

Dec. 11, 1928.

1,695,043

W. T. HAINES ET AL  
TELEPHONE EXCHANGE SYSTEM

Filed Oct. 22, 1926

8 Sheets-Sheet 1

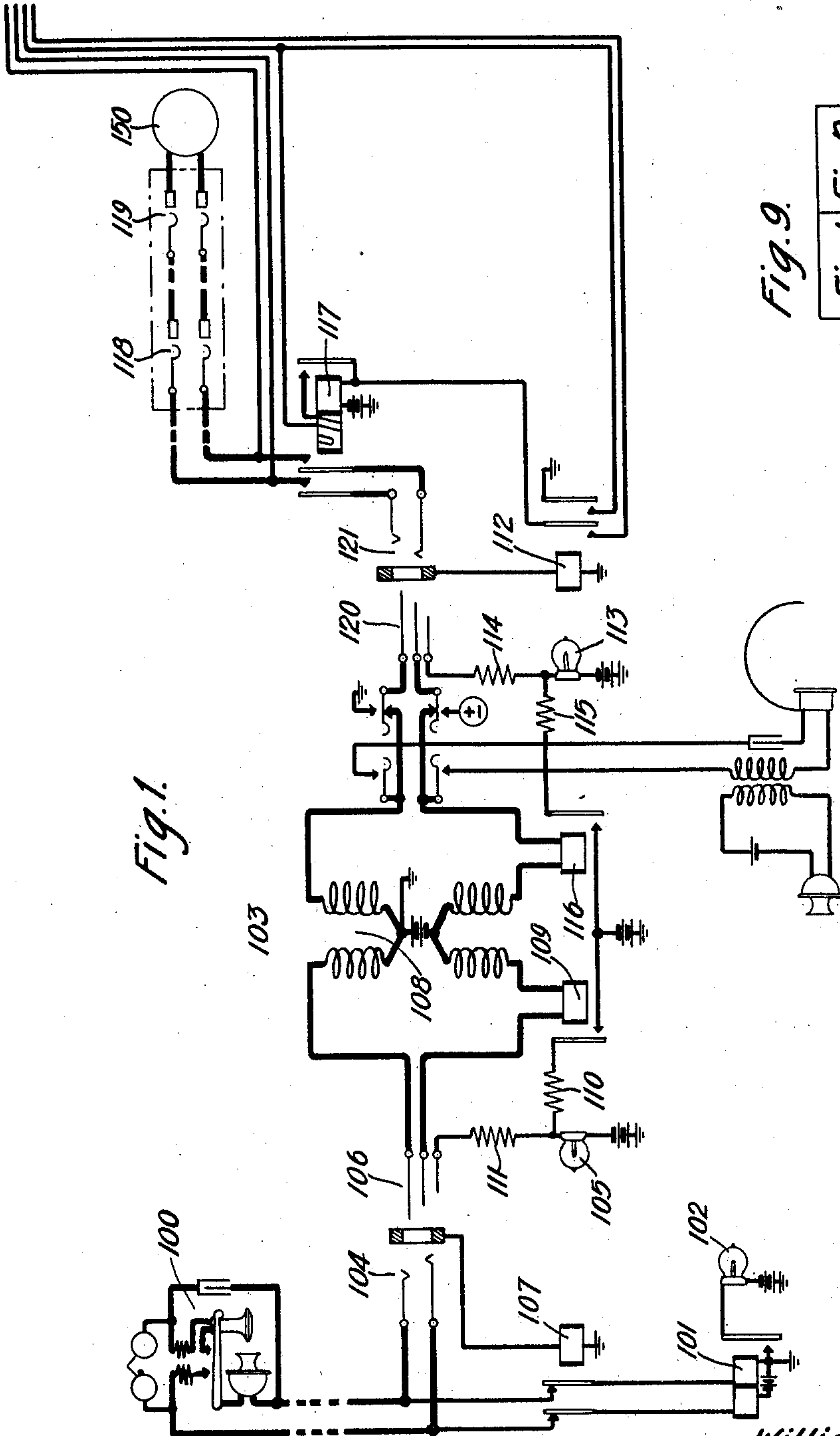


Fig. 9.

|         |         |
|---------|---------|
| Fig. 1. | Fig. 2. |
| Fig. 3. | Fig. 4. |
| Fig. 5. | Fig. 6. |
| Fig. 7. |         |

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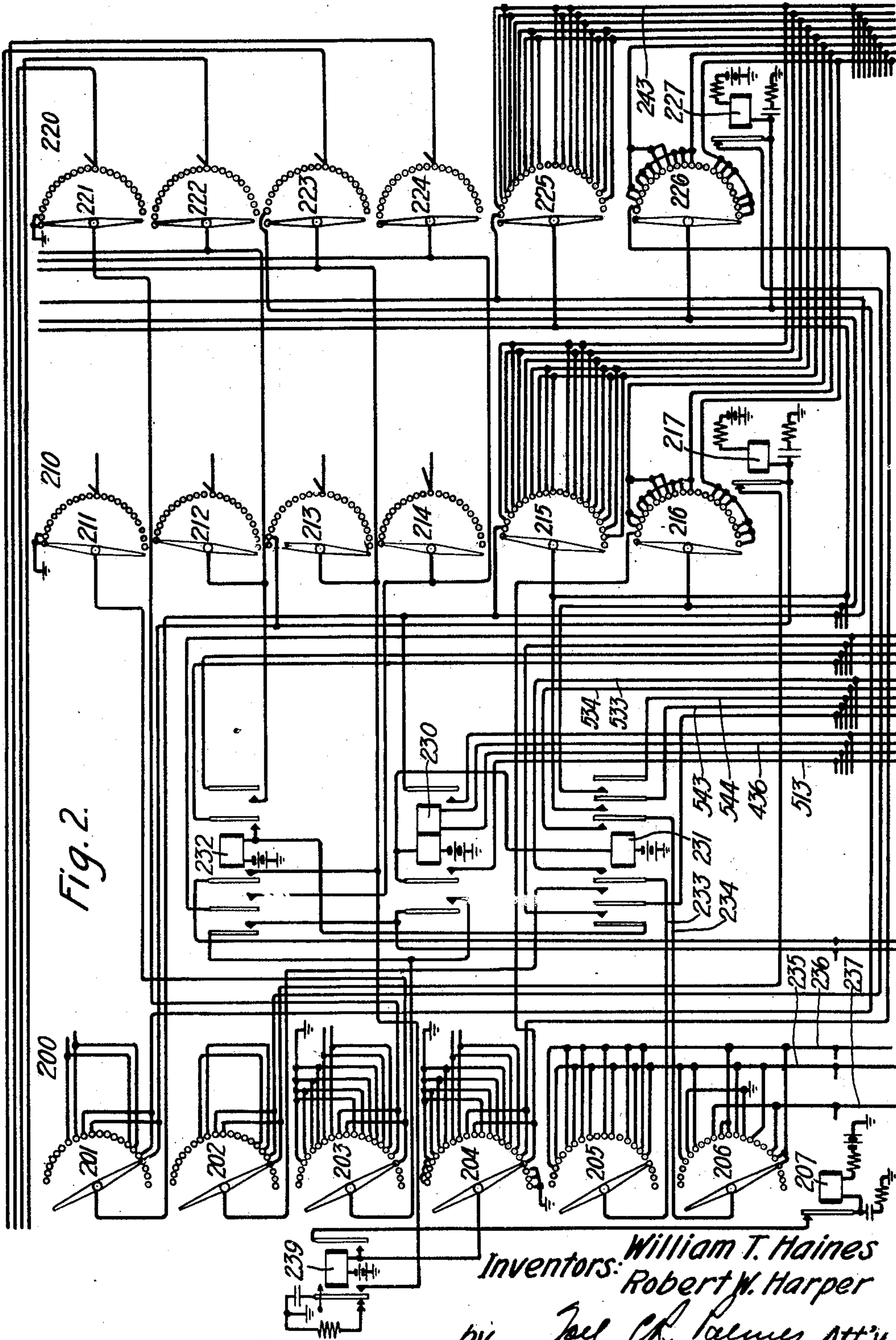
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8 Sheets-Sheet 2



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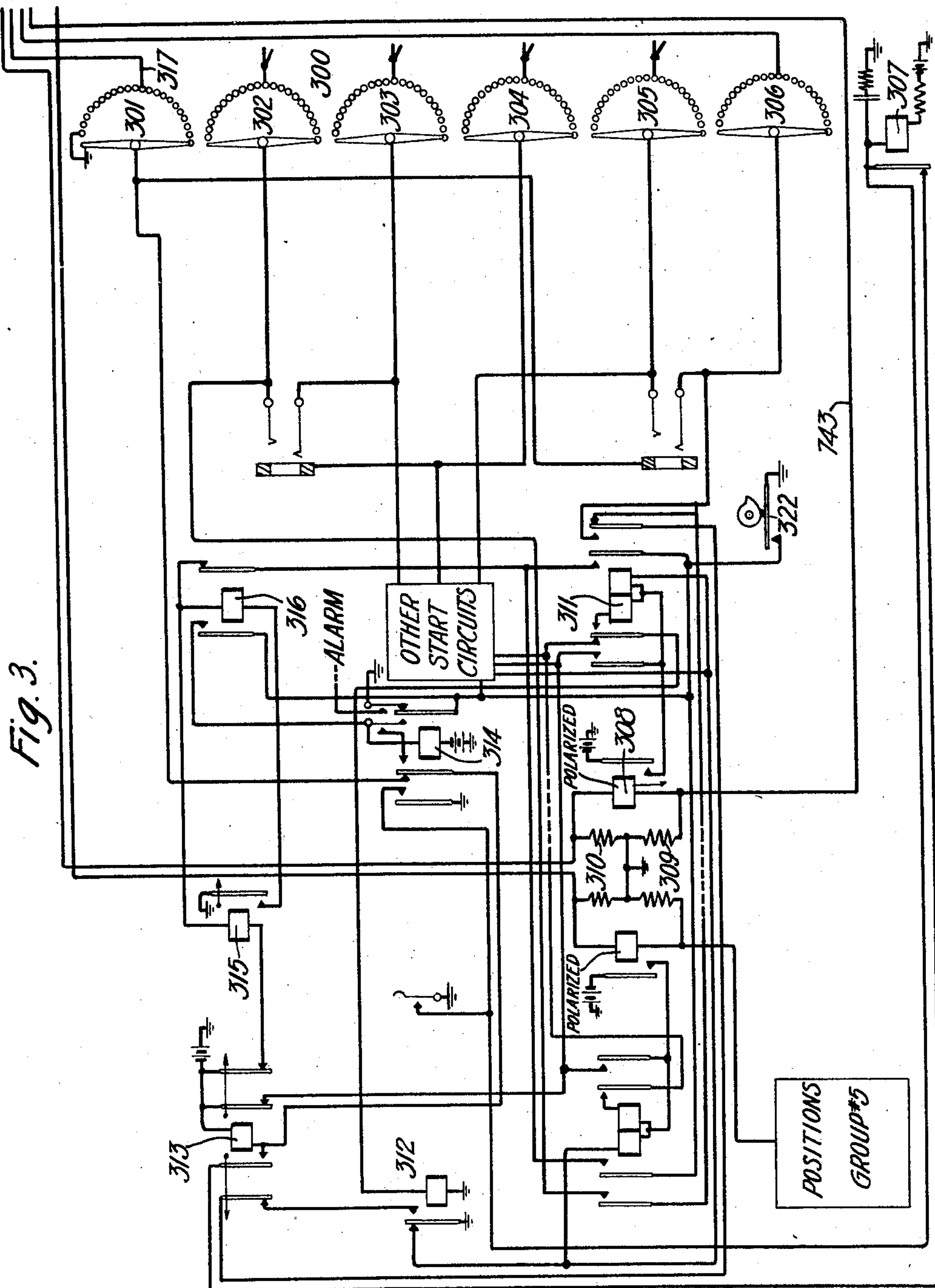
Dec. 11, 1928.

1,695,043

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8 Sheets-Sheet 3



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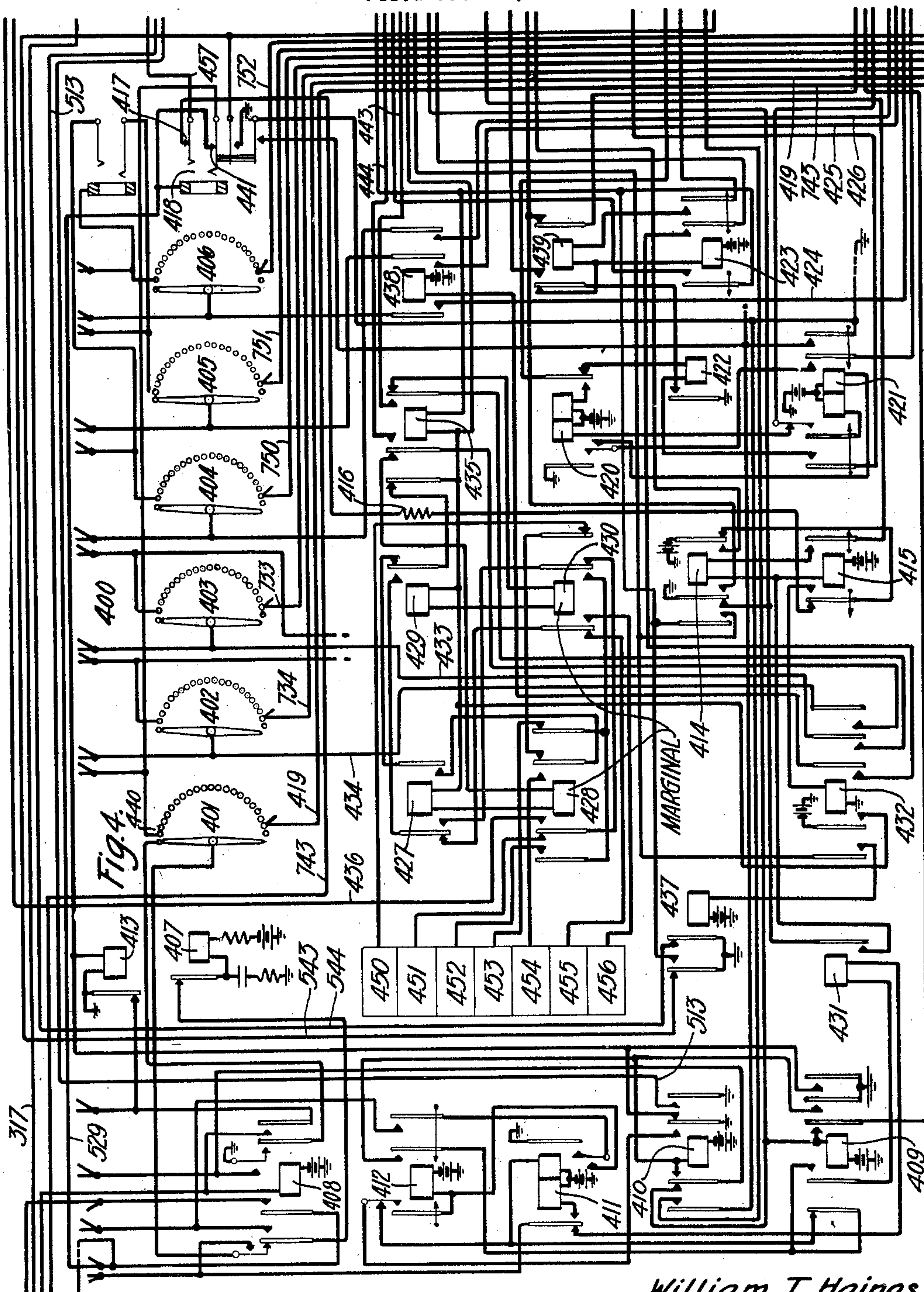
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W. T. HAINES ET AL

TELEPHONE EXCHANGE SYSTEM

Filed Oct. 22, 1926

8 Sheets-Sheet 4



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**Dec. 11, 1928.**

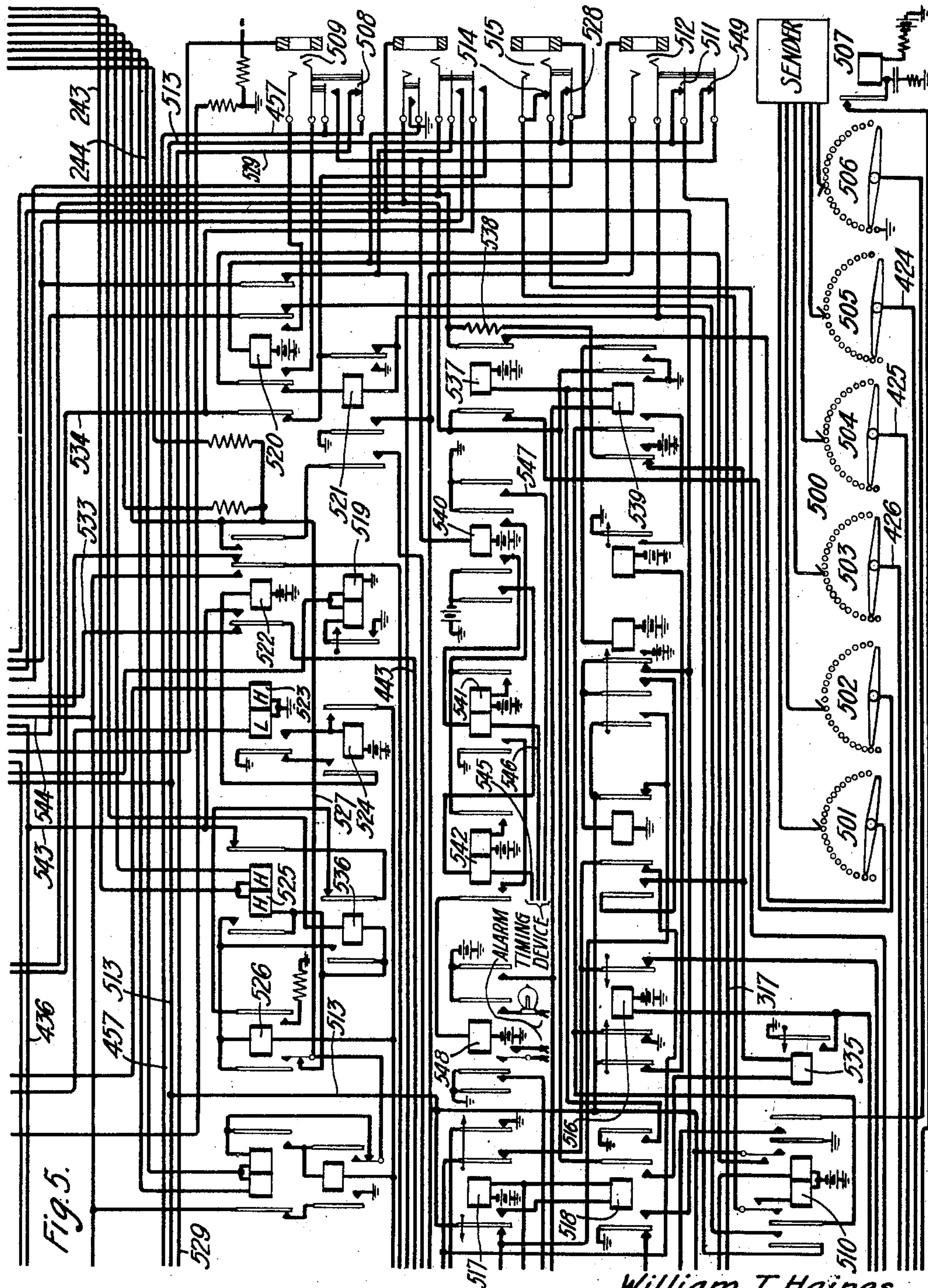
**1,695,043**

W. T. HAINES ET AL

TELEPHONE EXCHANGE SYSTEM

Filed Oct. 22, 1926

8 Sheets-Sheet 5



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Dec. 11, 1928.

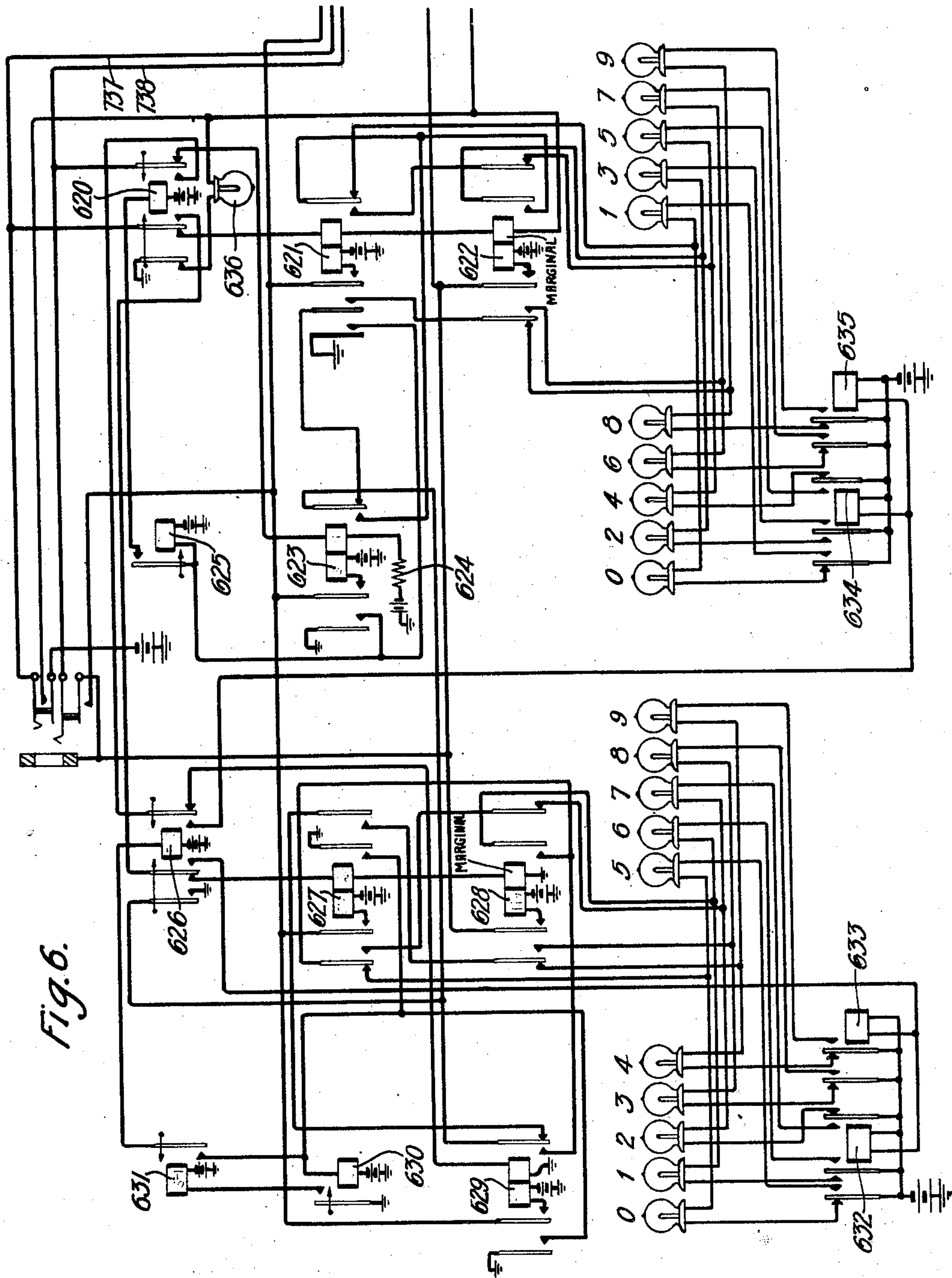
1,695,043

W. T. HAINES ET AL

TELEPHONE EXCHANGE SYSTEM

Filed Oct. 22, 1926

8 Sheets-Sheet 6



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Dec. 11, 1928.

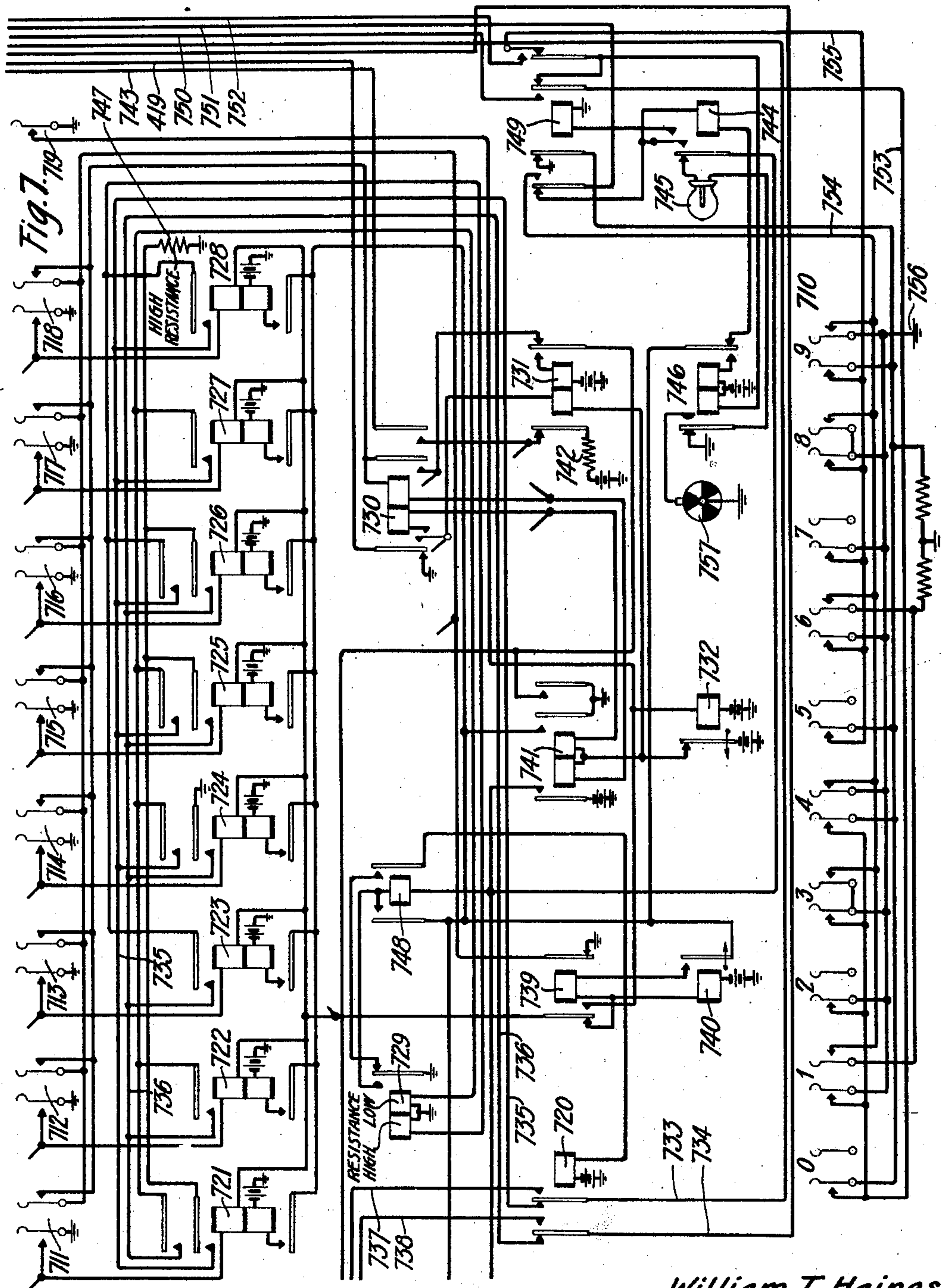
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W. T. HAINES ET AL

TELEPHONE EXCHANGE SYSTEM

Filed Oct. 22, 1926

8 Sheets-Sheet 7



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Dec. 11, 1928.

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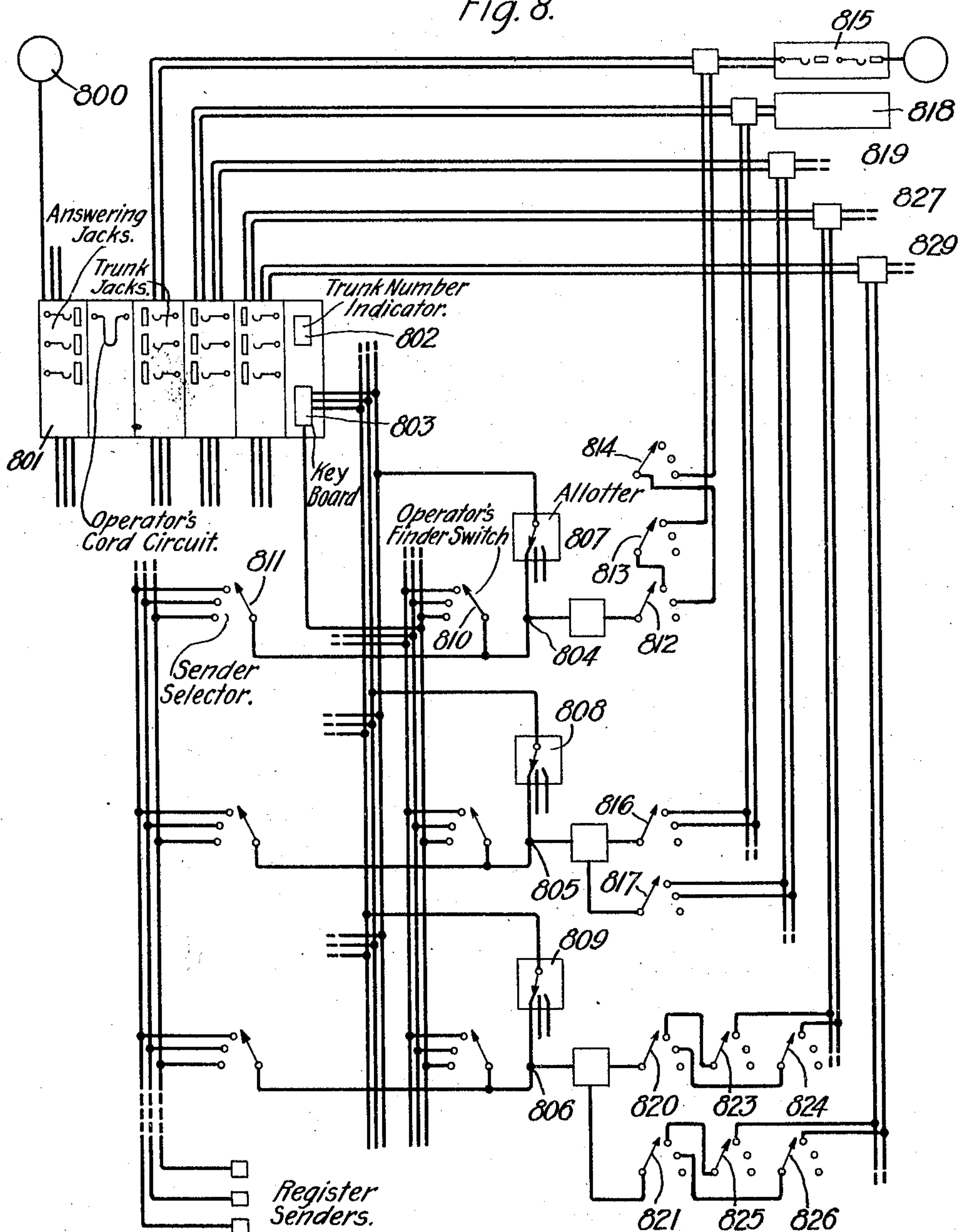
W. T. HAINES ET AL

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8 Sheets-Sheet 8

Fig. 8.



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## UNITED STATES PATENT OFFICE.

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## TELEPHONE-EXCHANGE SYSTEM.

Application filed October 22, 1926. Serial No. 143,362.

This invention relates to telephone systems and has for its object to reduce the number of switching units necessary for the connection of a particular manual office with a given number of machine switching offices.

According to one aspect of the invention, there are provided a plurality of common equivalent links, any one of which is associable in response to the operation of any one of a plurality of keys with an operator's position and is controlled thereby to select a group of trunks extending to one of a plurality of machine switching offices and to find an idle trunk in said group. The operation of such a key sets up a registration in a link which controls the selection of a trunk switch having access to trunks leading to the corresponding office.

In extending a connection from a manual office to a desired machine switching office the manual operator depresses a key corresponding to the wanted office. The operation of this key causes an allotter switch to allot a link circuit from a group serving the office whose key has been operated. The link circuit then operates to find the operator's position. A relay operated under the control of the office key sets up conditions on conductors extending to the link circuit which operate a group of relays in a particular combination to initiate the operation of a trunk finder having access to the trunks leading to the wanted office. When an idle trunk has been selected, an indication is sent back to the operator's position to inform her of the number of the trunk, after which she may insert the calling plug of her cord circuit in the jack of the trunk. In the meantime, the link circuit has also associated a sender with the operator's position and the operator registers the number of the wanted line on the sender by means of her numerical key set. After the completion of the registration her position is disconnected and she need pay no further attention to the connection unless signaled.

The link circuit shown is arranged to serve a maximum of eight offices. If the number of offices to which access is desired exceeds eight, additional groups of links may be provided individual to other groups of offices.

Likewise, each link is preferably arranged to have access to a maximum of twenty trunks to each of the eight offices. However, since this total number of trunks is a desirable maximum from a traffic standpoint, if the average number of trunks to a group of offices exceeds twenty, less than eight offices will usually be served by a particular group of links. Similarly, if any one office requires approximately this maximum number of trunks, a group of links will be assigned to that one office. It is, of course, possible to arrange link circuits of this type to discriminate between a larger number of offices and to have access to a larger number of trunks without departing from the spirit of the invention.

The operation of a system embodying the invention will be more clearly understood from a consideration of the following detailed description in connection with the attached drawings in which,

Fig. 1 shows a manual operator's cord circuit, a manual subscriber's substation and a diagrammatic representation of switches at an automatic office for completing a connection to a subscriber thereat;

Fig. 3 shows an allotter by means of which one of a plurality of link circuits may be assigned for use;

Figs. 6 and 7 show the operator's position equipment, Fig. 6 showing the lamps and control relays for indicating the number of the selected trunk, and Fig. 7 showing a plurality of office keys and the numerical keys of the operator's position. A strap or branch line is connected to the left-hand contacts of each office key in order to provide for a second set of such office keys if required for a second group of common links or switching devices. Likewise the straps or branch lines associated with conductors extending from relay 730 are included for the same purpose. The additional equipment required for operating a second set of common links is only the additional set of office keys such as 711 to 718 inclusive and an additional relay such as 730. The second set of keys is arranged one key per group of trunks the same as the first set and the switching devices or links are common to the second set of keys



and common to the groups of trunks which they serve;

Figs. 2, 4 and 5 show the link circuit; Fig. 4 including the position finder and the relays for discriminating between offices; Fig. 2 showing the trunk finder; and Fig. 5 showing the sender selector and other equipment;

Fig. 8 shows diagrammatically the relationship of the parts of the system;

Fig. 9 shows the manner of arranging Figs. 1 to 7.

Referring first to Fig. 8, substation 800 appears at the central office in an answering jack before an operator's position indicated at 801. Each operator is provided with a plurality of cord circuits and a plurality of outgoing trunk jacks leading to trunks which extend to all of the offices to which the manual office has direct connection. For use in establishing connections with machine switching offices, her position is also provided with a trunk number indicator 802 and a key board 803 which includes both office and numerical keys. Each operator is served by a plurality of groups of link circuits three such groups being represented by links 804, 805 and 806 respectively, each group having access to a particular group of distant offices. Each group of links is reached through an allotter such as allotters 807, 808 and 809 which serves to insure the use of the links of the group in rotation and may be controlled by a large number of operators. Each link circuit is provided with operator's finder switches such as switch 810 and a sender selector such as 811. If the number of operators exceeds the number accessible by the finder of one link, the groups of links and operators' positions are subdivided and an allotter provided for each subdivision. The link circuits are substantially of the same arrangement, except for modifications to care for the size of the trunk groups to which they have access. Link 804 for example, is represented as individual to a single office with a master switch 812 and trunk finders 813 and 814, both having access to trunks leading to office 815. Link 805 is provided with a plurality of trunk finder switches 816 and 817 by means of which access may be had to offices 818 and 819 respectively. Link 806 is indicated as having access to a plurality of offices, each office being served by a large number of trunks with master switches 820 and 821 to give access to a plurality of trunk finders 823 and 824, 825 and 826, which finders have access to trunks leading to offices 827 and 829 respectively. The operation of an office key sets up a registration in an associated link circuit which discriminates between trunk finders, such as finders 816 and 817 or between master switches such as switches 820 and 821 to cause the selection of a trunk to the proper office. Each link circuit serves to interconnect the operator's key set, a sender,

and the trunk outgoing to the wanted office, to indicate to the operator the number of the trunk and to control selections over the trunk. The talking circuit, however, is independent of the link, which reverts to common use.

#### *Detailed description.*

When the subscriber at substation 100 removes his receiver from the switchhook, his line relay 101 is operated, lighting lamp 102 which appears before an operator in the office with which the subscriber is associated. The operator, observing the lighting of lamp 102, inserts the answering plug of her cord such as cord 103 into the subscriber's jack 104. A circuit will then be completed from battery through lamp 105, resistance 111, sleeve contacts of plug 106 and jack 104, winding of cut-off relay 107 to ground. Relay 107 operates in this circuit and opens the circuit of relay 101, extinguishing lamp 102.

As soon as plug 106 is inserted in jack 104, a circuit is closed from battery through the lower left winding of repeating coil 108, winding of supervisory relay 109, ring contacts of plug 106 and jack 104, over the subscriber's line through the substation 100, back to the tip conductor of jack 104 and plug 106, upper left winding of repeating coil 108 to ground. Relay 109 operates in this circuit and connects battery over its front contact through resistances 110 and 111 to the sleeve contact of plug 106 shunting lamp 105 and preventing its lighting.

The subscriber then informs the operator of the number of the wanted subscriber, whereupon the operator depresses a key at her position corresponding to the wanted office.

Assuming that the wanted office is a machine switching office and is the one to which the key 711 corresponds, the operation of that key closes a circuit from ground over the left contact of key 711, upper winding of relay 721, left back contact of relay 739, winding of relay 740 to battery. Relays 721 and 740 operate in this circuit. A circuit is also closed from battery over the back contact of relay 732, left winding of relay 741, right winding of relay 730, over the right contact of key 711 to ground at the right back contact of relay 739. Relays 741 and 730 operate in this circuit.

The operation of relay 741 closes a locking circuit for relay 740 which extends through the winding of relay 739 over the front contact of relay 740 to ground at the inner right front contact of relay 741. Relay 739 does not operate as long as key 711 is held operated but as soon as the operator releases the key, it operates, removing the operating battery from relay 721 and the operating ground from relays 730 and 741. However, relay 741 also closes a locking circuit for relay 721 extending from battery through the lower winding and



lower front contact of relay 721 to ground at the inner right front contact of relay 741. In addition it closes a locking circuit for itself and relay 730 extending as previously traced through the windings of these relays, over the inner right front contact of relay 730, right back contact of relay 731 to ground at the outer right front contact of relay 741.

Relay 741 also closes a circuit from battery over its left contact, back contact of relay 744, through lamp 745 to ground at the left back contact of relay 746. This lamp remains lighted steadily until a sender is ready to receive the number of the called subscriber. Relay 741 likewise closes a circuit from battery over its left contact, through lamp 636 to ground at the outer left back contact of relay 620. This lamp remains lighted until an idle trunk has been found leading to the wanted office.

The operation of relay 730 removes ground from conductor 419 to mark this position as waiting connection with a link circuit. It also closes a circuit from battery through resistance 742, left back contact of relay 731, outer right front contact of relay 730, conductor 743, to the allotter circuit, through resistance 309, and through the winding of relay 308 and resistance 310, to ground. The closure of this circuit unbalances a Wheatstone bridge arrangement, of which resistances 309 and 310 form two arms, so as to cause relay 308 to operate.

The operation of relay 308 closes a circuit from battery over its front contact through the right winding of relay 311 to ground at the back contact of relay 312. Relay 311 operates and closes a circuit from ground through the winding of relay 312, inner left front contact, left winding and outer left front contact of relay 311 to battery at the inner right back contact of relay 313. Relay 312 operates in this circuit opening the ground at its back contact to prevent the operation of other relays similar to relay 311 and the use of the allotter until the allotted link circuit has been started into operation. The operation of relay 312 also closes a circuit from ground over its front contact, left back contact of relay 313, outer right front contact of relay 311, brush 306 and its associated contact, winding of relay 408 in the link circuit to battery. For a more complete description of the allotting arrangement reference is made to U. S. Patent 1,513,362, granted to L. M. Allen, October 28, 1924.

Relay 408 operates and locks over its outer right front contact to ground at the back contact of relay 413 to initiate the operation of the link circuit. It also connects battery over right back contact of relay 414, left back contact of relay 415, resistance 416, contact 417 of jack 418, conductor 457, contact 508 of jack 509, conductor 529 inner left front contact of relay 408 to ground through resistance

310 and through winding of relay 308 and resistance 309. This circuit balances the circuit previously traced through to the opposite side of relay 308 and causes that relay to release. Relay 311, however, does not release, since it is held operated in the locking circuit previously traced.

Relay 408 in operating also closes a circuit from battery through the winding of relay 409, and in parallel therewith from battery through the right winding of relay 510, left back contact of relay 410, inner right front contact of relay 408 to ground. Relay 409 operates and locks over its inner right front contact, right back contact of relay 516, inner right back contact of relay 517 to ground at the left back contact of relay 414. Relay 510 locks through its left winding and inner left contacts to ground at the inner left back contact of relay 516.

Relay 409 in operating closes a circuit from ground over its middle right front contact through the winding of relay 410 to battery. Relay 410 operates opening the energizing circuit of relay 409 and locking over its inner left front contact to ground at the inner right front contact of relay 408. The operation of relay 410 connects ground over its outer right front contact, conductor 513, contact 511 of jack 512, conductor 317, brush 301 of the allotter switch, left back contact of relay 314, to the winding of relay 313 and battery.

Relay 313 operates, opening the holding circuit of relay 311. It also closes a circuit from battery through winding and back contact of magnet 307, left front contact of relay 313 to its energizing ground. Magnet 307 operates in this circuit and steps the brushes of the allotter switch to the next set of terminals. As soon as brush 301 leaves the terminal connected to conductor 317, relay 313 releases. The allotter circuit is now ready to allot another link circuit for subsequent calls. Relays 314, 315 and 316 and interrupter 322 provide timed operating means for relay 313, to advance the allotter if the link fails to do so. When relays 731 and 415 operate as will be described hereinafter, the battery arms of the Wheatstone bridge are opened in the same order as they are closed. Since relay 308 is polarized this momentary unbalance will not affect the allotter.

Relay 410 in operating as previously traced, closes a circuit from battery through the right winding of relay 411, left back contact of relay 412 to ground at the inner right front contact of relay 410. Relay 411 operates and closes a circuit from battery through the winding of relay 412, inner right front contact of relay 411 to ground. Relay 412 operates after an interval and closes a holding circuit for itself over its left front contact to ground at the inner right front contact of relay 410 and opens the energizing circuit of relay 411. This relay, however, closes



a holding circuit for itself extending through its left winding and left front contact, outer left front contact of relay 408 to brush 401.

With position finder 400 normal, this circuit extends over the normal contact of brush 401 to ground at the middle right front contact of relay 408. All positions other than those seeking the use of a link circuit will have ground connected to the conductor appearing in the terminals of brush 401. Therefore, relay 411 will be held operated as brush 401 moves over its bank until the calling position is found. Relay 411 also closes a circuit from ground over its outer right front contact, outer right front contact of relay 412, middle left front contact of relay 408, back contact and winding of the position finder stepping magnet 407 to battery.

Magnet 407 operates interrupting its own circuit, and advances the brushes of the position finder in search of the calling position. When that position is found, battery will be connected to the terminal of brush 401 from the back contact of relay 732, left winding of relay 731, left front contact of relay 730, and conductor 419. Therefore, relay 411 cannot remain energized and it releases to extend the circuit just traced over the outer left front contact of relay 408, left back contact of relay 411, winding of relay 431, inner left front contact of relay 409, inner right front contact of relay 412, to ground at the middle right front contact of relay 409. Relays 731 and 431 operate in this circuit, relay 731 locking in a circuit from battery through its right winding and right front contact to ground at the outer right front contact of relay 741. The operation of relay 731 opens the original holding circuit for relays 741 and 730, but they are held operated in a circuit from battery over the back contact of relay 732, right winding of relay 741, left winding and inner left front contact of relay 730 to ground over conductor 419.

The operation of relay 431 closes a circuit from battery through the winding of relay 415, contact of relay 431, left back contact of relay 414 to ground. Relay 415 operates and closes a locking circuit for itself through the winding of relay 414, right contact of relay 415, left back contact of relay 517 to ground at the inner right front contact of relay 510. It also closes a circuit from ground through the winding of relay 432, left front contact of relay 415 to battery at the right back contact of relay 414. Relay 432 in operating extends a pair of conductors from the link circuit to the position circuit for the purpose of initiating the operation of the proper trunk selector. Relay 432 also supplies battery for the operation of the recording relays. One of the recording relay circuits may be traced from battery over the inner left front contact of relay 432 through the winding of sensitive relay 427, winding

of marginal relay 428, left back contact of relay 435, outer right front contact of relay 432, conductor 434, to brush 402, conductor 734, left back contact of relay 720, conductor 736 and thence to contacts of certain of the office relays. The second circuit extends from battery over the left front contact of relay 432 through the winding of sensitive relay 429, winding of marginal relay 430, right back contact of relay 435, middle right front contact of relay 432, conductor 433, to brush 403, over conductor 733 to the inner left back contact of relay 720, conductor 735 to other contacts of the office relays. The office relays 721 to 728 are arranged to connect conductors 735 and 736 to ground through a low or a high resistance in various combinations to operate relays 427 to 430 in corresponding combinations.

Since relay 721 is operated, conductor 736 is connected over the upper contact of relay 721 to ground through the low resistance right winding of relay 729 and conductor 735 is extended over the lower upper front contact of relay 721 to ground through high resistance 747. Therefore, relays 427, 428 and 429 will be operated. A circuit will thereupon be closed from battery at the left front contact of relay 432 over the outer left back contact of relay 435, front contact of relay 429, left front contact of relay 427, right back contact of relay 430, left front contact of relay 428 to conductor 436 and thence through the right winding of relay 230 to ground through the left winding of relay 519. Similar circuits may be traced for other operated combinations of relays 427 to 430 which lead to other trunk finder switches which have been indicated diagrammatically by the rectangles 450 to 456 inclusive.

Relay 519 operates in this circuit and after an interval connects ground over its front contact to its left winding and the circuit above traced, thus increasing the current flow in the right winding of relay 230 to operate that relay. As soon as relay 230 operates, it closes a holding circuit for itself and an operating circuit for relay 231 extending from battery through the winding of relay 231 and from battery through the left winding of relay 230, inner left front contact of relay 230, conductor 513 to ground at the inner right front contact of relay 510.

Relay 729 operates in the circuit above traced through its right winding and closes a circuit from ground over its right front contact through the winding of relay 748, to battery at the left front contact of relay 741. Relay 748 operates and locks to ground at the inner right front contact of relay 741.

Assuming that master switch 200 is standing in its first operative position, that is, position 4, and hence is controlling trunk selector 210, the operation of relays 231 and 230 closes a circuit from battery through the winding



and back contact of stepping magnet 217 of selector 210, brush 202 in position 4, middle left contact of relay 231, inner right back contact of relay 520, left front contact of relay 510, winding of relay 521, to ground at the inner right front contact of relay 510. A circuit is also extended in shunt of the winding of relay 521, over the back contact of relay 521, outer left back contact of relay 520 outer left front contact of relay 230, through brush 203 in position 4, over the brush 211 of trunk finder 210 to the trunk circuit connected to the terminal on which the brush 211 is standing.

A busy trunk will be characterized by ground connected to the terminal of this brush and will cause the energization of stepping magnet 217, while shunting the winding of relay 521, and the advance of the trunk finder to the next trunk. Assuming that none of the trunks connected to switch 210 are idle, brush 215 will be advanced to position 21 where a circuit will be closed from battery through the winding of magnet 217, brush 201 in position 4, brush 215 in position 21, middle right front contact of relay 231, conductor 543 to ground at the outer left contact of relay 437. Magnet 217 will be held operated in this circuit. At the same time a circuit is closed from battery through the winding of relay 239, brush 204 in position 4, brush 216 in position 21, outer right front contact of relay 231, conductor 544, to ground at the inner left contact of relay 437. Relay 239 operates and extends ground over its front contact to the back contact and winding of magnet 207 and battery, operating magnet 207 to advance the master selector to position 5. The grounded condenser connected to the left contact of relay 239 serves to protect the terminals of brush 201 while switch 200 is advancing.

As soon as switch 200 leaves position 4, the holding circuit of magnet 217 is opened and the switch 210 advances to position 22, where it remains until switch 200 reaches position 12 or returns to position 4, positions 4 and 12 being multiplied together. With switch 200 in position 5, a circuit is closed from battery through the winding and back contact of magnet 227, brush 202 in position 5 and thence as previously traced through the winding of relay 521, the shunt circuit now extending through brush 221.

When an idle trunk is found no ground will be connected to the terminal of brush 221 and relay 521 will be able to operate in the circuit traced for it, while magnet 227 does not operate in series with that relay. The operation of relay 521 connects ground over its right front contact to brush 221, marking the trunk busy to other trunk hunting switches.

Under the conditions assumed in the drawing, the first idle trunk encountered was

trunk No. 29, which is shown in full. The trunk groups begin to number from 0, hence the first trunk on switch 220 will be No. 20, and the tenth trunk No. 29. It now becomes necessary to give the operator an indication of the number of this trunk. For this purpose the operation of relay 521 closes a circuit from battery through the winding of relay 437, left front contact of relay 432, inner left front contact of relay 521 to ground operating relay 437. With relay 437 operated, a circuit is closed from battery over the inner left front contact of relay 432, winding of relay 435 to ground at the outer left front contact of relay 437. Relay 435 operated transfers the circuit traced over conductors 433 and 434 from the windings of relays 427 to 430 to conductors 443 and 444 respectively. Conductor 443 is extended over the left back contact of relay 522 to conductor 533, inner left front contact of relay 231, conductor 233 to brush 205, and conductor 444 is extended over the right back contact of relay 522, conductor 534, inner right front contact of relay 231 to brush 206.

This transfer opens the circuit of relay 729 permitting that relay to release and close a circuit from ground at its back contact over the front contact of relay 748 to the winding of relay 720 and battery. Relay 720 in operating disconnects conductors 733 and 734, which are connected with conductor 433 and 434 respectively as previously traced, from the contacts of the office relays and extends them to conductors 737 and 738 respectively. Conductor 737 is extended at this time over the inner left back contact of relay 620 through the right winding of sensitive relay 621, right winding of marginal relay 622, to battery at the left front contact of relay 741 and conductor 738 is extended over the right back contact of relay 620, right winding of sensitive relay 623, resistance 624 to battery.

The circuit of these relays is completed over brushes 205 and 206 to ground through low or high resistance in accordance with the position occupied by master selector 200. The brushes being in position 5, under the present assumption, the circuit of relays 622 and 621 extends over brush 205, conductor 236, low resistance left winding of relay 523 to ground and that for relay 623 extends over brush 206, through the high resistance right winding of relay 523 to ground. Therefore, relays 621, 622 and 623 are all operated. These relays lock through their left windings to ground at the right contact of relay 741.

The operation of relay 623 also closes an obvious circuit for relay 625, which relay closes a circuit for relay 620, but relay 620 is slow to operate to provide sufficient time for relays 621 to 623 to establish their locking circuits. Relay 620 in operating disconnects conductors 737 and 738 from relays 621 to 623 and connects them over the left front contact



of relay 620, left back contact of relay 626, right winding of sensitive relay 627, right winding of marginal relay 628 to ground, and over the right front contact of relay 620, right  
 5 back contact of relay 626 to ground through the right winding of sensitive relay 629 respectively. Relay 620 also extinguishes the no-trunk lamp 636, indicating that a trunk has been found and the indication of the  
 10 trunk number is being prepared.

Relay 523 in operating closes an obvious circuit for relay 524 which locks over its right front contact to ground at the left front contact of relay 437. When relay 620 operates  
 15 it extends conductors 737 and 738 to ground instead of battery, thereby releasing relay 523 to close a circuit from ground over back contact of relay 523, front contact of relay 524, winding of relay 522 to battery. The  
 20 operation of relay 522 disconnects conductors 443 and 444 from brushes 205 and 206 and extends conductor 443 over its left front contact to conductor 543, middle right front contact of relay 231, to brush 225, and  
 25 conductor 444 over its right front contact, conductor 544, outer right front contact of relay 231 to brush 226 respectively.

With switch 220 in position 10, conductor 543 is extended to conductor 243, left winding  
 30 of relay 525, left normal contact of relay 526, right front contact of relay 522, left front contact of relay 521, to battery at the inner left front contact of relay 432. Conductor 544 is open in this position. The resistance of the  
 35 left hand winding of relay 525 being high only relay 627 of the indicator is operated. Relay 525 also operates in this circuit.

The operation of relay 627 closes a circuit for relay 630 which in turn operates relay  
 40 631 and in turn operates relay 626, thus extending conductor 737 over the left front contact of relays 620 and 626 to battery through the windings of relays 632 and 633, and conductor 738 over the right front contacts of  
 45 relays 620 and 626 to battery through the windings of relays 634 and 635.

The operation of relay 525 closes a circuit from battery as previously traced to conductor 527 over the left normal contact of relay  
 50 526, left front contact of relay 525, winding of relay 526 to ground at the left front contact of relay 437. Relay 526 closes a holding circuit for itself, opens the circuit of relay 525 and connects ground over its left front  
 55 contact to the left back contact of relay 536, right back contact of relay 525 to conductor 543 and thence to conductor 737 and the windings of relays 631 and 632.

With relays 631 and 632 operated the lighting circuits for the indicator lamps are closed and these may be traced from battery over  
 60 the left back contact of relay 634 through the No. 2 tens lamp, right front contact of relay 622, right front contact of relay 623 to ground  
 65 at the left front contact of relay 626, and

from battery over the inner left front contact of relay 633, through the No. 9 units lamp, left back contact of relay 628, right front contact of relay 627, right back contact of relay  
 70 629 to ground at the left front contact of relay 626 indicating to the operator that the trunk No. 29 was the one of those outgoing to the wanted office which has been selected. The trunk indicating arrangement is substantially the same as that described and  
 75 claimed in application of H. W. MacDougall, Serial No. 715,511 filed May 24, 1924.

In the meantime, the operation of relay 510 closes a circuit from ground over the left  
 80 back contact of relay 516, inner left front contact of relay 510, contact 514 of jack 515, left normal contact of relay 421, left winding of relay 420 to battery. The operation of relay 420 closes a circuit for relay 421 at the inner left front contact of relay 420. Re-  
 85 lay 421 is slow to operate but upon closing its inner left front contact locks to ground over the front contact of relay 510 and the inner left back contact of relay 516. Relay 420 closes a circuit from battery through the  
 90 winding and back contact of sender selector magnet 507, inner right front contact of relay 421 to ground at the left front contact of relay 420. Relay 420 closes a holding circuit for itself through its right winding and inner  
 95 right front contact, outer right front contact of relay 510 to brush 506.

If the sender, to which switch 500 has access in the position it then occupies, is busy, ground will be connected to brush 506 and re-  
 100 lay 420 held operated to cause magnet 507 to advance the sender selector to the next sender. As soon as an idle sender is reached, ground will be removed from the terminal of brush 506 and battery will be connected there-  
 105 to from the sender, in consequence of which, relay 420 is released and closes a circuit from this battery over the back contact of relay 420, through the winding of relay 422, left front contact of relay 421, left back contact of  
 110 relay 518 to ground.

Relay 422 closes a circuit from ground at its front contact, left back contact of relay 439, winding of relay 423 to battery. Relay  
 115 423 locks in series with relay 439 over the outer right front contact of relay 423 to ground at the inner right contact of relay 510, but relay 439 does not operate as long as relay 422 remains operated. Relay 423 closes a circuit from battery through the  
 120 winding of relay 438, inner left front contact of relay 432, inner right front contact of relay 423 to ground at the outer right back contact of relay 517. Relay 433 extends three circuits from brushes 404, 405, and 406 of the position finder to brushes 503, 504, 505 respec-  
 125 tively whence they are extended to the sender registers. Relay 423 also closes a circuit from battery through the winding of relay 232, outer left front contact of relay 231,  
 130



right back contact of relay 520, left front contact of relay 423 to ground at the left front contact of relay 437. Relay 232 operates and locks over its inner right contact, contact 528 of jack 515 to grounded conductor 513, preparing the circuit from the sender to the trunk over which the automatic switches are controlled. Since relay 437 does not operate until the trunk is found, relay 423 cannot operate until both sender and trunk have been found.

As soon as the sender is connected with the link circuit, battery is connected to brush 504 and thence over conductor 425, inner right front contact of relay 438, brush 405, left back contact of relay 749, winding of relay 744, right back contact of relay 746 to ground at the inner right front contact of relay 741. Relay 744 operates and closes a holding circuit for itself over its outer left front contact to battery at the left front contact of relay 741, at the same time closing a circuit for relay 749.

The operation of relay 744 extinguishes lamp 745 indicating to the operator that a sender has been connected with the link circuit and that she may proceed to operate her numerical keys. The operation of relay 749 extends the above mentioned circuits from brushes 404, 405 and 406, over conductors 750, 751 and 752, to conductors 753, 754, and 755 respectively which are connected in various combinations to contacts of the numerical keys of set 710. The operation of the numerical keys connects ground directly or through resistance to one or more of these conductors, setting the registers of the sender in any well known manner, as for example that disclosed in the above identified patent to L. M. Allen. Since the operation of the sender forms no part of the present invention, it is believed that the reference to the above mentioned patent will be sufficient. Following the registration of the first digit, ground is connected to brush 506 from the sender in place of battery and relay 422 releases permitting relay 439 to operate in the locking circuit of relay 423. Relay 439 prepares for subsequent operations.

After the operator has completed setting up the called number, she may insert plug 120 in jack 121, operating relay 112, in series with lamp 113 and resistance 114. Since the circuit of the called subscriber is not closed at this time, relay 116 is not operated and lamp 113 lights in the circuit of relay 112. The operation of relay 112 prepares a circuit for relay 117 which will be traced hereinafter.

As soon as registration is completed in the sender, battery is again substituted for ground at brush 506 and relay 422 reoperated. The operation of relay 422 at this time completes a circuit from ground over its front contact, front contact of relay 439, winding

of relay 517 to battery. The operation of relay 517 closes a circuit through the winding of relay 518, front contact of relay 517 to ground at the middle right front contact of relay 510. The operation of relay 517 opens the holding circuit of relay 409. The release of relay 409 in turn opens the holding circuit of relay 431 and that relay disconnects the ground in shunt of the winding of relay 414 and permits that relay to operate in the locking circuit of relay 415. It also opens the holding circuit of relay 741 and 730. The release of relay 741 opens the holding circuits for all position relays including the trunk indicator and the release of relay 730 reconnects ground to the terminal corresponding to the position in brush 401. The position is now free for use in connection with other calls.

The operation of relay 232 as previously described connects the tip and ring conductors from the outgoing trunk to the distant office through brush 223 and 224 over the inner left front contacts of relay 232, over the back contacts of relay 537 to brush 501 and 502 to the sender. When registration is complete the sender will proceed to establish a fundamental circuit including these conductors and will proceed to control the operation of incoming selector 118 and final selector 119 to select the called subscriber's substation 150. When selections have been completed, the sender opens the circuit of relay 422 and that relay releases permitting relay 518 to operate in the locking circuit of relay 517.

The operation of relay 517 closes a circuit from battery through the winding of relay 537 to ground at the outer right front contact of relay 518. Relay 537 disconnects trunk conductors from the sender and in conjunction with the operation of relay 518 connects them together through resistance 538, left back contact of relay 539, winding of relay 535, inner right front contact of relay 518. The disconnection of the trunk conductors from the sender frees the sender for use with other links. The operation of relay 518 also closes a circuit from battery through the right winding of relay 117, left inner contact of relay 112, brush 222, outer right contact of relay 232 to ground at the left front contact of relay 518. Relay 117 operates and closes a holding circuit for itself over its front contact through its left non-inductive winding to ground at the outer contact of relay 112.

With relay 117 operated, the tip and ring conductors from the cord circuit are extended to the trunk circuit and also to the winding of relay 535. Relay 535 operates from battery and ground in the cord circuit and closes an obvious circuit for relay 516. The operation of relay 516, opens the holding circuit of relay 510 releasing relays 521 and 437 in turn. The release of relay 510 also disconnects ground from conductor 317 at its front con-



tact but ground is temporarily maintained on that conductor from the outer right front contact of relay 410, which is held operated to ground at the front contact of relay 408.

5 Relay 411 is reoperated over the back contact of relay 409 and the inner right contact of relay 412 to ground over the front contact of relay 410 and the inner right front contact of relay 408.

10 The operation of relay 411 again closes the operating circuit for stepping magnet 407 which now advances position finder 400 to position 21. At this time a circuit is closed from ground through the winding of relay 15 413, contact 441 of jack 418, 20th terminal of brush 401, outer left front contact of relay 408, left front contact of relay 411 and winding of relay 411 to battery. Relay 413 now operates and removes the holding ground 20 from relay 408 which releases in turn releasing relays 410 and 411 and 412. The release of relay 410 connects ground over its inner left back contact to the winding of relay 413 causing that relay to release. This ground is 25 also extended over brush 401 in position 21, and the back contact of relay 408, to the back contact and winding of magnet 407 to step switch 400 back to normal.

The release of relay 510 opens the locking 30 circuits of relays 415, 423 and 439, 517 and 518 and 232, which in turn permit the release of relays 537, 435, 524, 526 and 432. The link circuit has now been completely restored to normal.

35 If the operator depresses the wrong office key, she may correct it by operating the right key prior to the progress of the link circuit to the point where relay 230 locks. It will be remembered that the operation of an office 40 key operated relays 740, 741 and 730. The release of the key permits relay 739 to operate in the locking circuit of relay 740. At this time the depression of any other office key will close a circuit from ground over the left 45 contact of that key through the upper winding of corresponding relay over the front contact of relay 739, to the winding of relay 732 and battery. Relay 732 in operating disconnects battery from relays 741 and 730, in 50 turn removing battery and ground from the remaining circuits of the position and releasing the office relays. Relays 740 and 739 also release, opening the circuit of relay 732 and restoring the position circuit to register the 55 operation of the second office key. If the call is to be wiped-out altogether she may operate key 719, operating relay 732 to destroy the registration. Since no office key is operated when relays 739 and 740 release, no registration is made. 60

If the operator starts to operate the numerical keys before the sender has been attached to the link as indicated by the operation of relay 744 and the extinguishing of 65 lamp 745, the corresponding digits will not

be registered. With relays 744 and 749 not operated, the operation of any one of the numerical keys closes a circuit from battery, through the left winding of relay 746, right 70 back contacts of relay 749, over the left contact of the key to direct ground either at 756 or at the inner left back contact of relay 749. Relay 746 locks through its right winding to ground at the inner right front contact of relay 741. It also transfers the cir- 75 cuit of lamp 745 to ground through interrupter 757, causing lamp 745 to flash, to inform the operator that she has operated her numerical keys prematurely. In addition, it opens the circuit of relay 744, preventing 80 the establishment of the registering circuits from the key set 710 to the sender. In order to properly register the number, the operator must now operate an office key or the release key 719, operating relay 732. This 85 relay releases relay 431, permitting the operation of relay 414 in the locking circuit of relay 418. Relay 414 operates relays 516 and 539 to completely release the link. The operated office key will cause the allotment of 90 another link.

Relays 540, 541, 542 and 548 provide means for automatically disconnecting a link circuit which fails to complete its operations in a given length of time. 95

The position of Fig. 7 is shown equipped with a set of keys permitting the selection of 8 offices. It will, of course, be understood that it may also be provided with a 100 second set of keys for controlling the selection of another group of eight offices and it may likewise be provided with a plurality of keys which have an entire group of link circuits individual thereto. The link circuits serving trunks leading to only a single 105 office do not require the identifying means and are usually provided only with a relay such as relay 730, no office relay being necessary although it would be possible to equip each individual key with a single office selecting relay which would operate the identifying relays to start a master selector switch 110 such as master selector 200.

From an inspection of the drawings it will appear that the group of trunks corresponding 115 to key 711 numbers 80. The remaining trunk groups will, therefore, average approximately 10 trunks per group, if the preferred number of trunks, namely 160, is served by these links. In practice trunk 120 groups differing so largely in size would probably not be employed. Instead 2 trunk groups of approximately 80 trunks each might be grouped together and two office keys with their corresponding relays employed 125 to discriminate between the two groups. Where eight groups of trunks are served by one group of link circuits, trunk groups approximating 20 trunks apiece would in all probability be selected. The 130



complete set of keys and a large trunk group have been shown in order to illustrate the operation more completely. The following table indicates the relationship between the office keys of a group, the combination of resistances applied to conductors 735 and 736, relays of the group 427 to 430 and the office switch corresponding to each other:

| Keys. | Relays. | Ground to conductor 735-736 through. | Indicator relays operated. | Switch. |
|-------|---------|--------------------------------------|----------------------------|---------|
| 711   | 721     | High res. Low res.-----              | 427                        | 200     |
| 712   | 722     | Low res.-----                        | 428                        | 454     |
| 713   | 723     | High res.-----                       | 429                        | 450     |
| 714   | 724     | Low res. Direct-----                 | 427                        | 452     |
| 715   | 725     | Low res. High res.-----              | 428                        | 453     |
| 716   | 726     | High res. High res.-----             | 429                        | 451     |
| 717   | 727     | Low res.-----                        | 430                        | 456     |
| 718   | 728     | High res.-----                       | 427                        | 455     |

What is claimed is:

1. In a telephone exchange system, incoming lines, a plurality of groups of trunk lines, operators' positions, a plurality of operators' devices in each of said positions, one of said devices for each group of trunk lines, a group of switching devices common to said operators' devices, means responsive to the actuation of any one of said operators' devices to cause an idle one of said switching devices to select a particular group of trunks and an idle trunk line in said group, and means in said operators' positions for connecting incoming lines to trunks selected by the actuation of said operator's device.

2. In a telephone exchange system, incoming lines, a plurality of groups of trunk lines, operators' positions, a plurality of operators' devices at each of said positions, one of said devices for each group of trunk lines, a group of equivalent switching devices common to said operators' devices, means responsive to the actuation of any one of said operators' devices to associate an idle one of said switching devices with said operators' devices, means to identify the group of trunk lines corresponding to said actuated operators' device, means to cause said switching device to select an idle trunk line in the identified group, and means in said operators' positions for connecting incoming lines to trunks selected by the actuation of said operator's device.

3. In a telephone exchange system, a plurality of groups of trunk lines, operators' positions, a plurality of operators' devices at each of said positions, each device corresponding to a group of trunk lines, a group of equivalent link circuits, a plurality of switches each having access to one of said

groups of trunk lines, means responsive to the actuation of one of said operators' devices, to associate an idle link circuit with said device, means under the control of said actuated device to select a switch having access to the corresponding group of trunk lines, and means to operate said switch to select an idle trunk line in said group.

4. In a telephone exchange system, a plurality of groups of trunk lines, operators' positions, a plurality of operators' keys at each of said positions, one of said keys for each group of trunk lines, a group of equivalent switching devices common to said operators' keys, means responsive to the actuation of any one of said keys to associate an idle one of said switching devices with said keys, a plurality of relays, means to operate said relays in various combinations under the control of said actuated keys to identify the group of trunk lines corresponding to said actuated keys, and means to cause said switching device to select an idle trunk line in the identified group.

5. In a telephone exchange system, a plurality of groups of trunk lines, operators' positions, a plurality of operators' devices in each of said positions, one of said devices for each group of trunk lines, a group of equivalent switching devices common to said operators' devices, means responsive to the actuation of any one of said operators' devices to associate an idle one of said switching devices with said operators' devices, a group of sensitive and marginal relays, means to operate said relays in various combinations under the control of said actuated devices to identify the group of trunk lines corresponding to said actuated operators' device, and means to cause said switching device to select an idle trunk line in the identified group.

6. In a telephone exchange system, a plurality of groups of trunk lines, operators' positions, a plurality of operators' keys at each of said positions, each key corresponding to a group of trunk lines, a group of equivalent link circuits, a plurality of switches each having access to one of said groups of trunk lines, means responsive to the actuation of one of said operator's keys to associate an idle link circuit with said keys, a plurality of relays, means to operate said relays in various combinations under the control of said actuated keys to select a switch having access to the corresponding group of trunk lines, and means to operate said switch to select an idle trunk line in said group.

7. In a telephone exchange system, a plurality of groups of trunk lines, operators' positions, a plurality of operators' devices at each of said positions, each device corresponding to a group of trunk lines, a group of equivalent link circuits each including a plurality of switches each having access to one of said groups of trunk lines, means respon-



sive to the actuation of one of said operators' devices to associate an idle link circuit with said devices, a group of sensitive and marginal relays in said link circuit, means to operate said relays in various combinations under the control of said actuated device to select a switch having access to the corresponding group of trunk lines, and means to operate said switch to select an idle trunk line in said group.

8. In a telephone exchange system, a plurality of groups of trunks, operators' positions, one operator's device for each group of trunks in each of said positions, a group of switching devices common to said operators' devices, groups of trunk selecting switches, and means responsive to the actuation of any one of said operators' devices to select an idle switching device, to select a trunk selecting switch in a particular group and to select an idle trunk in said group.

9. In a telephone exchange system, incoming lines, a plurality of groups of trunks, an operator's position, one operator's device for each group of trunks in said position, a group of switching devices, means responsive to the

actuation of any one of said operators' devices for selecting an idle one of said switching devices and to cause said switching device to select a particular group of trunks and an idle trunk in said group, a visual signal to indicate the trunk selected, and means to connect an incoming line to said indicated trunk.

10. In a telephone exchange system, incoming lines, a plurality of groups of trunks, an operator's position, one operator's device for each group of trunks in said position, a group of switching devices, means responsive to the actuation of any one of said operators' devices for selecting an idle one of said switching devices and to cause said switching device to select a particular group of trunks and an idle trunk in said group, and means for having connected at the same time a plurality of lines to a plurality of trunks of the same group selected responsive to successive actuations of the same operator's device.

In witness whereof, we hereunto subscribe our names this 19th day of October A. D., 1926.

WILLIAM T. HAINES.  
ROBERT W. HARPER.