 (and therefore 53 and 54) by earthing numerically corresponding terminals on the banks associated with wipers 102 and 103 of the rotary switch, Fig. 2, the dialled number is repeated audibly to the despatcher in the following manner.

Since seventy-two has been dialled by the despatcher wiper 55 will be resting on terminal 86 and wiper 56 on terminal 87 of bank 52. At contacts 84 relay 78 completes a circuit for slow-release relay 119 as follows: earth at contacts 84, bank 120 of switch D, interrupter spring 118, relay 119 to earthed battery. At contacts 123 relay 119 completes a circuit for relay 124 which operates and at contacts 125 completes a circuit for magnet 101. Magnet 101 upon operation breaks the circuit of relay 119 which releases slowly and opens the circuit of relay 124 which also releases slowly and opens the circuit of magnet 101. Magnet 101 releases, again completing the circuit of relay 119 and the cycle of operations is repeated. Thus switch D steps at a slow rate (say about five steps per second) by relay interruption between magnet 101 and relays 119 and 124 and when wiper 102 reaches terminal 126 the following circuit is completed: earth at operated contacts 83, terminal 86, wire 88, terminal 126, wiper 102, relay 127 to earthed battery. Relay 127 operates and at contacts 128 locks up to resistance earth 129 and grounds wiper 102. Switch D continues to step and when on the next terminal 130, relay 131 is operated over arm 102, armature 128 and resistance earth 129. It will be seen upon examination of the bank connections of switch D that relay 131 is operated for the first time when wiper 102 rests on terminal 130, since previous engagements of the wiper 102 are ineffective owing to the relay 127 being inert and the circuit of relay 131 open at armature 128. It is again operated when wiper 102 reaches every alternate terminal so that in completing the half circle relay 131 is operated for seven short periods. At each operation of relay 131 the following circuit is completed: earthed battery, bell 114, operated contacts 132, operated contacts 84 to earth. Bell 114 will therefore give seven short rings. At contacts 85 the circuit of microphone 112 is completed through to back contacts 89 and 90 so that the despatcher listening on the

line will hear the seven rings. When wiper 102 reaches terminal 133 battery 134 will oppose the battery connected to the winding of relay 127 which releases, opening contacts 128. The wipers 102, 103, are arranged 180° apart so that when the wiper 102 leaves its bank, the wiper 103 engages the first contact in its bank. Switch D continues to step and when wiper 103 reaches terminal 135 the following circuit is completed: earth at operated contacts 83, wiper 56, terminal 87, wire 91, terminal 135, wiper 103, relay 127 to earthed battery. Relay 127 again operates and at contacts 128 locks up to resistance earth 129 and grounds wiper 103. When wiper 103 is stepped on to the next terminal 136, relay 137 operates to resistance earth 129, and it will be again operated on the next terminal but one. When wiper 103 reaches terminal 138 battery 134 again opposes the battery connected to winding of relay 127 which releases. Relay 137 is thus operated for two short periods and at each operation the following circuit is completed: earth at contacts 84, operated contacts 139, buzzer 113 to earthed battery. Buzzer 113 will therefore give two short buzzes which will be heard by the despatcher. Switch D continues to step and will at wipers 102 and 103 again repeat the above cycle of operations. The despatcher by the repeated signals of seven rings and two buzzes is able to verify that the switch C has followed the impulses and is standing with its wipers on the required bank terminals. The despatcher at this stage can still abandon the operation by hanging up the receiver, otherwise he can proceed with the operation by dialling a further digit such as one. Two earthed restoring wipers 104, 105, are provided arranged 180° apart. When the despatcher hangs up, a circuit over the interrupter contacts 118 continues to be completed for the relay 119 over one, or in succession, both, of the wipers 104, 105, and their banks 120, 121, until the wiper 104 leaves its last contact and the wiper 105 engages a dead contact. The relays 119, 124, thereby interact with the stepping magnet 101 as previously described, until the switch is restored to normal.

Assume that the despatcher proceeds with the operation. When relay 65 releases for the break of the loop it completes the following circuit: earth at back contacts 66, operated contacts 72, back contacts 73, operated springs 61, relay 92 to earthed battery. Relay 92 operates and when relay 65 again energizes on the following remake of the loop a circuit is completed for relay 93 as follows: earth at operated springs 60, operated contacts 79 and 94, relay 93 to earthed battery. Relay 93 operates, locks up over contacts 95, 79, 60, and at contacts 80 breaks

the circuit of relay 78 and completes an energizing circuit for relay 50. Relay 50 operates and at contacts 89 and 90 disconnects the microphone signalling circuit and switches through battery and earth from retardation coil 49 to wipers 54 and 53 respectively.

The number seventy-two having been dialled wiper 53 will be resting on terminal 48 and wiper 54 on terminal 47 of bank 51 so that an operating circuit is completed for relay 46 extending over the windings of coil 49, contacts 89, 90, wipers 54, 53 and contacts 47, 48. Such a relay as 46 would be used as a master relay controlling heavier circuit and power controlling switch gear of any known kind to start the machine. Another relay 46' similar to relay 46 is provided and energized by dialling the number 74, to initiate the stopping of the machine. A telephone transmitter such as 45 may be located in close proximity to the machine (generator, motor or the like) in the circuit of relay 46 so that the sound of the machine in starting could be audibly transmitted to the despatcher. Condenser 44 is connected to improve this transmission.

Should the despatcher, after dialling a number, decide not to go through with the operation corresponding to that number, the whole of the equipment can be restored to normal by simply replacing the telephone receiver. This results in the deenergization of relays 65 and 67. Relay 67 at contacts 96 completes the circuit for the release magnet 59 as follows: earth at operated springs 60, back contacts 96, magnet 59 to earthed battery. Release magnet 59 operates, releases switch C and opens contacts 69 to prevent the energization of relay 67 until the switch reaches normal. This ensures that the switch will be fully restored.

Condensers and non-inductive resistances shown across the magnets are provided to minimize sparking at contacts.

The main despatcher may wish to read power indicating meters at the substation, such as voltmeters, ammeters, or other measuring instruments of a like nature, and by way of illustration a meter reading circuit has been added to the drawing. The circuit shows the rotary switch E employed in a manner somewhat similar to switch D to indicate the positions of a voltmeter or ammeter by a number of signals transmitted to the despatcher.

Suppose, for example, the main despatcher wishes to read the amperes output of a certain motor generator and that in this case he dials ninety-nine. After satisfying himself that the two co-ordinate switch C is standing upon the proper terminals, he sends the operation impulse. Wiper 53 will be resting on terminal 40 and wiper 54 on

terminal 41 so that a circuit is completed for relay 143 over the windings of coil 49, contacts 89, 90, wipers 54, 53, contacts 41, 40 through microphone 117. At 110 is shown a rotatable arm capable of engaging a number of contact studs. This arm 110 may be part of or attached to an ammeter pointer so that, the stud upon which it is resting is indicative of the ammeter deflection. This arm 110 is shown resting on stud 144, thus corresponding to a certain ammeter reading. Arm 109 and co-operating studs may be for voltage reading. Relay 143 upon operation at contacts 145 completes a circuit for slow-release relay 146 via interrupter springs 147, which relay operates and at contacts 148 completes a circuit for relay 149. Relay 149 operates and at contacts 150 completes a circuit for magnet 106. Magnet 106 upon operation breaks the circuit of relay 146, which releases. Relay 146 opens the circuit of relay 149, which releases and opens the circuit of magnet 106. Magnet 106 releases, again closes the circuit of relay 146 at springs 147, switch E makes a step, and the whole cycle of operations is repeated. The control and signaling circuit are similar to those described in connection with switch D and associated relays so that only brief description will be necessary. When wiper 107 reaches terminal 151 the following circuit is completed: earth at operated contacts 145, arm 110, contact stud 144, terminal 151, wiper 107, relay 152 to earthed battery. Relay 152 operates and locks up at contacts 153 to earthed resistance 154. On the next step of switch E the resistance earth is extended to relay 155, which operates, and at contacts 156 closes the circuit of bell 116. The bell is rung at each alternate step and when wiper 107 reaches terminal 157 battery is connected to the wiper to oppose the battery connected to the winding relay 152 and cause its release. It will be seen that five rings are given by bell 116 which will be heard by the despatcher over the line from microphone 117 and will indicate to him the approximate reading of the ammeter. The five rings will be repeated at intervals due to the continuous stepping of switch E until the despatcher releases.

If the despatcher dials nine-eight, wipers 53 and 54 will be stepped on to terminals 38 and 39 respectively, causing the operation of relay 158 which at contacts 159 causes circuit operations similar to those of contacts 145, but in this case arm 109 is connected instead of arm 110. Thus the despatcher will receive audible signals corresponding to a reading of a voltmeter to the points of which the arm 110 may be attached. Wiper 108 and bank are provided to always return switch E to a normal position upon release, the relay 146 being ener-

gized over the wiper 108 until the wiper engages a dead contact in the normal position of the switch.

Such a method of determining quantities can be employed in many ways, such as the testing of the height of the level of water in a tank or other receptacle; also the reading of temperatures over a fairly rough scale can be performed by methods similar to this.

It will be observed that the master relays, during the periods when they are not actually in operation, have no connection with either battery or earth. Therefore the possibility of accidental operation caused by short circuits in their individual circuits is extremely remote, the master relays controlling the operation of the power controlling switch gear being included in circuits, which, except for the time they are actually placed in operation by the wipers of the operating bank, are totally dead or inert. By this arrangement I obviate the possibility of an accidental operation which would be productive of serious and expensive breakdowns in a substation. This is a feature of considerable importance and obviously not limited to a system employing two co-ordinate switches, but is equally applicable to relay and other switching systems.

Suppose that the dispatcher at the main power station desires to ring up the substation to ascertain if there is anyone there, say, for example, an inspector. He dials a number set aside for this purpose, which, in the drawing is shown as "00." When the dispatcher has dialled "00" wiper 53 will be resting on terminal 42 and wiper 54 on terminal 43. The circuit of relay 139 will be completed, the relay operating and closing at contacts 140 the circuit for bell 141. If someone is in attendance, he answers by removing the receiver from the substation telephone B. This breaks the bell circuit at contacts 142, which are contacts of the switch hook of telephone B, but for simplification in the drawing are not shown associated therewith. A key can be used instead of switch contacts 142.

Should an inspector visit the substation for inspection purposes and desire to isolate the substation from the control of the dispatcher at the main station, he operates safety key 68, which opens the circuit for relay 67 and diverts the dispatcher control to the signal bell 141. If, therefore, the dispatcher now dials, the bell 141 is rung to warn the inspector at the substation. The closure of the line loop at telephone A operates relay 65 which at contacts 66 closes the circuit of bell 141 over contacts 68, 142 to warn the inspector. The inspector can at telephone B carry out a routine test of the equipment by dialling the numbers allocated to the starting and stopping of the generator

and to the voltmeter and ammeter supervision, and then noting if the apparatus responds correctly.

Switch F can also be arranged so that should something occur in the substation requiring the dispatcher's attention, such as a tripped circuit breaker, an overloaded machine, or other irregular occurrence, switch F will immediately commence stepping to signal the dispatcher. The warning circuit is arranged so as to loop wires 98 and 99 thereby completing a circuit for magnet 62 over armatures 66, 72. The dispatcher upon removal of the receiver of telephone A energizes relay 65 which at contacts 66 opens the circuit of magnet 62 to stop the switch.

Key 97 is provided to enable a call signal to be sent to the dispatcher. Depressing the key is equivalent to looping wires 98, 99, and will cause the switch F to step and ring the dispatcher. Upon the dispatcher replying, conversation can ensue between telephones A and B.

What I claim is:—

1. In a remote control system, a controlling station, a substation, a two-wire controlling circuit between said controlling station and said substation, a two-coordinate electro-magnetic switch at the substation, means whereby said switch may be set to a selected position from the controlling station over said controlling circuit for selecting a particular control, and means including a single stepping switch whereby after the setting of said two-coordinate switch two distinctive trains of signals are automatically sent from the substation over the controlling circuit to indicate the position to which the said two-coordinate switch has been set.

2. In a remote control system, a controlling station, a substation, a controlling circuit between said controlling station and said substation, a two-coordinate switch, means whereby said switch may be set to a selected position from the controlling station over said controlling circuit for selecting a particular control, and means including a single stepping switch for sending two distinctive trains of audible signals from the substation over said controlling circuit responsive to the setting of the first switch to indicate the position to which said two-coordinate switch is set.

3. In a remote control and supervisory system, a controlling station, a substation, a controlling circuit between said controlling station and said substation, control relays at the substation for effecting the control and supervision, a two-coordinate switch, and means whereby said switch may be set to a selected position from the controlling station over said controlling circuit for selecting said control or supervisory relays, and means including a single stepping switch responsive to the setting of the

switch for sending two distinctive trains of audible signals from the substation over said controlling circuit to indicate the position to which said two-coordinate switch is set.

4. In a remote control and supervisory system, a controlling station, a substation, a controlling circuit between said controlling station and said substation, means such as relays at the substation for effecting the control and supervision, a two coordinate switch, means whereby said switch may be set to a selected position from the controlling station over said controlling circuit for selectively operating said relays; means for transmitting two distinctive trains of audible signals over said controlling circuit responsive to the setting of the first switch to indicate the setting of said switch, and means whereby further operation is necessary over said controlling circuit before the control and supervisory operations corresponding to the distinctive setting of the said selective means can be performed.

5. In a remote control system, a controlling station, a substation, a controlling circuit between said controlling station and said substation, control relays at said substation for effecting the control, a two-coordinate switch and means whereby said switch may be set to a selected position from the controlling station over said controlling circuit for selecting said control relays in response to first a rotary and then a vertical movement, a telephone receiver at said controlling station, a microphone at said substation arranged adjacent to an electric bell and an electric buzzer, and means whereby responsive to the setting of the two-coordinate switch first the bell and then the buzzer are intermittently operated a number of times corresponding to the rotary and vertical positions to which the said two-coordinate switch has been set to send an indication of the setting of said switch over said controlling circuit.

6. In a remote control system, a controlling station, a substation, a controlling circuit between said controlling station and said substation, means at said substation for effecting the control, a two-coordinate switch and means whereby said switch may be set to a selected position from the controlling

station over said controlling circuit for selecting said control, means for transmitting two distinctive trains of signals over said controlling circuit responsive to the setting of said two-coordinate switch to indicate its setting, and means whereby said two trains of signals are repeated in succession until the despatcher at the controlling station performs a further operation by which he proceeds or discontinues with the control.

7. In a remote control system, a controlling station, a substation, a controlling circuit between said controlling station and said substation, means including control relays at said substation for selecting one of a plurality of meters or the like an indication of the reading of which is desired at said controlling station, means operated from the control station for selectively operating said control relays, means including a single stepping switch common to all the meters for transmitting over said controlling circuit a train of signals indicative of the reading of said selected meter, and means whereby said indication is repeated until a further operation is performed at said controlling station.

8. In a remote controlling system, a controlling station, a substation, a two-wire controlling circuit between said controlling station and said substation, control relays for selecting a particular meter or the like at said substation, means operated from the control station for selectively operating one of said control relays to select a particular meter, a telephone at said controlling station, an electric bell at said substation, a microphone at said substation adapted to be connected in the circuit of said selectively operated control relay and arranged adjacent to said electric bell, and means including a single stepping switch common to all the meters for intermittently operating said bell a number of times to cause an indication of the reading of said selected meter to be transmitted over said controlling circuit and for repeating said indication until a further operation is performed at said controlling station.

In testimony whereof I have signed my name to this specification.

CHAS. C. PUCKETTE.