

Sept. 13, 1932.

C. ANTONIONO

1,877,635

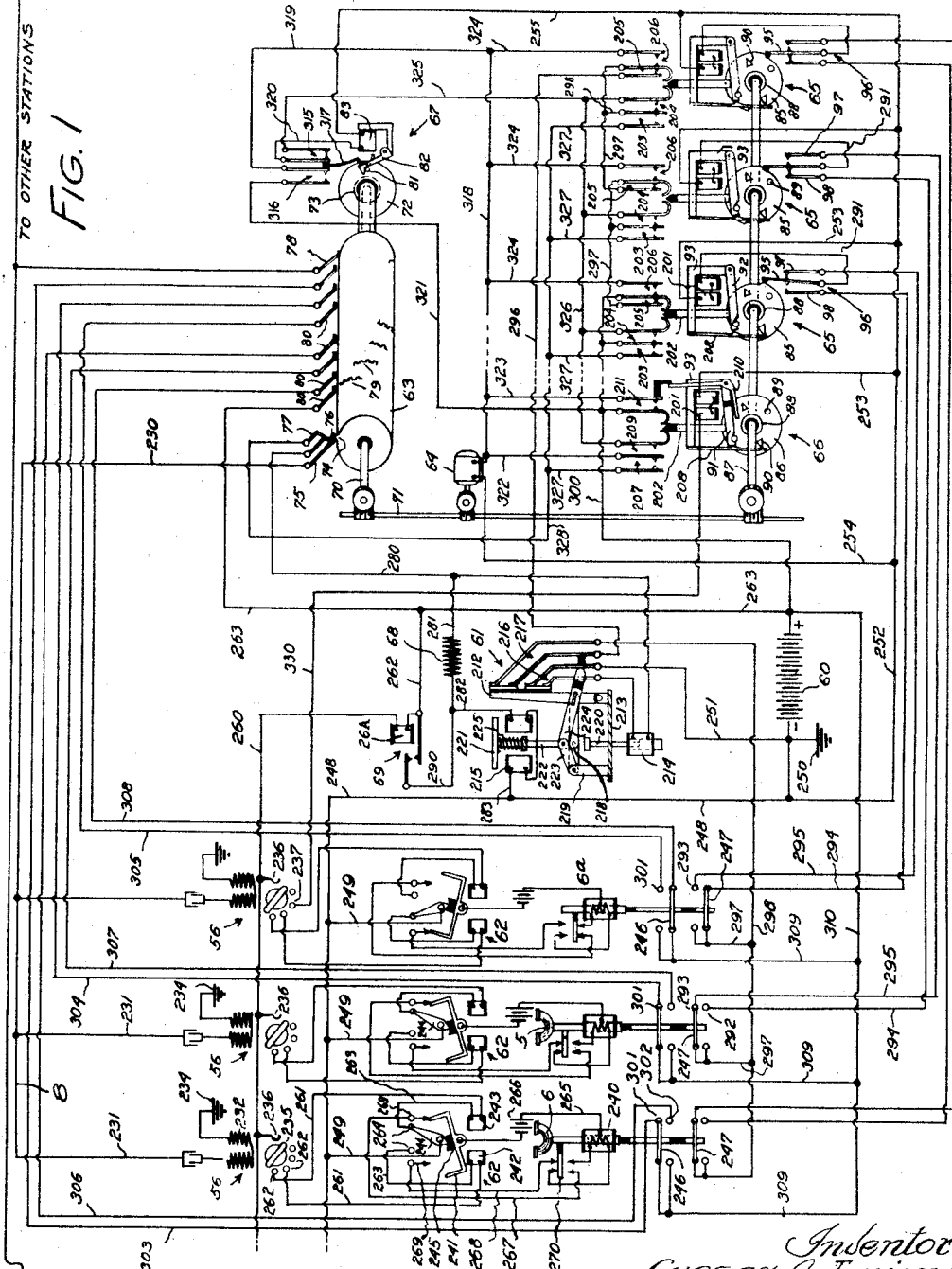
REMOTE CONTROL SYSTEM

Filed March 25, 1927

2 Sheets-Sheet 1

TO OTHER STATIONS

FIG. 1



witness:  
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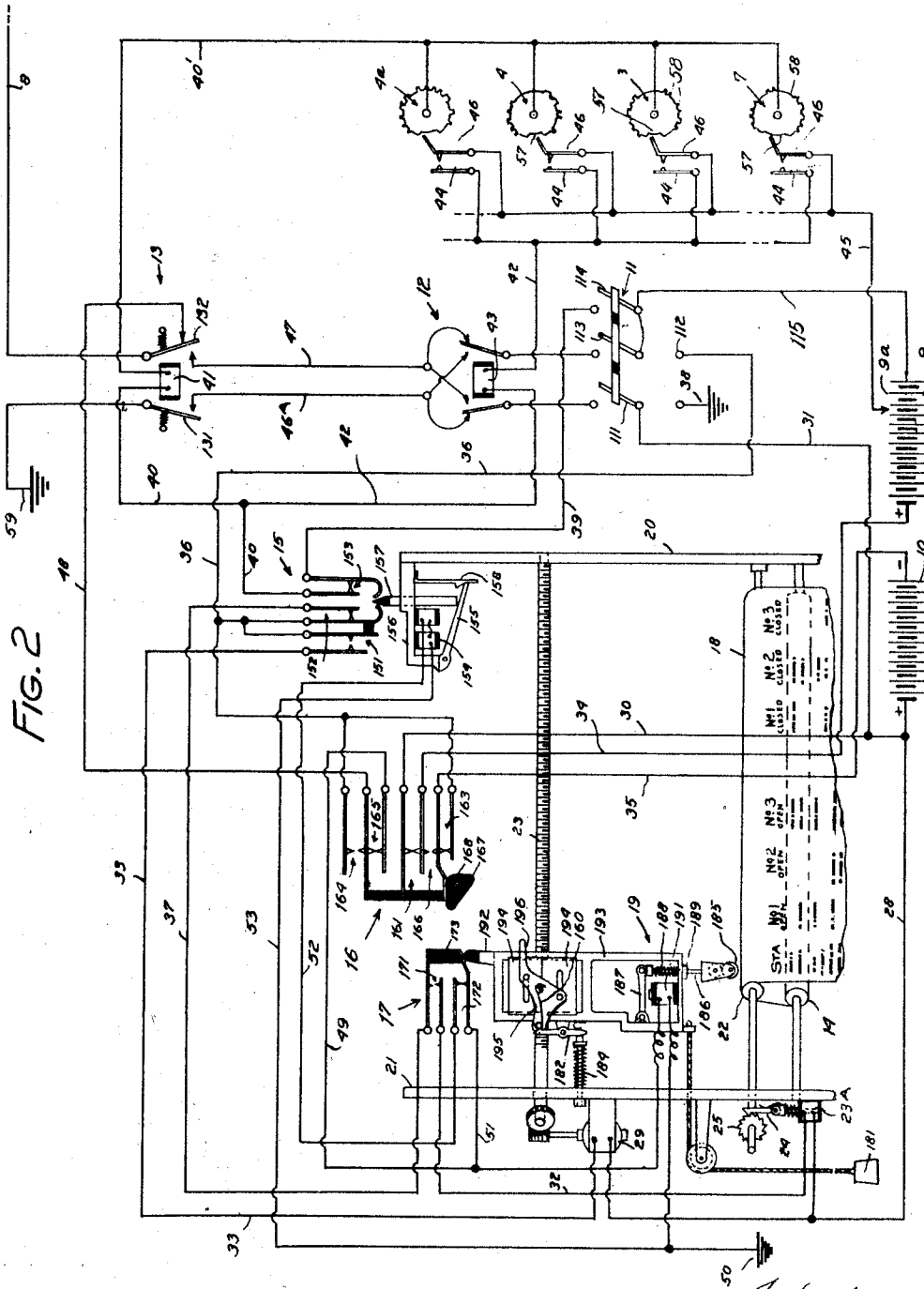
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## REMOTE CONTROL SYSTEM

Filed March 25, 1927

2 Sheets-Sheet 2



Witness:  
John C. Titus

Inventor  
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## UNITED STATES PATENT OFFICE

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## REMOTE CONTROL SYSTEM

Application filed March 25, 1927. Serial No. 178,369.

The main objects of this invention are to provide an improved single circuit system for controlling a plurality of substations from a supervisor's station; to provide means for printing a record of the positions of all of the main switches or other controlled devices in any of the substations; to provide means for recording the movements of said switches upon a chronological chart so that the supervisor at the controlling station may at any time be able to control the movements of the power switches, which are automatically recorded, and may also at any time determine and record the instant positions thereof; to provide a mechanism in which the operated and also accidental movement of any controlled switch in any substation will automatically close circuits which will put in motion a transmission mechanism and a receiving mechanism by which will be printed a record showing the position of every switch in the substation in which said switch was moved; to provide selective keys in the supervisor's station which control corresponding selecting switches in the substations; to provide means for operating the substation main switches and provide contacts related to the substation switches, which close the electric message sending and recording circuits; to provide means for holding the line by locking out all other substations and the supervisor's calling circuits until the message from any one substation is completed; to provide sending or signal circuits for each controlled element which are set up by said element according to the position it occupies, and to provide means for energizing said sending circuits actuated by a change in the position of said element, and also a change in the position of any of the other elements in the same substation; to provide means for holding back the signal at each substation until the line is clear; to provide a selective supervisor's key for each substation which will start in motion the sending and receiving systems and print a message on the chart to show the position of all of the controlled switches in any selective substation, without changing the positions of any of said substation switches; to provide in the supervisor's sta-

tion an automatically actuated printing device operating on a chart, on which will be made a permanent record of all of the operations which have occurred in each substation; to provide means for locking out the sending mechanism in the substations until the line is clear, and then locking out the sending mechanism of all substations except the one which has been called or in which a change has been made; to provide means for resetting the substation lockouts after a message has been completed to the supervisor's station; and to provide a trip magnet for operating the lockout at each substation, said trip magnets energized by the first impulse over the line. This application is a continuation in part of my abandoned co-pending application, Serial No. 715,958, filed May 26, 1924.

Other objects and advantages will appear in the following description with reference to the accompanying drawings showing an illustrative embodiment of the invention, in which:

Figure 1 represents one of the several substations, and shows a diagram of the substation circuits; and

Fig. 2 represents the supervisor's station, and shows a diagram of the controlling and recording circuits.

Referring to the drawings, the controlling or supervisor's station is provided with a coded key for each switch in all of the substations, as for example the keys 3, 4 and 4a for controlling the substation switches 5, 6 and 6a; and the supervisor's station is also provided with calling key for each substation, as the key 7 for the substation represented in Fig. 1.

A single line 8 is used for controlling all of the switches, for calling any substation, and for carrying the answer-back signals. The line 8 may have a grounded return, as indicated, or may have a metallic return.

The control station, shown in Fig. 2, also includes the local batteries 9 and 10, a double-throw switch 11, a pole changer 12, a line connector switch 13, a receiving relay 15, a battery connector switch 16, a receiver switch 17, and a recorder which includes the chart

18 and the printer 19. The recorder is mounted in a stationary frame represented by the side members 20 and 21 in which are mounted in parallel relation the chart platen roller 22 and the feed screw 23. The chart 18 is fed off from the roll 191, by rotating the platen roller 22, which is actuated by means of the solenoid 23A which controls the pawl 24 and the ratchet wheel 25 which is fixed to the platen 22.

The switch mechanisms 15, 16 and 17 are mounted in fixed relation with the frame of the receiving mechanism and are operated by the post 192, which is mounted on the traveling printer carriage frame 193. The frame 193 is slidably mounted on the feed screw 23, and is provided with a split feed nut 194, which is controlled to engage or disengage from the feed screw 23 by means of the lever 195, which is pivotally mounted on the frame. The carriage is drawn to the left or the starting position by means of the weight 181 so that the lower end of the latch 182, which is pivotally mounted on the carriage 193, rests against the stop 184, which is resiliently mounted in the frame member 21. When the latch 182 strikes against the stop, it is rotated to release the lever 195, which is then rotated by the spring 160 to cause the feed nut to engage the screw 23. When the carriage is fed across the chart to the right, a projection 196 on the lever 195 strikes against the right-hand frame member 20. This causes the lever 195 to rotate counter-clockwise against the action of the spring 160 and to open the feed nut 194, the lever being locked in this position by the latch 182 until the carriage is drawn back to the left and the latch strikes against the stop 184 as explained above.

At the lower end of the printing carriage 193 is provided an inking roller 185, which is carried on the lower end of a rod 186, which is slidably mounted in the bottom portion of the carriage frame 193. The upper end of the rod 186 is connected to the armature 187, which is pivotally mounted in the frame. The armature is drawn downwardly when the printing magnet 191 is energized, and is resiliently raised by means of the spring 188 on the rod 186 so that the stop collar 189 on said rod strikes against the frame. Thus it will be seen that when the printing carriage moves across the chart 18 the ink roller 185 may be drawn downwardly to print on a chart by energizing the magnet 191.

The armature 155, for the receiving relay magnets 154, is pivotally mounted in the frame 156, which is rigidly supported by the side frame member 20. When the magnet 154 is energized, the armature 155 is drawn upwardly to lift the plunger 157, which is slidably mounted in the frame 156, and the armature 155 is automatically locked

in the raised position by means of the spring catch arm 158, until the post 192 strikes against the lower end of the catch 158 and releases the armature. The receiving relay 15 has six spring contact fingers, the first two of which constitute the switch 151; the third and fourth constitute the switch 152; and the fifth and sixth, the switch 153. The ends of the third and sixth fingers are bent inwardly so that the fingers are spread when the plunger 157 is raised. As will now be apparent, this causes the switch 151 to close and opens the normally closed switches 152 and 153.

The battery connector 16 is provided with seven spring leaves; the first two constituting the switch 164; the second and third switch 165; the fourth and fifth constituting the switch 161; the fifth and sixth, the switch 166; and the sixth and seventh, the switch 163. The second, fourth and sixth fingers are insulatingly connected and rest on the fibre cam block 167, which is pivotally mounted on a fixed post 168. The arrangement is such that when the carriage post 192 passes to the right, it moves under the cam block 167 without changing the position of the battery switches, but when the post moves to the left in the return movement of the carriage, the post strikes and rotates the cam block 167 clockwise. This movement of the cam block raises the connected fingers and reverses the position of the switches. The switch 164 is then closed; the switch 165 opened; the switch 161 opened; 166 closed; and 163 opened. As soon as the post passes the cam block, the switches return to the normal position.

The receiving switch 17 includes the two switches 171 and 172, which are both connected to an insulating block 173, which is cammed upwardly by the finger 192 when the carriage is in a starting position. As soon as the carriage moves to the right, the block 173 drops down and closes the switch 171 and opens the switch 172. When the post returns it restores the switches to the normal position.

The positive terminal of the battery 10 is connected by the battery wire 28 to the chart spacer magnet 23A and the motor 29; by the lead 30 to the switch 161 of the battery connector 16; and by the lead 31 to the first blade 111 of the main switch 11. The opposite side of the feed magnet 23A is connected by the wire 32 to the normally open switch 171 of the receiving switch 17; and the opposite side of the motor 29 is connected by the wire 33 to the normally open switch 151 of the receiving relay 15. The switch 161 is normally closed and makes a connection from the battery lead 30 to the wire 34 which leads to the positive terminal of the battery 9. Thus it will be seen that normally the positive terminals of the batteries 9 and 10 are connected together, and that the circuits of

the spacer magnet 23A and the motor 29 are open.

The negative terminal of the battery 10 is connected by the battery lead 35 to the upper contact of the switch 163 of the battery connector 16. This switch is normally closed and makes a connection through the wire 36 to the upper contact of the normally open switch 164, to the normally open switch 151, to the normally closed switch 152, and to the lower and middle contact 112 of the control switch 11. The switch 152 makes connection from the wire 36 to the wire 37 which leads to the upper contact of the switch 171. The negative terminal of the battery 9 is connected by the lead 115 to the second and third switch blades 113 and 114 of the switch 11.

For receiving, the control switch 11 is thrown to the lower position. This connects the positive terminals of both batteries to the ground connection 38, and connects the negative terminals of the batteries together, thus placing the batteries in parallel relation when the battery connector switch 16 is in normal position.

For sending, the switch 11 is thrown to the upper position, and connects the end terminals of the battery 9 to the opposite sides of the pole changer 12. The negative terminal of the battery 9 is also connected through the third switch pole 114 to the wire 39 which connects to the normally closed switch 153 of the receiving relay 15. The opposite side of the switch 153 is connected by the wire 40 through the magnet 41 of the line connector 13 to the disks of the several operating keys 3, 4, 4a and 7. Connection is also made from the wire 40 by the branch 42 through the magnet 43 of the pole changer 12 and to the outer contact fingers 44 of the several operating keys.

The end cells 9a of the battery 9 are connected by the battery lead 45 to the inner contact fingers 46 of the sending keys. The opposite terminals of the pole changer 12 are connected by the wires 46A and 47 to the normally open contacts of the armatures 131 and 132 of the line connector 13. The line 8 is connected to the armature 132 which is normally held in position to contact with the connector 48 which leads through the normally closed switch 165 to the wire 49 which connects through the magnet 191 of the printer 19 to the ground connection 50. A branch 51, from wire 49, leads through the normally closed switch 172 to the wire 52 which connects through the magnets 154 of the receiving relay 15, to the connector 53 which is also connected to the grounded side of the printing magnet 191.

The operations in sending out a signal to a sub-station may now be described, it being understood that the switch 11 has been thrown to the upper or sending position.

The sending keys and the selectors, such as 56 which are located at the substations are of a type which is well known and in common use in signalling systems, as shown in the patent to J. C. Field, No. 1,434,776, and therefore are not shown in detail herein. In operation, the disk which corresponds to the circuit which is to be connected, is rotated once by means of a suitable key. Normally the end of the spring finger 46 registers with the notch 57 in the corresponding disk so that no connection is made from the wire 45 to the wire 40'. When the disk is rotated the finger 46 contacts with the disk, and when the end of the finger rides over the teeth 58 the finger 46 is raised and makes a contact with the finger 44.

When a disk engages its finger 46 a circuit is completed for the magnet 41, this circuit being from the positive terminal of the end cell 9a, through conductor 45, finger 46 and its associated disk, conductor 40', magnet 41, conductor 40, contacts 153 of switch 15, conductor 39, contacts 114 of switch 11 to the negative terminal of end cell 9a. Magnet 41, by attracting its armatures 131 and 132, connects the battery 9 in a series circuit with ground 59 and the conductor 8 which extends to the office. This series circuit is from ground 59, armature 131 of magnet 41, conductor 46A, back contact of magnet 43, contact 111 of switch 11, conductors 31 and 30, contacts 161 of switch 16, conductor 34, battery 9, contact 113 of switch 11, back contact of magnet 43, conductor 47, armature 132 of magnet 41, to line conductor 8. Current, therefore, tends to flow through the line conductor 8 in a certain direction.

When the teeth 58 of a disk cause its associated contacts 44 and 46 to engage, a circuit is completed for the magnet 43. The circuit of the magnet 43 is from the positive terminal of the end cell 9a, conductor 45, contacts 46 and 44 of the actuated sender, conductor 42, magnet 43, conductors 42 and 40, contacts 153 of switch 15, conductor 39, contacts 114 of switch 11 to the negative terminal of the end cell 9a. When the magnet 43 is energized the connection of the battery in the line is reversed and the polarity is changed as described above, and the teeth 58 are in coded arrangement so that the signals are sent over the line which consist in grouped impulses, and also with reversals in polarity. When the disk which has been operated reaches normal position, the notch 57 again registers with the end of the spring finger 46. The sending circuits are then broken and the magnet 41 is de-energized so that line connection switch 13 returns to normal position, and the switch 11 is then thrown down to receiving position.

The apparatus and connections at the sub-station will now be described. At each sub-station is provided a local battery 60; cut-

out switch 61; a plurality of service switches 5, 6, 6a; service switch operating relays 62; sending drum 63; sender motor 64; motor relay switches 65; station answering motor relay switch 66; sender drum lock 67; resistance 68; and resistance short-circuiting switch 69.

The sending drum 63 is insulatively mounted on the shaft 70 which is geared to the motor 64 through the connection of the shaft 71. Normally the drum is loose on the shaft, but is connected to the lock disk 72 which engages with a friction driving plate 73 which is keyed to the shaft 70. This friction drive for connecting the drum to the shaft may be of any well known construction and therefore need not be shown in detail. The drum 63 is a conductor and is provided at one end with a tooth 74 which, in the normal or zero position of the drum, contacts with and raises the spring contact finger 75, so that the finger 75 is in contact with the finger 76, which is in turn raised to contact with the finger 77. When the lug is not under the finger 75, the connection to the drum is broken and also the connection between the fingers. The line contact finger 78 is always in engagement with the drum, and a plurality of groups of teeth 79, in coded arrangement, are spirally disposed around the periphery of the drum to make contact in succession with a row of signal-circuit fingers 80. The lock disk 72 is provided with a post 81 which is normally engaged by the hook on the end of the pivoted armature 82 of the relay magnet 83 so that the drum is held from rotating until the magnet 83 is energized.

The disks 85 of the motor relay switches 65, and the disk 86 of the relay switch 66, are loosely mounted on the shaft 87, and frictionally connected thereto for driving by means of the friction plates 88, the shaft 87 also being geared to the motor 64 through the shaft 71.

Each of the disks 85 and also the disk 86, are provided with two diametrically opposed stop pins 89, and two similarly opposed cam lugs 90. The pins 89 engage in a notch in the ends of the armatures 91 and 92 which are pivotally mounted in the frames 93 of the respective relays, the armatures dropping down by gravity to engage the posts 89 and hold the disks from being turned by the shaft 87. The disks 85, of the relays 65, are made with one-half of the circumference on a longer radius than the other half. The contact fingers 95 of the double throw switches 96, one of which is included in each relay, ride against the edges of the cam disks so that when the finger 95 is riding on the longer radius, it makes contact with the switch finger 97, and when the finger 95 is riding on the shorter radius, it makes contact with the opposite switch finger 98.

The armatures 92 are drawn upwardly by the relay magnets 201 to release the disks, and raise the plungers 202 which are slidably mounted in the frames 93, to operate the group of switches 203, 204, 205 and 206.

When the armatures 92 and also the armature 91, are lifted, they are latched in the raised position by means of the spring latches 208, which are mounted on the frames 93. The lower ends of the latches 208 are engaged by the cam lugs 90 so that the latches are thrown out of engagement when the disks have nearly completed a one-half revolution. This allows the armatures to drop down and engage the next stop post 89, the magnets having been de-energized.

The relay 66 is also provided with an auxiliary armature 210, which is drawn upwardly with the armature lever 91, but is not affected by the latch 208, so that the armature 210 is released as soon as the corresponding magnet 201 is de-energized. When the armature 91 of the relay 66 is drawn upwardly, it operates the group of switches 207, 209, and 211. The auxiliary armature 210 is connected to the outer contact finger of the switch 211 so that that switch is held from closing after the plunger 202 has been lifted until the magnet 201 is de-energized.

The cut-out 61 comprises a master lever 212, which is pivotally mounted on the base 213; a trip magnet 214; restoring magnets 215; trip magnet switch 216; and the sender relay switch 217. The switch lever 212 is held in position to close the switches 216 and 217 by means of the toggle links 218 which connect from the lever 212 to the frame post 219 on the base. When the trip magnet 214 is energized, it raises its plunger 220 to strike and unlock the toggle linkage 218 which will allow the lever to fall away from the switches 216 and 217.

The armature 221, of the magnets 215, is connected by means of a rod 222 to the pivotal connection of the levers 223 and 224. The lever 223 is pivoted to the post 219, and the lever 224 is slotted to receive a pin in the switch lever 212. The armature 221 is normally raised by means of the spring 225, and the length of the slot in the lever 224 is such that when the armature 221 is pulled down by the magnets 215, the lever 212 is rotated clockwise into the normal position as shown. As will be understood, this allows the toggle linkage 218 to lock and hold the lever 212 in position, the outer end of the lever 224 is extended to bear against the contact fingers of the switches 216 and 217, so that the switches are held from closing until the magnets 215 are de-energized, and the armature 221 is returned to the normal position by the spring 225.

The line wire 8 is connected to the end finger 78, and the circuit including this conductor normally extends through the drum 63, 130

to the finger 75, which is connected by the wire 230 and the branches 231, through the two magnets 232 of the respective selector switches 56, the opposite ends of the magnets being grounded at 234. As mentioned above, the selector switches are of well known construction and act, when the properly coded signal is received, to make a contact through the contactor 235, from a selected contact point 262, to the hook 236.

A plurality of selector switches may be used in each substation, and several switches or other devices may be connected to each selector. At each substation one of the switches 56 is provided with a contact 237 which is used for calling that particular substation. Thus, it will be seen that when the coded signals are sent out from the supervisor station, current will flow to all of the selector switches in all of the stations, but the particular signal will only connect up the one contact which has been selected. The service switches are opened or closed by means of electro-magnets 240 which are controlled by the tilting armatures 241 of the respective service switch relay 62. The armatures 241 are pivoted at the center and are oppositely rotated by means of the electro-magnets 242 and 243; and the pivotally mounted contact arm 244 is thrown by means of the cam block 245, which is mounted on the armature 241. Each of the service switches carry two switch contact arms 246 and 247, one for controlling the signal circuits and one for actuating the sender, as will be described hereinafter.

The connections are as follows: The battery lead 248 and the branch wires 249 connect the negative terminal of the battery 60 to the switch arms 244. The negative terminal of the battery 60 is grounded at 250, and also connected by the battery lead 251 to the switch 216, and is also connected by the negative battery lead 252 and the branches 253 to each of the motor switch relay magnets 201. A branch wire 254 leads from the conductor 252 to one terminal of the motor 64, and a branch wire 255 leads to one terminal of the sending drum release magnet 83.

The hooks 236 are connected by the conductor 260 to one terminal of the short circuiting switch magnet 26A, which is then connected by the branch wire 262 to the positive battery lead 263. This lead also connects to the first one of the drum contact fingers 80 for sending the station answer signal to the supervisor station.

One terminal of each of the relay magnets 242 and 243 is connected by means of a wire 261 to the relative contact point 262 of the corresponding selector switch 56. The opposite terminals of the magnets 242 and 243 are connected respectively by the wires 263 to the contact posts 264, which are alternately engaged by the switch lever 244. The middle of the winding of the magnet 240 is con-

nected by the wire 265, through a local source of power 266, to the armature 241. The opposite ends of the coils of the magnets 240 are connected by means of the wires 267 and 268 to the contacts 269, which cooperate with the opposite ends of the armature 241. An alternating make and break connection for the leads 267 and 268 is provided by means of the contact arm 270, which is insulatingly mounted on the service switch whereby the lead 268 is closed when the service switch is closed, and the lead 267 is closed when the service switch is open.

From the foregoing, it will be seen that the relay magnet 243 of the switch shown at the left, is energized by making contact from the hook 236 to the relative contact point 262 by a circuit from the positive terminal of the battery 60, through the lead 263, branch 262, magnet 26A, hook 236, contact 262, wire 261, magnet 243, wire 263, switch arm 244, branch wire 249 and battery lead 248, to the negative terminal of the battery 60. This will energize the magnet 243 and rotate the armature 241 clockwise, to the opposite position. The switch arm 244 will also be thrown to the opposite position, and the relay magnet circuit broken. The end of the armature will contact with the wire 269, which is closed through the connection 270 to the lower end of the electro-magnet 240. This connection continues through the magnet to the center lead 265, through the local source of power 266, back to the armature 241. This will energize the lower portion of the electro-magnet 240, which is effective for drawing the switch 6 down to the open position. As soon as the switch moves, the connection for the wire 268 is broken and the connection for the wire 267 is made by the arm 270. When the opposite relay magnet is energized, the switch will be closed, and the circuits again re-established for opening the switch.

The initial signal from the line is also communicated through the contact finger 76 to the lead 280, which is connected to one terminal of the trip magnet 214, and through the resistance 68, and the restoring magnets 215 by the branch wires 281, 282, 283, to the negative battery lead.

The opposite terminal of the trip magnet 214 is connected through the switch 216 to the ground by means of the conductor 251, so that the first signal is effective for tripping the cut-out and opening the switches 216 and 217. The resistance 68 is such that the normal signal currents are not sufficient to energize the restoring magnets 215, unless a relatively high voltage impulse is sent over the line.

When the contact is made at one of the selector switches, the magnet 26A is energized to close the switch 69. This establishes a circuit from the positive battery lead 263 through the branch 262, through the switch

69, through the branch wire 290, which leads to the wire 282. Since the wire 282 connects through the magnets 215, the battery lead 248, to the negative side of the battery, the restoring magnets 215 will be energized and will pull the armature 221 down to momentarily restore the cut-out switch 61, when the restoring magnets 215 are again de-energized.

The open sides of the magnets 201, of the switches 65, are connected by the wires 291 to the contact fingers 95. The two contact fingers 98, and 97, of the double throw switch 96, are connected to the contacts 292 and 293 respectively by means of the leads 294 and 295. The contact points 292 and 293 are so arranged that the lower connector 247 is in contact with the point 293 when the service switch is up or closed, and is in contact with the other point 292 when the service switch is down or open. The opposite ends of the connectors 247 are connected by means of the branch wires 297 and the conductor 298 to one side of the switch 217. The opposite side of the switch 217 is connected by means of the conductor 296 to the inner terminal of the last switch 205, which is shown at the right. The opposite terminal of this switch 205 is connected by the wire 297 to the inner terminal of the next switch 205, and, by the branch 298 to the contact arm which is common to both of the switches 203 and 204. The switches 205 are thus connected in series, the first switch 205 being connected to the positive battery lead 300. It will now be seen that when the service switch 6a is closed, or raised, the bottom connector 247 is raised to contact with the upper contact 293. A circuit will then be completed for energizing the corresponding relay 65, which is shown at the left. This circuit may be traced as follows: from the negative battery lead 252, the branch 253, magnet 201, wire 291, through the connection of the arm 95 to the arm 97, lead 295 to the upper contact 293, connector 247, which is then in the upper position, branch 297, conductor 298, switch 217, conductor 296, through the series of closed switches 205, to the positive battery lead 300. Thus it will be seen that momentarily closing the cut-out 61 when the contact is made, sets up the relay switch operating circuits. It will also be seen that the sending relay circuits for the switches that have not been moved will remain open; but that if a switch has been moved the corresponding relay will be energized; and then the circuit will be broken for the new position of the switch, and the circuit for the opposite position connected up.

This is accomplished by the reversing switch 96. Each time the disk 85 is released, it is turned counterclockwise through one-half a revolution. Thus if the disk 85 shown at the left of the group is released, the end of the finger 95 remains on the longer radius and in contact with the finger 97, until at the end

of the movement, the finger drops down to the shorter radius portion and the disk is stopped. This changes the connection of the magnets 201 from the contact 293, which would have just been made by the contactor 247 to the contact 292, by opening the connection of switch arm 95 to arm 97, and by closing the connection of the switch arm 95 to the opposite switch arm 98.

To describe the signal circuits, the upper contact bar 246 of the service switches makes a contact with the post 302 when the service switch is closed and with the post 301 when the switch is moved to the open position. The upper contact posts 301 are connected respectively by the wires 303, 304 and 305 to the second, third and fourth sender contact fingers 80. The lower contact points 302 are connected by the wires 306, 307 and 308 to the fifth, sixth and seventh contact fingers 80. The opposite ends of the contact bars 246 make contact through the branches 309 to the positive battery lead 310. The connections through the contacts 301 and 302 constitute the signal circuits, and it will be seen that a signal circuit is related with each position of each of the service switches. The service switch will close the signal circuit corresponding to the position in which the switch is moved, while the opposite circuit will be open. When the sending drum 63 is rotating, the fingers 80 are consecutively connected to the line 8 to send out coded signals according to the arrangement of the groups of teeth 79 on the drum 63. These circuits may be traced as follows:

From the ground 250, through the battery 60, conductor 310, one of the branches 309, through the contact bar 246, one of the contacts 301 or 302, through the corresponding connection wire, to the drum contact finger 80, through the drum to contact fingers 78 and the line 8 which is connected to the line 8 of the dispatchers station, shown in Figure 2.

Since the trip magnet 214 is connected to the line through the contact finger 76 when the sending drum is in the normal position, and through the trip magnet switch 216, which connects to the ground, it is evident that the cut-out in any one of the substations cannot be closed as long as the line is energized by signal impulses. If the cut-out had been opened and the restoring magnets 215 operated, the switches 216 and 217 would be held away from the switch arm 212 until the restoring armature 221 returned to the upper position, but if the trip magnet 214 was connected so that it would be energized, the instant the switch 216 closed, it is manifest that the member 218 would not be allowed to lock. When the service switch is moved at any substation the circuit for actuating the corresponding relay 65 is connected up ready to be energized as soon as the switch 217 can be closed. If the line is busy, the cut-out cannot

be closed to connect the switch 217, so that the signal will be held up in the substation until the line is clear, whereupon the substation will gain control of the line and send in its signal.

By this arrangement means are provided whereby the change in position of any service switch is automatically recorded at the supervisor's station. This operation will occur whether the switches have been operated from the remote control or in any other manner. Means are also provided so that the supervising station can obtain a new indication of the positions of the switches in any substation when it is so desired, and an accurate double check record is kept of their operation.

The drum lock relay switch 315 and the motor holding circuit switch 316 are operated by the arm 317 which engages with the stop post 81. Normally, with the arm 317 in engagement the relay switch 315 is closed and the motor switch 316 is open; but when the lock disk 72 is rotating, the pin 81 moves out of engagement with the arm 317, and the positions of the two switches are reversed until the disk 72 returns to the starting position.

The open side of the motor 64 is connected by the lead 318 and the branch 319 to the switch 316; and the opposite side of the switch 316 is connected by the wire 321 to the positive battery lead 300. The motor lead 318 is also connected by the branch 322 to the inner terminal of the switch 207; by the branch 323 to the outer terminal of the switch 211; and by the branches 324 to the outer terminals of the switches 206. One terminal of the switch 315 is connected by wire 320 to one side of the magnet 83 and the other terminal of the magnet switch 315 is connected by the wire 325 to the bus wire 326, which is connected to the battery switch 209 and each of the switches 204. The outer terminals of the switches 207, and of the switches 203, are connected by the branch wires 327 to the conductor 328, which leads to the outer end switch finger 77. From the foregoing, it may now be seen that the motor circuit may be closed by any one of the normally open switches 211, or 203, and is also closed by the switch 316 while the sending drum is in rotation. By this arrangement, the motor may be started by one of the switches which are related with the relays 66 or 65, and is thereafter maintained in operation by the switch 316 until the drum 63 has made one complete revolution.

When a signal is received from the line, the corresponding selector switch is operated as described above; and the cut-outs 61 in each of the substations are opened by the first impulse through the connection from the contact finger 76, wire 280, trip magnet 214, trip magnet switch 216 and the ground 250,

the resistance 68 being too high to allow the normal signal to flow through the restoring magnets 215. As soon as the cut-out is operated, this circuit is opened at the switch 216. In this manner, the answer back senders are all disconnected from the line until the line is again cleared. At the substation in which a switch has been selected and operated, the cut-out 61 is momentarily closed when contact is made with the hook 236. This energizes the restoring magnets 215 as described above, whereby the armature 221 is drawn down against the pressure of the spring 225. This movement straightens up the toggle linkage 218 and thereby locks the switch lever 212 into closed position with the switches 216 and 217, which are then held open by the end of the lever 224. After the contact to the hook 236 is broken and the line is clear, the magnet 26A is de-energized to allow the switch 69 to open. This de-energizes the restoring magnets 215, and allows the switches 216 and 217 to close when the armature 221 has returned to normal position and the end of the lever 224 is withdrawn. As was described above, as soon as the switch 217 is closed, it completes the relay circuit for one of the magnets 201, which was set up by the service switch in moving to a new position.

When one of the relay magnets 201 of the relays 65 is energized, the plunger 202 is of course drawn up to open the battery connection switch 205 and to close the switches 203, 204 and 206. By opening any one of the switches 205, the relay magnet circuit is broken. This circuit may be traced from the battery lead 300, through the switches 205 in series, to the lead 296, through the switch 217, which is now closed, through the lead 298, through one or the other of the leads 294 or 295, to one or the other side of the reversing switch 96 through the magnet 201, to the negative battery lead 252.

When the switch 206 is closed, the opened side of the motor 64 is connected from the wire 318, through the branch 324, switch 206, to the positive battery lead 300, or from the switch 206 through the intervening switches 205 if one of the relays to the right has been operated. When the switch 203 is closed, the trip magnet is re-energized and the cut-out is again opened. This connection may be traced from the positive battery lead 300, through the switch 203, branch 327, wire 328, switch finger 77, switch finger 76, lead 280, through the trip magnet 214, switch 216, which is then closed to the negative side of the battery through the battery lead 251.

The lock magnet 83 is energized by closing the switch 204. This circuit is traced through the battery lead 300, switch 204, wire 326, branch 325, switch 315, through the relay magnet 83, the branch 255 to the negative battery lead 252. When the magnet 83 is

energized, it attracts the armature 82 and releases the disk 72. This starts the drum 63 to revolving through the connection of the friction disk 73, which is keyed to the shaft 70, since the motor has already been put in operation by the switch 206. The disk 65 corresponding to the operated switch is also released, and is then frictionally driven from the shaft 87 until the one-half rotation is completed. The relay magnet 201 is immediately de-energized as described above by opening switch 205 and the armature will be allowed to drop as soon as the succeeding cam lug 90 strikes the latch 208 and causes the latch to release the armature. The motor switch 206 opens before the drum has completed its operation, and the motor is then held in operative connection through the switch 316.

As soon as the drum starts to move, the contact to the finger 75 is broken. This disconnects the selector switches in the corresponding substation from the line 8. The connection to the switch finger 76 is also broken and the trip magnet circuit is thereby opened.

When the first contact finger 80 moves over the first group of contacts 79, a signal is sent out to indicate the particular substation. This connection may be traced from the ground 250 through the battery 60, positive battery lead 263, contact finger 80, through the drum 63 and the line contact finger 78.

As the drum continues to rotate each of the signals corresponding to the open positions of the service switches are consecutively connected to the line, and next the signal circuits corresponding to the closed positions of the switches. The signal circuits may be traced from the ground 250, battery 60, positive battery lead 310, branch 309, contactor 246 to either of the wires which lead from the contacts 301 or 302 to the relative contact fingers 80, through the drum, and contact finger 78 to the line 8. When the drum has completed its revolution, the lug 74 connects up the drum to the fingers 75, 76 and 77. The motor switch 316 is open, and the motor is stopped since the motor switches in the starting relays have previously been opened. The switch 315 is reclosed so that the magnet 83 may again be energized.

As will be described hereinafter, the receiver is adapted to send a relatively high voltage impulse over the line immediately after the answer-back signals have been completed. This high voltage impulse will flow from the line 8 through the drum, through the contact 76, the drum then having returned to the normal position, wire 280, branch 281, through the resistance 68, branch 282, through the restoring magnets 215, to the battery lead 248, which is grounded at 250. This will energize the restoring mag-

nets 215 in all of the substations and return the cut-outs to normal or closed position.

When it is desired to determine the positions of the switches in a substation, the proper code of impulses is transmitted over the line conductor 8 to cause the hook 236 of the desired selector switch 56 to engage its associated contacts 237. The first impulse over the line conductor 8 effects, in the manner heretofore described, the energization of the trip coils 214 of all the cut-out switches 61 so that they are immediately opened to prevent the operation of all of the answer back mechanisms as long as impulses are being sent to operate one of the selector switches 56.

When the hook 236 of the desired selector switch 56 engages its associated contacts 237, a circuit is completed for the magnet 201 of the answer back motor relay 66. This circuit is from ground 250, through negative battery lead 252, conductor 253, magnet 201, conductor 330, contact 237 and hook 236 of the desired switch 56, conductor 260, magnet 26A, conductor 262, positive battery lead 263 to battery 60. The energization of magnet 201 of switch 66 effects the closing of its contacts 207 and 209 but contacts 211 are held open by the auxiliary armature 210 until the magnet 201 is deenergized. The energization of the magnet 26A connects the restoring magnets 215 in the selected station across the battery 60 so that the lever 212 is moved into its contact-engaging position.

As soon as the selected switch 56 is released and its hook 236 disengages the contact 237, the magnet 26A and the magnet 201 of switch 66 are deenergized. The deenergization of the magnet 26A effects, in the manner above described, the closing of the switches 216 and 217 of the cut-out switch 61. The closing of the switch 216, however, effects, through contacts 211 and 207 of switch 66 and contacts 77 and 76 of the drum 63, a circuit for the trip magnet 214 so that the cut-out switch 61 is immediately opened after the magnet 201 is deenergized.

The closing of contacts 211 upon the deenergization of the magnet 201 of switch 66 also completes an energizing circuit for the motor 64. This circuit is from the positive terminal of the battery 60 through conductor 300, contacts 211 of switch 66, conductors 323 and 318, motor 64, conductor 254 to the negative terminal of battery 60. The motor 64 causes the drum 63 to rotate since the drum release magnet 83 is energized by a circuit from the positive terminal of the battery 60 through contacts 211 of switch 66, conductors 323, 318 and 322, contacts 209 of switch 66, conductors 326 and 325, contacts 315, conductor 320, release magnet 83, conductors 255 and 252 to the negative terminal of battery 60.

When the magnet 201 of switch 66 is de-

energized, the armature 91 is maintained in its attracted position by the latch 208 until it is released by one of the lugs 90. The opening of the contacts 207, 209 and 211 of the switch 66, when its armature 91 is restored to its normal position, does not effect the deenergization of the motor 64, however, until the drum 63 has made a complete revolution because as soon as the drum leaves its normal position, a circuit is completed for the motor from the positive terminal of the battery 60, through conductors 300 and 321, contacts 316 on drum switch, conductors 319 and 318, motor 64, conductors 254 and 252 to the negative terminal of the battery 60. This circuit remains completed until the drum is restored to its normal position, in which position switch 316 is open. During this revolution of the drum 63, answer back signals or impulses are transmitted over the conductor 8 in accordance with the relative positions of the switches 5, 6 and 6a at the selected station.

When the answer-back signal flows into the control station, it flows through the closed switch 132, wire 48, closed switch 165, wire 49, branch 51, closed switch 172, wire 52, relay magnets 154, wire 53 to the ground 50. This will energize the magnets 154 to draw up the armature 155 which will be locked by the latch 158. When the plunger 157 is raised, the switches 153 and 152 are opened and the switch 151 is closed. The incoming signal also flows from the wire 49 through the printing magnet 191 to the ground 50.

When the switch 151 is closed, the motor 29 is energized. This circuit may be traced from the positive battery lead 28, through the motor 29, wire 33, switch 151, wire 36, the closed switch 163, to the negative battery lead 35. The motor at once starts in operation to rotate the screw 23 and the printing carriage 193 is moved to the right since the feed nut 194 is closed. By this movement, the position of the receiving switches 17 are reversed, that is the switch 172 is opened to break the circuit of the relay 154 and the switch 171 is closed to connect up the circuit for the spacer magnet 23, which circuit is then open at the switch 152. The line remains connected through the printing magnet 191 to the ground, and the printing magnet is operated to draw the ink roller 185 down into contact with the chart 18, and print coded records of the signals. The movement of the carriage is, of course, timed with the rotation of the sending drum 63 so that when the drum has finished one revolution just before the post 192 strikes the latch 158 to release the armature 155. When the plunger 157 is allowed to drop by releasing the armature 155, the circuit for the motor 29 is opened at the switch 151, the circuit for the spacer magnet 23A is re-closed by the switch 152 and the wire 40 is reconnected to

the wire 39 in the calling circuits, by reclosing the switch 153. Immediately after the post 192 strikes the latch 158, the projection 196 on the feed nut lever 195 strikes against the right-hand frame member 20. This causes the feed lever 195 to be rotated counter-clockwise into position to open the feed nut 194, and the lever is locked in that position by means of the spring pressed latch 182.

The frame 193 is then drawn to the left by means of the weight 181. As was described above, the post 192 does not disturb the switches in the element 16 when the post passes to the right under the cam block 167; but when the carriage returns to the left, the post strikes and rotates the cam block 167 counter-clockwise. This closes the switch 164 and connects the line through the wire 36, switch contact 112, switch arm 113, to the negative terminal of the battery 9, the switch 163 being opened to disconnect the wire 36 from the negative lead 35 of the battery 10. The switch 165 is opened to disconnect the line from the wire 49 and the switch 161 is opened and the switch 166 closed. In this manner the two batteries 9 and 10 are momentarily connected in series to the line in order to send the relatively high voltage impulse for restoring the cut-outs in all of the substations. This circuit may be completely traced from the line 8, through armature 132 of magnet 41, conductor 48, switch 164, conductor 36, contacts 112 and 113 of switch 11, battery 9, conductor 34, switch 166, conductor 35, battery 10, conductor 31, switch lever 111 to the ground 38, since the switch 11 is always thrown down as soon as the control signals have been sent. As was described above, the post 192 lifts the block 173 to reopen the switch 171 and re-close the switch 172 and the latch 182 is operated by striking the stop 184 to release the lever 195 and move the halves of the feed nut 194 back into engagement with the screw 23 ready for receiving the next set of signals. On the return movement, before the switch 171 is opened the circuit for the spacer magnet 23A is closed by the switch 152 when the armature 155 is released. This circuit starts from the positive battery lead 28, through the magnet 23A, line 32, switch 171, wire 37, switch 152, wire 36, which is connected to the negative battery terminal through contact 163.

It is now manifest that when the printer 19 is moving to the right, the station "signal" is printed in the first column and the code marks for the signal circuits may be printed so that the marks are arranged in columns corresponding to the several signal circuits. The open switches will cause the signals to be printed in the first set of columns and the closed switches will show printed indications in the second set of columns with blank spaces in the columns which show the op-

posite positions of the switches. This is illustrated on the portion of the chart shown in Fig. 2. The number of the station is shown in the first column and the signal is printed in the No. 1 open column showing that this switch is open. No. 2 open column is blank showing that the second switch is then closed, and the No. 3 open column shows that No. 3 switch is open. The second series of columns serve as a check against the indications in the first series; that is No. 1 closed is blank, No. 2 closed shows the signal and No. 3 closed column is blank. This serves as a check on the signals which is especially desirable where only a positive indication is given from any one signal. If the signal or the circuits corresponding to that signal are out of order, there is still another set of circuits which will serve to check the first.

Although but one specific embodiment of this invention has been herein shown and described, it will be understood that numerous details of the construction shown may be altered or omitted without departing from the spirit of this invention as defined by the following claims:

I claim:

1. In combination with a plurality of substation switches, a signal sender connected to each switch for sending signals indicating the positions thereof, means associated with each switch for energizing the sender when a switch is moved, means independent of the switches for energizing the sender, and a cut-out switch associated with both of said means for deenergizing the same, said cut-out switch being controlled by the sender.

2. In a remote control system, the combination with a plurality of substation switches, a signal sender connected to each of said switches, means operated by the movement of any of the switches for actuating the sender, means for actuating the sender without moving any of the switches, and a cut-out switch responsive to both of said means for disconnecting the same while the sender is in operation.

3. In a remote control system, the combination with a substation switch, a signal circuit related with each position of the switch, a contactor carried by the switch and adapted to close one circuit and open the other according to the position of the switch, a receiver having an electrically operated printer, a control drum for connecting the signal circuits in succession to the printer, and means for simultaneously actuating the receiver and the control drum at predetermined speed so that the printer records the received signals in separate columns according to the position of the switch.

4. In a remote control system, the combination with a substation switch, a signal circuit related with each position of the switch, said circuits alternately opened and closed by the

movement and according to the position of the switch, means connected to the line for receiving and recording the signals, and means responsive to the movement of said switch from either of its positions to the other position for energizing and connecting the signal circuits to the line in consecutive order.

5. In a remote control system, a controlled switch, a signal circuit related with each position of the switch and closed by the switch when in the relative position, and means responsive to the movement of said switch for consecutively energizing said circuits so that a signal is given by the circuit in closed relation with the switch and no signal is given by circuit which is not in closed relation.

6. In a remote control system, a substation switch having two positions, a signal circuit for each position of the switch closed by the switch when the switch is in the position corresponding thereto, and means responsive to the movement of said switch from either of its positions to the other position for energizing the circuits consecutively so that a positive indication is given by the circuit which is closed by the switch and no signal is given by the circuit which is then open.

7. In combination in a remote control system, a chart, a carriage, a printing device on the carriage, means for moving the carriage across the chart, means for moving the chart to space, a substation having a switch, means whereby said moving means are both actuated by a change in the position of the switch, sending means consecutively in cooperative relation with the switch for each position thereof and means for operating said sending means relative to the movement of said carriage in order that the printing device is actuated in a predetermined position in the travel of said carriage so that a blank space in one position is a check on the printed space in another position.

8. In combination in a remote control system, a substation switch having two positions, a chart, a printer, means for moving the printer across the chart, a sender consecutively in relation with each position of the switch and means for operating said sender at such a speed relative to the speed of said printer that said sender effects the energization of the printer in predetermined positions in its movement.

9. In combination in a remote control system, a plurality of substation switches movable from one position to another, a chart, a printer movable across the chart, a sender adapted to send in consecutive order a signal for each position of each switch, and means for operating said sender and printer at speeds which cause said printer to print each signal in a predetermined position in its movement.

10. In a remote control system, a plurality of substation switches movable from one posi-

tion to another, a signal circuit related with each switch in each position thereof, a sender for energizing the circuits in a predetermined sequence, a chart, a printer moved across the chart and responsive to the signal from each circuit and means for operating said printer at a speed which causes the printer to respond to the signals from said sending means in predetermined positions in its movement across the chart.

11. In a remote control system, the combination with a service switch of signal circuits related with the switch in each position thereof, a sending drum for consecutively energizing the signal circuits, means for operating the drum, a relay switch controlling the means, a single-pole double-throw switch for energizing the relay, a contactor connected to the service switch, a contact in relation with the contactor in each position of the switch, the opposite poles of the double-throw switch being connected respectively to the two contacts, and means included in the relay for reversing the position of the double switch at each actuation of the relay.

12. In a remote control system, the combination with a plurality of selectors and service switches controlled by the selectors, of a sending drum having a contact adapted to connect the line to the selectors when the drum is in normal position, signal circuits related with the service switches and controlled by the drum, means for operating the drum controlled by moving one of the switches to a new position, a cut-out for disconnecting said means, a trip magnet connected to the contact on the drum and through a switch in the cut-out for opening the cut-out when the first signal is received from the line, a restoring magnet for closing the cut-out, the restoring magnet energized by the selector so that the drum operating means is disconnected as soon as the signal is received, and is re-connected to the line by restoring the cut-out as soon as the line is cleared of signals.

13. In a remote control system having a supervisory station connected to a plurality of substations, means at the supervisory station for signalling the substation, a sender at each substation for sending answering signals to the supervisory station, a cut-out switch at each substation for disconnecting said senders when signals are being sent, a receiver at the supervisory station for receiving and recording the answer-back signals, means operated by the receiver for sending a relatively high voltage impulse back to the substations after the answer-back signals have been received and means responsive to said relatively high voltage impulse for closing said cut-out switches.

14. In a remote control system having a supervisory station connected to a plurality of substations, two line batteries normally connected to the line in parallel relation, send-

ing means at each substation for sending answer-back signals to the supervisory station, a cut-out at each substation for disconnecting the means while the line is busy, the cut-out being opened by a normal signal impulse in the line and being restored by a relatively high voltage impulse, a receiver at the supervisory station for receiving and recording the answer-back signals, and a battery pole changer switch operated by the receiver after a series of signals has been recorded adapted to momentarily change the batteries into series relation for sending a relatively high voltage impulse into the line to restore the cut-outs so that the senders may be energized.

15. In a remote control system, a receiver for receiving and recording the answer-back signals comprising a chart, an electromagnet for spacing the chart, a printer, a motor for moving the printer across the chart, means for restoring the printer to the starting position, an electromagnet for energizing the motor when the signal is received, means for de-energizing the motor when the carriage has moved across the chart, a switch opened by the printer in the normal position for energizing the spacer magnet, and a switch in cooperative relation with said switch which is closed when the motor switch electro-magnets are energized so that the spacer magnet is operated during the return movement of the carriage.

16. In combination in a remote control system, having a selector switch which makes a contact to complete a local battery circuit, a line circuit connected to operate the selector switch, signal circuits, a sender for connecting the signal circuits to the line, a cut-out having a trip magnet and a restoring magnet, a trip magnet switch and a sender actuating switch normally closed by the cut-out, the trip magnet being connected to the line through the trip magnet switch, and the restoring magnet being energized by said local battery circuit, and a lever connected to the restoring magnet to hold the trip magnet and sender switches out of relation with the cut-out for closing until the restoring magnet is de-energized by the opening of the selector switch when the line is cleared.

17. In a remote control system having a selector switch and a line circuit for operating the selector switch to close a local battery circuit, a signal related with the selector switch and a sender for connecting the signal circuit to the line, a cut-out switch for energizing the sender, a trip magnet connected to the line to open the cut-out switch, a restoring magnet for closing the cut-out switch energized by the selector switch, and means connected to the restoring magnet for preventing the cut-out switch from energizing the sender until the line is cleared and the selector switch is restored to normal position.

18. In a supervisory control system, a supervisor's office, a remote station, a plurality of switches at said station, means controlled by said switches for sending in succession  
5 electric impulses corresponding to each switch which is in a certain position and then electric impulses corresponding to each switch which is in another position, a chart in said office and means controlled by said impulses  
10 for printing a record of the instant position of said switches in columns corresponding to the respective positions of the several switches.

19. In a supervisory control system, a supervisor's office, a remote substation, a plurality of substation switches at said substation, a sender at said substation for sending in succession electric impulses indicating the position of each switch, a recorder at said  
20 office responsive to said electric impulses, said recorder having a recording member movable to different positions, and means for operating said sender and said recording member so that the impulses indicating the positions of  
25 the respective switches are always sent when said recording member is in predetermined positions of its movement whereby records of each switch are made in separate columns.

Signed at Chicago this 21st day of March  
30 1927.

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