

April 28, 1936.

W. H. MATTHIES

2,039,015

TELEPHONE SYSTEM

Filed July 21, 1934

5 Sheets-Sheet 1

FIG. 1	FIG. 3
FIG. 2	FIG. 4
FIG. 5	

FIG. 6.

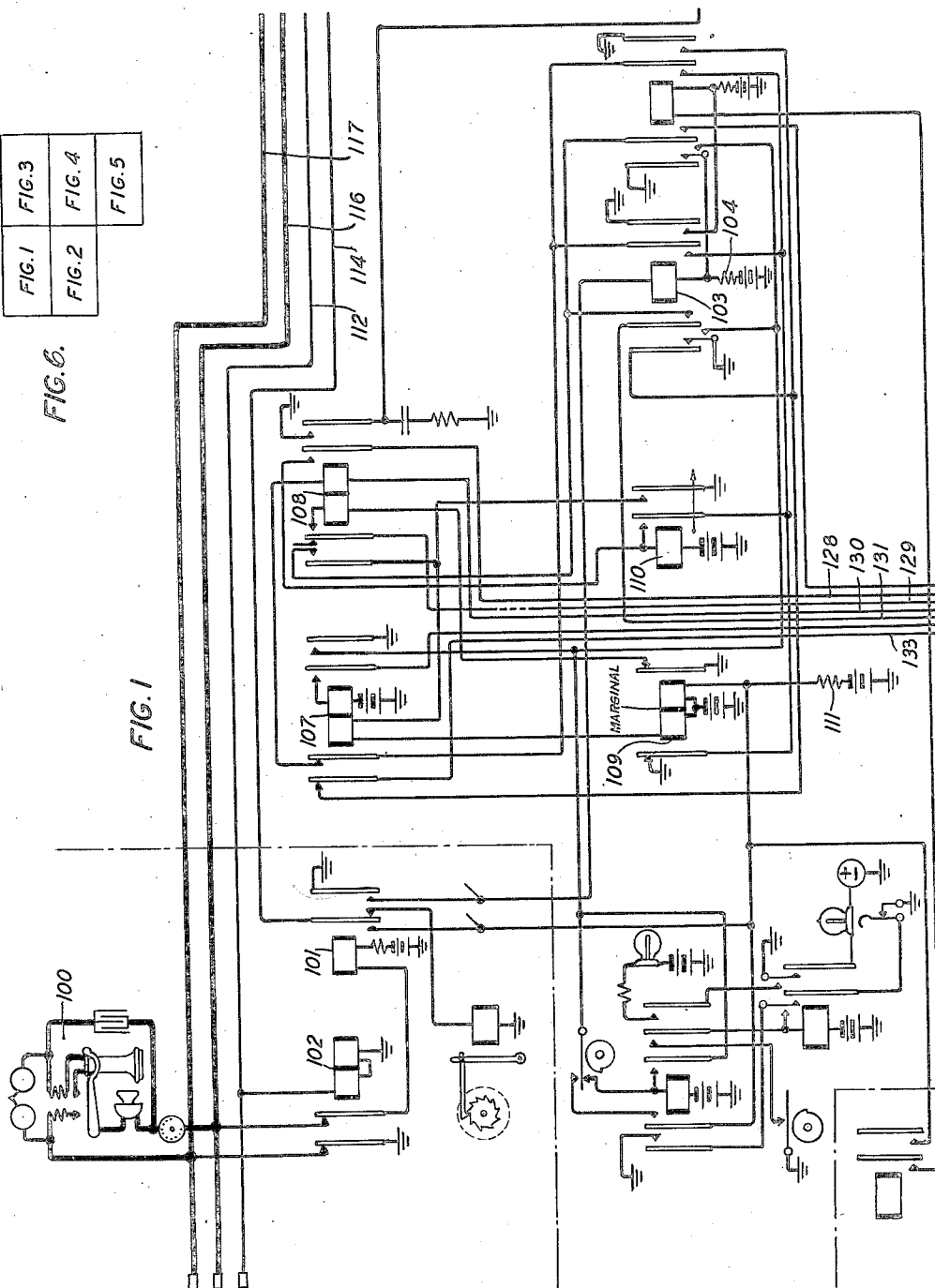


FIG. 1

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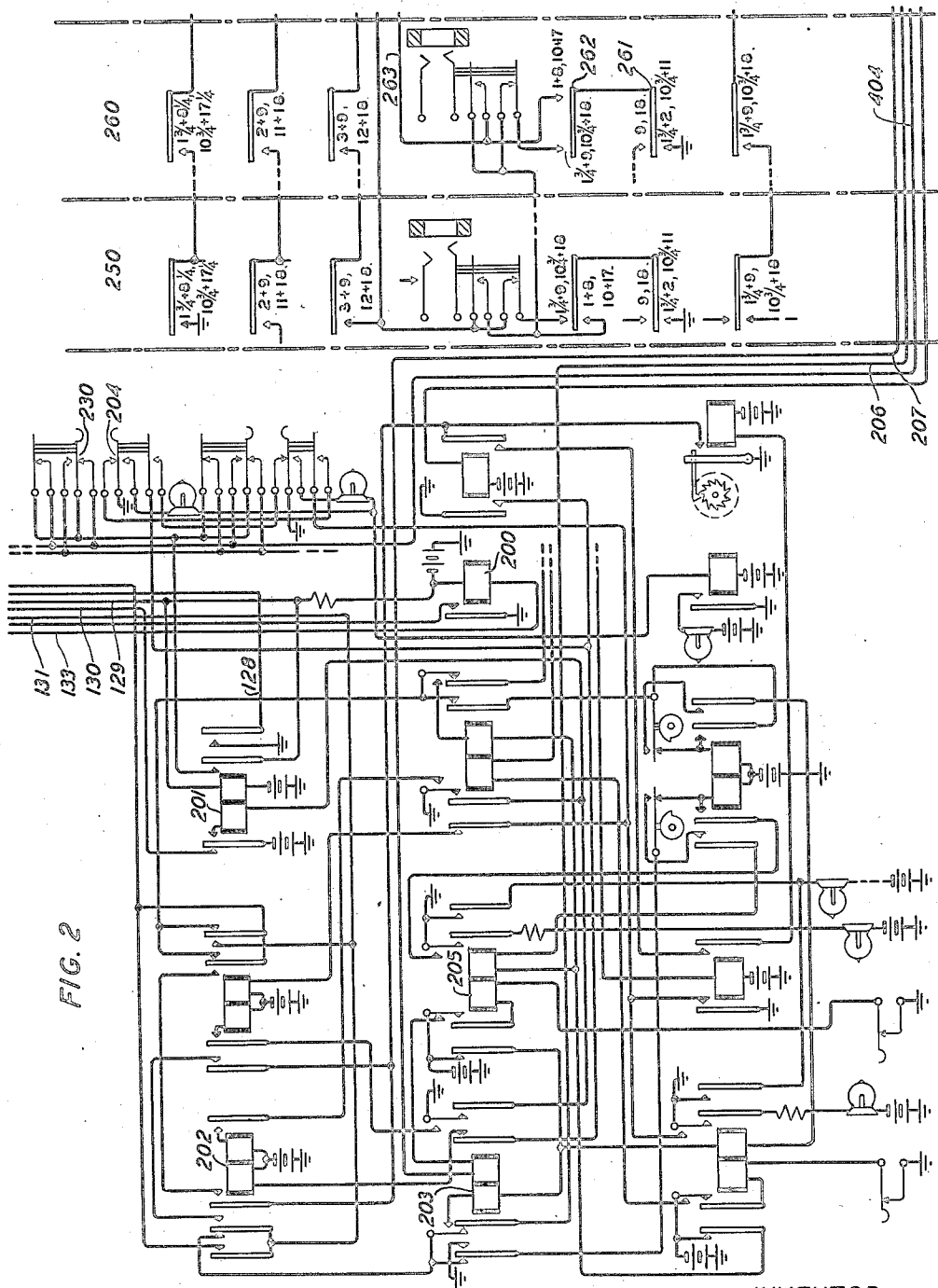
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5 Sheets-Sheet 2



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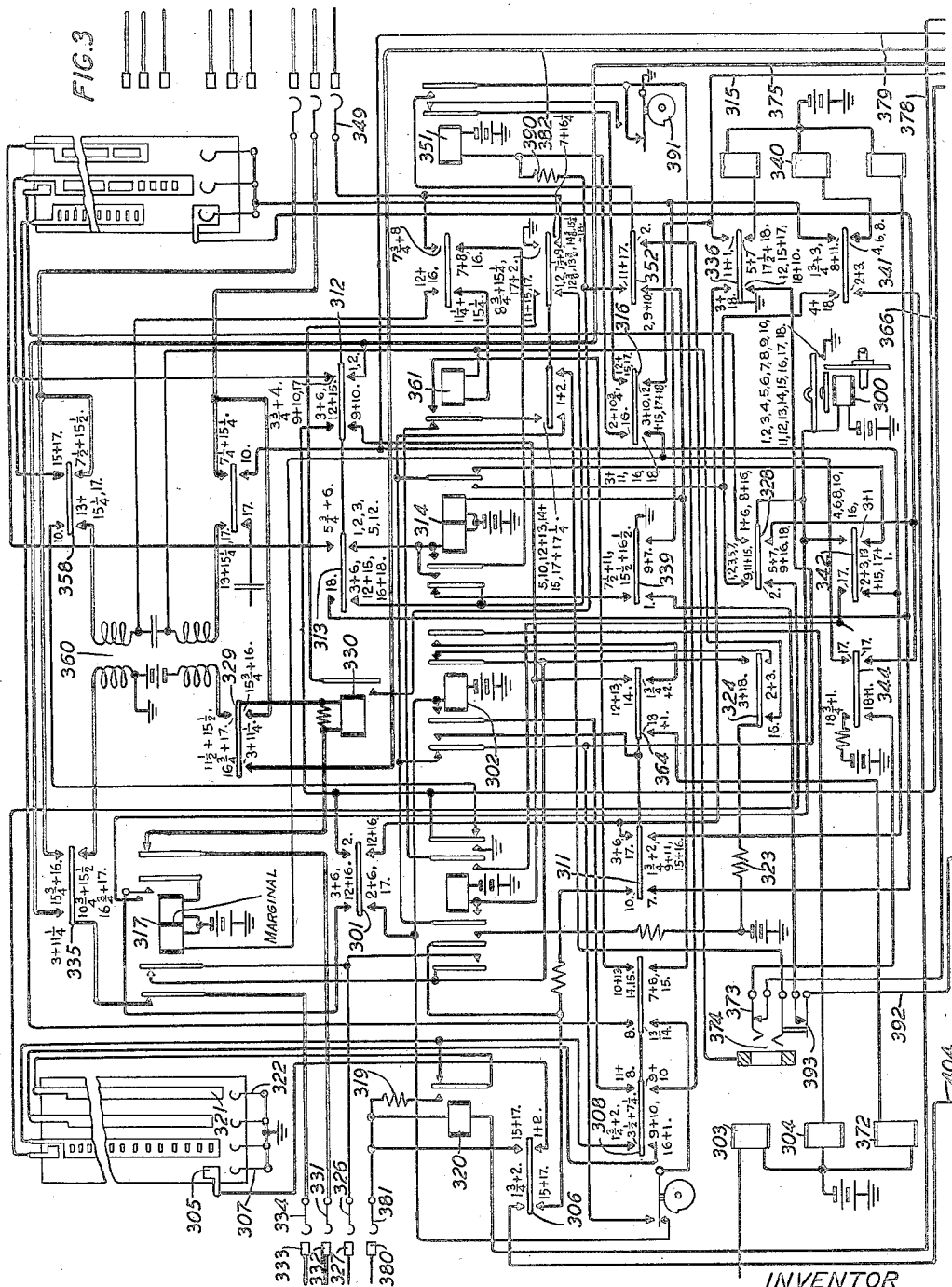
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5 Sheets-Sheet 3



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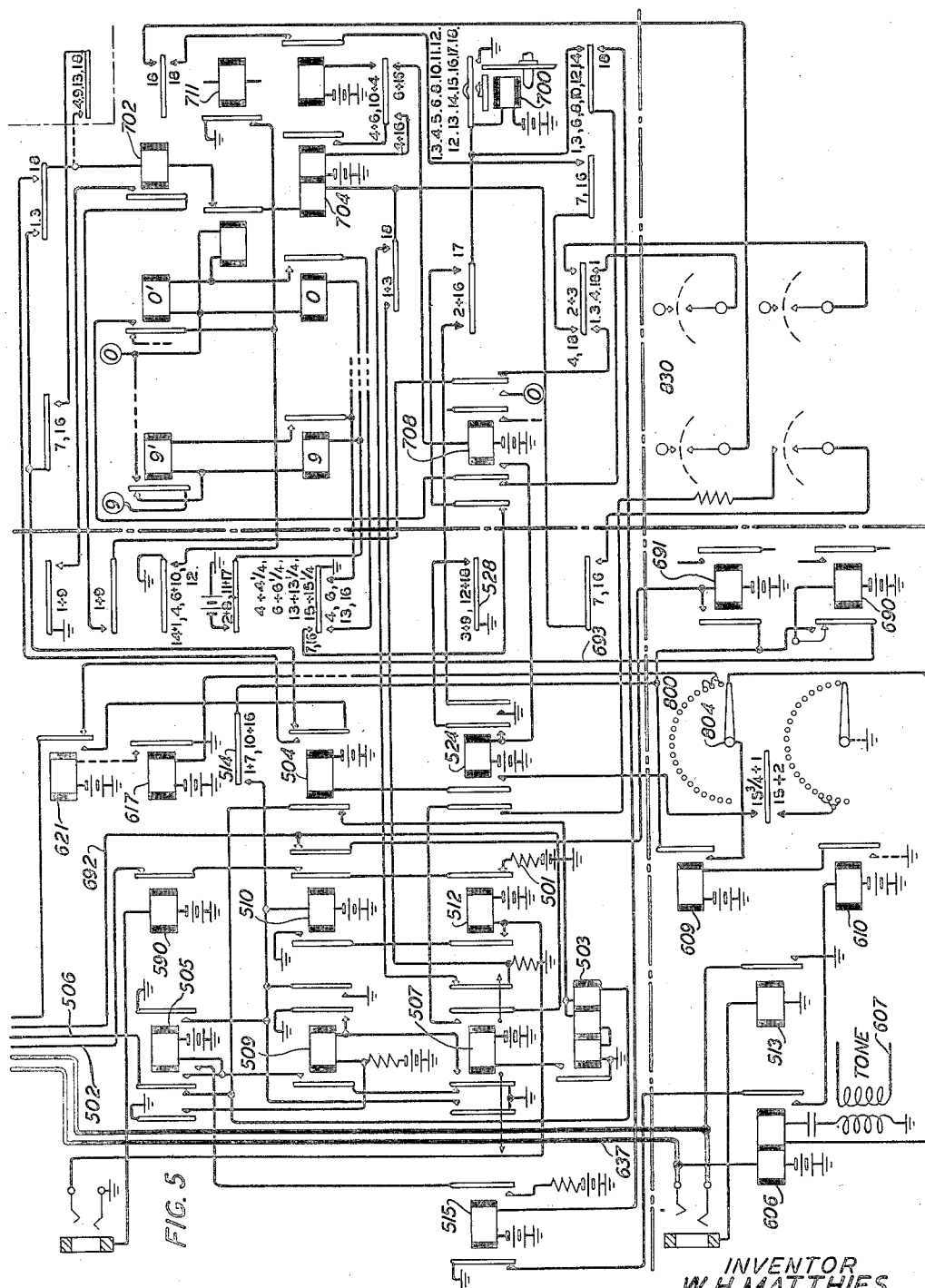
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TELEPHONE SYSTEM

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5 Sheets-Sheet 5



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2,039,015

TELEPHONE SYSTEM

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Application July 21, 1934, Serial No. 736,287

9 Claims. (Cl. 179—18)

This invention relates to automatic switches for use in telephone exchange systems and more particularly to switches of the multiple brush type.

5 One of the objects of the invention is to provide a switch capable of hunting in either direction, that is, of traversing over one bank of terminals in search of a free line or set of terminals when moving in one direction and of
10 traversing over another bank of terminals in search of a free line or set of terminals when traveling in the opposite direction to return to its normal position.

15 Another object of the invention is to provide a switch having a magnetically controlled escapement device to guide the downward movement of the selector, the magnets of which are used at the same time, to test the terminals being traversed by the moving brushes of the selector.

20 In selector switches, especially of the well known panel type, the selection of a terminal-set is usually made when the switch moves in the upward direction only, during which the brushes engage a row of terminals. Particularly, in well
25 known automatic telephone systems involving the use of panel switches as sender selectors, it has been the practice to cause a switch to hunt over a bank of terminals until the top of the bank is reached whereupon the switch is returned to normal and the hunting operation is
30 repeated. This obviously involves a loss of time in connecting a register sender to a calling line besides necessitating the use of more switches than would be required if a switch were capable
35 of hunting in both directions.

In the present invention, it is proposed to avoid this loss of time by causing the switch to hunt when it is returning to normal and to do it by
40 controlling the downward movement of the selector by an escapement device which is controlled by two cooperating magnets that cause the switch to descend one step at a time, each of said magnets testing the alternate terminal-sets engaged
45 by the brushes.

In accordance with the present invention, therefore, one specific embodiment of which is herein described by way of illustration, this is accomplished in the following improved manner: The
50 upward hunting of the selector is controlled in the usual way, that is, by an up-drive magnet under the control of a terminal testing relay. When the last terminal-set of the bank is reached and the selector cannot be connected thereto,
55 circuits are closed whereby the selector is switched

to the brush-set having access to the terminals of another bank and the test of the alternate terminal-sets therein is transferred to the winding of each of the two magnets which control the escapement device, the winding of one magnet being
5 used to test the odd terminal-sets and the winding of the other magnet being used to test the even terminal-sets. The selector, under the control of the escapement, is then caused to descend one terminal-set at a time during which one of
10 the magnets tests for the free condition of the terminal-set to which the brushes of the selector are then connected. If the terminal-set tests busy, the magnet is energized, the escapement device is operated and the selector is caused to
15 descend a step whereupon the other of the two magnets is connected to the succeeding terminal-set for a test thereof. Should the selector reach its normal position without contacting with an idle set of terminals, the selector is again switched
20 to the brush-set having access to the terminal-sets of the first bank, the escapement test circuit is disconnected, and the usual up-drive circuit is reestablished for the upward movement; the test
25 of the terminal-sets in the one bank on the upward movement and the test of those on the second bank on the downward movement of the selector continuing until a free line or set of terminals is found.

A clearer conception of the scope and purpose
30 of the invention will be obtained from a consideration of the following description in connection with the attached drawings in which:

Fig. 1 shows a calling subscriber's line together
35 with certain relays for preventing interference between calling lines;

Fig. 2 shows a start circuit and a portion of two link circuits;

Fig. 3 shows a line finder and district selector;

Fig. 4 shows a link circuit for associating the
40 sender with the district selector;

Fig. 5 shows a portion of the register sender; and

Fig. 6 shows the manner in which Fig. 5 should
45 be arranged.

The invention has been embodied in a disclosure which is substantially like that of U. S. Patent 1,567,072 to W. H. Matthies, granted December 29, 1925. Both the present disclosure and
50 that of the Matthies patent show a skeletonized sender in which the numbers employed are, for the most part, the same as those in the more complete disclosure of U. S. Patent 1,589,402, granted to O. H. Koop, June 22, 1926, and refer-
55

ence to the Kopp patent is made for operations not completely described herein.

As in the case of the above mentioned patents, a plurality of link circuits is arranged to serve a group of calling lines and are taken into service in rotation. When a link circuit completes its function, it hunts for and associates itself with a district selector which is ready for use and the link and district remain in a sub-allotted condition until the next link in the series has been put into service. The link circuit is then put into an allotted condition from which it will be advanced by the initiation of a call and the action of the start circuit of Fig. 2. The trip circuit of Fig. 1 and start circuit of Fig. 2 are so arranged that only one line may be served at a time in order that there may be cooperation between two groups of lines to each of which a group of link circuits is individual. The details of these functions are described in the above mentioned Matthies patent and, since they form no part of the present invention, will be omitted from the following description except insofar as they are necessary to an understanding of the present invention.

Assuming that the subscriber at substation 100 is one entitled to establish connections only within a limited area, the link circuit of Fig. 4 is arranged to indicate this fact to the sender in the manner to be described hereinafter. When the subscriber at substation 100 removes his receiver from the switch-hook, a circuit is closed which extends from battery through the winding of the relay 101, inner back contact of relay 102, over the subscriber's line, to ground at the outer contact of relay 102. Relay 101, in operating, closes a circuit from battery through resistance 104, winding of relay 103, to ground at the outer front contact of relay 101. It also prepares a partial circuit path from battery through resistance 111 and the right winding of relay 109 in parallel, inner front contact of relay 101 to conductor 114 from which it is completed when the line finder connects with the terminals of the calling line. Relay 103, in operating, closes a circuit from battery over the back contact of relay 201, conductor 130, right winding of relay 108, inner back contact of relay 107, inner right contact of relay 103, to ground at the left contact of relay 109.

Relay 108 operates in this circuit and closes a locking circuit for itself which extends from battery through the right winding of relay 201, conductor 129, over back contacts of relays similar to relay 108 individual to other groups of lines appearing before the same line finder, inner left front contact and left winding of relay 108, to ground at the right back contact of relay 109. Relay 108 closes a circuit from ground at its outer right front contact through the winding of trip magnet 303 of the line finder to battery in preparation for tripping the proper set of brushes when the line finder is operated. Relay 201 operates in the locking circuit of relay 108 and, in combination therewith, closes a circuit from ground over its outer right contact, conductor 128, inner right contact of relay 108, winding of relay 110 operates and then to battery. Relay 110 locks over its inner right contact to ground at the left back contact of relay 109. Relay 110 closes a circuit for starting the allotted line finder. Assuming that the link and line finder shown are the ones to be used next, sequence switch 400 will be standing in position 1 and sequence switch 300 in position 2. The operation of relay 110 will, therefore, close a circuit from ground at its outer right contact, outer left front contact of relay 108,

inner left front contact of relay 103, conductor 131, left back contact of relay 202, inner left back contact of relay 203, conductor 206, upper left and lower right contacts of cam 403, brush 402 and terminal 401, conductor 378, upper right and lower left contacts of cam 301, winding of relay 302 to battery.

Relay 302, in operating, closes a circuit from battery through the winding of up-drive magnet 304 of the line finder, right front contact of relay 302, lower right contact of cam 364, outer left front contact of relay 302, to ground at the lower left contact of cam 336. The line finder moves upward under the control of magnet 304 and, since trip magnet 303 is operated, the proper set of brushes is tripped. As soon as the line finder moves upward, a locking circuit is provided for relay 302 extending over its inner left front contact, upper contacts of cam 368, right back contact of relay 320, commutator strip 321, brush 322 to ground, which holds relay 302 operated independent of the trip circuit. As soon as commutator brush 307 engages segment 305, a circuit is closed from ground over brush 307 and segment 305, lower right and upper left contacts of cam 305, conductor 404, contact 230 of key 204, inner right front contact of relay 201 to conductor 129 and the right winding of relay 201. This circuit shunts the winding of relay 108 and causes said relay to release, in turn releasing the trip magnet 303. When brush 307 leaves segment 305, the circuit of relay 201 is opened and said relay also releases, freeing the start circuit. When line finder brush 331 makes contact with terminal 380, which is connected to conductor 114 and therefore to battery, a circuit is completed from this battery through the winding of relay 320, lower left and upper right contacts of cam 341, to ground at the lower right contact of cam 320. Relay 320 operates in this circuit and closes a shunt around its winding through resistance 319, to ground over commutator strip 321 and brush 322. This reduces the resistance in series with the winding of marginal relay 109 sufficiently to cause that relay to operate and open the locking circuit of relay 110, which, in turn, opens the energizing circuit of relay 302. The operation of relay 320 also opens the locking circuit of relay 302, causing that relay to release. The release of relay 302 closes a circuit from ground through the winding of cut-off relay 102, conductor 112, terminal 327, brush 326, inner left back contact of relay 317, right back contact of relay 302, lower right contact of cam 324, resistance 323 to battery. The operation of cut-off relay 102 opens the circuit of line relay 101, removes battery from conductor 114, and releases relays 109 and 320.

At the time relay 302 operated, it closed a circuit from ground at the lower left contact of cam 336, outer left front contact of relay 302, lower right contact of cam 311, conductor 379, terminal 407 and brush 406 of the link district finder 410, lower right contact of cam 408, winding of relay 409, resistance 411 to battery. Relay 409 operates and closes a circuit from battery through the winding of sequence switch magnet 400, lower contact of cam 412, to ground at the outer left contact of relay 409, advancing the link sequence switch 400 to position 2. When sequence switch 400 leaves position 1, relay 409 is released. In position 2, a circuit is closed from battery through the winding of relay 413, right lower and left upper contacts of cam 414, left back contact of relay 415, to ground at the lower left contact

of cam 416. Relay 413 operates, closing a circuit from battery through the right winding of relay 417, left outer front contact of relay 413, to ground at the right back contact of relay 415. Relay 417, in operating, closes a circuit from battery through the winding of up-drive magnet 418 of the sender finder 420, bottom contact of cam 419, outer right contact of relay 417, to ground at the left back contact of relay 409. The sender finder moves upward under the control of magnet 418 in search of an idle sender in the group of senders which terminate in the upper bank accessible to the upper set of brushes connected through the back contacts of relay 448, which is normal at this time.

It will be observed that the teeth of the sprocket wheel 471 engage with the slots of the elevator rack 485. This wheel is carried on a shaft 486 which also carries pawl 487 and the internal ratchet wheel 488 with which said pawl cooperates. The shaft is free to turn in sleeve 489 of member 490, which in turn, extends and is rigidly attached to the hub of escapement wheel 473 but is not so shown in order to more clearly disclose other parts of the escapement device 480. When, therefore, the elevator moves upwards as the result of the operation of magnet 418, sprocket wheel 471 turns in a counter-clockwise direction and at the same time causes the internal pawl 487 likewise to pass over the teeth of the internal ratchet wheel 488 without effect. Inasmuch as shaft 486 is free to turn in shaft 490 then, as the elevator moves upwards, shaft 490 remains stationary and escapement wheel 473 is uninfluenced.

Relay 413 further closes a circuit from battery through the middle winding of relay 415, right contacts of cam 421, right winding of relay 415, to ground at the right contact of relay 413. The current in this circuit, however, is not sufficient to operate relay 415 but does create a flux in the windings of this relay so that it becomes quick to operate when the test circuit is closed. The test circuit extends from brush 422 over the No. 4 back contacts of relay 448, left contacts of cam 419, right back contact of relay 409, left winding of relay 415, upper contacts of cam 421, right winding of relay 415, to ground at the right contact of relay 413, and in parallel therewith through the right lower contact of cam 421, middle winding of relay 415 to battery.

An idle sender is characterized by battery through a resistance connected to conductor 502. When, therefore, brush 422 engages terminal 423, corresponding to the sender of Fig. 5, which is assumed to be idle, the test circuit above traced is completed from battery over resistance 501, right back contact of relay 512, right inner contacts of relay 510, contacts of relay 590, conductor 502, brush 422 and thence as previously traced through the left winding of relay 415 to ground. Relay 415 operates quickly and closes a locking circuit for itself from battery through its middle winding, right contacts of cam 421, to ground on the right front contact of relay 415. It also opens the circuit of relay 417 which releases, in turn, releasing magnet 418 and bringing the sender finder to rest on the terminals of the idle sender, at which time pawl 481 has entered a slot in rack 485 and holds the elevator in the selected position. The release of relay 417 further causes the release of relay 413. With relay 413 released and relay 415 operated, a circuit is closed from battery through the winding of sequence switch magnet 400, lower left contact of cam 476, left back con-

tact of relay 413, left front contact of relay 415, to ground at the lower left contact of cam 416, advancing sequence switch 400 to position 3.

If the sender assumed to be idle is not in fact idle but busy and all the other senders which terminate in the upper bank of sender finder 420 are also busy, the up-drive magnet 418 continues to drive the brushes of the finder up above the last terminals of the bank at which time brush 463 engages commutator segment 449 whereupon a circuit is completed from ground on brush 463, segment 449, left contact of cam 408, winding of relay 409, resistance 411, to battery. Relay 409 operates, opens the circuit of up-drive magnet 418, closes a circuit for relay 448 extending from ground through the left outer front contacts of relay 409, left contact of cam 412, lower winding of relay 448 to battery and further closes a parallel circuit to magnet 454 which operates to disengage pawl 481 from the elevator rack and to leave the elevator in a position to descend of its own weight. Relay 448 operates and transfers the link conductors from the brushes cooperating with the upper bank of terminals to the brushes cooperating with the lower bank except that the test conductor to brush 422 is now opened while another test circuit is completed to brush 459 of the lower brush-set by way of the lower contact of relay 448, contact of cam 460, contacts 482 or 483 carried by the oscillating member 468 of escapement shaft 484 to the winding of either escapement magnet 465 or escapement magnet 466 depending on the position of oscillating member 468 as more completely described hereinafter.

At the time the brush shaft reached a position above the last set of terminals on the upper bank, the operation of magnet 454 left the elevator free to move of its own weight as already described. At this time relay 448 is also operated and the link is transferred from the upper set of brushes to the lower so that as the elevator prepares to move downward, the brush shaft is ready to test the several senders in the lower bank and connect with any idle sender. The weight of the brush shaft, in its descent, influences sprocket wheel 471 to turn in a clockwise direction, but pawl 487, being engaged with a tooth of the internal ratchet wheel 488 cannot move in the same direction unless it moves shaft 490 with it and hence escapement wheel 473. As the escapement wheel revolves through one step, it cams the right member of escapement lock 472 which, in tilting to the right, turns shaft 484 and member 468 to cause the engagement of contact-set 482. At this time the elevator will have descended one notch to position the lower brush-set on the uppermost set of terminals of the lower bank.

With relay 448 operated and the lower set of brushes resting on the top set of terminals of the lower bank, a test is now made of the sender connected to this set of terminals. If the sender is busy, terminal 470 is either open or connected to ground, in which event the path from ground through winding of the escapement magnet 465, contacts 482, contacts of cam 460, bottom contact of relay 448, brush 459, terminal 470 is without battery potential and magnet 465, therefore, will not operate and the escapement wheel 473 is therefore free to rotate further. Said escapement wheel, in rotating a further step as the elevator drops another notch, will now cam the left member of escapement lock 472, thus tilting the lock to the left and rotating shaft 484 and member 468 to the right. Member 468 now opens

its left set of contacts 482 and closes its right set 483 whereupon the winding of escapement magnet 466 is connected to test brush 459 which is now in engagement with a test terminal, corresponding to terminal 470, of the next set of terminals. If the sender connected to these terminals is busy, magnet 466 will not operate, the elevator shaft will descend another notch and, through the motion of the escapement lock 472, will operate the oscillating member to the left, whereupon magnet 466 is disconnected and magnet 465 is connected to the test circuit. At this time the brushes will have descended into contact with the next set of terminals. This operation continues until either the brush shaft has descended to the lowest set of terminals in the bank, if all the senders are busy, or until an idle sender is reached having battery through resistance 501 available on its test terminal. In the latter event either magnet 465 or magnet 466 operates over the path previously traced to terminal 470, whereupon the operated escapement magnet attracts the detent 472 and locks escapement wheel 473 to prevent further descent of the elevator shaft. At the same time, the operated magnet 465 or 466 connects ground to the left lower contact of cam 476 completing the circuit of magnet 490 and advancing sequence switch 400 to position 3. When the switch reaches position $2\frac{1}{4}$ magnet 454 is released whereupon pawl 481 enters the slot of the elevator rack opposite to which it is positioned and holds said elevator in a position of rest with the brushes connected to the terminals of the selected sender. As the switch advances to position $2\frac{1}{2}$ a locking circuit is provided for relay 448 extending from battery over its upper winding and "O" contact to ground on cam 469. With relay 448 thus locked, the selected sender terminating in the lower bank is connected through the front contacts of said relay to the selectors which are to be operated thereby as more completely described hereinafter in a connection between a sender terminating in the upper bank and said selectors, the operations in either case being the same except that, in the case of a sender terminating in the upper bank, the operations take place over the back contacts of relay 448 while in the case of a sender terminating in the lower bank they take place over the front contacts of said relay.

Further, when the switch has advanced beyond position $2\frac{1}{4}$ and the sender has advanced in response thereto the circuit of the operated escapement magnet is opened, causing it to release which, in turn, restores the escapement shaft to a neutral position.

In the event that no idle sender is found in the lower bank then, when the elevator has reached the position where brush 463 makes contact with commutator segment 406, ground is connected to resistance 411 over the left lower contact of cam 456, causing relay 409 to release and thereby release relay 448 which now connects the upper set of brushes to the circuit for testing the senders in the upper bank. The release of relay 409 further opens the circuit of magnet 454 which upon releasing causes pawl 481 to engage the top slot of elevator rack 485.

The circuit of the up-drive magnet 418 is now again reclosed and the shaft is moved upward over the terminals of the upper bank in search of an idle sender; the operation of hunting over the upper bank on the upward movement and over the lower bank on the downward movement

continuing until an idle sender is found on either bank, or the subscriber disconnects.

When, after an idle sender is found, sequence switch 400 reaches position $2\frac{3}{4}$, the following circuits are closed for informing the sender that the calling line is entitled to only restricted service. One circuit extends from ground, upper right and lower left contacts of cam 405, No. 2 armature of relay 448 and back contact thereof if the idle sender terminates in the upper bank, brush 438, terminal 439, conductor 692, outer right contact of relay 510, winding of relay 691 to battery. The other circuit extends from ground over the right lower and left upper contacts of cam 435, No. 1 back contact of relay 448, brush 436, terminal 437, back contact of relay 621, conductor 693, normal contacts and winding of relay 690 to battery. Relays 691 and 690 operate in these circuits. These relays then prepare circuits which are effective if the subscriber dials the code of a restricted area to route the call to an operator's position.

When sequence switch 400 reaches position 3, a circuit is closed from ground through the left and middle windings of relay 503, left back contacts of relays 504 and 505, conductor 506, terminal 430, brush 431, No. 3 back contact of relay 448, right upper contact of cam 434, brush 432 and terminal 433, conductor 315, lower contacts of cam 316 (assuming that the district selector has been advanced to position 3 as above described), through the left winding of relay 317 to battery and, in parallel therewith, over the upper left contact of cam 316, through the winding of relay 351 to battery. Relay 317 is marginal and does not operate; relay 351 operates but is ineffective at this time. Relay 503 also operates and closes an obvious circuit for relay 507 which, in turn, closes a circuit for relay 509. Relay 509 closes a circuit for relay 510. With relays 507 and 509 operated, locking ground is provided over the lower contact of cam 514 to relays 690 and 691. Relay 510, in operating, opens the energizing circuit of relay 691, and relay 690 opens its own energizing circuit so that the discriminating condition exists only temporarily.

As soon as sequence switch 400 arrived in position $2\frac{3}{4}$, it prepared the pulsing circuit for receiving dial pulses. This circuit may be traced from battery through the left winding of relay 606, conductor 637, terminal 440, brush 441, No. 5 contact of relay 448, lower left contact of cam 429, brush 478, terminal 477, conductor 375, left contact of cam 335, outer left back contact of relay 317, brush 334, terminal 333, conductor 117 through the subscriber's substation, conductor 116, terminal 332, brush 331, right back contact of relay 317, winding of relay 330, left contact of cam 329, conductor 382, terminal 442, brush 443, upper right and lower left contacts of cam 403, No. 5 back contact of relay 448, brush 444 and terminal 445, to ground at the back contact of relay 513. Relay 606 operates, in turn, operating relay 610 in the well known manner, relay 610 operating relay 609. A circuit is thereupon closed from the source of tone 607 through the right winding of relay 606, timing switch 804 in its normal position, front contact of relay 609, lower contact of cam 514, to ground at the front contact of relay 509. This tone is transmitted to the calling subscriber to inform him that the sender is ready to receive impulses which he may then send out by manipulating his dial.

When relay 510 operated, it removed battery from conductor 502, releasing relay 415 if

the sender selected terminates, as assumed, on the upper bank. With relay 415 released, a circuit is closed from battery through the winding of sequence switch magnet 400, lower right contact of cam 476, left back contact of relay 415, to ground at the lower left contact of cam 416. Sequence switch 400 advances to position 5 over this circuit and remains in this position throughout the further operation of the sender.

10 Assuming that the calling subscriber registers a number in an office to which he is allowed to have access, relays 690 and 691 will be ineffective and the call will be completed in the manner described in the above identified patent to O. H. 15 Kopp. When the connection has been set up to the called subscriber's line, reverse battery from the incoming selector operates relays 702 and 704 in the usual manner. These relays in turn cause the operation of relay 708 and relays 524 and 20 504. With these relays operated, the sender is then advanced to the position for making talking selection. The district selector sequence switch is advanced to position 10 in the manner described in the above identified patent. Relay 25 351 is operated in parallel with the winding of relay 317 throughout selections. The operation of relay 504, above mentioned, opens a shunt around the right winding of relay 503 including that winding in the circuit of relays 351 and 317. 30 Relay 351 thereupon releases, advancing the district selector to position 11 in which position ground is connected over the upper right contact of cam 336 to conductor 315, which is extended over terminal 433, brush 432, right upper and 35 left lower contacts of cam 446, left winding of relay 415, right back contact of relay 409, lower contact of cam 434, No. 3 back contact of relay 448, brush 431, terminal 430, conductor 506, left back contact of relay 505 to the windings of relay 40 503. Since these are also connected to ground, relay 503 now releases, in turn releasing relay 507. The release of relay 507 does not release relay 509 since this relay is locked to its own front contact. A circuit is therefore closed from 45 ground over the back contact of relay 507, left front contact of relay 509, to the winding of relay 505 which locks over its middle left front contact to conductor 506 and to ground as above traced.

After talking selections are completed, relay 50 515 operates, connecting battery to conductor 506 in parallel with the winding of relay 505. The current in this circuit is now sufficient to operate relay 415 which closes a circuit from battery through the right winding of relay 417, left lower and right upper contacts of cam 421, to ground 55 at the right front contact of relay 415. Relay 417 operates and closes a circuit from battery through the winding of sequence switch magnet 400, left upper contact of cam 479, outer right front contact of relay 417, left back contact of relay 409 to ground, advancing sequence switch 400 to position 6. In this position, all of the conductors extending into the sender are opened and the sender is completely released. As soon as sequence switch 400 leaves position 5, relay 415 60 releases and in turn releases relay 417. In position 6 a circuit is closed for switch magnet 400 extending from ground on the left lower contact of cam 416, left back contacts of relay 417, right upper contact of cam 476, winding of magnet 400 to battery. Magnet 400 operates and advances the switch to position 7.

When sequence switch 400 reaches position 7, the link circuit is ready to associate itself with 75 another district. If another district is standing

in position 1 waiting association with a link, a circuit will be closed from ground over the lower left contact of cam 339 of that district, contact 393 of jack 374, conductor 392, upper contact of cam 416, left back contact of relay 415, left upper and right lower contacts of cam 414, winding of relay 413 to battery. Relay 413 closes a circuit from battery through the right winding of relay 417, left outer front contact of relay 413, to ground at the right back contact of relay 415. 10 Relay 417, in operating, closes a circuit for up-drive magnet 447 of the district finder 410, upper right contact of cam 479, outer right front contact of relay 417, left back contact of relay 409, to ground. The district finder moves upward under control of magnet 447 in search of the district which is awaiting a link. Such a district is identified by battery connected over the left contacts of cam 344 of that district, contact 373 of jack 374, to conductor 366. Relay 413, in operating, closes the same circuit through the right and middle windings of relay 415 as it closed in position 2. At this time the test circuit extends from ground at the right front contact of relay 413, through the right winding of relay 415, upper contacts of cam 421, left winding of relay 415, right back contact of relay 409, lower left and upper right contacts of cam 419 to brush 451. 25

If the district for which the district finder is hunting does not lie between the last position occupied by the finder and the top of its bank, it will continue to move upward until brush 453 engages segment 452, thereby completing a circuit from ground segment 452, over the upper right contact of cam 408, winding of relay 409, resistance 411 to battery. The operation of relay 409 opens the test circuit, opens the circuit of up-drive magnet 447 and closes a circuit from battery through the winding of down-drive magnet 454, upper right contact of cam 412, left front contact of relay 409 to ground. The district finder is restored to its lowermost position under the control of magnet 454, at which time a circuit is closed from ground over brush 453, bottom segment 455 of the district finder commutator, lower right contact of cam 456 to resistance 411, shunting and releasing relay 409 which restores the test circuit and the circuit of up-drive magnet 447. When brush 451 encounters terminal 450 to which conductor 366 extends, the test circuit is completed and relay 415 operates quickly as in the previous case. Relay 415 locks through its middle winding, the right contacts of cam 421, to ground at its right front contact, opening the circuit of relay 417 to release magnet 447 and bring the district finder to rest on the terminals of the district. With relay 415 operated and relay 417 released, a circuit is closed from battery through the winding of sequence switch magnet 400, lower left contact of cam 476, back contact of relay 413, left front contact of relay 415, upper left contact of cam 416, to ground on conductor 392. Sequence switch 400 advances to position 8 in this circuit. 45

Relay 415 is held operated in position 8 from battery in the district over terminal 450, brush 451, upper right and lower left contacts of cam 419, back contact of relay 409, left winding of relay 415, upper contacts of cam 421, to ground at the right front contact of relay 415. With relay 415 operated, a circuit is closed from ground at the lower left contact of cam 416, left front contact of relay 415, lower right contact of cam 429, brush 478, terminal 477, conductor 375, lower right contact of cam 312, lower right contact of 75

cam 313, left winding of relay 314 to battery. Relay 314 closes a circuit from battery through the winding of sequence switch 300, upper left contact of cam 328, right front contact of relay 314, left back contact of relay 302, to ground at the lower left contact of cam 336. Sequence switch 300 advances to position 2 in this circuit, releasing relay 314. The advance to position 2 removes ground from conductor 392 and battery from conductor 366. The removal of battery from conductor 366 opens the circuit of relay 415 and that relay releases, closing a circuit from battery through the winding of sequence switch magnet 400, lower right contact of cam 476, left back contact of relay 415, to ground at the lower left contact of cam 416. Sequence switch 400 advances to position 9.

The link circuit remains in this position until the link circuit standing next to it in the series is advanced from position 1 for the purpose of selecting a sender. Link circuit 260 occupying that relationship to the link circuit of Fig. 4, a circuit may be traced from ground over the lower contact of cam 261, upper right contact of cam 262, conductor 263, upper right contacts of cams 461 and 462, winding of sequence switch magnet 400 to battery, advancing the link circuit to position 10 which is the equivalent of position 1, so that the link circuit is ready to operate in response to the next call in the group of lines served thereby.

Inasmuch as the present invention is not concerned with the specific operation of the district selector of Fig. 3, or the operation of selectors to further extend the calling line and the functioning of the sender to control selections no detailed description thereof has been given herein. The selector circuits employed in the establishment of the talking connection are released following the termination of the conversation in the manner fully set forth in the patents hereinbefore referred to.

What is claimed is:

1. In an automatic switch, a movable shaft, brushes carried by said shaft, a plurality of stationary terminal-sets arranged for engagement by said brushes, a first and second magnet for testing alternate terminal-sets, respectively, and a compound escapement controlled by said magnets for limiting the downward movement of said shaft when either of said magnets operates in response to the busy condition of the terminal-set being tested.

2. In a selector switch, a movable shaft, brushes carried by said shaft, a plurality of stationary terminal-sets arranged for engagement by said brushes, a first and second magnet for testing odd and even stationary terminal-sets, respectively, and a compound escapement controlled by said magnets to limit the selective movement of said shaft in accordance with the busy or idle condition of the terminal-set being tested.

3. In an automatic switch, a shaft movable by gravity, brushes carried by said shaft, a plurality of stationary terminal-sets arranged for engagement by said brushes, an escapement operable by the movement of said shaft and a test magnet for testing for the busy or idle condition of terminal-sets, said magnet being operable upon the engagement of said brushes with an idle set of terminals to lock said escapement thereby arresting the movement of said shaft with said

brushes in engagement with the idle set of terminals.

4. In an automatic switch, a shaft movable by gravity, brushes carried by said shaft, a plurality of stationary terminal-sets arranged for engagement by said brushes, an escapement operable by the movement of said shaft and two test magnets for testing for the busy or idle condition of alternate terminal-sets respectively, either of said magnets being operable upon the engagement of said brushes with an idle set of terminals to lock said escapement thereby arresting the movement of said shaft with said brushes in engagement with the idle set of terminals.

5. In an automatic switch, a shaft movable by gravity, brushes carried by said shaft, a plurality of stationary terminal-sets arranged for engagement by said brushes, an escapement operable by the movement of said shaft, two test magnets for testing for the busy or idle condition of alternate terminal-sets respectively, and means controlled by said escapement for alternately rendering said magnets operable, either of said magnets being operable upon the engagement of said brushes with an idle set of terminals to lock said escapement thereby arresting the movement of said shaft with said brushes in engagement with the idle set of terminals.

6. In an automatic switch, a shaft movable by gravity, brushes carried by said shaft, a plurality of stationary terminal-sets arranged for engagement by said brushes, an escapement wheel operable by the movement of said shaft, an oscillatory escapement lock operable by said wheel, two test magnets for testing for the busy or idle condition of alternate terminal-sets respectively, said magnets being respectively associated with the opposite ends of said escapement lock, and contacts controlled by said escapement lock to alternately render said magnets operable, either of said magnets being operable upon the engagement of said brushes with an idle set of terminals to lock said escapement lock against oscillation thereby arresting the movement of said shaft with said brushes in engagement with the idle set of terminals.

7. In an automatic switch provided with movable brushes and a plurality of stationary terminal-sets arranged for engagement by said brushes, a single winding magnet to control the movement of said brushes over said terminals, said magnet operating over a busy circuit completed through the brushes and an associated terminal-set when said terminal-set is busy and not operating when said terminal-set is free.

8. In an automatic switch provided with movable brushes carried by a shaft and a plurality of stationary terminal-sets arranged for engagement by said brushes, a single winding magnet to control the downward movement of said brushes, said magnet operating over a busy circuit completed through the brushes and an associated terminal-set when said terminal-set is busy and not operating when said terminal-set is free.

9. An automatic switch comprising a movable shaft, brushes carried by said shaft, a plurality of stationary terminals arranged for engagement by said brushes, and a single winding magnet for controlling the downward movement of said shaft, influenced by the test condition prevailing on the terminal-set engaged by said brushes.

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