June 24, 1930. J. L. McCOY 1,765,494

SUPERVISORY CONTROL SYSTEM

Filed Jan. 2, 1924 4 Sheets-Sheet 1

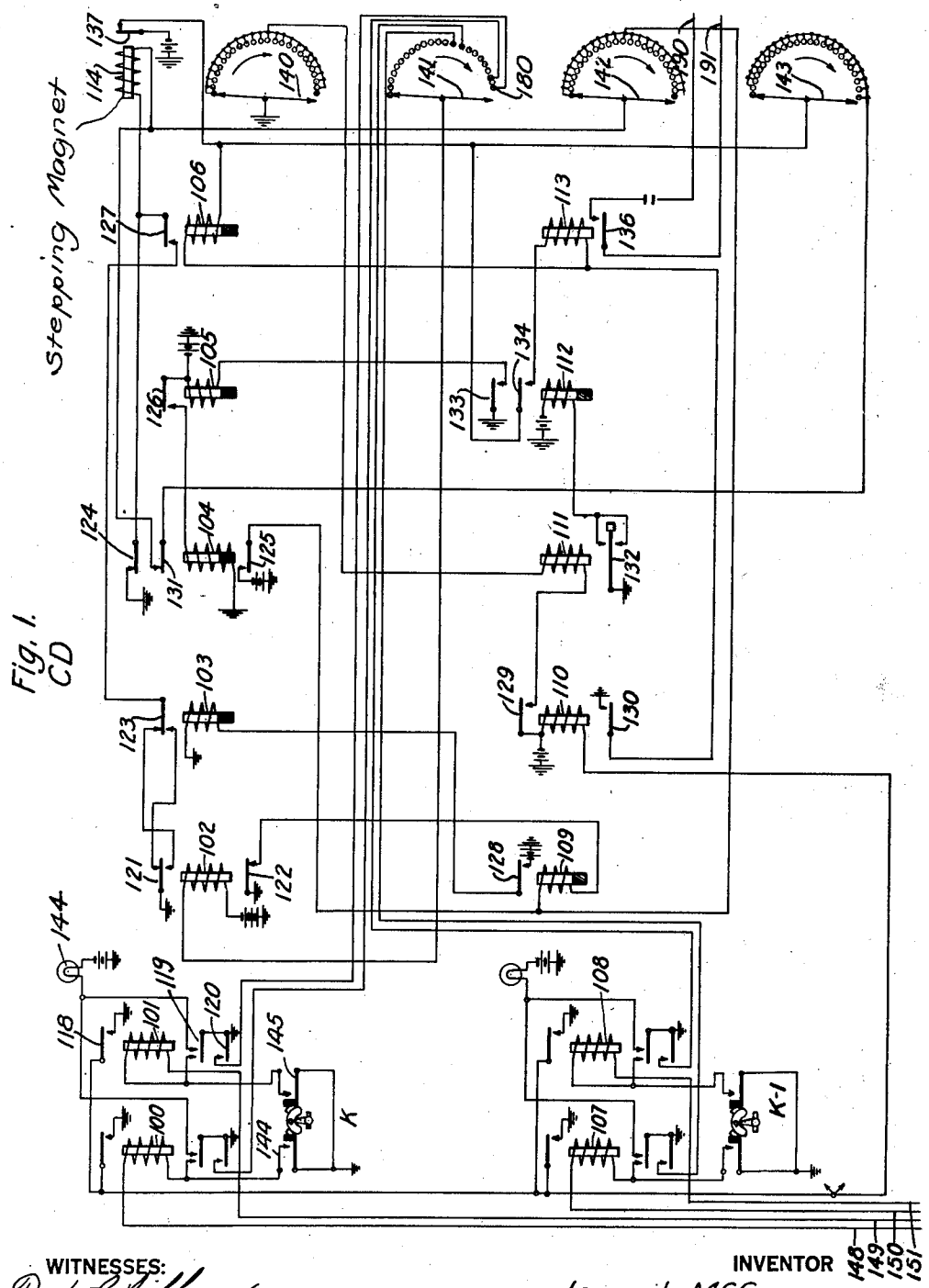



Fig. 1.
CD

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SUPERVISORY CONTROL SYSTEM

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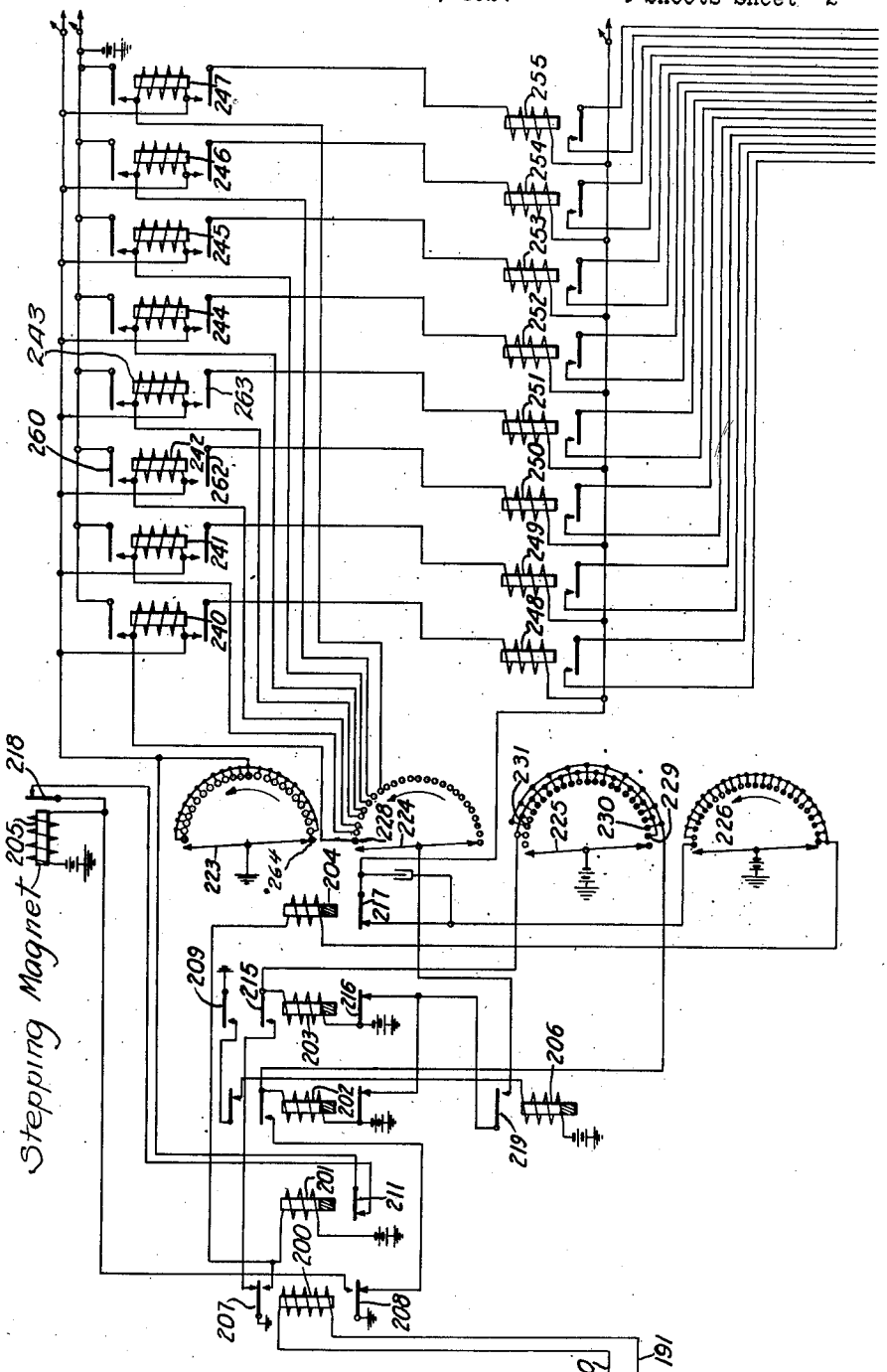



Fig. 2
H

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SUPERVISORY CONTROL SYSTEM

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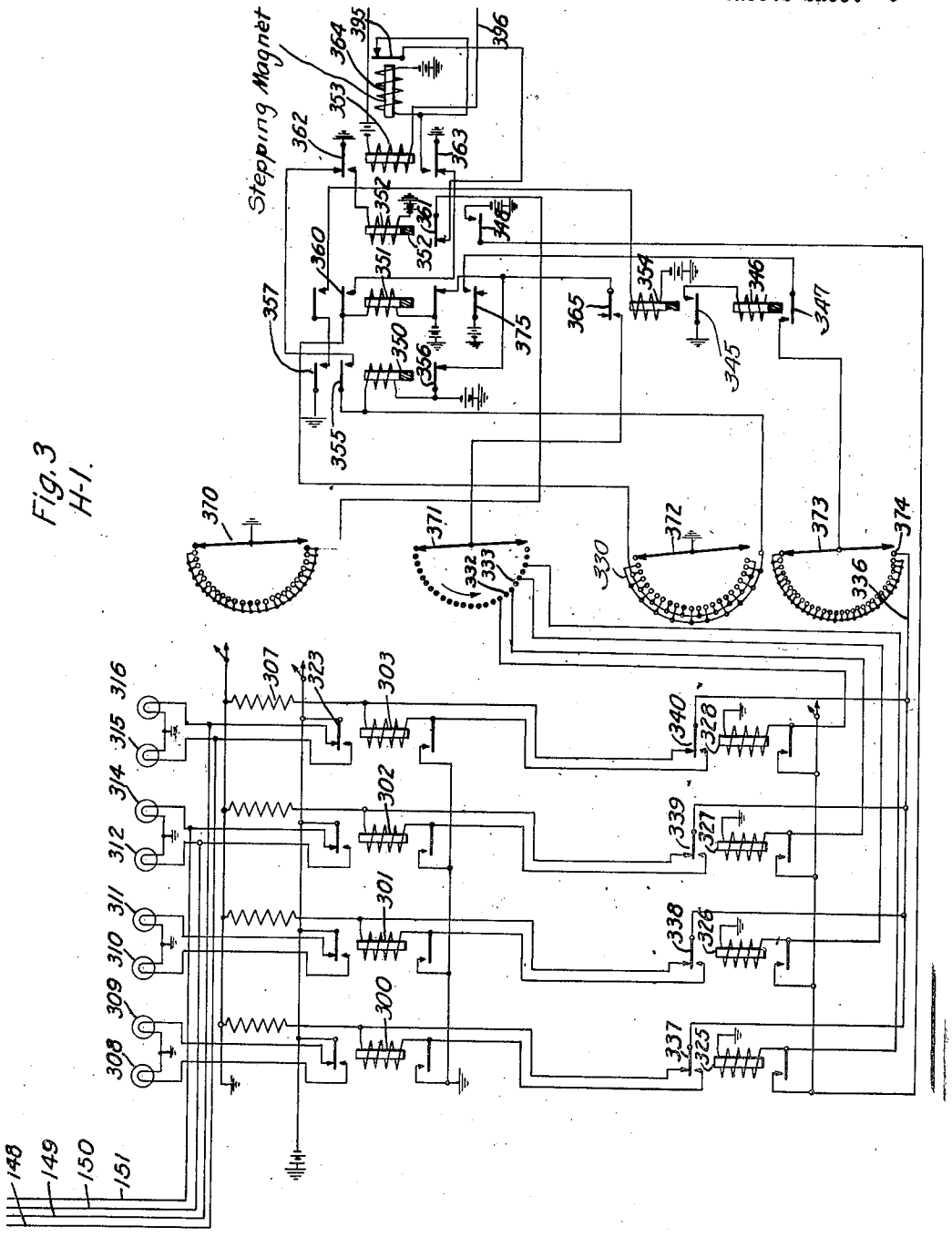



Fig. 3
H-1.

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SUPERVISORY CONTROL SYSTEM

Filed Jan. 2, 1924 4 Sheets-Sheet 4

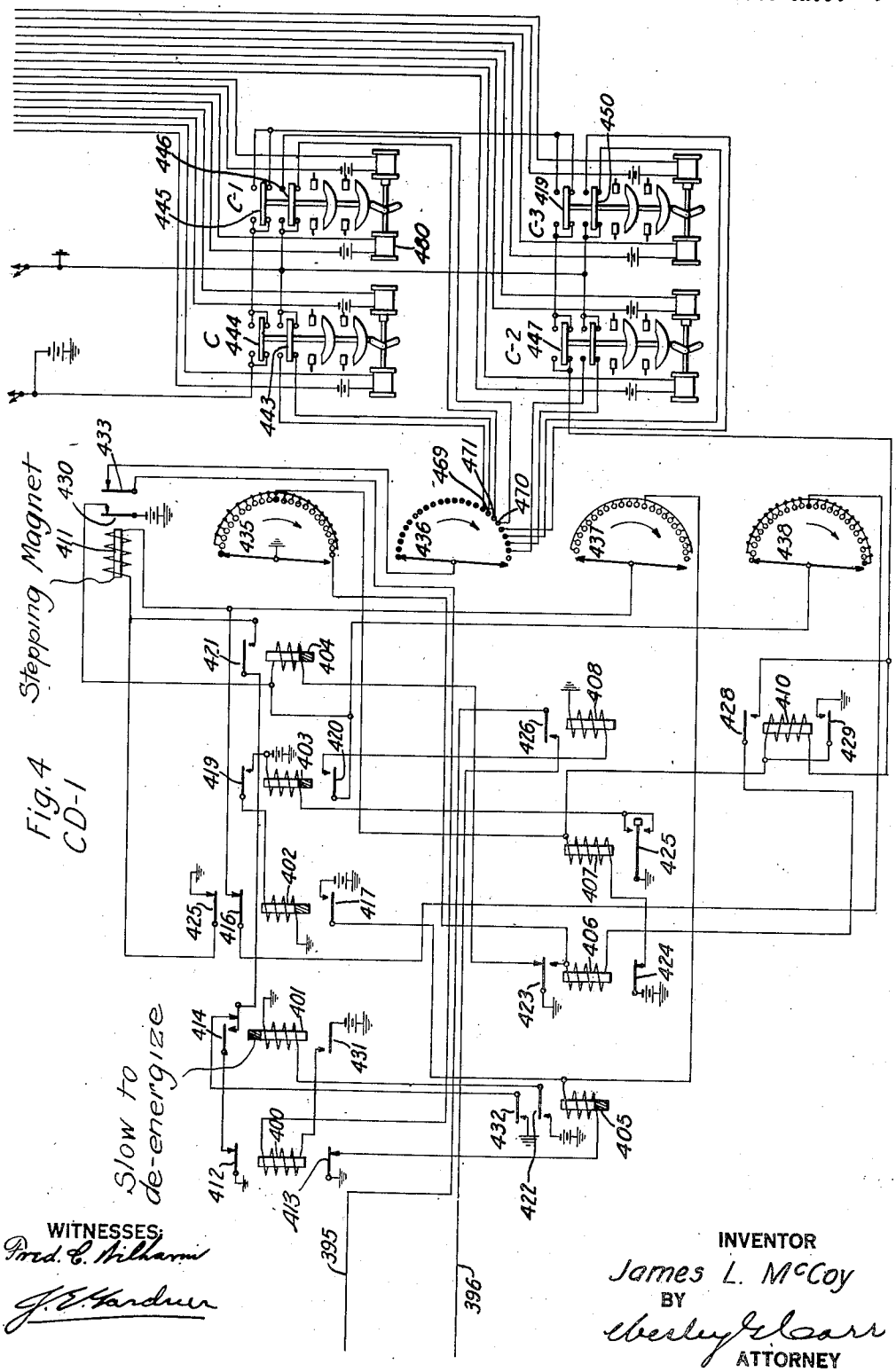



Fig. 4

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# UNITED STATES PATENT OFFICE

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## SUPERVISORY CONTROL SYSTEM

Application filed January 2, 1924. Serial No. 683,963.

My invention relates to systems for controlling and supervising from a central point remotely-disposed electrical apparatus, for example, the controlling and supervising of apparatus units or translating devices in substations from a central dispatcher's office.

One object of my invention is to provide an improved code-sending arrangement that operates as a combined finder and code sender.

Another object of my invention is to provide a control arrangement at the dispatcher's office whereby it is possible to control a plurality of apparatus units substantially simultaneously.

Still another object of my invention is to provide circuit arrangements which are automatically responsive to the operation of apparatus units in the substation to send back a plurality of answer-back signals to check the condition of each apparatus unit whenever one is operated.

There are other objects of the invention which, together with the above, will appear more fully in the detailed description which is to follow.

Referring now to the drawings, Figures 1 to 4, inclusive, when placed side by side with the corresponding lines at the end thereof in alinement, show the circuits of the apparatus for supervising and controlling, from a dispatcher's office, the circuit interrupters located at a remotely-disposed substation.

The apparatus shown in Figs. 1 and 3 is that located at the dispatcher's office, while the apparatus shown in Figs. 2 and 4 is that located at the substation. The dispatcher's office and substation are connected by a trunk line comprising four conductors 190, 191, 395 and 396. This, of course, may be changed to three by making two conductors common.

Referring now more particularly to Fig. 1, keys K and K—1 are ordinary double-throw keys that are of a type familiar in telephone practice. Associated with the keys K and K—1 are relay groups comprising relays 100 and 101 and 107 and 108, respectively. Relays, such as 100 and 101, are provided for the purpose of controlling a combined finder and code-sending switch CD.

The code-sending switch CD is of the usual rotary type disclosed in the patent to Clement 1,107,153, and is provided with a set of four wipers 140 to 143, inclusive, each wiper of which is adapted to engage a contact bank comprising twenty-five bank contact members. The wipers 140 to 143, inclusive, of the code-sending switch CD move in a forward direction only and are restored to normal by the continued operation of a motor magnet 114 at the end of such operation.

A connector H (Fig. 2) is also a switch of the usual rotary type, the wipers 223 to 226, inclusive, of which each engage a bank of twenty-five contact members and are adapted to move in a forward direction only. The wipers of the connector switch H are restored to normal at the end of each operation. The circuits of the connector switch H are so arranged that it is adapted to be directly controlled from the office.

Relays, such as 240 to 247, inclusive, are provided for the purpose of controlling relays 248 to 255, inclusive. Relays 248 to 255, inclusive, are, in turn, adapted to operate circuit breakers C, C—1, C—2 and C—3, shown in Fig. 4.

The connector switch H—1 of Fig. 3 is similar to the connector switch H previously described and is adapted to control the operation of lamp supervisory relays, such as 300 to 303, inclusive, through the medium of relays 325 to 328, inclusive. A code-sending switch CD—1 of Fig. 4 is similar to the code-sending switch CD previously described, except that its operation is initiated by the movement of the circuit breakers, such as C, C—1, C—2 and C—3. The circuit breakers C, C—1, C—2 and C—3 are of the usual type and are provided for the purpose of controlling the operation of translating devices, the closing of feeder circuits, or such equipment as is necessary in a substation of an electrical system of distribution.

Only a sufficient amount of the apparatus has been illustrated to enable the operation to be understood. It will be apparent that the capacity of the system may be increased by adding circuit interrupters and keys connected in the same manner as those shown.

Having briefly described the apparatus

shown in the drawings, I will now describe its detailed operation. For this purpose, it will be assumed that the dispatcher desires to close the circuit breaker C—1 at the substation in order to initiate the operation of a translating device. To accomplish this result, the dispatcher will operate the key K in such a direction as to force a spring 145 into engagement with its working contact, thus completing a circuit extending from ground by way of the said spring and its working contact, through the winding of a relay 101, conductor 149, back contact and armature 323, and thence to battery. The relay 101 is energized over this circuit and establishes a locking circuit for itself at armature 119, at the same armature closes a circuit for a monitoring lamp 154, at armature 120 places ground upon the bank contact 180, and at armature 118 completes a circuit from ground by way of the front contact and said armature, through the winding of relay 110 to battery.

The relay 110 operates over this circuit and the operation of its armature 129 establishes a circuit for the relay 111 over a path extending from battery by way of the said armature and its front contact, through the winding of the relay 111, the bank contact with which the wiper 140 is in engagement, and the said wiper to ground, and its armature 130 operates to complete another circuit extending from ground through the winding of the slow-release relay 106, the back contact and armature 137 to battery. The relay 111, upon being energized, operates at its armature 132 to close a circuit for the slow-release relay 112.

At this time, it might be well to mention that the armature 132 of the relay 111 is peculiarly constructed, so that, when the relay is deenergized after being energized, the armature 132 vibrates for an interval thereafter alternately making its front and back contacts. The relay 112, upon operating, causes its armature 133 to close a circuit for the slow-release relay 105, and its armature 134 to complete a circuit extending from ground by way of the front contact and armature 130 of the relay 110, through the winding of relay 113, the front contact and armature 134, and thence to battery by way of the back contact and armature 137. The relay 113, upon operating causes its armature 136 to complete a circuit for the line relay 200 of the connector switch H at the substation (Fig. 2) over trunk conductors 190 and 191.

The line relay 200 of the connector H is energized at this time and operates its armature 207 to complete a circuit for a slow-release relay 201 and also for a slow-release relay 204, and it also operates its armature 208 to complete the circuit of the stepping magnet 205. The relay 204, upon operating, causes its armature 217 to open one point in the circuit of the relays 248 to 255, inclusive, for a purpose which will appear hereinafter. The stepping magnet 205 is energized at this time, thereby placing the pawl of the switch in such position as to actuate the shaft carrying the switch wipers 223 to 226, inclusive, upon the deenergization of the magnet. The operation of the armature 218 and its magnet 205 is without particular function at the present time.

Returning now to the operation of the code-sending switch CD at the dispatcher's office, the relay 106 is energized over the previously traced circuit and operates to prepare a circuit for the stepping magnet 114 at armature 127. The slow-release relay 105 is energized to close a circuit for the slow-release relay 104 at armature 126. The armatures 124 and 131 of the latter relay, upon operating, open certain points in the circuit of the stepping magnet 114 and its armature 125 completes a circuit extending from battery by way of the front contact and armature 125, through the winding of a slow-release relay 109, the back contact and armature 122 of the relay 102 to ground. The relay 109 is energized over this circuit and actuates its armature 128 to close a circuit for a slow-release relay 103.

The latter relay, upon being energized, establishes a circuit which extends from ground by way of the armature 121 of the relay 102 and its back contact, the front contact and armature 123 of the relay 103, the front contact and armature 127 of the relay 106, through the winding of the stepping magnet 114, the wiper 142 and its associated bank contact, the armature 125 of the relay 104 and its front contact, and thence to battery. The stepping magnet 114 is energized over this circuit and operates its armature 137 to open the circuit of the slow-release relay 106 and also to open the circuit of the repeating relay 113. Another result of the energization of the magnet 114 is that the pawl associated with armature 137 is placed in such position as to actuate the switch shaft carrying the wipers 140 to 143, inclusive, upon the deenergization of the magnet.

The deenergization of the relay 113 follows the energization of the stepping magnet 114. As a result of this operation, the circuit of the line relay 200 of connector H (Fig. 2) is opened and this relay is deenergized to open the circuit of the stepping magnet 205. The stepping magnet 205 retracts its pawl, thereby advancing the switch shaft carrying the wipers 223 to 226, inclusive, one step.

As a result of the operation of the wiper 225, a circuit is closed extending from ground by way of the said wiper, back contact 229, through the winding of the slow-release relay 203, and thence to battery. The relay 203 operates its armature 215 to establish a locking circuit for itself by way of the back con-

tact and armature 207 of the line relay 200, and its armature 209 prepares one point in the circuit of the slow-release relay 206.

Referring now to the operation of the code-sending switch CD, as the circuit of the slow-release relay 106 is opened, this relay is deenergized after an interval, thereby opening the circuit of the stepping magnet 114 at the armature 127 and permitting the magnet to be deenergized, thereby advancing the switch shaft carrying the wipers 140 to 143, inclusive, one step, and also closing a circuit at the armature 137 for the slow-release relay 106 and the repeating relay 113. The relay 113 operates to again close the circuit of the line relay 200 of the connector H at the substation. The relay 106 operates to close the circuit of the stepping magnet 114 at armature 127.

At the substation, the energization of the relay 200 again closes a circuit for the relays 201 and 204 and also for the stepping magnet 205. The stepping magnet 205 operates to place the pawl in such position as to operate the switch shaft, as before. Another result of the operation of the relay 200 is that the locking circuit of the relay 203 is opened. By reason of the fact that this relay is slow-releasing, it is not deenergized at this time.

At the dispatcher's office, the alternate operation of the relays 106 and 113 and the stepping magnet 114 continues until the switch wipers 140 to 143, inclusive, are brought into engagement with the contact set which includes the bank contact 180.

At the substation, as a result of the intermittent opening and closing of the circuit of the line relay 200, the switch wipers 223 to 226, inclusive, are brought into engagement with the bank contact set which includes the bank contact 228.

When the switch wiper 225 was advanced into engagement with the bank contact 230, a circuit was completed for the slow-release relay 202. This relay maintains itself energized during the operation of the switch wipers, as does the relay 203. As a result of both of these relays being energized, a circuit is completed for the slow-release relay 206.

Returning now to the operation of the code-sending switch CD, as a result of the wipers 140 to 143, inclusive, being brought into engagement with the bank contact set which includes the bank contact 180, a circuit is completed extending from ground by way of the front contact and armature 120, the bank contact 180, wiper 141, and through the winding of the relay 102 to battery. The relay 102 is energized over this circuit and operates, at its armature 121, to open the circuit of the stepping magnet 114, at the front contact of this armature to prepare another circuit for the said magnet, and at armature 122 to open the circuit of the slow-releasing relay 109.

After an interval, the slow-release relay 109 is deenergized to open the circuit of the slow-release relay 103. Shortly thereafter, the relay 103 is deenergized to thereby complete a circuit extending from ground by way of armature 121 and its front contact, the back contact and armature 123, the front contact and armature 127, through the winding of the stepping magnet 114, the wiper 142, the bank contact with which the said wiper is in engagement, and the armature 125 and its front contact to battery. The stepping magnet 114 is operated over this circuit and the circuits of the relays 106 and 113 are opened.

Upon the deenergization of the slow-release relay 106, the stepping magnet 114 is deenergized to advance the wipers 140 to 143, inclusive, into engagement with the next set of bank contacts. The operation of the relay 113 opens and closes the circuit of the slow-release relay 200 of the connector switch H at the substation.

As a result of the movement of the wipers of the code-sender CD, the circuit of the relay 102 is opened and this relay deenergizes to open the circuit of the stepping magnet 114 at armature 121 and to prepare another circuit for the said magnet at the back contact of the said armature, and at armature 122 to complete a circuit for the relay 109. The relay 109 operates to close a circuit for the relay 103. The slow-release relay 103 operates to close another circuit for the stepping magnet 114.

Referring now to the operation of the connector switch H at the substation, it will be seen that the line relay 200 is maintained energized for an interval of time that is determined by the operation of the slow-release relays 109 and 103 in the code-sending switch CD. During this interval, a circuit is maintained for the relay 202, the wiper 225 being in engagement with the contact 231. However, the circuit of the slow-release relay 203 is not maintained and this relay is deenergized to cause its armature 209 to open the circuit of the slow-release relay 206 and its armature 216 to complete a circuit extending from battery by way of said armature and its back contact, armature 219 and its front contact, wiper 224, bank contact 228, through the winding of relay 242, the bank contact with which the wiper 223 is in engagement and the said wiper, and thence to ground. The relay 242 is energized over this circuit and operates, at armature 260, to establish a locking circuit for itself from ground over wiper 223, winding of relay 242, front contact and armature 260 and battery to ground, and at armature 262 to prepare a circuit for the relay 250. The slow-release relay 206 is deenergized after an interval of time to open the previously traced circuit for the relay 242. This relay is not deenergized at this time, by reason of the fact that it has established a locking circuit for itself.

In the code-sending switch CD at the dispatcher's office, the stepping magnet 114 and the relays 106 and 113 continue to operate alternately until the wipers 140 to 143, inclusive, are brought into engagement with their twenty-fifth set of bank contacts. As a result of the wiper 142 being brought into engagement with its twenty-fifth set of bank contacts 155, the circuit of the stepping magnet 114 is opened. As a result of the operation of the wiper 140, the circuit of the relay 111 is opened and this relay is deenergized, thereby causing its armature 132 to vibrate for an interval of time thereafter, repeatedly closing the circuit of the slow-release relay 112 and maintaining it energized. By reason of the continued energization of the relay 112, the relay 113 is maintained energized for an interval of time, thereby maintaining the circuit of the line relay 200 of the connector H closed for the same interval of time.

At the connector H, as a result of the wiper 226 being brought into engagement with its twenty-fifth bank contact, the circuit of the slow-release relay 204 is opened and a circuit is prepared for the relay 250. After a short interval of time, the slow-release relay 204 is deenergized and a circuit is completed extending from battery by way of the wiper 226 in engagement with its twenty-fifth bank contact, the back contact and armature 217, through the winding of the relay 250, the armature 262 and its front contact, and thence to ground by way of the twenty-fifth bank contact and the wiper 223. The relay 250, upon being energized, completes a circuit for the closing coil 480 of the circuit breaker C—1. The closing coil of the circuit breaker C—1 operates to close this breaker whereby a translating device, or other apparatus unit, is placed in operation.

Returning now to the operation of the code-sending switch CD, the slow-release relay 112 is deenergized after an interval of time, thereby opening the circuit of the relay 113, which is deenergized, and also opening the circuit of the slow-release relay 105. The slow-acting relay 105 is deenergized after an interval of time to open the circuit of the slow-release relay 104 which is also deenergized. As a result of the retraction of the armatures of the relay 104, the circuit of the slow-release relay 109 is opened at armature 125, and at armature 124 a circuit is completed extending from ground by way of the back contact and said armature, through the winding of the stepping magnet 114, the armature 131 the bank contact with which the wiper 143 is in engagement and the said wiper, and to battery by way of the back contact of armature 137. The stepping magnet 114 operates to restore the wipers 140 to 143, inclusive, to their normal position. The relays 109 and 103 are deenergized after an interval of time. In the above manner, the code-sending switch CD is restored to normal.

It will be noted that the starting relay 110 is not deenergized at this time, by reason of the fact that the relay 101 is maintained energized. The code-sending switch will then function again in the same manner as before described. The purpose of this repeated operation of the code-sending switch CD will be described hereinafter.

Referring now to the connector switch H, the line relay 200, upon being deenergized, opens the circuit of the slow-release relay 201. As a result of the deenergization of the relay 201, a circuit is completed extending from ground by way of wiper 223, the bank contact with which this wiper is in engagement, the back contact and armature 211, the back contact and armature 218 of the stepping magnet 205, and through the winding of the stepping magnet 205 to battery. The stepping magnet 205 operates over this circuit until the switch wipers 223 to 226, inclusive, are brought to their normal position, whereupon the stepping magnet circuit is opened at the wiper 223 and the rotation of the switch ceases. In the above manner, the connector switch H is released, responsive to the operation of the desired circuit breaker.

It will be noted that, when the circuit breaker C—1 operates, the switches 445 and 446 are also operated. It will be also noted that the operation of the switch 445 momentarily opens the locking circuits of the relays 406 and 410. The relay 410 is thus deenergized and opens another point in its locking circuit at its armature 429, and at its armature 428 opens another point in the circuit of the relay 406, whereby both of these relays are maintained deenergized when the switch 445 engages its working contacts. It will also be seen that, when the circuit breaker C—1 is operated, the switch 446 is operated, ground is removed from the bank contact 471 and is connected to the bank contact 470. This operation is brought about in order to send a different code back to the dispatcher's office to inform him that the breaker C—1 is now in its closed position.

It should be mentioned at this time that, at the end of each operation of the code-sending switch CD—1, the relays 406 and 410 are locked energized and, consequently, with the operation of a circuit breaker switch, such as 445, these relays are deenergized. The manner in which this locking circuit is completed at the end of the operation of the code-sending switch CD—1 will be described fully hereinafter.

The relay 406, upon being deenergized, establishes a circuit through its armature 424 for the relay 407 over a path extending from battery by way of the armature 424 and its back contact, through the winding of the relay 407, the bank contact with which the wiper

435 is in engagement and the said wiper to ground. Another result of the deenergization of the relay 406 is that a circuit is closed through its armature 423, extending from ground by way of the armature 423 and its front contact, through the winding of the relay 404, and thence to battery by way of the back contact and armature 430.

When the switch 445 of the circuit breaker C—1 engages its working contacts, another circuit is closed for the relay 410 over a path extending from ground by way of wiper 435, the first bank contact, through the winding of the relay 410, by way of the resting contacts and the switch 447 of circuit breaker C—2 the resting contacts and the switch 419 of the circuit breaker C—3, the working contacts and the switch 445 of the circuit breaker C—1 and the resting contacts and the switch 444 of the circuit breaker C to battery. The relay 410 is energized over this circuit and operates to establish a locking circuit for itself at armature 429, and to prepare a circuit for the relay 406 at armature 428.

The relay 407 is energized over the above circuit and operates its armature 425 to close the circuit of the slow-release relay 403. The armature 425 of the relay 407 is so constructed that, when the relay is deenergized, it will vibrate for an interval thereafter, alternately engaging and disengaging its front and back contacts.

The slow-release relay 403 causes its armature 419 to close a circuit for the slow-release relay 402 and its armature 420 to complete a circuit extending from ground through the winding of the relay 408, the front contact and armature 420, and thence to battery by way of the back contact and armature 430. The relay 408 is energized over this circuit and, upon operating, its armature 426 establishes a circuit over the line conductors 395 and 396 for the line relay 353 of the connector switch H—1 at the dispatcher's office. The relay 353, upon being energized, establishes a circuit through armature 362 for the slow-release relay 352, and through the armature 363 completes a circuit for the stepping magnet 364. The stepping magnet 364 operates to so position its pawl as to actuate the switch shaft carrying the wipers 370 to 373, inclusive, upon being deenergized.

At the substation, the operation of the relay 402 closes a circuit for the relay 405 through the armature 417. The relay 405, upon operating, causes its armature 422 to complete a circuit for the slow-release relay 401, and its armature 432 to close a circuit for the magnet 411 extending from ground by way of the armature 432 and its front contact, the normally closed springs controlled by armature 414, armature 421 and its front contact, through the winding of the stepping magnet 411, wiper 437 and the bank contact with which the said wiper is in engagement, and the armature 417 and its front contact to battery. The relay 401, upon operating, opens a point in the above circuit but maintains the circuit of the stepping magnet intact at armature 414, and at armature 431 prepares a circuit for the relay 400. The stepping magnet 411 is energized over the above circuit and operates to place its pawl in such a position as to actuate its switch shaft carrying the wipers 435 to 438, inclusive, upon its deenergization, and at its armature 430 opens the circuit of the slow-release relay 404 and also the circuit of the repeating relay 408. The repeating relay 408 is immediately deenergized to open the circuit of the line relay 353 of the connector H—1 at the dispatcher's office.

When the relay 353 is deenergized, it thereby opens the circuit of the magnet 364. The magnet 364 retracts its armature to advance the wipers 370 to 373, inclusive, into engagement with the first off-normal set of bank contacts. The operation of the wiper 372 into engagement with the bank contact 330 closes a circuit extending from ground by way of said wiper and bank contact, and through the winding of the slow-release relay 350 to battery. The slow-release relay 350 is energized over this circuit and operates its armature 356 to disconnect one battery connection from the armature 365 and to prepare a circuit for the relay 354 at armature 357. The relay 350 also establishes through its armature 355 a locking circuit for itself to ground by way of the back contact and armature 362 of the line relay 353.

The energization of the relay 410 has already been described. When now the switch wiper 435 reaches its twenty-fifth contact, an energizing circuit is completed for the relay, from ground over the wiper of switch 435 and its twenty-fifth contact, the winding of the relay 406, armature 428 and its front contact, by way of the resting contacts and the switch 447 of the circuit-breaker C—2, and the resting contacts and the switch 419 of the circuit-breaker C—3, the working contact and the switch 445 of the circuit-breaker C—1, and the resting contacts and the switch 444 of the circuit-breaker C, to battery. The relay 406, when thus energized, completes a locking circuit for itself to ground over the armature 423.

At the substation, the slow-release relay 404, upon being deenergized, by reason of the operation of the armature 421, opens the circuit of the stepping magnet 411, which is deenergized to advance the switch wipers into engagement with their first off-normal set of bank contacts and to close a circuit for the slow-release relay 404 and the repeating relay 408. Upon being energized, the repeating relay 408 again closes a circuit for the line relay 353 of the connector H—1. The movement of the wiper 435 of the switch CD—1

opens one point in the circuit of the relay 406 and closes a circuit for the relay 410. The slow-release relay 404, upon being energized, again closes the circuit of the stepping magnet 411. The alternate operation of the slow-release relay 404, the repeating relay 408 and the stepping magnet 411 continues until the switch wipers are brought into engagement with the bank contact set that includes the bank contact 469. As a result of this operation, a circuit is completed extending from ground by way of the stationary back contact members and the relay switch 443 of the circuit breaker C, the bank contact 469, wiper 436, the back contact and armature 433, through the winding of the relay 400, the front contact and armature 431 and to battery. The relay 400 is energized over this circuit and operates its armature 412 to open the circuit of the stepping magnet 411 and to operate its armature 413 to open the circuit of the slow-release relay 405.

At the dispatcher's office, the line relay 353 is energized and deenergized a plurality of times as a result of the repeated operation of the repeating relay 408 at the substation. As a result of these operations of the relay 353, the switch wipers 370 to 373, inclusive, are stepped into engagement with the bank contact set which includes the bank contact 332.

Referring now to the operation of the code-sending switch CD—1 at the substation, the slow-release relay 405 is deenergized after an interval and opens the circuit of the slow-release relay 401. The relay 401, upon being deenergized, causes its armature 431 to open the circuit of the relay 400, and its armature 414 prepares a circuit for the stepping magnet 411. The relay 400 is deenergized to close a circuit for the slow-release relay 405. The latter relay is energized to close a circuit through the armature 432 for the stepping magnet 411 extending from ground by way of the front contact and said armature, the back contact and armature 414, armature 421 and its front contact, through the winding of the stepping magnet 411, the wiper 437, the bank contact with which the said wiper is in engagement, and armature 417 and its front contact to battery.

The stepping magnet 411 is energized over this circuit and operates its armature 430 to open the circuit of the repeating relay 408 and the slow-release relay 404, and also operates its armature 433 to open another point in the circuit of the relay 400. The stepping magnet 411 also operates to position its associated pawl to actuate the switch shaft upon its deenergization. In addition, the operation of the slow-release relay 405 actuates its armature 422 to close a circuit for the slow-to-release relay 401. The latter relay is energized, opens the previously traced circuit for the stepping magnet 411 and completes a new circuit for it through the armature 414.

The relay 401 also through its armature 431 prepares a circuit for the relay 400 and, through its armature 414, prepares another circuit for the stepping magnet 411. The deenergization of the relay 404, which follows shortly after the operation of the magnet 411, opens the circuit of the said magnet and causes the wipers 435 to 438, inclusive, to step into engagement with the next set of bank contacts, which is the contact set including the bank contact 471.

As the circuit breaker C—1 is now in closed position, there is no ground potential upon the bank contact 471 and the switch wipers step to the next bank contact set, which includes the bank contact 470, under the control of the stepping magnet 411 and the slow-release relay 404. When engagement is made with this set of bank contacts, as the circuit breaker C—1 is in a closed position, there is a ground potential upon the bank contact 470 and a circuit is completed by way of said bank contact and wiper 436, the back contact and armature 433, through the winding of the relay 400, and thence to battery by way of the front contact and armature 431.

The relay 400 is immediately energized to cause its armature 412 to open the circuit of the stepping magnet 411 and its armature 413 to open the circuit of the slow-release relay 405. The slow-release relay 405 is deenergized, thereby opening a point in one circuit for the stepping magnet 411 and also opening the circuit of the slow-to-release relay 401. The relay 401 is also slow to deenergize and, consequently, retracts its armature after an interval of time, thereby opening the circuit of the relay 400 to deenergize the same.

At the dispatcher's office, in accordance with the operation of the repeating relay 408 and the code-sending switch CD—1, the line relay 353 operates to control the stepping magnet 364 to advance the wipers 370 to 373, inclusive, into engagement with the bank contact set which includes the bank contact 333, as previously described. During the interval of time that the slow-release relays 405 and 401 are deenergized, the line relay 353 is maintained energized and, consequently, the relay 351 is deenergized, its circuit being opened at the wiper 372, to complete a circuit for momentarily placing battery upon the wiper 371. However, as there is no lead connected to the bank contact 333 with which the said wiper is in engagement at this time, this operation is without particular function.

Referring now to the operation of the code-sending switch CD—1, the relay 400, upon being deenergized, completes a circuit for the slow-release relay 405. The operation of this relay serves to close a circuit for the stepping magnet 411 and also for the slow-to-release relay 401. The magnet 411 serves to advance the switch wipers into engagement with the next set of bank contacts. The operation of

the code-sending switch CD—1 and the connector switch H—1 continues in the manner described, a pause occurring in the operation of the switches CD—1 and H—1 in accordance with the position of the various circuit breakers, or other apparatus units, that are to be supervised.

When a pause occurs, either the relay 350 or the relay 351 will be de-energized after an interval of time, depending upon whether the pause occurred during an even-numbered pulse or an odd-numbered pulse. Thus, for example, if the pause occurred, as we have here assumed, on an odd-numbered pulse, the switch wiper 372 will complete an energizing circuit for the relay 351, but the relay 350 connected to all the even-numbered contacts of the switch wiper 372 will have no energizing circuit.

After an interval of time, the relay 350 will permit its armature 356 to close its back contact, and a circuit will thereupon be completed for the relay 328 from ground to battery, armature 356 and its back contact, armature 365 and its front contact, the switch wiper 371 at its seventeenth contact, and, through the winding of relay 328, to ground. In a similar manner, if the pauses occur at the eighteenth, nineteenth, and twentieth impulses, the relays 327 to 325, respectively, will be energized. Upon energization, the relay 328 locks itself over its lower armature and armature 348 battery to ground.

When the wipers 435 to 438, inclusive, of the code-sending switch CD are brought into engagement with their twenty-fifth set of bank contacts, the circuit of the relay 407 is opened by the operation of the wiper 435. Also, by the operation of the wiper 437, the circuit of the stepping magnet 411 is opened and, consequently, the rotation of the switch ceases temporarily. The relay 407, upon being de-energized, releases its armature 425, thereby permitting this armature to vibrate for an interval, sending impulses of current to the slow-acting relay 403, during which time this relay is maintained energized, as is the repeating relay 408. By the operation of the wiper 435, a circuit is completed for the relay 406, which operates to open the circuit of the relay 404. This relay deenergizes also to open one point in the circuit of the stepping magnet.

At the dispatcher's office, during this interval of time, the line relay 353 is maintained energized and, as the circuits of the relays 350 and 351 are opened, these relays are deenergized. As a result of this operation, the relay 351 opens the circuit of the slow-acting relay 354, and a circuit is closed for an interval of time extending from battery by way of the armature 375 and its back contact, armature 347 and its front contact, wiper 373, the bank contact 374, to common conductor 336. The armature 337 to 340, inclusive, on the relays 325 to 328, inclusive, are connected to this common conductor. These armatures control either the energization of the relays 300 to 303, inclusive, or the deenergization of these relays, depending upon whether the armatures are attracted or retracted, which, in turn, is controlled by the energized or deenergized condition of the relays 325 to 328, inclusive.

It will be remembered that the operation of the relays 325 to 328, inclusive, is controlled by the pauses in the operation of the connector switch H—1, which, in turn, is controlled by the code-sending switch CD—1 in accordance with the condition of the apparatus units, such as the circuit breakers C, C—1, C—2 and C—3.

Considering the supervisory relay 303, as the relay 328 is in a deenergized condition, a circuit is completed from battery upon the common conductor 336 by way of armature 340 and its back contact, resistor 307 and thence to ground. This circuit serves to shunt the relay 303 which is deenergized to open the circuit of the supervisory lamp 315 and to close the circuit for the supervisory lamp 316. The operation of the armature 323 also opens the locking circuit of the relay 101 associated with the key K. By the deenergization of the relay 101, the operation of the code-sending switch CD ceases. By the change in supervisory signals, the dispatcher is apprised that the circuit breaker C—1 at the substation is now in a closed position. In a like manner, the supervisory signalling devices 308 to 314, inclusive, are changed in accordance with the condition of the apparatus units in the substation with which they are associated and supervised.

Returning now to the operation of the code-sending switch CD—1 at the substation, the operation of the armature 425 ceases after an interval of time, and shortly thereafter, the slow release relay 403 is deenergized. Upon retracting its armatures, the relay 403 actuates its armature 420 to open the circuit of the repeating relay 408 and actuates its armature 419 to open the circuit of the slow-release relay 402.

The slow-release relay 402 is deenergized after an interval of time to operate its armature 417 to open the circuit of the slow-release relay 405 and its armatures 425 and 416 to complete a circuit extending from ground by way of the back contact and the armature 425, through the winding of the stepping magnet 411, the back contact and armature 416, the bank contact with which the wiper 438 is in engagement and the said wiper, and thence to battery by way of the back contact and armature 430.

As the stepping magnet 411 interrupts its own circuit, this magnet operates to advance its switch wipers 435 to 438, inclusive, into their normal position when the stepping mag-

net circuit is opened at the wiper 438. The relay 405 is deenergized shortly thereafter to open the circuit and thus deenergize the slow-to-release relay 401.

Returning now to the operation at the dispatcher's office, the slow-release relay 350 is deenergized at the same time as the relay 351. However, this operation is without particular function at the present time. The slow-acting relay 354 is deenergized shortly after its circuit is opened by the retraction of the armature 360 of the relay 351. The relay 354, upon de-energization, opens at its armature 345 the circuit of the slow-release relay 346. The deenergization of the relay 346 follows after a short interval of time. The operation of this relay serves to open the previously traced circuit for controlling the supervisory relays 300 to 303, inclusive.

When the circuit of the line relay 353 is opened, this relay is deenergized to open the circuit of the slow-release relay 352, which also is deenergized after an interval of time. As a result of the deenergization of the relay 353, the locking circuits of the relays 325 to 328, inclusive, are opened through the armature 348, and through the armature 361 a circuit is completed extending from ground by way of the wiper 370, the bank contact with which the said wiper is in engagement, armature 361 and its back contact, armature 395 and its back contact, and, through the winding of the stepping magnet 364, to battery. As the stepping magnet 364 interrupts its own circuit, it operates to step the wipers 370 to 373, inclusive, to their normal position.

It will be remembered that the energization of the relay 303 causes the stopping of the code-sending operation by opening the circuit of the relay 101. By this provision, in the event that the code sent out by the code-sending switch CD does not get through, by reason of inductive disturbances in the trunk line extending between the substation and the dispatcher's office from nearby high-tension lines, the proper circuit breaker at the substation will not be operated and, consequently, the code-sending operation will reoccur until the desired apparatus unit is successfully operated and the proper answer-back signal, indicative of its changed condition, is received at the dispatcher's office.

It will also be apparent that the circuit arrangement in the code-sending switch CD—1 at the substation is very desirable, inasmuch as the position or condition of each apparatus unit is checked every time an operation is performed at the substation, whether such operation is initiated by automatic, manual or dispatcher's control.

My invention is not limited to the specific arrangement of the apparatus illustrated, but may be variously modified without departing from the spirit and scope of my invention, as set forth in the appended claims.

I claim as my invention:

1. In an electrical control system, the combination with a control office, a substation and apparatus units in said substation, of a selector switch comprising a plurality of selecting contacts and a wiper moving thereon at said office and substation, means for moving the switches at the control office and substation in synchronism, means operative during the movement of said switches for momentarily stopping them at a plurality of positions, means operative during each of said momentary stops to select a particular apparatus unit, and means for thereafter simultaneously operating the selected units.

2. In a signalling system, a first station, a second station, apparatus units at said second station, synchronously operated rotatable selectors comprising contacts and wipers at said first and said second station, means whereby one of said selectors controls the movement of the other selector to each selecting position in synchronism with its own movement, means, including said selectors, for sequentially selecting a plurality of said apparatus units for operation from said first station, and means for operating said selected units simultaneously only if said selectors are in synchronism.

3. In a signalling system, a first station, a second station, apparatus units at said second station, synchronously operated selectors comprising contacts and wipers at said first and said second station, means whereby one of said selectors controls the movement of the other selector to each selecting position in synchronism with its own movement, means, including said selectors, for sequentially selecting a plurality of said apparatus units and means for subsequently operating said selected units simultaneously from said first station only if said selectors are in synchronism.

4. In a signalling system, a first station, a second station, a plurality of apparatus units at said second station, synchronously rotating selecting means for sequentially preparing said units for operation, means whereby one of said selectors controls the movement of the other selector to each selecting position in synchronism with its own movement, means for testing the synchronism of said synchronous selecting means, and means for subsequently operating said selected units simultaneously if said selectors are in synchronism.

5. In a signalling system, a first station, a second station, a plurality of apparatus units at said second station, synchronous selecting means comprising selecting contacts and wipers therefor for sequentially preparing said units for operation, means whereby one of said selectors controls the movement of

the other selector to each selecting position in synchronism with its own movement, means for testing the synchronism of said synchronous selector means, and means for subsequently operating said selected apparatus units simultaneously if said selectors are in synchronism.

In testimony whereof, I have hereunto subscribed my name this 27th day of December, 1923.

JAMES L. McCOY.